A STUDY OF THE BOOMERANG.

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In the beginning of my studies I sought access to the literature on boomerangs and strove hard to hunt up everything written about them, but in such an out-of-the-way place as Milwaukee I succeeded but poorly, and whatever I read was either entirely false or only partially true or even invented. For example, the Encyclopædia Britannica, article "Boomerang," gives the manner of throwing wholly wrong, for just the reverse of its statement is true. Lubbock, in "Prehistoric Times," page 443, second edition, gives some correct statements, but they are useless for a person wishing to make a boomerang. Other communications in periodicals or daily papers are not worth mentioning. It is clear, after my experience, that those writers never handled this instrument or studied its properties closely enough to be entitled to publish anything about it. Some, for example, say it is a weapon of war. This can hardly be true, for the boomerang is a very costly instrument with the natives of Australia, considering the small number in every tribe that can make good ones and the difficulty they are under for want of proper tools; for the natives possessed but stone knives and stone hatchets to work the very hard wood the boomerangs are made of. One kind of this wood is the weeping-myale (*Acacia pendula*), which covers portions of eastern Australia for miles; but I think the boomerang is made also of other hard and heavy woods. Now the boomerang can not be a weapon of precision, and even if in a skirmish somebody be hit, it is of small execution, and the instrument is then lost. A stone or a common club will do more harm and is evidently much cheaper. Their spears, which can be manufactured by much less work, are dangerous weapons, as the natives throw them about 90 feet with sure aim; or, according to Captain Cook, a distance of 50 yards. From these reasons alone I believe the pretension that the boomerang is a weapon of war must fall to the ground. This opinion is supported by the testimony of Mr. Oldfield (Lubbock, *l. c.*). This gentleman says: "The boomerang is but little used in war."

But the boomerang is a good weapon for hunting birds; not that it would be thrown at a single bird with some chance of success, but it is very effective when hurled among a large flock of flying birds. The rapidity with which the instrument rises and the comparatively large space it describes will almost insure the hitting of a bird, and then bird and boomerang both will fall to the ground on nearly the same spot. But when the boomerang does not strike a bird it will then return near to the hunter, if it was properly thrown. Another false opinion is that the natives strike with the boomerang a bird sitting on the branch of a tree; for the probability is that the instrument will break or get entangled and stuck among the twigs of the tree, as it sometimes happened in my practice. Another saying is that the boomerang is applied for hitting and killing kangaroos. This may be possible when the animal is very near to the hunter, say 30 or 40 feet distant, but I doubt that a boomerang will disable a kangaroo, whereas a spear will fell it to the ground.

Mr. Oldfield goes on to say:

> The natives never attempt to kill a solitary bird or beast by means of the boomerang. On the other hand, in swampy localities, where water-fowl congregate largely, the boomerang is of essential use, for a great number of them being simultaneously hurled into a large flock of water-fowl insures the capture of considerable numbers.

It is not necessary to reflect any more upon such wonderful tales of what a boomerang in a dexterous hand will possibly perform. A person that takes the trouble to practice with this instrument will soon see which of such tales are tenable and which are not. The generally credulous public swallow such stories the more readily the more wonderful things they relate.

CONSTRUCTION OF THE BOOMERANG.

By my experience I am led to believe that there exist, perhaps, different general forms of boomerangs equally perfect; but I would make sure only of one general form, which, however, can vary between pretty wide limits. The two instruments sent by me to the Smithsonian are representations of this form. (Figs. 1, 2.)

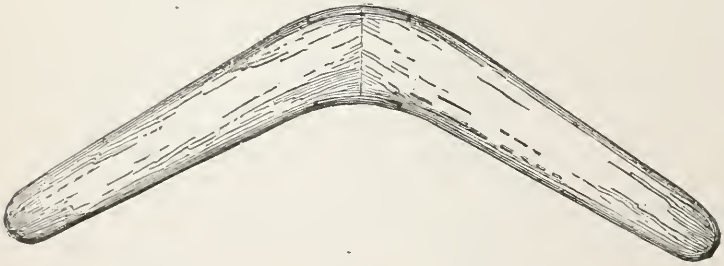

FIG. 1.

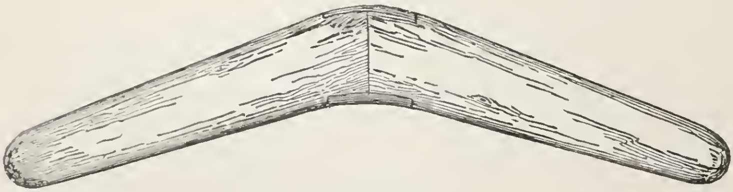

FIG. 2.

The boomerang, according to those specimens, consists of two symmetrical wings; that is, symmetrical in regard to a plane by which these two wings are joined.

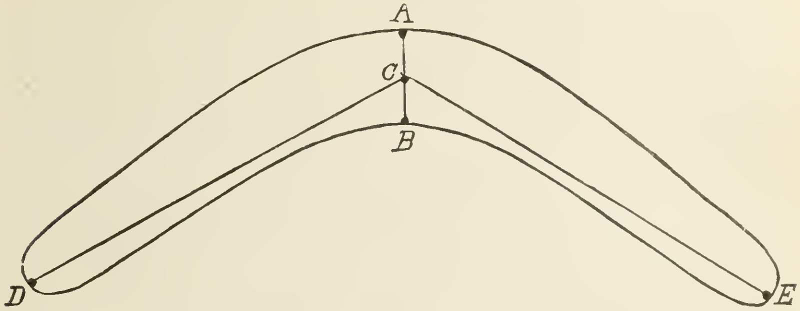

FIG. 3.

The angle of the lines D C and E C, which pass through the center C of line A B, and also through the centers D and E of the ends, I will call the "angle of the boomerang." The size of this angle varies between wide limits. My instruments have angles from 100 up to 140 degrees, and yet all these different instruments can be made to work properly; that is, boomerang-fashion. Perhaps this circumstance is the principal reason that the boomerang is at all popular in Australia. For if the efficacy of this instrument were limited by an angle of a fixed size, how few branches of trees would be found suitable. However, certain sizes of angle are more convenient to the thrower than others, and I found that angles from 116 to 120 degrees are very convenient. The relation between thickness, breadth, and length, absolute weight of the boomerang, and specific gravity of its material can very probably be expressed by numbers, but they are unknown, and evidently vary also between extended limits. The instruments sent to the Smithsonian have very nearly the numbers 1: 6: 36; that is, the maximum breadth is six times the maximum thickness, and the length of each wing is six times its maximum breadth. But writing $5\frac{1}{2}$ instead of 6 in the above proportion, so that the latter would be $1 : 5\frac{1}{2} : (5\frac{1}{2})^2$, would be just as near the ideal numerical relations. I am inclined to believe that these numbers are influenced by the specific gravity of the material. That the above proportion does not entirely govern the geometrical form of the boomerang, I conclude from the fact that after breaking part of the wing (say one-fourth of its length) off from a good instrument, I did not notice any material loss of its good quality.

Lubbock has given the measurements of one boomerang and Professor Erdman at Berlin, Germany, the dimensions of three others. These measurements may serve as a guide to a superficial construction of the boomerang; but these writers do not mention, as it seems to me, the essential point of a good boomerang: "the angle of inclination of the two wings." The wings of my instruments have each a plane side.

These two planes have to form a small angle between them, and I found that the way of effectively throwing the instrument and the manner of throwing it depend mostly on the size of this angle of inclination, which may vary from zero to three degrees, although the number 3 is not the utmost limit for successful throwing. The greater the angle between these limits, the less inclined toward the horizon the initial plane of rotation must be, all other points being the same. Instead of a plane, one side of each wing may form a curved surface little deviating from a plane, without the quality of the instrument being impaired. For brevity's sake, the joined planes of the two wings may be termed the plane side or lower side of the boomerang; it is the side facing the ground during the flight. The opposite surface of the boomerang may be termed the rounded or upper side. The surface form of this side seems to be quite arbitrary; however, a good form and perhaps the best one is such that the instrument, placed with this (upper) side on a plane table, fits the table exactly either by a plane surface or by a plane curve. In practice an approximation to this demand is sufficient; also a moderate upward curving of both wings will answer.

The tapering of the wings from the middle of the instrument toward the ends may be very slight both in regard to thickness and breadth; for example, if the instrument is three-eighths of an inch thick in the middle, it may be two-eighths of an inch at the ends, and if $2\frac{1}{2}$ inches broad in the middle, it may have $1\frac{3}{4}$ inches at the ends.

It may not be out of place here to mention a curious instance transmitted from antiquity. The old Grecian geographer, Strabo (book IV, chapter IV, 3), says:

> The Gauls use a piece of wood resembling a pilum, which they hurl not out of a thong, but from their hand, and to a farther distance than an arrow. They principally make use of it in shooting birds.

APPROXIMATE THEORY OF ITS FLIGHT.

As to the mechanical theory of the flight of the boomerang I can say but little. Firstly, the rotation of the instrument about its free axis through the center of gravity is the fundamental condition of success. The faster the rotation, the longer the boomerang floats in the air.

Secondly, the nutation of the axis of rotation has to be considered. This nutation decreases with the angle of inclination of the two wings of the boomerang and increases with the increase of the said angle. In the case of a small angle, the plane of rotation keeps parallel to the initial position of this plane, or very nearly so. If the two wings form one plane with their lower sides (this angle being zero), the instrument has no perceptible nutation, and must be thrown perpendicularly to the vertical plane passing through the hand. The instrument then rises and returns nearly in the same plane that it went up. This throw is rather difficult. In the second case, the angle of inclination of the two wings being rather large, the plane of rotation is constantly changing in regard to its inclination with the horizon, and by this circumstance causes the instrument to describe a series of complicated curves like those of a large bird of prey before it settles at the feet of the thrower. In general the initial plane of rotation must form an acute angle with the horizon, which may increase to a right angle when the inclination of the two wings is nearing its maximum.

A very elaborate mathematical treatise on the boomerang has been published by Prof. Werner Stille, Highland, Ill. It is a communication to Poggendorf's Annalen der Physik, published at Berlin, Germany. Mr. Stille starts from the supposition that the boomerang should form a skew surface, a kind of screw. Accidentally I possessed an instrument of a screw-like form. When properly thrown it screwed up all right, but did not return.

HOW TO THROW THE BOOMERANG.

Take the boomerang with the full fist by one end, so that the flat side of the instrument faces the ground, and then fling it away with outstretched arm, giving it at the same time a rotatory motion by a jerk with the wrist. In the moment of leaving the hand the boomerang should have an inclination toward the left, and its progressive motion should be in an upward direction under a certain angle of elevation. The angle of inclination to the left and the angle of elevation vary from one instrument to another, and have to be ascertained by some gentle trial throws for any particular instrument before the thrower applies the full power of his arm. The field for practice should be soft ground, free of stones or other hard objects. Throw it against the wind, or half against it. Do not practice when a hard breeze is blowing.

I do not enlarge here on the different curves the boomerang describes in accordance to its form and the manner of throwing, for it would be unintelligible, unless illustrated by actual experiment.