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Contents

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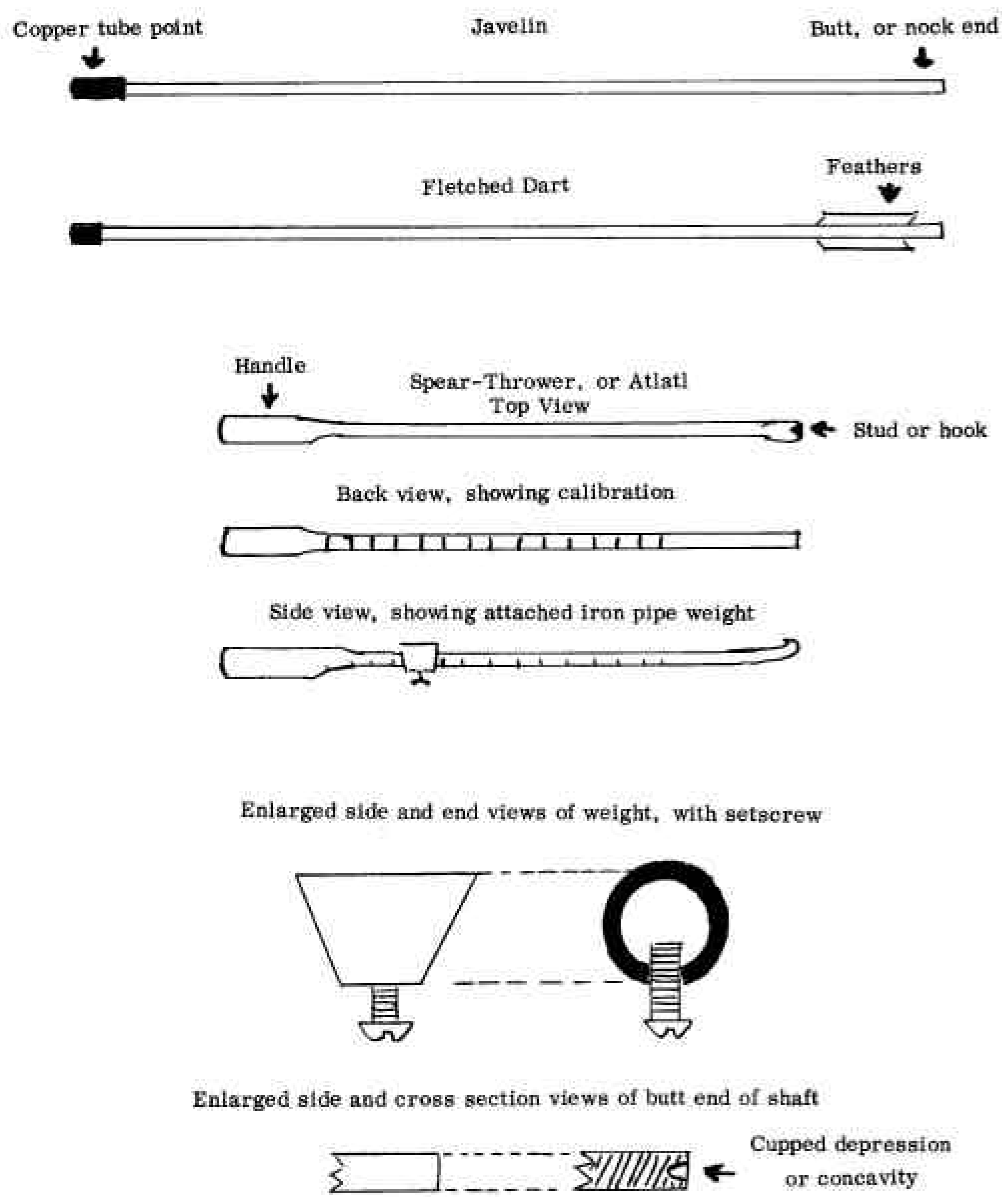
A WORKING ATLATL



EXPERIMENTS WITH THE SPEAR THROWER

Clayton Mau Morgan Chapter

It is quite generally assumed by archeologists that early man used a spear held in the hand and manipulated it as a thrusting weapon long before he invented the spear-thrower, or throwing stick, which, if one designates it by it's Mexican name, is also known as the atlatl. In operation, the spear-thrower served as an extension of the arm and so made it possible to cast missiles adapted to its use with added velocity and to a greater distance. This increased range of his destructive efforts gave the Amerind a greater advantage over the animals, birds, and fish, which furnished many of the necessities of his mode of life, and also made it possible for him more effectively to defend himself against predaceous animals and other enemies. Without doubt, among the innumerable innovations which over the millennia of human history have enabled Homo sapiens increasingly to dominate his environment, and so to raise his scale of living, the spear-thrower, probably man's first great invention, deserves to rank at, or at least near, the top.

The former use of the atlatl has left to the archeologist but little more than the lithic projectile points of the missiles cast by its aid, and the weights--one form of which is conventionally called a bannerstone--which were affixed to it to increase its efficiency. With few exceptions the shafts of spears, javelins, and darts, and the throwing sticks themselves, have disintegrated with passing time and are now but rarely to be found in their entirety.

Some leading archeologists believe the throwing stick was brought from Asia to this continent by the Paleo-Indians, that for thousands of years it served as the primary weapon of the Archaic period and thereafter was continued in use well into the Woodland centuries. That the spear-thrower was known to primitive peoples over most of the world is certain. On this subject Townsend (1959) says:

"Spearthrowers have been found in the prehistoric caves of France and Switzerland and persist to this date among the peoples of New Guinea, Australia, Palau, northeastern Asia, and among the Eskimos. In the Americas it does not seem unreasonable to suppose that they were once in general use throughout both continents--certainly the Indians of the Northwest Coast and Alaska and the Eskimos from Hudson Bay to Greenland used them. They have been found in Peru and along the Amazon and on much of the northwest portion of South America. On the basis of the earliest contacts with the New World, the literature indicates that the atlatl's greatest spread was in Central Mexico because the early Spanish explorers found them in use there, and, in fact, atlatls hurling cane darts were used by natives of Lake Patzcuaro to kill birds until about 1917.

"Probably the atlatl was an implement of very wide distribution over North America in ancient times until it was displaced throughout most of its range by a superior propulsion device, the bow. It persisted until very recently in certain local regions where

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the mode of living did not demand the improved instrument of death-dealing or where, by choice, the atlatl was retained for special reasons. Cave finds in southwestern Texas lend weight to the view that some peoples used atlatls along with the bow and arrow, and it is probable that the two were used contemporaneously in Mexico. Today the Eskimos retain their atlatls and use them in conjunction with their guns in the hunt for waterfowl and seals. Continued use of the atlatl as a symbolic or ceremonial device may have prevailed to a certain extent after the introduction of the bow and arrow.

"Indisputable proof has been found of the use of the atlatl in California, Oregon, Arizona, Texas, New Mexico, Utah, Colorado, Nevada, Arkansas, Florida, and Oklahoma, and it has been stated that "the bow came into use in the New World in relatively recent times, and that prior to its introduction, or its much less probable local invention, the spear-thrower enjoyed continent-wide distribution in both Americas.""

That early man made extensive use of the throwing stick over a long period of time in what is now New York State is evident from the provenience and large number of atlatl-related artifacts which have been recovered. Bannerstones, birdstones, boatstones, and other lithic objects which may have been used as throwing stick weights have been found throughout the area. Also, projectile points, which are quite evidently too small to serve on hand thrust spears but too large to use on arrows, and so may have been used on missiles cast by a throwing stick, are found in large numbers.

During the last two-and-a-half years, this writer has made a number of atlatls, javelins, and darts and has experimented with them intermittently and as the weather permitted, in the hope that this ancient weapon might be reconstructed in a form which embodied the basic scientific principles of its long outmoded prototype. The effect on the flight of the projectile of points of various weights, and of bannerstones of different sizes affixed to the thrower at all possible positions, were matters of primary interest.

Early in the experiment an examination was made of available literature on the subject which, unfortunately, proved to be decidedly meager in extent. Also, exhibits relating to the weapon were viewed and studied in various museums, among which were the American Museum of Natural History and the Museum of the American Indian, Heye Foundation, in New York City; the Smithsonian Institution in Washington, D.C.; and the Museum of Arts and Sciences in Rochester, New York.

As additional information was gained from these and other sources, and concurrently from continuing trial casting, new equipment was made embodying such changes and improvements as seemed desirable. Constructed in accord with this mode of procedure were about seventy-five javelins and darts, twenty-five atlatls, and five "bannerstones, " all of such various dimensions, weights, and other specifications as seemed necessary, or appropriate, to make possible a combination which would perform with satisfactory efficiency. The criterion of each combination was the length of flight of the missile. While this standard of comparison is to be admired for its simplicity, it is recognized that for both hunting and warfare maximum range, under some conditions, could be of far less importance than would accuracy, foot-pounds of energy of the blow struck, and perhaps other advantages, any or all of which might be realized with a weapon of shorter range.

Field testing embraced both unfeathered projectiles, which in this paper will be designated as javelins, and those which were feathered or fletched, which will be called darts. As the experiment progressed, it became evident that the former type, although far more difficult to make than the latter, as will be seen, was nevertheless capable of attaining a considerably greater range. It was with the unfletched missile--the javelin--therefore, that this writer was chiefly concerned, the assumption being that, if the more difficult projectile could be successfully reproduced, the construction of the simpler one would be comparatively easy.

At an early stage in the experiment it was found that the fashioning of a successful throwing stick, and of satisfactory missiles therefore, was not the simple task it at first might appear to be. Essential for effective functioning of the weapon was the incorporation in its construction of several features which, although they appeared quite insignificant, were of basic importance.

The Throwing Stick

During the two-and-a-half years (and 3,394 casts) over which this experiment was conducted about twenty-five throwing sticks, as above mentioned, of various designs and dimensions were made and tested. They ranged from 12 to 30 inches in length and were made of several different kinds of wood. Those shaped from white ash proved to be most satisfactory, as this wood is relatively hard and strong and is not prone under stress to split. With the javelins, described below, used for most of the testing, a throwing stick close to 24 inches long was found to be most effective. To achieve maximum range it was thinned to as light a weight as possible, consistent with the rigidity and strength necessary to withstand the strain of the thrust without breaking. Its handle was made sufficiently large to permit a firm grip, but no larger than was necessary for this purpose. Beyond the proximal, or handle, portion its diameter was greatly reduced, so as to achieve minimum weight.

The construction of the distal end, or that opposite the handle, of a satisfactory throwing stick is a matter demanding precise workmanship and considerable trial and error casting to determine what modifications of angles, curves, and surfaces should be made to attain best results. Not only must the nock of the missile shaft be held in contact with the distal end of the thrower when the swing of the cast is begun, and thereafter while the thrust is being imparted, but also, during the swing it must be made to disengage itself from the thrower at exactly the proper instant to start the projectile on its course.

To realize these objectives, several designs of the release portion of the thrower are known to have been utilized by the Amerind. That which many archeologists believe was the form most generally used was the one to which this writer gave greatest attention.

Essentially, this form comprises a proximally facing, bluntly pointed protuberance, nob, or stud, sometimes called a hook, about an eighth of an inch long, carved onto a rounded surface at the distal end of the thrower. This protuberance was made with a base diameter about one-half that of the nock end of the shaft, into which a cupped-out hollow, or depression, was made of proper shape for its accommodation. These features make it possible to place the butt of the missile over the stud, preliminary to the cast and, by a slight rearward pressure of the finger or thumb on the shaft, to hold the two in contact, thus preventing any premature slipping of the rear end of the projectile from the thrower. A further advantage of this arrangement is that it allows a missile to be carried in a nocked, or what might be called "loaded," position for instant use, either in light or darkness.

During the cast, as the distal end of the thrower is swung along its arc, which most often is overhead, the butt of the shaft rocks over and off the stud and along the curved surface until it reaches an angle which causes it to separate from the thrower, thus launching the projectile on its flight.

The separation of the missile from the thrower at precisely the proper instant is a matter of utmost importance in successful casting. Released too soon, the butt of the missile is forced upward too far; released too late, downward. In either case the range of the projectile is greatly reduced, while its accuracy is ruined.

Archeological research reveals that over the centuries a great many different forms of atlatls were produced. On some, the protuberance or stud was made of copper; on others, of deer antler. The handle portions, in some cases, were provided with a hole, or with holes, or with thong loops for the insertion of the thumb or fingers, so as to make possible a firmer grip. For the writer, however, no great increase in the range of the weapon was discernible from these variations in handle design.

Projectiles

Approximately 75 javelins and darts of various specifications were used during the course of this experiment. Made of several kinds of wood, among which were birch, maple, oak, hickory, white pine, and white ash, they ranged in length from two-and-a half to five-and-a-half feet and in diameter from one-fourth to three-fourths of an inch. To simulate Archaic man's flint points, three-eighths inch copper tubing, three-and-a half inches of which weigh approximately one ounce, was cut into appropriate lengths. Affixed to the forward ends of the shafts and held in place by indentations in each side made with a punch, a sufficient number of these sections were produced to provide a uniformly graded series of points running in weight, by one-eighth ounce variations, from three-eighths of an ounce to one and three-eighths ounces, avoirdupois.

As the effect of points of different weight on the flight of the missile was a matter of basic interest in this experiment, the weighing of the sections of copper tubing was done with considerable care, so the error would be no greater than one one-hundredth of an ounce. This degree of accuracy was easily attained by means of an apothecaries' scale and the use of BB lead shot. As fifty of these shot weigh one ounce, one shot equals one-fiftieth, or two one-hundredths of an ounce. To obtain a point of any desired weight, a hack saw was used to cut a section of tube which measured a bit longer than was deemed necessary. This was then weighed and filed down, bit by bit until, placed in one pan of the scale, it just balanced the appropriate number of shot counted out into the other.

Using javelins with points of various weights and shafts of different lengths and kinds of wood, hundreds of trial throws were made. It was evident that satisfactory performance of unfletched javelins demanded adherence to some quite rigid specifications in their design and construction. Even a slight deviation from the measurements identified with maximum performance made itself apparent in a disproportionate reduction in both range and accuracy of the projectile.

It was found that, with the wood used, long shafts were often deficient in stiffness, or spine. Bending and buckling excessively under pressure of the thrust, they could not be given sufficient velocity for long flights. Weaker shafts might even break in two. On the other hand, those which were too short proved difficult to aim with enough accuracy to be effective.

Most satisfactory of all the shafts tried were 36 inch dowel rods, three-eighths of an inch in diameter. Made of birch and weighing about one-and-a-half ounces each, these were carefully selected for straightness, spine, and uniformity. With them, best results were obtained when a one-ounce point was used, thereby bringing the complete javelin--shaft and point--close to two-and-a-half ounces in weight.

Although these projectiles were made with considerable care, so as to be as nearly alike as possible, some of them almost invariably attained greater ranges than others. The difference, it was found, was due, in part at least, to a variation in the point of balance of the javelin. A well-balanced missile, properly cast from a well-designed throwing stick, will leave the latter with the axis of the projectile in close alignment with its trajectory and will continue in that relative position throughout its flight. Even when imperfectly hurled, a properly balanced missile will show a strong tendency to assume such an alignment and to hold closely to it for the remainder of its course. A poorly balanced projectile, however, will weave and wobble throughout its flight, with a ruinous impairment of both its range and accuracy.

The unfletched javelins used by this writer attained maximum ranges only when they balanced, held on a knife edge, at a point between 28 and 35 per cent of the distance from the front end of the point to the rear of the nock. Best performance was obtained from those which were in equilibrium when held close to the 31 per cent position.

This degree of accuracy of balance was not difficult to achieve. By using the sharp edge of a piece of broken glass to remove minute shavings from the shaft at the appropriate place the point of equilibrium could be moved, within limits, as desired. Differences in the balance of what seemingly are uniformly made javelins, with dowel sticks as shafts, are due to several causes, the most common of which, probably, is a slight over or under size of the rods themselves. Although those of three-eighths inch diameter are supposed to measure .375 of an inch across, it was found that they often were somewhat larger or smaller and consequently, before being reworked, the javelins of which they formed the shafts showed considerable variation in the length of their flights.

For satisfactory performance of unfletched missiles, it is necessary that the nocks of the shafts be of uniform size. It is the diameter of the nock and its relation to the stud, curves, and angles of the distal end of the atlatl which determine the exact instant when the butt will separate from the thrower and the javelin will begin its independent flight. Precise dimensions of the parts involved are essential if the weapon is to function successfully. In this respect the throwing stick and its missile differs from the bow and arrow. Whereas the user of the atlatl, once he has commenced his cast, has no control over the instant when the projectile separates from the throwing stick, the arrow can begin its flight only when it is released by the archer.

The necessity for uniformity in the size of the nocks of unfletched javelins drew the attention of this writer to the perforated stones not infrequently found in collections of artifacts, and which some archeologists believe were used to standardize the diameter of arrows. Such a perforated stone was found southeast of Conesus Lake, Livingston County, in upstate New York, by the late George Penning, of Conesus. Measuring about two inches across and one inch in thickness, this stone had a round perforation which tapered moderately from each side to the center. Using it to reduce the size of a section of three-eighths inch dowel rod, it was found, by means of a micrometer, that the resulting diameter was .372 of an inch. As the very heaviest big game arrows sold by modern archery equipment houses are usually no more than 11/32, or slightly less than .344 of an inch in diameter, it was surmised that the perforation of this stone was too large to make it appropriate for use with arrows, and hence it might have been employed to size the butts of atlatl missiles. Test casting of javelins and darts with their nock ends brought down by its means to .372 of an inch demonstrated that this was a very satisfactory diameter. The implement, consequently, was used to make the butt ends of all missiles, so far constructed uniform in size. That this perforated stone had been used by some Archaic aborigine several millennia ago to standardize the nocks of atlatl projectiles is open to doubt; that it was used for this purpose, however, in the 1960's in the atomic age, and did an admirable job, is certain.

Points and Shafts

The average weight of several Genesee type points, probably of the Middle to Late Archaic periods and dating back to approximately 4000 B.P, was found to be between three-fourths and seven-eighths of an ounce. If one assumes that the point was secured to the shaft by binding materials which equaled, perhaps, one-eighth or one-fourth of its weight, point and binding together then totaled approximately one ounce, or about the same as the section of tubing which resulted in flights of maximum distance for the unfletched javelins used by the writer. One could therefore feel some justification for believing that points of similar weight might have been used on unfletched javelins by Archaic man. If this conclusion is valid, the width of the stems of these Genesee points could be assumed to be about equal, to facilitate effective hafting, to the diameter of the forward ends of the canes on which they were used. As the stems averaged about three-fourths of an inch across, this could have been approximately the greatest diameter of the shafts.

A description of the projectile canes found by Guernsey and Kidder in 1916 (Webb and DeJarnette, 1942) in White Dog Cave in northeastern Arizona is as follows:

... "The tips or distal ends are the heaviest parts, averaging one-half inch in thickness; from this maximum diameter there is a gradual taper to the butts or proximal ends, which average three-eighths of an inch through. They are made of straight slender branches of some light wood with a small pithy heart; the bark has been carefully removed, the twigs trimmed close, and in some cases the knots have been further eliminated by rubbing. (The distal ends of these canes were drilled to accommodate fore shafts.)"

From caves about 20 miles northeast of E1 Paso, Texas, some shafts were recovered in 1927 which were described in these words:

"The spear shafts are very interesting. . . .They were made from the flower stalks, of the agave, which, although light, is very strong and suitable for such purposes. Their average length varies between 5 ft. 3 in. and 4 ft. 9 in. The distal ends of these shafts are the heaviest. They have an average diameter of one-half inch and taper gradually towards the butt ends. The latter average a little less than a quarter of an inch in diameter. (These, also, had a hole bored in the distal end to take a fore shaft.)"

In some parts of the country, the Archaic hunter or warrior must have had considerable difficulty in procuring an adequate supply of canes for the making of javelins and darts. As these projectiles were light in weight it can be surmised that the atlatl-armed aborigine, like his bowman successor, carried with him in some kind of a quiver, a suitable supply of "ammunition." A one-shot weapon, certainly, would not be considered as effective as one which could project, in rapid succession, a number of potentially destructive missiles.

While the flora indigenous to some areas in Archaic times may have produced an abundance of canes or reeds sufficiently straight, stiff, light, and strong to use as shafts, other areas, probably, were deficient, or entirely lacking, in this respect. For the hunters and warriors of these latter sections it is probable that such essential projectile parts were secured from outside sources, as was done in various areas in the case of copper, pipestone, steatite, mica, obsidian, salt, and other articles. That Indian intercommunication and the bartering of such trade goods were common in early historic times is well known; references to it are fairly frequent in literature dealing with the period.

On this subject Fundaburk and Foreman say:

"It was the wide commercial-barter travels which gave the Iroquois their close acquaintance with the northern central United States; and when they received firearms from the Dutch about 1620, they quickly conquered a large portion of what had once been their commercial territory, extending from the Great Lakes to northern Tennessee on the south, and to the Mississippi River on the west."

Results of Testing

The miscellaneous assortment of atlatls and javelins above described yielded, in experimentation as might be expected, a great diversity of results. As defects in their design or construction became apparent, they were either modified or discarded by this experimenter. From this process a fairly satisfactory combination of the principles and parts essential to successful performance of the weapon finally emerged. Using these results, the writer was able quite uniformly to throw unfletched javelins a distance of 180 to 200 feet with, occasionally, one of greater range. Without doubt, a younger and more athletic person could very substantially improve on this performance.

To summarize, longest casts were made with equipment of the following specifications:

Throwing stick -- 23 3/4 inches in length, measured from the end of the handle to the base of the distal stud. Made as light in weight as possible consistent with the requisite strength.

Javelin--36 inches long, 3/8 inch in diameter, cupped on the nock end, which was .372 of an inch in diameter, balanced at close to 31 per cent of the distance from the extreme distal to the proximal ends, with one ounce point. Total weight, 2 1/2 ounces.

Light Weight Points, used with Fletching

When sufficient fletching is used, even an unpointed shaft can be made to travel its course with its axis close to the line of its trajectory. So great, though, is the air resistance on the excessive surface of feathers necessary to insure this alignment that the resulting short range of the missile renders it ineffective for many purposes. However, with a point lighter in weight than would be required for an unfletched javelin, and only enough feathering to give the shaft sufficient rotation to prevent weaving and wobbling during flight, a dart can be made highly efficient in performance. Its range, though, due to increased resistance of the air, will be shorter than that of the heavier pointed plain javelin. With dowel rods used for shafts, as above described, the experience of this writer indicates that the minimum weight of points suitable for unfletched javelins is about 5/8 of an ounce; with lighter heads the flight of the missile is erratic and inaccurate. Hence, it seems that the hundreds of thousands of pre-bow and arrow projectile points which so far have been recovered on this continent, by far the larger number are too light for unfletched shafts and, therefore, they probably were designed for use on feathered darts.

Although shorter in range than the unfletched javelin, the feathered dart possesses some important advantages when compared with the heavier headed missile. For one thing, the use of fletching diminished the importance of precise balancing and so permits greater latitude, or error, in the construction of the dart which, consequently, may be easier to produce than the javelin. Also, it seems plausible that for many purposes a short range projectile might be more desirable and effective than one capable of longer flight and, under some conditions could be entirely adequate to meet the requirements of hunter or warrior. Not to be ignored, moreover, is the assumption that, as it took time and labor to produce missiles, an effort would be made after they had been hurled to regain them for future use. The shorter their range, therefore, the easier would be the task of their recovery.

Some Aspects of Point Typology

It is assumed, as a hypothesis, that pre-bow and arrow Archaic man, in general, utilized heavy points on hand thrust spears, those of somewhat lighter weight on unfletched javelins, and still lighter ones on feathered darts. In each case it seems reasonable to believe that the typology of his points was largely determined by the purpose, or purposes, for which they were to be employed, and the characteristics of the shafts to which they were to be attached. Variations in point stylization thus may have been due more to utilitarian and regional considerations than to any traditional affinities or predilections of the aborigines' ethnic group.

A number of considerations would play a part in determining the shape of the heads of points. For use over water, swamps, or soft soils, on small game, or where deep penetration was desired, a thin lanceolate type might be most effective. On the other hand, for large animals, and for use in heavily wooded areas, or over frozen ground, a relatively thick point of rugged construction, not prone to break on contact with unyielding objects, might be more satisfactory. The stem of a point designed for a shaft of firm cross sectional structure might be made relatively thin, so as to permit easy insertion in the opening produced by a short sprit in the end of the cane; it would roughly correspond in width with the diameter of the shaft at the point of attachment. The length and shape of the ears, if any, on the stem would suggest how firmly it was intended the binding should hold the point to the shaft against a rearward pull on the latter. For a pithy centered cane, the stem could be expected to be relatively thick, or even almost round, so as to fit into the hollowed-out end of the shaft, about which a tight binding could be made.

Decrease in Size of Points

As stated above, it is quite generally believed that the spear-thrower, with its various types of projectiles, was the chief weapon of Archaic man, and that it continued to be his main means of offense and defense until it was gradually supplanted by its more efficient rival --the bow and arrow. The change from old to new, as usual with most great inventions, was slow; in this case it seems to have occurred at different times in various parts of the country, and over a period of several centuries. When it began, it is reasonable to believe the older weapon, with several thousands of years of service behind it, had been brought, considering its inherent defects and limitations, to a high state of perfection. By contrast, its newer rival was still in the development stage, and probably was far less superior to the traditional weapon than the improvements suggested by a few hundred years of experimentation and practical use were to make it.

During this transitional period the production of heavier projectile points, suitable for javelins ;and darts, could be expected to decline, while that of lighter ones, appropriate for arrows, to increase. That this slow change in typology was practically completed in central and western New York by the year 1500 A.D. is supposed by a study made by Vanderlaan of numerous points found on eleven sites in that area. From the charts accompanying this report one could conclude that, whereas, by approximately 1200 A.D., the throwing stick was still being employed to a limited extent, along with the bow, which was coming into increasing use, by 1500 A.D. it seems to have been completely superseded by the latter.

Whether small points were used on a dart or an arrow or, perhaps, at different times on both, are questions which cannot be answered with certainty. In this connection, however, it is interesting to note that the heaviest point used on modern big game arrows, as made by one of the largest archery equipment manufacturers in this country, weighs 130 grains, or considerably less than one-third of an ounce.

Throwing Stick Weights

Museum exhibits indicate that bannerstones varied greatly in size, ranging roughly from perhaps one ounce or less to well over a pound in weight. As each of them, other than those possibly intended for ceremonial purposes, must have been adapted to the whole tool of which it was a component, there evidently was a great diversity in throwing sticks, javelins, and darts.

In the writer's collection of artifacts is a winged bannerstone, conventional in size and shape, and similar to those frequently seen in museums. It's weight was found to be 4 7/8 ounces. To duplicate it, for ballistic purposes, a short section was cut from a one-inch galvanized iron pipe. Through one side of this a 3/16 inch hole was drilled, tapped, and furnished with a set screw. The complete weight--pipe and screw—was then brought down, by means of a file, to exactly 4 7/8 ounces. Other similar "bannerstones" were made, thus providing weights of 3 1/2, 4, 4 7/8, 6 3/8, and 8 1/2 ounces.

The backsides of the throwing sticks, for two-thirds of their lengths, were then calibrated in inches, beginning at the proximal ends. These arrangements made it possible, by sliding any one of the "bannerstones" over the distal portion of an atlatl, to secure it firmly, by means of the set screw, at any desired point between 5 and 18 inches from the end of the handle.

With the javelins used by the writer, it was found the longest flights were obtained with the 4 7/8 ounce weight. However, the one of 4 ounces was but slightly inferior in performance, while that of 6 3/8 ounces was not far behind. The lightest, 3 1/2 ounces, and also the heaviest, 8 1/2 ounces, proved to be relatively less effective.

Thereafter, using in the testing only the 4 7/8 ounce weight, it became apparent that the greatest range of the javelins, 220 to 250 feet, was attained when it was secured to the thrower at somewhere between 7 and 9 inches, as indicated by the calibration. It was hoped that a single point could be found which, with the same javelins, uniformly would yield the best results. This precise uniformity, however, proved to be elusive and could not be maintained over any extended period. This was due, perhaps, to the variable human factor, which plays such a large part in the use of the weapon, and to changing wind conditions.

A well-constructed throwing stick, naturally, will produce longer casts than one which is defective. The latter, however, even with a weight attached at the optimum position, may show no appreciable increase in the length of the flights attained

As a result of hundreds of casts, it was found that the 4 7/8 ounce weight, when fastened to a well-made atlatl close to the 8 inch position, almost invariably will increase the range of the projectile by between 15 and 25 per cent. The reason Archaic man used bannerstones and other weights on his throwing sticks is, therefore, easy to understand: they allowed him to reach out with his javelins and darts considerably farther than was possible with a plain, unweighted thrower.

Some writers are of the opinion that the winged and crescentic types of atlatl weights were designed to symbolize the flight of a bird. While this may be true, the shapes of these stones are also of practical advantage to the user of the weapon for a quite apparent reason. It sometimes happens that, just at the moment the forward swing of the throwing stick is begun, in preparation for a cast, the cupped nock of the missile accidentally slips off the stud, which is supposed to hold it in contact with the distal end of the thrower. Before the shaft has had time to fall very far, the forward movement of the thrower brings any projecting portion of the attached weight into forcible contact with the projectile, perhaps midway of its length, thereby striking the latter a sharp blow. This often results in a broken shaft. By shaping the wings of the bannerstone, or other weight, on a receding slant, rather than as a sharp projection, the missile, on contact, is thrown to the right or left and, consequently, often suffers no damage

Some writers refer to bannerstones, birdstones, boatstones, and other weights, which may have been used on throwing sticks, as charms or fetishes. From the skilled craftsmanship evident in the shaping of many such objects, and their high polish, it seems reasonable to believe that Archaic man placed a high value on those which had demonstrated their worth and so might have considered them as endowed with cryptic qualities or supernatural powers. Certainly, an accessory which increased the range of his destructive efforts by as much as 15 or 25 per cent would be held in high esteem and treated as a cherished possession by any aborigine.

The Weapon's Numerous Forms

From the wide variety of sizes, weights, and designs of projectile points, bannerstones, and other atlatl weights recovered to date, one is led to conclude that, in his attempts to produce a throwing stick and missiles best adapted to his needs, early man experimented with every conceivable combination and form of the component parts of the weapon. Once this empirical and adventitious approach resulted in an effective combination, it may be surmised that a supply of projectiles closely similar in ballistic qualities to those which had been found satisfactory would be produced. With no apothecaries' scale, B B shot, micrometer, or other modern tools, the attainment of any great degree of uniformity must have been an exacting task, and one in which a deft hand was required.

Throwing Stick versus Bow

In at least one respect the atlatl possessed an advantage over the bow. Unlike the latter, it necessitated the use of only one arm and hand for the casting of a missile. To Archaic man in his canoe, and later to the Eskimo in his kayak, this must have been an important consideration, as it left his other hand free to manage a paddle, or for other purposes.

The throwing stick, however, incorporated some defects which greatly impaired its efficacy. One of these was inherent in the method of launching the projectile, which required a vigorous, and perhaps conspicuous, swing of the arm. This, one can imagine, often was sufficiently evident to an agile animal or other game, to enable it to make good its escape from the missile. By contrast, when using the bow, the arrow can be quickly launched, with a minimum of movement on the part of the archer and from almost any position. The newer weapon, also, had other advantages. Important among these were its lighter weight "ammunition," which, being of shorter length than javelins and darts, enabled the hunter or warrior to carry a larger supply and, in thickly wooded areas, to do so more easily. Moreover, in some respects, it probably demanded less precise workmanship in its construction and hence was easier to produce.

These and other advantageous features combined, naturally caused the aborigine to favor the newer over the older weapon. Consequently, in most parts of the country, when the historic period opens, the throwing stick, with its javelins and darts, for most purposes had been discarded, and the bow, with its arrows, had become established as the primary weapon of the Amerind.

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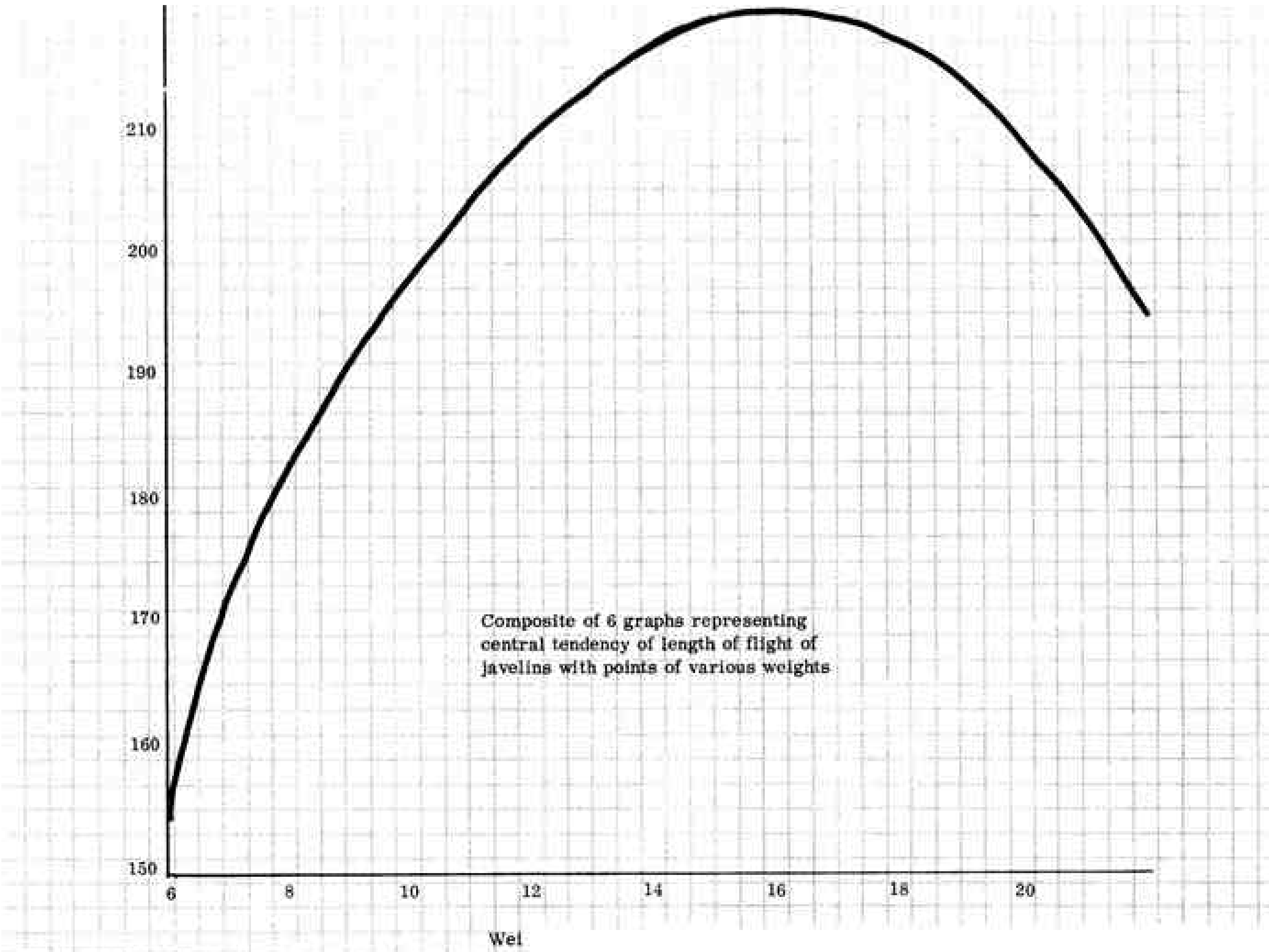
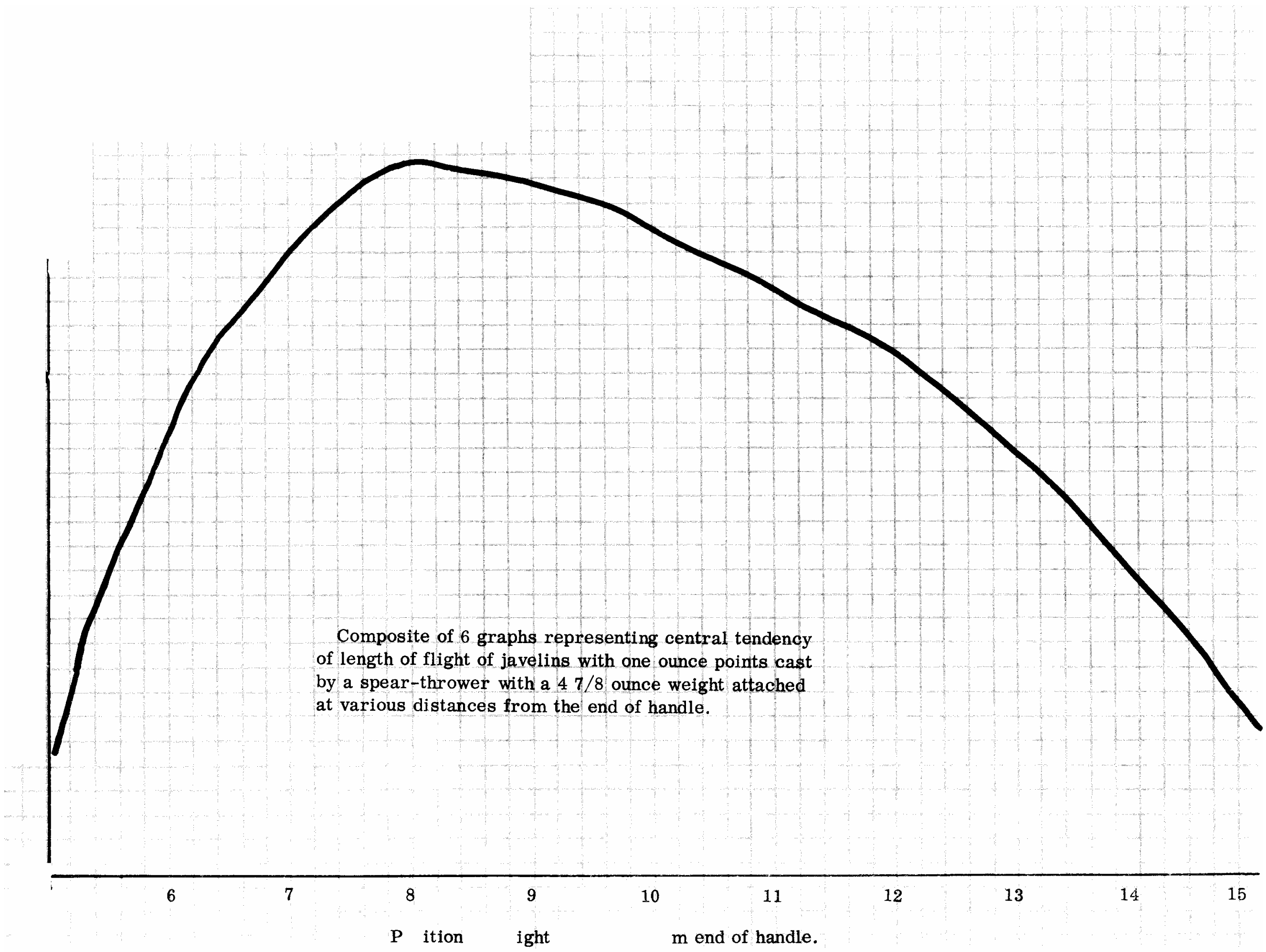


Weight of point in 16ths of an ounce



Position of weight in inches from end of handle.

(Editorial Addendum: The foregoing is the first illuminating study of the atlatl since that of Webb and DeJarnette (1942) when its use during the Archaic was first authoratively recognized. Subsequently, Webb, in his "Indian Knoll, Site Oh2, Ohio County, Kentucky," University of Kentucky Reports in Anthropology and Archaeology, Vol. IV, No. 3, Part 1, demonstrated that the atlatl, with hook and bannerstone as components, was included as grave goods with Archaic burials. In this report there are also several reconstructions of probable forms of the atlatl, the wooden parts of which had decayed since burial. They are reconstructions from the archaeological evidence alone, however, and no such ballistics and technological information as Dr. Mau has presented accompanies them.

The Mau study directly contradicts the conclusions reached by Orville H. Peets in his "Experiments in the Use of Atlatl Weights," American Antiquity, July, 1960, where it is stated that "Evidence is supplied that the weights often attached to atlatls do not add to the force of the dart. . . .It is proposed that the purpose of the weights was to secure balance on the hand of the atlatl-dart combination." These conclusions by Peets, based on experiments with an atlatl and weight archaeologically recovered from the Baylor Rock Shelter, Culberson County, Texas, now seem subject to considerable revision. One effect of Mau's study in future archaeological reporting should be that hereafter, the size of projectile points must be reckoned by weight, rather than by linear dimensions of length and width. Dr. Mau's speculations about the style-shape of projectile points are, perhaps, open to argument; but the evidence, derived from controlled experiment and presented here for the relationship of weight of points and bannerstones to the technology of weapons and hence to cultural weapon traits, provides the archaeologist with new insight into artifactual inventories.

What does it mean, for instance, when points from the same site and in the same style-shape occur in three different weight-sizes? Is it any longer possible to be positive about the beginning days of the use of the bow and arrow? Oren F. Evans has reported in "Probable Use of Stone Projectile Points", American Antiquity, July 1957 that unfletched arrows of about 3/8" in diameter and tipped with points up to 5" long can be shot with killing force and accuracy up to 120 ft. Fletched shafts, on the other hand, are efficient only with the lighter, smaller, points usually designated "arrow points." This same principle of heavy point with unfletched shaft and light point with fletched shaft has been demonstrated by Mau for atlatl projectiles. The once-popular rule of thumb that a point longer than 1 3/4" had to be a dart or javelin point, and that points under that might be classified arrow points, can no longer be safely applied. The surest evidence of the use of the atlatl is the weight or bannerstone, the hook of the distal end, and the grip, if this happens to be of preserved material, even though many, perhaps most, atlatls at early time levels, were used without weights.

A 6000 YEAR OLD MIDDEN OF VIRGINIA OYSTER* SHELL AT CROTON POINT, LOWER MID HUDSON

Louis A. Brennan Metropolitan Chapter

The only archaeological survey ever undertaken of the lower Mid-Hudson, as far as this writer knows, was that sponsored by Vassar College, Poughkeepsie, and directed by Dr. Mary Butler in the summers of 1939 and 1940.

In her cursory report (Butler, 1940) of this survey appearing in The Vassar Alumnae, October, 1940, Butler writes that there is "a definite difference in culture between the oyster shell-eaters of Westchester County and the mussel-eaters of northern Dutchess County, with the suggestion of an overlap of the two cultures at Cruger's Island."

Cruger's Island, about 85 miles upriver from New York harbor, and at the northern border of Dutchess County, appears to be, on the strength of this oblique reference, the northern limit of the use of oysters by Hudson River Amerinds and hence to be the northern limit of growth of oysters in the Hudson at any time.

The Butler article, non-technical in tone, does not, however, make clear whether oyster shell was present on the site, at the northern tip of Cruger's Island, or whether the overlap was of cultures only and not an admixture of oyster and mussel shell on the site. But at a site on the nearby South Cruger's Island, dug by James Shafer, with participation by Dr. William A. Ritchie (Ritchie, 1958) the only shell reported is mussel, which is in the top of three archaeological strata.

The northernmost occurrence of shell of the Virginia oyster in the Hudson Valley directly recorded in the literature is at Bannerman's Island, about 25 miles south of Cruger's Island, at the southern boundary of Dutchess County. Excavated by Shafer and Ritchie (Ritchie, 1958) it yielded oyster shell in association with campfire charcoal C14 dated at 4480 plus or minus 300 years ago.

The growth of oysters so far north at the date ascertained, when they will not grow anywhere at all in the Hudson at present under natural conditions, argues convincingly for a marked difference in both climate and sea level between 4500 years ago and today. Shellfish are very sensitive indices of climatic and water conditions.

Though it seems to be a matter of wide public supposition that the reason oysters will not now grow in the Hudson is pollution, this does not appear to be the case. A contact made this past summer by Sigfus Olafson, colleague of the writer in excavation of oyster middens in Haverstraw Bay, with Mr. J. Butler Flower, a professional oyster grower, provides a different picture. Mr. Flower holds at present the concession to grow oysters on the west side of the Hudson below the Tappan Zee Bridge at Tarrytown. In 1958, Mr. Flower planted a bed of oysters in this concession and lost the whole bed when a heavy snow was melted off by a heavy rain, and the resultant influx of fresh water reduced salinity temporarily to near zero.

According to Mr. Flower, the optimum water temperature for oyster growth is 72 degrees F. At a high limit of 80 degrees F. and a low limit of 45 degrees F, the oyster closes and suspends metabolic activity. Optimum salinity is 21 parts per thousand, that is, 2. 1%. The maximum salinity recorded by Mr. Flower in the general vicinity of Croton Point was 11 parts per thousand in a deep hole near the Tappan Zee Bridge; salinity increases slightly with depth.

*Paper delivered at the annual meeting of the Eastern States Archaeological Federation, Philadelphia, Nov. 9, 1963.

What is immediately apparent is that present climate, salinity, and sea level are somewhat sub-marginal for the growth of oysters under natural conditions. The reason sea level becomes a condition of oyster growth is that it is the main factor in salinity. The only way in which salinity could be increased, to the extent of supporting oyster beds as far upriver as Bannerman's Island, is by a rise in sea level, which would put a great deal more sea water into the valley. A depression of the land might do this, but the scheme of sea level fluctuation proposed by Dr. Rhodes W. Fairbridge of Columbia, (Fairbridge), which shows several sea level-climatic highs between 6000 and 2000 B.P, provides sufficient explanation for the oyster-growing periods evidenced by archaeological shell middens that are everywhere deposited along the shores of Haverstraw Bay and the Tappan Zee.

What must be emphasized is that the Hudson River, except in its narrow, canyon-like trench, is quite shallow in the vicinity of Croton Point, which divides this section of it into the Tappan Zee to the south and Haverstraw Bay to the north. Any appreciable rise in sea level, say of two or three feet, would radically alter the ratio of sea water to fresh water. In the Fairbridge scheme, sea level was above present for about 3000 years of the 4000 between 6000 and 2000 B. P. During the Christian era it has been above present level no more than 500 years. During the 3000 years before Christ, during which climate and water level were as high or higher than-present in the Tappan Zee and Haverstraw Bay areas the water was, on several occasions, at 5800 B.P., at 5000 B.P., at 4500 B. P. (note the correlation here with the Bannerman's Island date of 4480 B.P.) at 3800 B.P., and at 2200 B.P, at periodic crests from 5 to 10 ft. higher than at present. During the Christian era water level stood above present only between about 750 A.D, and 1250 A.D. and then only by a foot or two.

If the crustal level of the land stood, during the last four millenia B.C. at anything like its present height, the waters of the Hudson were greatly increased in salinity by simple extension of the sea up the valley. But another factor favorable to oyster growth was at work during periods of higher than present sea level. Sea level highs are achieved through the melting of glacial ice during periods of climatic warmth. This warmth would mean milder winters and warmer water all year round. If water temperature never fell below 45 degrees F, the temperature at which oysters cease metabolic activity, or fell below it only briefly, then the growth period, in favorable salinity conditions was continuous or nearly continuous.

What emerges from the application of the data in oyster ecology to the Fairbridge scheme of sea level and climatic fluctuation is that most of the very extensive middens of oyster shell on both banks of the Hudson below Bear Mountain bridge, which is the northern limit of Haverstraw Bay, must have been deposited between 6000 B.P. and 2000 B.P. (or 1 A.D.). It is equally clear that, since there were two periods during these four millennia when sea level was below present, these periods being between 4400 and 3900 B.P. and between 3400 and 2600 B.P., there will be some eras of Hudson River riparian archaeology missing from the shell midden record. Also plain is the fact that we need not mourn the loss of middens now covered by river water. There are undoubtedly sites below the present water level from periods when sea level was below present, but they are not shell midden sites. It is reasonably clear now that oysters will not grow here under even present conditions.

But what was not previously evident is that the maximum size reached by oysters varied with the climatic-sea level high period during which they grew. At least the writer did not suspect this when he and his colleagues, Olafson and Mauck Brammer began excavation in 1961 into a three-foot deep shell midden at the northern tip of Croton Point, called Enoch's Neck on some maps but known more recently as Kettle Rock Point because erosion was bared a huge kettle-shaped boulder there. The midden was of consistent depth along a 75 ft, bank and rested on a glacial till of which about five feet was exposed.

It became apparent from the first five foot square excavated that the midden was stratified as to size of oysters. The bottom 18 inches was of large, loosely packed oyster shell, a good deal of it whole, through which were scattered shells of the ribbed mussel, Volsella plicatulus or Volsella demissa, a salt or brakish water species. Because oyster shells in this layer which reached lengths of 7 in. and an imposing bulk were quite numerous, it was called the GO,(for giant oyster) horizon.

GO horizon shell did not rest directly on the till but in and on a soil of humic origin, black, homogenous in texture, sticky or mucky when wet, lacking any content of sand, pebble or stone, and about 4 inches deep. The GO midden was topped off by a 3 inch to 4 inch layer of badly shattered shell, which this writer has elsewhere argued may have been a beach. Whether it was a beach or not, it is the debris of a long period of weathering. At a site about a mile upriver called Parham Ridge, dug by the writer and his colleagues in 1959 and 1960, a badly decayed shell midden, which we now believe to have been a GO horizon midden, lay under 8 inches of soil, which in turn lay under a shell midden yielding steatite pot fragments but no ceramics. The steatite layer was also characterized by the extensive use of quartzite, a material not conspicuous in earlier middens.

At Croton Point the shell midden on top of the GO midden also yielded much quartzite. A quartzite chipping floor, the material derived from river pebbles, was in association with it, and though no steatite occurred, neither was there any ceramic pottery. The shell was large, but no specimens were over about 5 inches and were mainly about 4 to 4 1/2 inches. There was no ribbed mussel.

Putting together our information from the Parham Ridge and Kettle Rock sites, we came to the conclusion that the quartzite bearing midden dated at about 3800 B.P., at the time of a well-documented Younger Peron high when, according to the Fairbridge scale, sea level stood at about 10 feet above present. The GO midden preceded this by the time interval represented by the 8 inch soil at Parham Ridge and the shattered shell layer at Kettle Rock.

According to the Fairbridge scale there were three peaks of sea level preceding the Younger Peron high; as stated above they were at 4500 B.P., at 5000 B.P., and at 5800 B.P. The question that had to be answered was: during which of these highs were the GO horizon oysters eaten by Hudson River riparian dwellers.

The artifact content of the GO horizon midden at Kettle Rock provided no clues. Found in it were a pebble chopper with a side-cutting edge, a round-muller hammerstone (which is in no way diagnostic because this type of tool is found at every midden level and in virtually every heap of shell we have ever investigated), a pestle-like spool-stone, a small black flint biface about the size of half a dollar, a possible break of which is obscured by incrustation, some flakes that may have been casually utilized, and two curious spalls triangular in cross section and about an inch long. One of these is black flint and the other an off-white chalcedony. They may conceivably be blanks or cores for the manufacture of a style of point, tear drop in shape but with a quasi-stem found in small but significant numbers in the Parham Ridge GO horizon and at the entirely pre-ceramic, non-midden hunting station Winterich site on a hilltop just south of Croton Point. Bert Salwen of Columbia University, digging with a party of students, took the broken flint blade of what appeared to be a narrow-bladed projectile point from the GO layer at Kettle Rock in 1962, but it is the only evidence of any kind that stone projectile points were used during these times.

With three highs to choose from, in which to place the Kettle Rock GO horizon midden, and no artifactual clues, we estimated that it fell into the earliest high period, at 6000-5800, for two reasons. The first of these is the absence of stone projectile points in a GO midden at another location on Kettle Rock Point on the eastern side of and at a higher level than the C14 dated midden and at a GO midden at Montrose Point, whereas there had been projectile points in the midden at Parham Ridge which we believe to have been GO horizon in age. That no stone projectile points will ever be found in the earliest GO middens we cannot safely predict, but as of now they are an absent trait, and because of this absence we inclined to place the Kettle Rock GO midden as early as it could be placed according to the Fairbridge scale, that is, at about 6000-5800 B.P.

Our second reason for estimating this date for the Kettle Rock GO midden was that never again did oysters reach such a size in this area. This size is not extra-ordinary as oysters go. According to Mr. Flower they can be raised on Long Island under controlled conditions at present to this size in five years, whereas the largest GO oysters reached this normal maximum in 20 to 25 years. But at no other climatic-sea level horizon did Croton area oysters reach this normal maximum in any numbers. But this normal maximum is extraordinary for this area, and it seemed only congruous to correlate GO horizon oysters with the most pronounced high in the Fairbridge chart, which happens also to be the earliest.

Also unique in our excavating experience was the presence of the ribbed mussel in this midden and in no subsequent one. Salwen took cores through the entire midden depth at Kettle Rock and did a shell count, which confirmed that the GO midden shell were significantly larger than later- shell, and that it contained an appreciable amount of ribbed mussel, but according to the count, some ribbed mussel is present in later horizon shell. All this writer can say is that he has never seen ribbed mussel in any shell dump or horizon which he knew to be later than the GO horizon stratigraphically or by artifact typology.

This writer also considered the GO horizon midden at Kettle Rock to belong to the earliest high because it appeared to be the basal member of a series of middens which had been reduced by water action and other weathering to the shattered shell of the shattered shell layer mentioned earlier. The arguments that this shattered shell level had been a beach are somewhat involved and have been presented elsewhere, in the NYSAA Bulletin of March, 1962 (Brennan, 1962) and in the Pennsylvania Archaeologist for December, 1962 (Brennan, 1962a) by this writer.

Through the courtesy of Dr. Irving Rouse of Yale, a charcoal sample from the GO midden, collected by Salwen in May, lyn2, was accepted by the Yale Geochrometric Laboratory. The results received this past summer (1963) were 5863 plus or minus 200 B.P. or 3900 B.C. The charcoal was collected in small fragments from through-out the GO midden and represents, Salwen has told this writer, an average age for the midden rather than a maximum age. The charcoal was certainly not in place of deposit when found.

The approximately 6000 year date appears to verify the Fairbridge graph, at least as to the first higher-than present water level in this area of the Hudson and as to climatic warm period which, according to Fairbridge, caused the sea to rise about 45 feet in 200 years to about 12 feet above present level. The peak at 5800 B.P. seems confirmed as having been slightly but significantly higher than any subsequent peak of both sea le vel and climate.

Archaeologically the date establishes the foundation for a chronology for the middle and late Archaic, the transitional and the early ceramics period sequence of cultures along the most important inland water travelways in the Northeast. There can be no doubt that an intensive project of C14 dating of oyster midden horizons in the Tappan Zee-Haverstraw section of the Hudson would be worth any institution's time and effort, for the results it will yield in archaeology, geology, and climatology. Because this area has been a marginal one, the effects of climatic change are decisively written here. But it will take considerable labor to uncover them.

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LAST CALL

This is the first, last, and only call for nominations for Fellowships and for the Achievement Award for 1963. For the standards and -rules of eligibility for Fellowship and Achievement consult the Bulletin, No. 11, November, 1957. Nominations with supporting information, should be sent to committee chairman, L. A. Brennan, 39 Hamilton Avenue, Ossining, New York.

FORTIFICATIONS OF NEW YORK DURING THE REVOLUTIONARY WAR: 1776-1782
continued.

Michael Cohn Metropolitan Chapter

THE BRITISH LINES AT HARLEM AND McGOWNS PASS

Location: The British lines ran from 116th Street and the Hudson River east to 105th Street and Fifth Avenue. East of Fifth Avenue was a swamp which forced the main road to go between the soft ground and the cliffs in what is now Central Park, this passage being known as McGowns Pass.

Construction: September 22, 1776 Robertson, British chief engineer, "began to make a chain of redoubts from the North to the East River across the heights of Harlem." On September 28 "All redoubts ordered abatissed." On September 24, "all five redoubts, three batteries of one gun each besides a line of 200 yards finished according to plan proposed." October 1st, "two new fleches ordered near McGowns" and on the 5th,"I (Robertson) began a line of interior parapet eight foot thick...at the end of that line a square redoubt 40 feet a side, the front eight feet thick and the other three sides six feet thick. "(1)

On May 25, 1778, some redoubts are mentioned at McGowns in orders (2), but on a fragmentary map of 1782, only a small triangular work is shown near where the blockhouse stands today. (3)

Armaments: 1776, at least three guns (1); 1779, none (4); 1780, one 4-pounder for signaling (4).

History: These lines were constructed to prevent a repetition of the affair of Harlem Heights and also to serve as siege lines in case Washington decided to make another stand in New York after Howe came around his flank at Throggs Neck on October 12, 1776.

After the fall of Fort Washington the area served as campground for various British and Hessian regiments.

Garrison: Though much of the British Army must have been in the lines during the weeks of September, 1776, very little is known of their exact disposition. The 17th Regt. was withdrawn from their advanced post at McGowns on October 11th. (5)

May 25, 1778 Lt. Col. Cambell of the 71st was in charge here (2). Later in 1778 the regiments of Lissing and Lengerke are listed at McGowns (3), and the regiment of Mirbach is assigned winter quarters here in October, 1778 (6). On the 30th of August, 1781 the 37th Regt was encamped here (7).

Archeology: None

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(1) Robertson Ibid p. 100-101

(2) Orderly Book of the Brigade of Oliver de Lancey, September 13, 1776-1778 (Published as Vol. III of the Jones Fund Publications, NYHS 1917)

(3) Fragmentary Manuscript Map dated 1782 from Eastern Manhattan 80th Street to 120th Street. Ms NYHS

(4) Edward Hagaman Hall, McGowns Pass and Vicinity, American Scenic and Historic Preservation Society, New York 1905, p. 25

(5) Order Book of the 17th Regiment of Foot, October 11 - December 28, 1776 Ms NYHS
(6) Clinton OB
(7) General Orders OB

THE AMERICAN LINES AT HARLEM

Location: A triple line of defenses thrown up at Harlem. Some outposts as low as 135th Street, then the first line at approximately 147th Street, the second at 155th Street, and the third about 160th Street. Since each line is higher than the one preceding it, they more or less covered each other.

Construction: These lines were built by the Americans after the retreat from Kip's Bay. Square redoubts were placed at about 100 yards from each other (1) and the whole strengthened with palisades and fraising (2). The line was leveled by the British 6th Brigade and one battalion of the 2nd Brigade, on November 22, 1776. (2)

History: The lines were thrown up after the battle of Harlem Heights on September 16, 1776 and so played no role in that battle. On October 30 Earl Percy made a demonstration against these lines to cover the move of General Knyphausen from White Plains to the Bronx. (3) On November 16th the lines were attacked as part of the general assault on Ft. Washington, but the decisive move was a flank attack from across the Harlem by the 42nd Highlanders supported by 20 pieces of artillery. (4)

Armament: In the accounts little distinction is made between the guns in these lines and the armament considered part of Ft. Washington itself.

Archeology: None

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(1) Charles Knowles Bolton (Ed) Letters of Hugh, Earl Percy, from New York and Boston, 1774-1776. Charles Goodspeed, Boston 1902, p. 72.

(2) Orderly Book of Capt. Henry Knight, Aide-de-Camp to Gen. Howe, Sept. 26, 1776 - June 2, 1777. Ms NYHS

(3) Earl Percy ibid p. 75

(4) A View of the Attack on Fort Washington and Rebel Redoubts near New York on the 16th of November by British and Hessian Brigades, drawn on the spot by Thomas Davies, Capt. Royal Artillery. Ms NYPL (reproduced) I. N. Phelps Stokes & Daniel C. Haskell, American Historical Prints, NYPL 1933 plate 24.
also
Claude Sauthier, A Topographical Map of the North Part of New York Island Exhibiting the Plan of Fort Washington, now Fort Knyphausen, with the Rebel Fortifications to the Southward, etc. Publisher: William Faden, London, 1777.