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University of Pennsylvania Radiocarbon Dates I

Elizabeth K. Ralph

University Museum and *Department of Physics, University of Pennsylvania, Philadelphia*

CONSTRUCTION of a carbon-14 dating laboratory at the University of Pennsylvania was started in October 1951 (*1*). The equipment is essentially the same as that developed by Anderson, Arnold, and Libby (*2*). Numerous sieges of contamination and other minor difficulties have delayed the completion of the first series of results until this time.

Initial and subsequent control measurements have been made with "dead" anthracite and modern wood samples. With the exception of periods of contamination, the anthracite samples have shown no net counts greater than two σ different from the background rates which have varied between 4.0 and 7.0 counts/min. The modern wood determinations were lower than expected (*3*). Therefore, archeological samples of known age were measured as shown in Fig. 1. The line through these points is drawn with the C^{14} half-life slope [5568 ± 30 yr (*4*)]. Eight determinations of 10- to 50-yr old modern wood from New Jersey and Pennsylvania have given an average value of 6.42 ± 0.04 counts/min; two runs of young poplar from Afghanistan, 6.37 ± 0.12 counts/min. The graph of known-age samples indicates that the basis for the time scale should be higher. Since the unknown samples are comparable in physical and chemical characteristics to those of known age rather than to modern wood, it was decided to base the age calculations on the figure obtained from the archeological measurements. (This corresponds to the assumption of a value of 6.70 ± 0.10 counts/min for modern wood). When more data are available from this and other laboratories, it is hoped that this discrepancy will be clarified.

The error listed with each age includes the standard error σ and the ± 0.10 uncertainty for the time scale. Counting times have been limited to 48 hr. The prefix "P-" is used to designate the sample numbers for this laboratory. The letters *a*, *b*, or *c* following a number represent the 2nd, 3rd, or 4th portion of a particular sample. A separate counting run has been made on each portion.

The caves that have been dated were excavated by Carleton S. Coon. Belt Cave was first excavated in 1949 (*5*). Samples of charred bone then taken were dated by Libby (*6*). In 1951 Belt Cave was excavated further, and work at Hotu Cave was begun. The samples dated in this laboratory consisted of charcoal collected from many levels in both caves. In the few cases where these dates correspond with levels dated by Libby, it must be remembered that his samples were charred bone, collected in 1949, whereas the ones in the present list were charcoal, obtained in 1951.

Belt (*Ghar-i-kamarband*) and Hotu are two neighboring caves eroded out of Jurassic limestone by wave action during some early high-water period of the Caspian Sea. They are situated in the face of a limestone crop just south of the railroad and motor roads on the southern Caspian shore of Iran, 4½ mi west of Behshahr and an equal distance south of the present shoreline, at about latitude 36°20′ N, longitude 53°35′ E, just east of the modern village of Turujan. The unexcavated floor of Belt Cave lay 15.42 m above the 1951 Caspian shoreline; that of Hotu, 18.37 m. The rock-bottom of Belt, which was reached by excavation, lies 9.7 m above this line, and the lowest point reached in excavating Hotu was 6.0 m above this line.

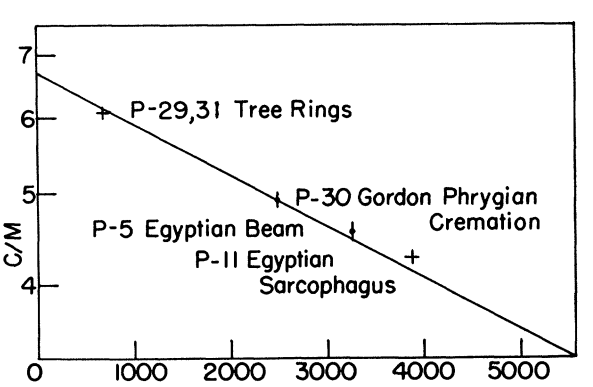

Fig. 1. Counting rates for samples of known age.

No.	Sample	Age (yr)
I.	*Belt Cave*	
P-19 P-19a P-19b	Strip C′, 95 to 105 cm, Software Neolithic. This level contains Neolithic artifacts, including a soft, burnished pottery and indirect evidences of agriculture and animal husbandry. The principal animals are sheep and goat.	7015 ± 405 7395 ± 495 7430 ± 460 Average, 7280 ± 260
P-26 P-26a	Strip C′, 150 to 160 cm, bottom of Preceramic Neolithic. This level contains indirect evidence of agriculture and bones of sheep and goat.	7680 ± 470 7905 ± 475 Average, 7790 ± 330
P-24 P-24a	Strip C′, 175 to 190 cm, Gazelle Mesolithic. Below a soil change, this level contains a fauna dominated by *Gazella subgutterosa* with a distinctive Mesolithic industry. The level corresponds to Libby's sample No. 574, dated 8545 ± 500 yr (*7*).	8785 ± 575 8360 ± 510 Average, 8570 ± 380
P-27	Strip C′, 200 to 230 cm, yellow soil. A lens of coarse, apparently windborne loess separating the cultural levels above and below it and containing few artifacts.	12,275 ± 825
P-20 P-20b	Strip C′, 230 to 250 cm, Seal Mesolithic. A flint workship with implements similar to Solecki's Shanidar B-1 in northern Iraq. The fauna is dominated by a small species of seal (*Phoca* sp.) and includes a large breed of domestic (?) dog (*Canis familiaris*). The level corresponds to Arnold and Libby's samples No. 492 and 547, a mixture of which dated 8004 ± 900 yr (*4*).	11,400 ± 800 11,550 ± 750 Average, 11,480 ± 550
II.	*Hotu Cave*	
P-18	Upper black soil (subsurface). Excavated from trench C at the sealed mouth of the cave, this sample represents the most recent occupation, in post-Achaemenian and pre-Islamic times.	Trench C, 1220 ± 230
P-43	190 to 200 cm, level 10, Iron Age. Also post-Achaemenian and pre-Islamic, this level contains unstudied late Iron Age pottery and the bones of sheep, goat, ox, pig, and red deer (*Cervus elaphus*).	Trench A, 2200 ± 280
P-44	200 to 240 cm, Iron Age. The dates for samples P-44, P-14 and 14a, P-32 and 32a, P-15a, P-17 and 17a, P-41, P-33 and 33a, and P-52, obtained from samples lying between two major soil changes and internally consistent, cover the archeological horizon between extreme dates of 750 and 1230 B.C.	Trench B, 2970 ± 270
P-14	310 to 320 cm, level 19, early Iron Age.	Trench A, 2880 ± 340
P-14a	310 to 320 cm, level 19, early Iron Age.	Trench A, 2485 ± 235 Average, 2685 ± 210
P-32	380 to 400 cm, level 25, early Iron Age.	Trench A, 2500 ± 260
P-32a	380 to 400 cm, level 25, early Iron Age.	Trench A, 2890 ± 310 Average, 2695 ± 200
P-15a	400 to 415 cm, level 26, early Iron Age.	Trench A, 2775 ± 315
P-17	415 to 430 cm, level 27, early Iron Age.	Trench A, 2975 ± 345
P-17a	415 to 430 cm, level 27, early Iron Age.	Trench A, 2650 ± 340 Average, 2810 ± 290
P-41	400 + cm, early Iron Age.	Trench B, 2890 ± 370
P-33	440 to 460 cm, level 29, early Iron Age.	Trench A, 3270 ± 390
P-33a	440 to 460 cm, level 29, early Iron Age.	Trench A, 2630 ± 260 Average, 2950 ± 230
P-52	500 to 520 cm, level 33. This sample was taken from a level with a large rock fall and contained some painted pottery.	Trench A, 2860 ± 380
P-45	Sample P-45, 535 + cm, painted pottery. Sample P-34, 520 to 590 cm, levels 34–38, painted pottery. These samples came from a horizon containing painted pottery, polished blackware, and burnished software.	Trench B, 6515 ± 425
P-34		Trench A, 4830 ± 480
P-35	Sample P-35, 590–660 cm, levels 39–41, software. Sample P-36, 580 + cm, software. These samples came from a Neolithic horizon containing software similar to that of Belt Cave (sample P-19) and containing bones of ox and pig as well as of sheep and goat. (The dates of samples P-52, P-34, and P-35, at variance with corresponding levels in trench B, have been checked for laboratory contamination. It is possible that these levels absorbed younger organic solutions that washed down from	Trench A, 4730 ± 320
P-36		Trench B, 6385 ± 425

No.	Sample	Age (yr)
	accumulations of bat dung above them. Trench A was in the back of the cave, behind trench B, where water collected).	
P-37 P-12 P-38 P-39	The remaining samples are from trench D of Hotu Cave, which underlies trenches A and B, below a marked soil change and an abrupt change of surface level. The C^{14} record gives a minimum of 910 and a maximum of 2610 yr for this time gap. Whereas the soils of trenches A and B are cultural deposits, those of trench D are geologic. The soil in trench D contains angular limestone rubble, which is rare or lacking above. The flints found in Gravels I to III, including those associated with sample P-37 (Gravel II), are extremely crude. The fauna consists largely of sheep, ox, and red deer. Whether or not the questionable and unproved site contamination of the levels above might also have extended into the underlying soils of trench D is unknown.	
P-37	765 cm, Gravel II (A-49), sub-Neolithic.	Trench D, 8070 ± 500
P-12	950 cm, Gravel IV, hearth under skeletons No. 2 and 3 (vole eaters). This sample consists of charcoal taken from the hearth under and associated with Hotu skeletons No. 2 and 3.	Trench D, 9190 ± 590
P-38	1015 cm, Black under Red I (vole eaters). The next hearth down in the red gravels, and nearly identical in time with P-12, makes these two levels a chronological unit. Culturally the vole eaters are represented by only 19 implements—too few for certain identification. The fauna, except for a few possible intrusions at the top, consists entirely of vermin and small birds, notably the mole-vole (*Ellobius* sp.), and thrush (*Turdus turdus*). Although they are roughly contemporaneous with the gazelle hunters of Belt Cave (sample P-24, 24a), these vermin-collectors cannot, on the basis of present evidence, be considered to have been the same people.	Trench D, 9220 ± 570
P-39	1115 cm, Black under Red II (seal hunters?). A hearth lower down in the red soil complex, apparently contemporaneous with the Seal Mesolithic of Belt Cave (sample P-20, 20b). Its industry, a blade culture, is also inconclusive, but could have resembled that of the Seal Mesolithic of Belt. These men hunted both seal and gazelle. In an even lower level for which we have no charcoal was found one bone of a giant wild ox (*Bos primigenius*).	Trench D, $11{,}860 \pm 840$

References and Notes

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Existence of Periods in the Stock Market

Fred B. Daniels

Red Bank, New Jersey

THE existence of periods in economic time series still seems to be a subject of controversy. A recently published book (*1*) claims that periods of 3½, 9, 18, and 54 yr (as well as a few others) can be demonstrated in certain economic series and suggests various physical phenomena, including sunspots, as underlying causes. On the other hand, E. B. Wilson (*2*) has found that neither the periodogram technique nor the autocorrelation function gave any evidence of periodicity in the *Ayres Index of American Business Activity*. Wilson's negative results are not surprising, however, considering the nature of the Ayres index; it is a composite of a number of individual series, and the con-