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A BIBLIOGRAPHY OF REPLICATIVE EXPERIMENTS IN ARCHAEOLOGY

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AND

LITHIC TECHNOLOGY: AN INTRODUCTORY BIBLIOGRAPHY

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I. A BIBLIOGRAPHY OF REPLICATIVE EXPERIMENTS IN ARCHAEOLOGY

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This bibliography is based on one published earlier by the first two authors and differs from it to some degree because we have deleted some references and added a number of new ones. Mr. Hester has been invited to share authorship because he has contributed to the library research and organizing of the references. Experiments in stone flaking do not appear in this bibliography since they are listed in the separate bibliography on lithic technology assembled by Mr. Hester and published in the present volume.

Archaeology, which is primarily a method for the study of the ways in which prehistoric peoples lived, has available as primary facts the material vestiges of human action in the form of artifacts, graves, and residues of economic and industrial activities. The purposes which tools, structures, and other monuments served -- i.e. their actual identification - - is one of the first questions the archaeologist tries to answer about the remains he studies in the field or the specimens which he recovers. It is not, however, that he is interested as such in the identification of a pointed bone tool as a device which is an awl, but rather in what inferences can be derived from that identification. Thus, if the bone awl was used in making basketry, a number of inferences about human activity flow from this observation. But even an apparently simple and readily recognizable bone awl may not have served as an aid in the manufacture of basketry. Thus, A. L. Kroeber (1909, Putnam Anniv. Vol.:11-12) wrote of this tool in California:

> "Through all of California, bone awls were used by the Indians. In most parts they have been found among prehistoric remains and we have every reason to believe that exploration will discover them where they have not yet been reported. The recent Indians used them but sparingly for sewing, as they had but little to sew. Through the greater part of the state, or wherever coiled basketry was made, an awl was, however, the indispensable means for the manufacture of this.....In northwestern California, however, coiled basketry is unknown, nor is there even a shadow of any evidence that it was ever made. All basketry is in twined weaves which do not require an awl for their manufacture. The Indians of north-

> western California, however, use a pointed bone implement, which, though its characteristic shape frequently varies somewhat from that of the awls of the remainder of California, is on its face and essentially an awl. Its principal function, however, is the piercing, slitting and preparing of lamprey eels....If the Indians of northwestern California, instead of preparing their eels and twining their baskets even today, had become extinct or completely civilized several generations ago, the natural assumption of the archaeologist exploring their village sites would have been that their bone awls served the purpose of making the coiled basketry which is found nearly everywhere else in the state, but which they do not make."

Most identifications of prehistoric artifacts are made by the process of ethnographic analogy, whose application goes back to the very beginning of scientific archaeology. This procedure has been described by R. Ascher (SW Jour. Anthropol. 17:317-325). Early in the eighteenth century Mercatus, Dugdale, Wurm, Sibbald, and Plot identified chipped and polished stone objects of Paleolithic and Neolithic age found in Europe as stone tools made by man because they were similar to those then being made and used by American Indians (for details see Heizer, 1969, Man's Discovery of his Past: Chap. 2; Laming-Emperaire, 1964, Origines de l'archéologie préhistorique en France; and, Lynch and Lynch, SW Jour. Anthropol. 24:46-49). And in the early part of the second half of the nineteenth century, when the first books on prehistory were being written, frequent reference to the tools of modern primitives was made for identification of the function of prehistoric ones. Thus Sir John Lubbock wrote in 1870 in the preface to his The Origin of Civilization and the Primitive Condition of Man:

> "In my work on 'Prehistoric Times' [first published 1865, and where the terms Paleolithic and Neolithic were introduced] I have devoted several chapters to the description of modern savages, because the weapons and implements now used by the lower races of men throw much light on the signification and use of those discovered in ancient tumuli, or in the drift gravels; and because a knowledge of modern savages and their modes of life enables us more accurately to picture, and more vividly to conceive, the manners and customs of our ancestors in bygone ages."

Useful identifications of the function of artifacts by recourse to analogy to items made and used by living aboriginal communities continue to be made to the present day in many regions of the world (Anderson, 1969, Science 163: 133-138; Chang, 1967, Current Anthropol. 8:227-243), although clearly such interpretative methods are rapidly becoming less and less possible with the accelerated disappearance of pre-industrial patterns of life. Eventually, such identifications through analogy will be dependent almost entirely upon the published ethnographies and museum collections of extinct cultures, and one can only be fearful that much of the data significant to future archaeologists will not have been recorded (cf. White and Peterson, 1969, SW Jour. Anthropol. 25:45-67; Gould, 1968, SW Jour. Anthropol. 24:101-122).

There remain, however, a great many prehistoric artifacts whose purpose and manner of use are either unknown or disputed. Let us take one example. The bâton de commandement, a perforated antler shaft, was first assumed to be a rod of authority, but the following functions have also been suggested for this object: sling handles, tent pegs, dress fasteners, cheek pieces of horse bits, skin dressing tools, magic staves, shaft straighteners, thong stroppers, drumsticks, and twitches to hold an animal's lip (Hole and Heizer, 1965, An Intro. to Prehistoric Archaeology:214; Clay, 1929, Antiquity 3:344-345). We do not, in fact, know what the bâton was used for by Upper Paleolithic peoples.

Another avenue leading to extracting information from artifacts and other archaeological remains is replicative experimentation. Most often this has taken the form of an attempt to discover the technological processes employed in the manufacture of artifacts (Ascher, 1961, Amer. Anthropol. 63: 793-816; Proudfoot, 1965, Advancement of Sci., July:125-133). The most direct and obvious way to accomplish this is to recreate the original processes by making a duplicate -- i.e. conducting a replicative experiment. A good deal of effort has been devoted to this end, and the following bibliography cites a number of such attempts. The faking of prehistoric objects, now a very large business indeed, can be looked upon in one sense as the replication of specimens, but in these matters the experimenters do not publish accounts of their procedures. Identification of fakes, however, often involves the reconstruction of technology (ancient, modern, or both), and such discussions are clearly relevant to our topic here.

At times prehistoric people have left a sufficient amount of manufacturing debris at their working spot to enable the archaeologist to discover the steps which were anciently gone through in producing a certain form. Archaeological specimens which were broken during manufacture or were abandoned before they were completely finished can also provide useful information on manufacturing methods. For examples see Saville (onyx jars; 1900, Bull. Amer. Mus. Nat. Hist. 13:105-107), Holmes (flint bifaces; 1919, Bur. Amer. Ethnol., Bull. 60), Cadzow (bone combs; Penn. Archaeol. 3:10-11), and Schumacher (C-shaped shell fishhooks; 1875, Archiv für Ethnogr. 8:223-224).

Also closely related in method to replicative experiments in technology are activities involving repair and reconstruction of aboriginal architectural features such as, for example, Neil Judd's restoration of Betatakin (Judd, 1930, Proc. U.S. Nat. Mus 77:1-77) or the reconstruction of the Highland Maya ruin of Zaculeu (Woodbury and Trik, 1953, Ruins of Zaculeu, Guatemala). Reconstructions may also be made in the form of models such as those of pole-framed, mat-walled, open-roofed enclosures based on ceramic miniatures or engraved representations on pottery or stone (Delougaz, 1960, Iraq 22:90-95), of in the form of architectural drawings, Proskouriakoff's Album of Maya Architecture (1946, Carnegie Inst. of Washington) presenting one outstanding

example of the latter. Similarly related to replication is the procedure followed by a textile analyst who makes a copy, using string and pins, of a piece of finger-or loom-woven textile; as examples we cite a sling-pocket made of cordage analyzed by O'Neale (1947, Amer. Antiquity 13:179-180) and the same author's analyses of Nazca textiles (Ibid., 1937, Field Mus. Nat. Hist., Anthropol. Mem. 2, No. 3). Although these aspects of replication are of great interest and importance, we have not undertaken to include the very numerous references in the present bibliography.

Supplementing interpretation of function through ethnographic analogy, a quite considerable effort has also been made to identify the purposes of artifacts and other remains through replicative use. These experiments usually take the form of demonstrating the efficiency and appropriateness of some artifact in performing a particular task, an early example of which was that of Pitt-Rivers (1876, Journal Royal Anthro. Inst. 5:357-390) in showing the practicality of animal scapulae used as shovels, and antler picks for chalk or flint digging. Related studies in the effectiveness and performance of artifacts include the experiments of Pope (1923, Univ. Calif. Publ. Amer. Arch. Ethnol., 13, No. 9) in determining the pull of aboriginal bows and the flight distance and penetrating qualities of arrows, or of Coles' (1963, Proc. Prehist. Soc. 29:326-356) analysis of the musical range of Bronze Age trumpets.

Although closely related, at times being only a logical extension of either or both of the preceding categories of experimentation, it might be useful to distinguish replicative experiments in the realm of non-material culture. Here we have in mind efforts to learn how certain technical data were obtained or how certain abstract concepts came to be formulated. Thus, various methods have been devised by modern scholars by which the ancient Maya could have efficiently handled the enormous units of time involved in their calendrical and astrological calculations. Hawkins' (1965a, Stonehenge Decoded; 1965b, Amer. Scientist 53:391-408) experiments seeking to elucidate the eclipse-predicting nature of Stonehenge and Hatch's (1971, Contrib. U.C. Arch. Res. Fac. No. 13: 1-64) analysis of the significance of the centerline of the La Venta site are logically only attempts to identify the function of a "complex artifact". The innumerable attempts to discover the mysteries of the Egyptian pyramids at Giza are similar in aim. For a list of references which go back to the early seventeenth century on the pyramids see C. F. Ph. Van der Vecht, 1941, De Steenen Spreken (pp. 464-467).

Replication may have been more common in prehistoric times than archaeologists are generally aware of. Menzel (1956, 5th Internat. Cong. Anthropol. & Ethnol. Sci.:596-600) defines archaism as the "deliberate attempt by a later people to imitate or revive features of culture of an earlier period," and gives some Peruvian examples. In the Late Period (seventh century B.C.) in Egypt there was considerable imitation of much earlier and greatly admired Old and Middle Kingdom relief carving and literature (Smith, 1958, Art & Architecture of Ancient Egypt: 240-241; Aldred, 1961, The Egyptians: 155). Ford (1959, Amer. Mus. Nat.

Hist. Anthrop. Papers 47, Pt 1: 220) records that the Point Barrow Eskimo copied a prehistoric boot pattern shown them by an archaeologist. There have been a number of revivals by Pueblo potters of ancient wares, the instance of Maria (Marriott, 1963, Maria, The Potter of San Ildefonso) being perhaps the best known. In all of these cases replication through experiment must have been involved, though for different ends than the archaeologist usually carries out such work.

Finally, we can recognize a category of replicative experiment which is rather apart from the preceding groups which are all concerned with the more or less direct reconstruction of ancient culture. Here we have in mind those experimental projects which attempt to reproduce archaeological conditions or processes. These are experiments aimed at determining how archaeological situations develop and are thus indirectly, although ultimately to be sure, concerned with the reconstruction of culture. We have examples such as the reconstruction of Neolithic wattle-and-daub houses with a time-study of their weather-induced decay and their remaining features after incineration (Hansen, 1961, Kuml:128-145). Such experiments involving the long-term observation of the process and rate of transformation of features through time into archaeological situations hold enormous potential for improved archaeological field interpretation and cultural reconstruction.

In the bibliography which follows many of the citations which we list refer to true experiments where an actual "laboratory" effort has been made to go through the steps involved in replication. Other citations, however, deal with more conjectural or hypothetical replication in that, while the various steps and processes involved are reconstructed and described, no actual attempt at replication in fact was carried out. In these cases actual replication may have seemed unnecessary, or impractical, or some other reasons may have prevented actual duplication. Many such cases are thus perhaps not entirely bona fide examples of experimental replication, but nevertheless, we have thought it useful to list some of them.

I. REPLICATIVE TECHNOLOGICAL EXPERIMENTS.

1. Stone statue sculpture by hammer-dressing (Heyerdahl 1959; Heyerdahl and Ferdon 1961).

2. Using quartzite hammerstone to dress the surface of a sarsen stone at Stonehenge. "On comparing it with the blocks tooled by the builders of Stonehenge, they were seen to be almost perfectly identical." (Gowland 1902:79).

3. Using metal and stone tools to reproduce the pocked surface-dressing of megaliths (Powell and Daniel 1956:28).

4. Manufacture by pecking and abrasion of small stone objects (Treganza and Valdivia 1955; McGuire 1891).

5. Drilling of stone (McGuire 1892, 1896; Rau 1869, 1881; Evans 1872: 43, 45, 143; Joly 1894:215-216).

6. Stone bead drilling (Haury 1931).

7. Straightening of arrowshafts (Cosner 1951).

8. Quarrying granite with plugs and heavy wedges (Clarke and Engelbach 1930; Lucas 1962:499).

9. Sawing with string and sand abrasive and with a thin-edged flint flake (Evans 1872:40).

10. Pottery-making, decoration, and firing (Griffin and Angell 1935; Denninger and Ebinger 1953; Bimson 1956; MacIver 1921; Noble 1960; Thorneycroft 1933; Hodges 1962; Cornwall and Hodges 1964; Mayes et al 1961, 1962; Hansen 1964:115; Lucas 1962:379; Childe 1937; Williams 1968:320; Yamanouchi, Kono and Ezaka 1964:218-220; Braunholz 1934; Liddell 1929; Matson 1955; Quimby 1949.)

11. How Olmec Style I clay figurines were constructed as shown by six steps of production using plasticine models (Drucker 1952:Pl. 24).

12. Reproducing Egyptian pottery glazes (Lucas 1962:169-178; Binns 1932).

13. Trephining human skulls (Munro 1897:220).

14. Trephining dog skulls with prehistoric flint tools. Philip Mills Jones, M.D. between October 22, 1899 and June 12, 1900 carried out four trephinings using prehistoric stone tools sent to him by

W J McGee of the Bureau of American Ethnology. All were successful. At McGee's request Jones wrote an account of his experiments for publication which he sent to McGee. Apparently because the latter was away from Washington when the manuscript arrived it was mislaid and never published. Jones gave an illustrated lecture on the experiment on April 1, 1900 to the Medical Society of California, and says this is recorded in the Transactions of the Society for 1900 (Jones 1900:6-8).

15. Building a Stone Age type house in Denmark (Hansen 1962; for another similar example, see Johnstone 1957:55-56).

16. Building a Danish Neolithic wattle-and-daub walled, turf-roofed house based upon archaeological data. Involved was splitting logs with wooden wedges, experimental burning of the house and manufacture of wooden utensils of Neolithic type (Hansen 1964).

17. Reconstruction of Middle Mississippian pole-framed, wattle-and-daub walled dwelling (Nash 1968: Pls. 2A-3).

18. Reproduction of a Neolithic bow from England (Clark 1962, 1963).

19. Making replicas of Turkish composite bow, English longbow of sixteenth century type, King Philip's bow from New England ca. 1660 A.D. (Pope 1923:350-353).

20. Smelting copper ore (Coghlan 1940).

21. Smelting iron ore (Wynne and Tylecote 1958).

22. Hardening copper by hammering (Lucas 1962:213).

23. Bronze casting in ancient molds (Voce 1951).

24. Replicating prehistoric Mexican cire perdue metal castings (Long 1964).

25. Methods used in Egyptian mummification using natron (Lucas 1962:288-294).

26. Making papyrus paper (Lucas 1962:138-139).

27. Building an ocean-going balsa sailing raft (Heyerdahl 1950).

28. Sailing a copy of a Viking ship across the Atlantic (Thorvildsen 1967).

29. Paddling experiments in Hawaii using recently made Polynesian canoe built according to ancient type to estimate probability of success in open ocean exploration (Horvath and Finney 1969).

30. Fitting oars to a naval cutter to replicate oars as shown on the ship Odysseus depicted in the 5th century Siren Vase (Tilley 1971).

31. Frection of Egyptian obelisks; monoliths of Avebury; Stonehenge sarsens and lintels (Daniel 1962:21; Engelbach 1923; Stone 1924; Daumas 1962:162; Thomsen 1954).

32. Experiments by LeBas in the cutting and polishing of Egyptian granite (Barber 1900:74, 79; see also Kennedy 1821).

33. Raising a fallen Easter Island monument with levers (Mulloy 1961).

34. Carving Easter Island statues (Skjolsvold 1961).

35. Replicating "Hebrew" script on a stone, to illustrate how easily such stones (of reputed antiquity in the United States) could be forged (Whittlesey 1881).

36. Building an Egyptian pyramid (Dunham 1956; Petrie 1930).

37. Time and labor required to build earth or rubble mounds, to dig ditches or build defense works (Ashbee and Cornwall 1961; Jewell 1963; Erasmus 1965; U.N. Economic Commission 1961; Wheeler 1953, 1954).

38. Transport of multi-ton stones without the use of the wheel (Heizer 1966; Atkinson 1956:99-110; Heyerdahl 1959:132-134; Heyerdahl and Ferdon 1961:365-372, 511-512; Heyerdahl 1952:366-371; Grant 1966: 131, 180; Drucker, Heizer and Squier 1959:126; Lehman 1957; Roder 1944-49; Routledge 1919:257; Kida 1912; Johnstone 1957:69-71).

39. Experimental research with ancient mortars and building materials (Znaczko-Jaworski 1958).

40. Reproducing lines and colors of prehistoric cave paintings (Johnson 1957).

41. Experiments in reproducing Egyptian oleo-resin wood varnishes (Lucas 1962:360-361).

42. Acid etching of marine shells (Haury 1937:150-151; Haury and Teiwes 1967:680-681).

43. Reproducing Scottish "vitrified forts" (Childe and Thorneycroft 1938; Jewell 1963:16-17).

44. Experimental making and burning of cane torches of prehistoric type found in Salts Cave, Kentucky (Watson 1969:33-36).

45. Extracting live Strombus gigas animal from its shell (deBooy 1915:79-80.

46. How Maya jade earplug flares were made (Smith and Kidder 1951:39; Kidder, Jennings and Shook 1946:124).

47. How precolumbian obsidian earspools were made (Thomsen and Thomsen 1970).

48. Prehistoric methods of working jade (Kidder, Jennings and Shook 1946:118-123; Barrow 1962; Hansford 1949).

49. Testing whether bevel edged projectile points rotate in flight (Wilson 1898).

50. Experimental breaking of fresh sheep femora to show that spirally - fractured antelope bones from Makapangsgat Cave were intentionally and not accidentally produced (Dart 1960; Dart and Kitching 1958).

51. Breaking animal bones with stones to show that archaeological specimens from Sarawak can be duplicated by this means (Harrisson and Medway 1962:336, Pl. I).

52. Whittling a fossil bone with steel knife to produce an identical specimen to the "bone implement" from the Piltdown locality (Weiner 1955: Pl. 6).

53. Experiments in the butchering of bison (Frison 1970).

54. Constructing a Maya chultun (Puleston 1971).

55. Replication of the Piltdown mandible and canine tooth using a modern orang-utan mandible and canine (Weiner 1955: Pls. 4-5).

56. Reproduction of a Hopewell copper earspool (Willoughby 1903).

57. Laboratory experiment to determine hydration rate of obsidian at 100°C and 1 atm. H_2O pressure. Results then applied to archaeological examples to determine their age by amount of hydration (Friedman, Smith and Long 1966:323).

58. Time-labor experiment using rough limestone choppers for cutting trees and brush to clear fields for maize agriculture (Hester 1953).

II. EXPERIMENTS TO DETERMINE HOW ARTIFACTS WERE USED.

59. Stone axes used to cut trees (Evans 1897:162; Iversen 1956; Jorgensen 1953; Leechman 1950; Morris 1939:137; Nietsch 1939:70; Aberg and Bowen 1960:146; Klindt-Jensen 1957:38; Smith 1893).

60. Forest clearance with stone axes and planting of grain in Denmark (Iverson 1956; Proudfoot 1965:131).

61. Woodcarving with aboriginal tools (McEwen 1946).

62. Stone tool blades used as digging implements (Sonnenfeld 1962).

63. Efficiency of an animal scapula as a shovel (Curwen and Curwen 1926; Jewell 1963:52; Pitt Rivers 1876).

64. Efficiency of antler picks used in chalk or flint digging (Pitt Rivers 1876; Jewell 1963:51-52).

65. Method of hafting and use of ard (Aberg and Bowen 1960:144-147; Steensberg 1964; Hansen 1964:118-121; Hansen 1969:69-92).

66. Chopping down a fir tree with a hafted Neolithic axe (Semenov 1964:128)

67. Quantitative comparison of the efficiency of stone vs. steel axes (Saraydar and Shimada 1971).

68. Felling a tree by fire (Shaw 1969).

69. Use of a stone-bladed hoe in tillage (Sonnenfeld 1962).

70. Determining pull of aboriginal bows, flight distance and penetrating abilities of arrows (Pope 1923).

71. Experiments on the use of atlatls, the casting distance of atlatl darts, and the function of atlatl weights (Browne 1940; Davenport 1943; Hill 1948; Kellar 1955; Peets 1960; Hobbs 1963).

72. Experiments on different weights of projectile points (Evans 1957).

73. Cooking in earth ovens (Layard 1922; O'Kelly 1954).

74. Using stone tools to excavate a Maya chultun (Puleston 1971).

75. Stone-boiling of meat (O'Kelly 1954).

76. Use of ancient harvesting implements (Steensberg 1943; Curwen 1930b; 1935; Braidwood 1967:110).

77. Catching ocean fish with C-shaped shell fishhooks (Robinson 1942).

78. Navigating a balsa sailing raft from South America to Polynesia (Heyerdahl 1950). (cf No. 27 supra)

79. Using notched animal ribs or scapulae for fiber extraction (Morris and Burgh 1954:61-62, 100; Osborne 1965).

80. Efficiency of Bronze Age leather or metal-faced shields (Coles 1962:184-185).

81. Cooking in animal skins (Ryder 1966; cf. Black 1969; Ryder 1969).

III. EXPERIMENTS IN NON-MATERIAL ASPECTS OF CULTURE.

82. Methods used in Egypt for determining true north (Edwards 1961: 255-261).

83. Astronomical knowledge and eclipse prediction practices of the builders of Stonehenge (Hawkins 1965a, 1965b).

84. Analysis of the musical range of Bronze Age trumpets (Coles 1963).

85. How Maya dates and numbers might have been calculated (Folley 1935; Lizardi Ramos 1964; Long 1948; Sanchez 1961; Satterthwaite 1947; Thompson 1941).

86. Chewing bulrush (Scirpus americanus) stalks in effort to determine whether fibrous quids of this plant found archaeologically had dietary, stimulant, narcotic or thirst-quenching properties (Jennings 1957:226).

87. Eating mirabilite (Na_2SO_4 10 H_2O), a mineral secured in prehistoric times in Salt Cave, Kentucky. Four tablespoons eaten "are sufficient to produce a definite laxative effect on the human system". (Watson and Yarnell 1966:846).

88. Replicating and eating the last meal of Tollund Man (Johnstone 1957:101; Glob 1971:13).

IV. EXPERIMENTS TO ILLUSTRATE ARCHAEOLOGICAL SITUATIONS OR PROCESSES.

89. Cutting animal bones to determine evidence in Pleistocene bones of human tool use (Lartet 1860).

90. Natural production of bone objects sometimes interpreted as artifacts (Nelson 1928; Pei 1938; Miller 1969).

91. Planned destruction of a mud hut village (Gordon 1953).

92. Destruction by fire of a scale model of a Plains earth lodge (Smith 1953).

93. Reconstruction of Neolithic wattle-and-daub houses; time-study of their weather-induced decay; accidental burning of a house and study of its features after incineration (Hansen 1961).

94. Controlled tropical milpa maize agriculture to determine yield and changes in soil fertility (Steggerda 1941; Cowgill 1961, 1962).

95. Experimental cornfield of Indian type in Arizona (Franke and Watson 1936).

96. Burying human hair in different soils to determine variable preservation (Brothwell and Spearman 1963:429-430).

97. Storage capabilities and effects on grain in basketry-lined beehive earth pits (Proudfoot 1965:132).

98. Rate of silting of ditches (Curwen 1930a; Pitt Rivers 1898; Pyddoke 1961; Wheeler 1954).

99. Experiments with fresh seeds of chili peppers soaked in trisodium phosphate to compare with use of seeds of the same plant found in prehistoric coprolites treated with the same chemical (Callen 1967: 262).

100. Establishing a "fertile zone" in the cenote of Chichen Itza "by throwing in logs shaped like human beings and having the weight of an average native...Regulating my (dredging and diving) operations by these calculations found them to correspond with gratifying accuracy". (Thompson 1932).

101. Experiments of grinding on a metate and crushing in a mortar seeds of Setaria to compare milled seeds with those found in prehistoric human coprolites. (Callen 1967:288).

102. Floating gourds (Lagenaria) for extended period in sea water to determine how long seeds will remain viable (Whitaker and Carter 1954).

103. Random scattering of cement casts of Acheulian handaxes and flakes in the bed of an ephemeral stream; bone refuse exposed in the open, and domestic animal bones exposed to the air under a protective screen and changes in position and condition noted at intervals (Isaac 1967).

104. Etching with dilute hydrochloric acid fresh cuts in Egyptian limestone sculptures to compare with original surface as a test of the specimen's antiquity (Stross 1960:21A-22A).

105. Building an archaeological site and observing the changes in the site's natural history through time (Ascher 1970:215-216).

106. Reconstructing and using a Roman catapult (Johnstone 1957:95-96).

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Abbreviations Used

AA American Anthropologist.

AAnt American Antiquity.

Antiq Antiquity.

M Man.

PPS Proceedings, Prehistoric Society (formerly PPS of East Anglia).

UC-CARF University of California, Contributions of the Archaeological Research Facility.

UC-ASR University of California, Archaeological Survey Reports.

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II. LITHIC TECHNOLOGY: AN INTRODUCTORY BIBLIOGRAPHY

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There has been over recent years an increasing emphasis in prehistoric archaeology on the study of culture process. One aspect of this new emphasis has been an effort of some archaeologists to isolate and study various facets of prehistoric behavior. One manner by which prehistoric behavioral data can be obtained is through technological studies. Here we are concerned with lithic technology, and specifically the analysis of chipped stone artifacts and manufacturing debris. Such research can take many forms, including replicative experiments (as illustrated by the work of F. Bordes and D. Crabtree), the technological study of finished tools, examination of tools in various stages of production, and of the residues derived from the manufacturing process. Also important in lithic technological research are studies aimed at determining the function of prehistoric chipped stone implements, using a variety of techniques including microscopic wear pattern analysis and the measurement of tool edge angles.

Though a renewed importance has been placed on the study of lithic technology, much basic research was carried out in the late 19th century and during the early decades of the present century. The present bibliography represents an effort to compile the most useful references, old and new, relating to research on chipped stone materials. It is, of course, selective. Many archaeological reports make brief mention of lithic technology; to include all of these would have greatly lengthened the bibliography and as a result, these have not been cited. Unpublished manuscripts and papers presented at scientific meetings are also not cited here (excepted are papers either in press or submitted for publication).

To aid in the use of the 520 references listed in the following pages, I have grouped them under fifteen descriptive headings; the bibliographic listings follow.

I. FLINT WORKING TECHNIQUES: GENERAL SUMMARIES.

Bixby 1945; Bordes 1947, 1968, 1969, 1971; Bordaz 1968, 1970; Capitan 1917; Cole 1965; Crabtree and Gould 1970; Daumas 1962; Eames 1951; Ellis 1940; Evans 1872; Fowke 1895; Healy 1966; Hodges 1964, 1970; Holmes 1919; Honea 1965b; Humphreys 1952; Joly 1883; Knowles 1953; Kragh 1964; Lacaille 1954; Leakey 1950, 1960, 1965; Louis 1935; MacNeish et al. 1967; McGimsey 1963; Mewhinney 1957; Mitchell 1949; Moorehead 1910; Oakley 1964; Pfeiffer 1912; Pond 1930; Ross 1970; Sankalia 1964; Stevens 1870; Tripp 1964; Watson 1950; Witthoft 1967b.

II. DISTINGUISHING BETWEEN HUMAN AND NATURAL FLAKING.

a) General.
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b) Wear Pattern Studies of Chipped Stone Tools.
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Shafer and Hester 1971; Walcott 1965; Webb and others 1971; J. P. White 1968, 1969; Wilmsen 1968a, 1970; Witthoft 1955, 1969.

c) Use of Modern Chipped Stone Tools to Replicate Ancient Wear Patterns.
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d) Techniques for the Microscopic Analysis of Chipped Stone Tools.
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e) Silica Polish on Chipped Stone Tools
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IV. REPLICATION AND EXPERIMENTATION.

a) General.
Ascher 1961; Bixby 1945; Coutier 1929; Crabtree 1966, 1967a, 1967b, 1970; Crabtree and Gould 1970; Gorodzow 1914; Kragh 1952; Leakey 1950; Nero 1967; Sollberger 1968; Witthoft 1957, 1967b.

b) Replicating Prehistoric Flint Knapping Techniques.
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c) Use Position of Chipped Stone Tools.
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d) Replicating Prehistoric Blade Production.
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e) Using Chipped Stone Tools to Work Wood.
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f) Using a Chipped Stone Tool to Process Maguey and Yucca leaves.
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VI. TECHNOLOGICAL STUDIES OF CHIPPED STONE MATERIALS FROM ARCHAEOLOGICAL SITES.

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VIII. NATURAL ALTERATION OF CHIPPED STONE MATERIALS.

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b) Decomposition of Flint Through Natural Heat and Frost Fracture.
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c) Natural Striation/Scratching of Chipped Stone Artifacts.
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IX. MINES, QUARRIES AND WORKSHOPS.

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XII. SUGGESTED PROCEDURES FOR DESCRIBING CHIPPED STONE MATERIALS.

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XIII. PHOTOGRAPHING CHIPPED STONE ARTIFACTS.

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b) Photomicrography of Lithic Artifacts.
MacDonald and Sanger 1968; Mirambell 1964; Semenov 1964.

XIV. BEHAVIORAL ASPECTS OF USING STONE TOOLS.

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XV. PHYSICAL PROPERTIES OF MATERIALS FROM WHICH CHIPPED STONE TOOLS ARE MADE.

Goodman 1944.

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Abbreviations Used

AA	American Anthropologist.
AAnt	American Antiquity.
AN	American Naturalist.
Antiq	Antiquity.
Arctic Ant	Arctic Anthropology.
BSPF	Bulletin, Société Préhistorique Française.
BTAS	Bulletin, Texas Archeological Society.
JRAI	Journal, Royal Anthropological Institute.
M	Man.
NH	Natural History.
PA	Plains Anthropologist.
PPS	Proceedings, Prehistoric Society (formerly PPS of East Anglia).
SWM-M	Southwest Museum, Masterkey.
UC-CARF	University of California, Contributions of the Archaeological Research Facility.
UC-ASR	University of California, Archaeological Survey Reports.

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ADDENDUM

As this paper was going to press, several important papers concerned with lithic technology were published. These are: Coles, J. M. (1971), The Early Settlement of Scotland: Excavations at Morton Fife. PPS, Vol. 37, Pt. 2: 286-366 (flake analysis); Frison, G. C. (1971), The Buffalo Pound in Northwestern Plains Prehistory: Site 48 CA 302, Wyoming. AAnt, Vol. 36, No. 1: 77-91 (resharpening of stone tools); Mitchell, G. F. (1971), The Larnian Culture: A Minimal View. PPS, Vol. 37, Pt. 2:274-283 (replication of flaking techniques); Rosenfeld, A. (1971), The Examination of Use-Marks on Some Magdelanian End Scrapers. In: Prehistoric and Roman Studies (G. Sieveking, ed.): 176-182 (wear pattern analysis); Sieveking, G., et al. (1971), Characterization of Prehistoric Flint Mine Products. Nature, Vol. 228, No. 5628:251-254 (flint mines, Old World); Shafer, H. J. (1971), Investigations into South Plains Prehistory, West Central Texas, Papers Texas Archeol. Salv. Proj. No. 20 (flake analysis, resharpening of stone tools, fitting flakes to core, deer-skinning experiment); Speth, J. D. (1972), Mechanical Basis of Percussion Flaking. AAnt, Vol. 37, No. 1:34-60.

In addition to these recently published papers, I have learned of a series of experiments in lithic technology conducted at Virginia Commonwealth University (Richmond). These experiments were part of an archaeology course (Experimental Archeology 499-E) and have been published in newsletter form. This newsletter was edited by Errett Callahan (course instructor) and contains a series of short papers which record experiments carried out by him and his students. These include: flint-knapping research (Callahan), the use of choppers and handaxes to dig pits (D. Ruecroft), the use of choppers and handaxes to chop down trees, and a comparison of their relative efficiency (J. Mangan), the use of handaxes to dig in soil and to cut willow branches (J. Raskin), and experiment by Callahan in which he used Acheulean-style handaxes and cleavers to dig for roots and to cut wood (he makes observations on wear patterns resulting from these experiments), the experimental manufacture of wooden spears (with fire-hardened tips and with stone-pointed tips), the comparison of the accuracy of wooden and stone-tipped spears, and the experimental hafting of stone points on spears (J. Raskin and S. Richardson), and wear pattern studies of scrapers and denticulates used in various experiments (Callahan).