1.—NOTES ON THE MARKS OF PERCUSSION ON SILICEOUS ROCKS.

Pl. I. and II.

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(Read April 10, 1911.)

1. INTRODUCTION.

When a solid body suffers a blow, it is obvious that that portion of the energy of the blow that is not converted into heat, must give rise to vibrations radiating from the point of impact in all directions. It is further apparent that these vibrations may not only result in detaching a flake, but if the energy was large enough, there may be a surplus, resulting in vibrations which must give rise to accessory marks, not only on the parent block, but also on the detached flake. On the other hand, the energy may not be sufficient to achieve these results, yet it must leave some traces behind at that point of the surface where the blow struck, that is to say, the point of impact. We will thus have a wide range, beginning with the inefficient blow, that is to say, a blow which was not sufficient to detach a flake, and ending with a blow of such energy not only to detach a flake, but to give rise to numerous accessory marks of percussion. Between these two extremes there must be various stages, according to the force of energy applied and the result achieved.

It goes without further saying that the permanent effects of a blow must largely depend on the tenacity of the substance. The more ductile it is, the larger will be the energy required to detach a flake, and the more of it will be spent in the production of useless vibrations. The more brittle it is, the less energy will be required, and the larger is the amount of energy available for the production of accessory effects. The resistance to the transmission of oscillations created by the blow is another factor which is of great importance. The whole problem is, in fact, a physical one which ought in the first instance be treated on a mathematical basis, but I am afraid that it would be of little use to the Archæologist if dealt with in an abstract sense. From his point of view it is better to study the effects, the cause being known.

It is certain that these effects must be a function of the composition of the matter, supposing the energy being the same. The effects of a blow striking with the energy of 100 foot pounds, must be quite different if the substance be lead or antimony, a hornblende rock, jadite, nephrite, or flint. It would be outside the scope of this paper to investigate into the effects of blows on Hornblende rocks or Nephrite and other allied substances largely used in the manufacture of stone implements. I propose to deal here only with the effects of blows on that substance of which most of the stone implements are produced, viz., siliceous rocks.

In its purest form the siliceous minerals are represented by crystallised quartz, having 46.67 per cent. of silicon. Through the admixture of other substances, a large variety of minerals are produced, but in all of them the percentage of silicon is considerably smaller than in crystallised quartz. The mineral most commonly used in the manufacture of stone implements is flint in Europe, the various siliceous rocks resulting from the metamorphism of permian rocks, which are called chert or hornstone and porcellanite in Tasmania. (1)

However different in composition these minerals and rocks may be, they have one feature in common, viz., an exceedingly fine conchoidal fracture.

But even the casual observer cannot fail to notice that the nature of the fracture greatly varies in the different kinds of siliceous rocks. I have no data for determining what causes produce the most suitable fracture for the manufacture of implements. Pure rock-crystal and its nearest relation, chalcedony, have not, particularly not the latter, the same fine fracture, as, for instance, the impurer flint, and it seems certain that the quality of fracture does not depend on the pureness of the silica. In fact, the instance here quoted proves that the less purer mineral has a better fracture than the purer one. Natural and artificial glasses have an exceedingly good fracture, and it almost seems as if the quality of fracture were dependent on the presence of iron. I advance this theory with all reserve, as long and tedious chemical and physical examinations would be necessary to establish it.

In manuals and text-books of Mineralogy the fracture of siliceous rocks is described as "conchoidal," the surface produced by fracture having elevations and depressions in form like one-half of a bivalve shell.

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1) Noetling, Preliminary Note on the Rocks used in the manufacture of the Tronatta.—Pap. and Proceed. Roy. Soc., Tas., 1909, page 85.

2. HISTORICAL SUMMARY.

As far as my knowledge goes, the first who studied the mechanics of the fracture of flint was a Frenchman, M. Jules Thore, who published in 1878 a paper in the Bull. de la Soc. de Bord., Dax, on this subject. Unfortunately this journal is not available in Hobart, and it may be that much of what I am saying here has already been expounded in this paper.

Many authors, particularly Mortillet (1), Skertchly (2), and Sir John Evans (3), have given essays on the manufacture of gun flints, and the connection between this craft and the manufacture of stone implements. However valuable these observations may be, there is a great difference between the equipment of a modern gun flint manufacturer, and that of neolithic or palæolithic man, and it is more than probable that implements of the gun flint maker considerably differed from that of a Tasmanian, for instance. With regard to the latter, we know that his only implement for detaching a flake from a parent block was another stone, and even the more delicate work of marginal chipping was done by means of a stone, as the invention of pressing off small flakes by means of a piece of bone or stag's horn had not been made by the Tasmanians. The most important fact we can glean from all these accounts is the statement (4) "that success depends a great deal upon the condition of the flint as regards the moisture which it contains, those which have been too long exposed upon the surface becoming intractable, and there being also a difficulty in working those that are too moist." I can fully confirm this from my own observations and experiments. A pebble of chert taken from the gravel deposits, which still retains its moisture, flakes much better than the same kind of rock when found on the surface of an old camp. The next important observation is the statement that the surface must be struck at an angle of about 45deg., and that a spherically-ended hammer was used. All these accounts deal, however, more with the art of manufacture than with the mechanical effects of percussion, and even Sir John Evans has devoted only a few lines to this important subject. (5)

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(1) Musée Préhistorique, pl. II.

(2) Memoir, Geological Survey of England, 1879.

(3) Ancient Stone Implements of Great Britain.

(4) Ancient Stone Implements of Great Britain, page 18.

(5) Ancient Stone Implements of Great Britain, pages 273-274.

Apart from a diagram on the back of the cover of Prof. Schweinfurth's publication (1) I know only of one publication that more explicitly deals with this matter. Prof. M. Verworn, in his most interesting and important memoir on the archæolithic implements of the Cantalian (2) gives a complete description of the various marks produced by percussion. Previously G. and A. de Mortillet had drawn attention to certain features observable on flint flakes, which he took to be the most characteristic signs of an artificial nature of such flake. Prof. Verworn adds a considerable number of other marks which had hitherto been entirely overlooked, in particular he draws attention to the Strahlen spruenge (star-cracks).

Though very exhaustive, I do not think Prof. Verworn's study is quite complete, and my studies on the Tasmanian tero-watta (3) have afforded important additions on this subject. Though a good deal of what I have to say here will not be new to the student in Europe, it will be of the greatest interest to the Australian student. In particular I shall be able to prove that the "thumb mark" of the amateur collector is not an intentional, but quite an accidental feature.

3. THE MARKS OF PERCUSSION.

We will begin our studies ab ovo; that is to say, we will assume that an Aborigine found a boulder or pebble of such kind of rock as was suitable for the manufacture of a tero-watta. As I pointed out the nature of these rocks in a previous paper (4) I need not go here into further details. We will further assume that he obtained the boulder from a gravel deposit, and took it to his camping ground in order to break it at his leisure.

In most cases, particularly when the boulder was obtained from the diluvial gravel beds, its surface was covered with a crust due to weathering. This crust must

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(1) Deutsch-Französisches Wörterverzeichniss der die Steinzeit betreffenden Literatur, 1906.

(2) Die archæolithische Cultur in den Hipparionschichten von Aurillac (Cantal) Abhand. d. K. G. d. Wiss. Goettingen. Math. Nat. Classe, N.F., Vol. IV., No. 4, 1905, page 21.

(3) According to W. Schmidt (Zeitsch. f. Ethnologie, 1910, Heft. VI., page 915) either tero-na or tero-watta (tero-na-watta?) is the correct designation of the Tasmanian archæolithic implement.

(4) See this journal, 1909, page 85.

be distinguished from the patina, which formed later on the surfaces produced by flaking, though the original crust and the later patina are in fact only different stages of one and the same process, viz., chemical decomposition of the original matrix.

This boulder could be broken in two ways, either it was dashed against a hard object, or it was struck with another stone. It is obvious that the first method was very uncertain, and though it may have occasionally been resorted to (1), it is pretty certain that usually the boulder was broken by means of another stone, which served as a hammer, and which frequently must have been wielded with great force. Such hammer stones are by no means uncommon, particularly in quarries and it is a remarkable fact that, with very few exceptions, chiefly Diabas pebbles were used as hammer stones.

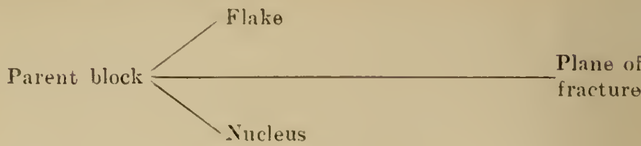
Whether other stones were used as anvils is not quite certain. A priori it is very probable that such stones were used, because it is easier to break a stone resting on a hard than on a soft, non-resisting surface. The nucleus from Kempton does not indicate that it rested on some hard material when it was broken, and so far I have not found any stones which I could definitely identify as anvil stones. It is, however, pretty certain that during the finishing process the tero-watta was held in the hand, and did not rest on an anvil. This is, however, a different question altogether, though it is of some importance because the marks of a blow on the stone held by the hand are probably quite different from those on a stone resting on a hard support.

We will now assume that the Aborigine, having provided himself with a hammer stone, struck the boulder with a strong, smart blow. It will be useful to explain a few terms before proceeding further. We may call the original boulder the "parent block," and every fragment that was struck off, however big or small it may have been, a "flake." What remained of the parent block after one or more flakes had been struck off is called "nucleus" or "core."

The parent block is, therefore, divided by a blow into flake and nucleus, the flake being the desired object, the nucleus the useless residue. It need hardly to be mentioned that more than one flake can be, and has been,

(1) Ling Roth, Aborigines of Tasmania, 2nd ed., page 151.

struck off a parent block before the desired one was obtained. We have therefore



We will now study the effects of this blow on the parent block; there are only two alternatives: either a flake was detached, or it was not. If the blow was effective, a flake of smaller or larger size was detached; but if it was not effective, the result must be a shattering of tne surface into countless splinters at that point where the hammer struck the parent block, viz., the "point of impact." It is further obvious that in order to detach a flake, the hammer must not penetrate into the matrix of the parent block. If it does, a good deal of the energy will be spent in shattering and pulverising the matrix, and the remainder of the force is probably not sufficient to detach a suitable flake. The hammer must also strike the surface in one point only, and for this reason a spherical hammer or a pebble is the most suitable implement. A flat or pointed hammer will either shatter the surface or penetrate into the matrix.

If the blow did not detach a flake, that is to say, if it was ineffective, such result may have been due to insufficient energy, or the penetration of the hammer into the matrix, or both causes. The result will, however, always be the same, viz., a shattering of the surface, and its intensity is determined by the energy of the blow and the resistance of the parent block.

A.—MARKS OF INEFFECTIVE BLOWS.

Traces of ineffective blows are frequently observed; they are particularly common on rejects in the quarries, and Plate I. gives a very good idea of the effects of an ineffective blow.

The principal result of an inffective blow is the production of a fairly deep impression or indentation whose surface is broken by numerous fine fissures running more or less parallel; the fine lamellæ of rock thus produced are intensively splintered by cross fissures, thus producing

REJECT FROM NICHOLS'S QUARRY WEST, MELTON MOWBRAY, SHOWING THE TRACES OF TWO INEFFECTIVE BLOWS.

a zone of intense destruction amounting almost to pulverisation of the matrix. It is impossible to mistake the marks of an ineffective blow; they are too characteristic.

Professor Verworn was the first who drew attention to this feature, which he calls "Splitterbrueche" (splinter-fractures), and he is of the opinion that they were the result of several blows administered to one and the same spot if the first blow was not sufficient to detach a flake.

This may be so with regard to the flint implements of Europe, but it certainly does not apply to the tero-watta of Tasmania. So far I have not found a single specimen which would corroborate Prof. Verworn's view. If the blow did not detach a flake, but produced splinter fractures only, the second blow was never administered to the same spot, but directed a little away from it. This may have had the desired effect or not, and another specimen from the same locality proves that at least three ineffective blows were placed side by side without detaching a flake.

B.—MARKS OF EFFECTIVE BLOWS.

(a) The Production of Flakes.

We will now examine the results of an effective blow, viz., one that detached a flake from the parent block. It is obvious that in order to be effective the blow must be administered with sufficient energy to overcome the resistance of the parent block, and the hammer must not penetrate into the matrix, and it must strike its surface at one point only.

It is further obvious that when a flake was detached from the parent block, that point of the surface which was struck by the hammer was on top, or nearest to the hand holding the hammer stone. The plane of fracture along which the flake was detached from the parent block must be nearer to its centre than its surface. The position of the parent block with reference to the workman, and the position of the flake with reference to the parent block enables us thus to distinguish five sides which must occur in every flake, viz.,

1. External face.
2. Internal face.
3. Proximal end or edge.
4. Distal end or edge.
5. Lateral edges

} as shown in Plate II. (1)

(1) It must be understood that Fig. 1 to Fig. 9, Plate II., are diagrams only.

1. EXTERNAL FACE (Indical Face). (E.F.)

It is obvious that the original crust or surface of the parent block must represent the external face of the first flake that was struck off. This flake may remain as it is, and it may be taken in use just as it fell off, or else it may be considerably altered by chipping, to such an extent that sometimes hardly any trace of the original surface is left.

The external face, or, as I prefer to call it the Indical face, is always more or less convex, only in rare instances it is flat. (See later, Internal Flakes). The term "external flake" may appropriately be used for all flakes, whose indical or external face is formed by the original surface of the parent block.

2. INTERNAL FACE (Pollical Face). (I.F.)

It is obvious that the internal face, or, as I prefer to call it, Pollical face, is opposite the external one, and must represent the plane of fracture along which the flake was detached from the parent block. It is, therefore, unquestionable that if there are any marks of any kind on it, the negatives of such marks must appear on that part of the nucleus where the flake became detached.

The internal or Pollical face is usually flat, sometimes slightly convex towards the proximal end, but it never attains the convexity of the external face. The accessory marks of percussion must always appear on the internal face (1).

3. THE PROXIMAL END OR EDGE (p.e.)

That portion of the flake which was struck by the hammer stone may be called the proximal end or edge. It is obvious that the proximal end must bear the strongest effects of percussion, having sustained the first impact.

4. THE DISTAL END OR EDGE (d.e.)

That portion of the flake opposite to the point of impact or proximal edge may be called distal end or edge.

(1) It is hardly necessary for me to explain that it is the case of an external flake just as it fell off, and not of one whose external or indical face was subsequently wrought.

Being furthest away from the point of impact, the marks of percussion must decrease in intensity from the proximal towards the distal edge.

5. THE LATERAL EDGES.

Strictly speaking we should also distinguish between the lateral edges but it is clear that the terms "right" and "left" will be misleading, because the right edge of the Indical face is the left of the Pollical face and vice versa, with regard to its left edge.

In my descriptions, and unless space or other reasons do not permit it in the illustrations, I always place a flake in such a way that its proximal end represents the top, the Pollical face being looked upon. In this position I apply, for want of any better ones, two nautical terms. I call the left side or edge, port side or port edge, and the right side, starboard side or edge (1). Thus, if we speak of the port side or edge of the Indical face, we know it is exactly opposite of the port side or edge of the Pollical face, while if we were to speak of the left edge of the Indical face, we were always obliged to add "which represents the right edge of the Pollical face."

The two faces are of necessity always well defined, but as the intersection of the plane of fracture with the surface of the parent block, the line of fracture must form a closed curve, the lateral edges are frequently not so distinctly set off against the distal edge. This is particularly shown in the semi-crescent flakes whose distal and lateral edges merge into one semi-lunar curve.

The above features are characteristic of the external flake, but they must be somewhat modified with regard to the external Indical face, should there subsequently more flakes be struck off the same parent block.

The Tasmanian Aborigines had two ways of further treatment of the parent block after the first external flake had been struck off. We will assume that Plate II., Fig. 2 be the first external flake that was struck off. As already stated, the negatives of all marks on its Pollical (internal) face must appear on the nucleus.

We will now assume that the next flake (Plate II., Fig. 4) was detached from the parent block by a plane of fracture that was approximately parallel to that which separated the

(1) If anybody can suggest better terms than these two which avoid the misleading words "left" and "right," I am only too pleased. For the present I cannot find anything better.

first one. In other words, that the parent block was turned and the hammer struck again the surface. The flake thus detached cannot strictly be called an external flake, though some portion of the original crust is still present in it. We notice, however, that it is in a different position; instead of being present on the external face, it is now on the proximal end of the flake. The external (Indical) face of this flake is really the counterpart (negative) of the first flake that was detached from the same block.

Flakes of this type may be called internal flakes, and the nucleus of Kempton, with its 43 flakes, affords an excellent illustration of this type. The external (Indical) face of the last flake that was struck off is formed by the negatives of the internal faces of the two previous flakes, their planes of fracture intersecting at an angle, and thus producing a ridge extending more or less medially from the proximal to the distal end. (Fig. 4a.)

All flakes having one or more ridges extending from the proximal to the distal edge, which are usually called "knives," are internal flakes, because it is indubitable that long and flat planes cannot be produced by subsequent trimming or marginal chipping, but they must represent the planes of fracture of previous flakes; in other words, the negatives of the Pollical (internal) face of such flakes (1).

To the European mind the above seems to be the most sensible method of striking off flakes. The mind of archæolithic man, including the Aborigines, hit, however, on still another one.

Though I have not found, so far, a core and flakes illustrating this other method, the proofs are ample enough in the shape of implements. Theoretically the external flake should have sharp edges all round, because the plane of fracture intersects the surface of the parent block in a line. Specimens of this type are not very common, most of them I found at Devonport. If, however, a larger number of tero-watta is examined it will be noticed that though they are unquestionably external flakes, the proximal end, instead of forming an edge, is truncated by a plane, which I call "Percussion Face, P.F.," for reasons explained further on, which always forms an obtuse angle with the Pollical (internal) face. If the implement is, as is usually done,

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(1) The famous Aurignac knives appear to me to be internal flakes, and their peculiar form is, in my opinion, not the result of a deliberate intention, but more probably due to the manner by which the flakes were detached from the parent block. (See also the figure in Sir John Evans' book illustrating the manufacture of gun flints.)

placed in such a way that the pollical (internal) face forms a right angle with the horizontal, this plane is always inclined towards the Pollical face.

I have made a few measurements to determine the angle formed by these two planes, and find the following angles:—

Tero-watta from	Pontville (Shene)	123deg.
,,	Rose Dale	124deg.
,,	Merton Vale	127deg.
,,	Winton	129deg.
,,	Maryvale	130deg.
,,	Hutton-park	133deg.
,,	Old Beach	135deg.

The size of this angle is significant, and its importance will be explained later on.

The Percussion face exhibits a very characteristic feature; its "radial" diameter, that is to say, the distance from the external to the internal edge is always smaller than the distance from side to side, the "peripheral" diameter. As both edges are convex, the internal one usually less than the external, the outline of the plane of percussion is that of a spherical bi-angle, the two points being at the port and starboard side respectively.

Of course, this lenticular shape is not always well preserved, and more often than not, only traces remain, particularly when there is marginal chipping along its external edge.

There cannot be the slightest doubt that the Percussion face is the remainder of an old plane of fracture which was formed when a former flake, whose internal (Pollical) face now forms an angle of about 135deg., with the internal (Pollical) face of the second flake was struck off the parent block.

In order to understand this fully we must revert to the first external flake, and Plate II., Fig. 2a., will further illustrate this. Let us assume that the first external flake (No. 1) was struck off the parent block, the remaining nucleus then exhibited on one side a more or less level or flat plane representing the plane of fracture. This plane must of necessity be the negative of the external (Pollical) face of the external flake (No. 1) struck off, and if we were to proceed according to the first method, it would form the external (Indical) face of the next flake, i.e., the internal flake, 1st order (No. 2.) The Tasmanian Aboriginal, as well as archæolithic man in Europe, treated such a nucleus differently: he turned the parent block round till the plane of fracture was fairly level, and then struck it with a smart, sharp blow at an angle of about 45deg. If the blow was effective, the flake became detached, and it is easy to see that if the blow fell under an angle of 45deg., the new plane of fracture, that is to say, the Internal or Pollical face of the new flake must form an angle of 135deg. with the old one. (See Fig. 2a.) Hence the significance of the angle formed by the Percussion face and the Internal (Pollical) face, because we can gauge from it the angle under which the hammer stone struck the parent block. In the specimens mentioned above it would be.

Tero-watta from	Pontville (Shene)	57deg.
,,	Rosedale...	56deg.
,,	Merton Vale	53deg.
,,	Winton	51deg.
,,	Maryvale...	50deg.
,,	Hutton-park	47deg.
,,	Old Beach	45deg.

These figures prove conclusively the statement which, if I am not mistaken, was first promulgated by Sir John Evans, that in order to be effective the critical angle under which the hammer must strike the parent block is approximately 45deg.

It is now also clear why this plane of fracture is called the Percussion face.

We might call flakes thus detached external flakes of the second order, and such a flake would exhibit three faces, viz.:—

(2)
Percussion Face.

Internal (Pollical) Face. (3)

External (1) (Umbilical) face.

The External face being the oldest, the Percussion face the next, and the Internal face the youngest in order of succession. The last two representing planes of fracture, the first the original surface of the parent block.

It must, however, be understood that these features are generally not as simple as here described; frequently the external (Indical) face is considerably changed by striking off small flakes in order to reduce the thickness of the implement. Equally often the Percussion face has entirely disappeared, or is greatly reduced in size by marginal chipping along its external (Indical) edge. This is particularly the case in tero-watta that are carefully worked all round by marginal chipping. It is, however, always possible to locate from the marks of percussion exhibited on the internal (Pollical) face the position of the Percussion face, and it is very seldom, even in the most highly finished tero-watta, that not a trace of the Percussion face can be discovered.

It is, of course, quite feasible to strike off several external flakes of the second order from one and the same parent block, after a good working plane of percussion had been produced by the detachment of the external flake of the first order. No doubt this has been frequently done, but it is also probable that internal flakes were struck off. Such internal flakes should show a portion of the original crust at the distal end (unless it was removed by subsequent chipping), besides a percussion plane, which may, however, also have been removed by marginal chipping. The fine knife-like tero-watta figured in my paper, "Notes on the Tasmanian Amorpholithes" (Fig 23, 23a, 23b), most probably represents a flake of this type.

It will be easily seen how these flakes, which we may call Internal flakes of the second order (Fig. 5a), differ from those of the first order. In the latter there is no real Percussion face, the plane of percussion being formed by the original surface of the parent block. Unless removed by chipping the internal flake of the first order should have a fragment of the original crust adhering at the proximal end, and there may also be some of it at the distal end. The last flake struck off the nucleus from Kempton is a typical example of an internal flake of the second order.

The above characters, distinguishing the different kind of flakes, are summarised in the following table:—

External (Indical) Face formed by the original crust of the parent block: I. EXTERNAL FLAKES.	1. External and Internal Face only, original crust forms plane of Percussion.	External Flakes of 1st order, Fig. 2.
	2. External, Internal, and Percussion Face, plane of Percussion represents a former plane of fracture.	External Flakes of 2nd order, Fig. 2a.

External (Indical) Face formed by the plane of fracture of former flakes: II. INTERNAL FLAKES. (Usually distinguished by one or two longitudinal ridges on the Indical face.)	3. External and Internal Face only, original crust forms plane of Percussion and is if preserved at proximal end.	Internal Flakes, 1st order, Fig. 4 and 4a.
	4. External, Internal, and Percussion Face, original crust is if preserved at distal end.	Internal Flakes, 2nd order, Fig 5. and 5a.

External flakes of the first order are not very common; of this class are the most primitive types of human implements produced from the fracture of siliceous rocks. External flakes of the second order form the great majority of the tero-watta, and they frequently show a most elaborate finish of the Indical (external) face.

Internal flakes are apparently rarer than the former; the last flake struck off the Kempton nucleus forms an exceedingly good type of the first order; the second order is apparently more common than the first, and all the tero-watta, generally called knives belong to this group.

C.—ACCESSORY MARKS OF PERCUSSION ON THE INTERNAL (POLLICAL) FACE.

The accessory marks of percussion are strictly limited to the internal (Pollical) face, where they extend from the internal edge of the Percussion face all over the surface up to the distal edge. These are:—

1. The process of percussion.
2. The cone or bulb of percussion.
3. The concentric wrinkles of percussion.
4. The scar of percussion.
5. The radiating fissures of percussion.

1. THE PROCESS OF PERCUSSION (P.P.)

Pl. II., Fig. 3.

The process of percussion does not often occur; if it does, it invariably forms a kind of projection of the pollical edge of the percussion face, as will be seen from Plate II., Fig. 3.

I cannot find any reference to this peculiar effect of percussion, but it is unquestionable that it represents nothing but the top of an abortive cone of percussion.

Professor Verworn mentions certain features which he calls "conical fissures" occurring on the percussion face. These conical fissures turn their convexity towards the indical face, while the convexity of the process of percussion is directed towards the pollical face.

There is no doubt that both features are closely connected, probably representing a more or less imperfect cone of percussion.

I never observed conical fissures in the Tasmanian tero-watta, while it seems that the process of percussion has not been observed in European archæolithes. This may probably be due to the difference in the nature of hornstone and flint, though it requires further obesrvations before this view can be considered as certain.

2. THE CONE OR BULB OF PERCUSSION (C.P.)

Pl. II., Fig. 6.

Perhaps the most characterisitc feature is the cone, or, as it is frequently called, the bulb of percussion (1). It is always situated at the proximal end of the Pollical face, and its point merges into the Percussion face. (Plate II., Fig. 6.)

The occurrence of this cone in the Tasmanian tero-watta is rather peculiar. In the first instance, it represents always a truncated cone, the point being cut off by the Percussion face; secondly, it is always composite, being composed of several cones showing different angles of sides, the top portion showing invariably a more acute angle than lower portion. Generally two cones, separated by a sharp edge, are formed. The top or proximal cone showing an angle of about 30deg., the lower, or distal cone, having an angle of about 60deg. In rarer instances the lower portion is composed of two cones, whose angles, however, differ very little. So far I never observed that the top cone was divided into two portions.

Sir John Evans has given a very ingenious explanation of the origin of the cone of percussion. The only question we might ask is, how is it, that if this purely mechanical explanation be correct, that the cone of percussion is only produced in siliceous rocks and minerals?

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(1) The term bulb of percussion was according to Sir John Evans first used by the late Dr. Hugh Falconer.

3. CONCENTRIC WRINKLES OF PERCUSSION (W.P.)

Pl. II., Fig. 9.

The vibrations of the molecules which gave rise to the cone of percussion at the point of impact must necessarily decrease in strength with the distance from this point. Instead of a cone, curious concentric wrinkles are produced, exactly like those caused by a stone thrown into water. Plate II., Fig. 9, illustrates this feature:—

Professor Verworn has already observed that these wrinkles form an invaluable assistance in determining the oroximal end of an archæolithic implement, their concavity being invariably turned towards the point of impact. This is a matter of course, because the point of impact forms the centre from which the vibrations radiate, and the wrinkles produced on the Pollical face must naturally represent concentric circles.

It sometimes happens that one of these wrinkles coincides with the line of fracture. In that case the edge is not sharp, but rounded off, and, therefore, useless for cutting puropses. It requires sharpening by marginal chipping (retcuches). I have several fine specimens in my collection, showing the partly sharpened edge, while another portion still preserves its original rounded-off shape. Considering that the curvature of the wrinkles is turned towards the Indical or External face, it is rather difficult to understand why the marginal sharpening was produced by blows directed from the Pollical towards the Indical face, and not vice versa, which seems so much easier and more effective. This is again one of those problems which puzzle the modern mind, and which I have frequently met with in the course of my researches. The only explanation I can offer is, that the archæolithic Tasmanian could not possibly think of any other way of sharpening the edges than by blows directed from the Pollical face towards the Indical face; it was apparently impossible for him to conceive any other method, and if ever he happened to make a mistake, he promptly corrected it by reverting to the time-honoured method.

4. THE SCAR OF PERCUSSION (S.P.)

Pl. II., Fig. 7.

Frequently there appears on the Pollical face, instead of either cone or wrinkles of percussion, an ellipsoidal mark.

separated by a sharp edge from the remainder of the surface; it usually represents the highest part of the Pollical face, and inside the edge it is slightly concave.

The longitudinal axis generally runs in the direction of the blow, i.e., from the proximal to the distal end, and the top coincides with the Pollical edge of the plane of percussion.

Inside the sharp edge there are sometimes faint concentric wrinkles, but they never extend beyond the edge.

This is the "thumb mark" of the amateur collector, and though there is no doubt that the thumb rested on the flat Pollical or Internal face, the scar of percussion is not an intentional, but purely accidental feature.

A combination of cone and scar of percussion is often observed; in that case the scar commences some distance below the point of the cone, and the concentric wrinkles run diagonally.

5. RADIATING FRACTURES OF PERCUSSION (R.P.)

Pl. II, Fig. 8.

On either side of the marks above described there appear frequently, though not always, short, closely set, splintery fractures, radiating from the point of impact. Sometimes they may also appear on the top cone, but they are generally limited to both sides. It often happens that these radiating fractures are the only signs of percussion on the Pollical face, and then they are just as valuable in determining the point of impact, and therefore the proximal end, as any of the other marks. Professor Verworn was the first who noticed these "Strahlen-spruenge," as he calls them, but a comparison of his figure with a Tasmanian tero-watta seems to indicate that though due to the same cause, the "ray fissures" are not quite identical with the "radiating fractures." Verworn's "ray fissures" are true fissures radiating from the point of impact apparently all over the Pollical face; the "radiating fractures" of the tero-watta are certainly not fissures; on either side of the cone, scar or wrinkles of percussion, close to the point of impact, the surface does not flake smoothly, but the force apparently produces a number of thin lamellæ, which, by breaking off, produce this peculiar feature.

It is more than probable that the different chemical composition of flint and hornstone produces these somewhat different features, of what must be considered one and the same effect of percussion.

CONCLUSION.

The accessory marks above described represent the five principal mechanical effects of percussion, but it must not be supposed that they always occur together in one and the same specimen. In fact, so far, not a single specimen has come under my notice which exhibits all of them simultaneously. The production of accessory marks of percussion is unqestionably influenced to some degree by the mineralogical nature of the rock. The cone of percussion is more frequent in the porphyritic breccia and porcellanite than in chert or hornstone rock; while, on the other hand, the concentric wrinkles of percussion are always well defined in chert or hornstone, while hardly noticeable in porcellanite or porphyritic breccia.

The shattering of the surface is also always much better shown in chert or hornstone than in any of the other rocks.

It is therefore certain that the nature of the rock influences the character of the marks of percussion. The different composition must produce a different resistance to the transmission of vibrations, and as a result we may anticipate the production of certain marks in preference to others in certain rocks.

But though this may be so, it is impossible to say at this stage, what amount of energy was required to produce a certain effect. So far, all we know is that a flake, however large its size, was detached by a simple blow only from the parent rock. It is further very probable that failure was not chiefly due to insufficient energy, but probably more to the hammer stone not striking the surface at the critical angle of about 45deg. The intense shattering of the surface which denotes the ineffective blow proves conclusively that the blow was administered with great force, yet no flake was detached. Insufficient energy can, therefore, not have been the sole reason of failure; it might be argued that the ineffective blow was administered by inexperienced hands; for instance, of children. This may be so or not, it only proves that these hands had not learnt to direct the blow at such an angle towards the surface that the energy was utilised in detaching a flake, and not shattering the surface. The same may also frequently have happened to older and more experienced hands.

Though we can, therefore, to some extent account for the marks of the ineffective blow, it is impossible to say what caused the accessory marks of the effective blow. If we take it that the sole object of the effective blow was the detaching of a flake, any marks accidentally produced during this process must represent wasted energy. In other words, if a certain amount of energy had not been wasted in the production of these marks a much smaller force would have been sufficient to detach a flake. The distinctiveness of the accessory marks of percussion may, in some way, be a measure of the quantity of misspent energy, but this does not explain why either cone, scar, wrinkles, or a combination of these three prominent marks were produced. It is, perhaps, probable that the angle under which the hammer struck the parent block has something to do with the production of these marks. It is certain that the best effect was produced when the hammer struck at an angle of 45deg.; if the hammer struck the surface at an angle of 90deg., the result was most probably intensive shattering, but no detachment of a flake. It is, therefore, very probable that the accidental marks of percussion are a function of the angle under which the hammer struck the surface of the parent block. In all probability they are the results of blows that struck the surface at an angle of more than 45deg. and less than 90deg. This view is greatly supported by the evidence of the tero-watta above mentioned; in the tero-watta from Old Beach, which was detached by a blow that struck the percussion face under an angle of 45deg., there are hardly any accessory percussion marks, while all the others show them to a great extent. It is obvious that the smaller the angle was under which the hammer struck, the less was the effect, and it is more than doubtful that a blow directed at an angle of less than 30deg. will have any other effect except just grazing the surface.

Sir John Evans's observation further seems to confirm this view. He says (1):—"If a blow from a spherical-ended hammer be delivered at right angles on a large flat surface of flint," the result will be the cone of percussion. If this view be correct, the cone of percussion would represent one extreme, the neatly detached flake without any accidental marks, the other extreme of the line extending from 45deg. to 90deg., and all other marks would be produced by blows striking the surface between these two extremes.

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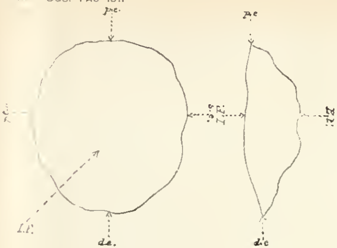
(1) l.c., page 273.

I am, unfortunately, not in the position to verify this theory by experiments, which can only be carried out in a laboratory well equipped for such purposes. It would, however, be of the greatest interest if such experiments were made, if for no other purpose than to prove or disprove the view that such marks can be produced by other than human agency.

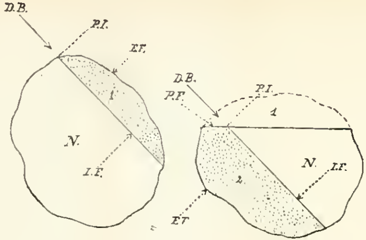
During the early part in the controversy that was going on about the origin of the Eolithes, or, as I prefer to call them, Archæclithes, it has been frequently held that natural agencies could produce such marks of percussion as here described, and even Prof. Verworn assumes that natural processes could produce them. If a siliceous rock falls from a great height on a hard surface, it is very probably broken if the energy developed be sufficient. If the pebbles moved by the energy of a torrent strike against each other, flakes may probably become detached; even if the force of the surf hurls the pebbles of the shingle against hard objects it is possible that they may be broken, but will all this result in the marks of percussion here described? I certainly doubt it; never have I noticed among the shingle broken pebbles showing marks of percussion, nor did I notice them anywhere else.

I maintain that any of the marks of percussion here described, including those of the ineffective blows, cannot be produced accidentally by natural agencies, but only by the agency of a hammer held by a human hand intentionally striking a stone. And, furthermore, in order to produce them it must be a spherically-ended hammer, that is to say, a pebble, which hits the surface in one point only. Even if this view were considered to go too far, it is absolutely certain that all specimens showing a Percussion face, and on whose Pollical face the accessory marks of percussion appear, must be produced by human agency, because it is impossible to assume that a boulder was first divided by any kind of natural agency and afterwards a similar agency acted on the plane of fracture detaching thereby a flake.

My studies have led me to believe that, next to the Percussion face, the five accessory marks of percussion are the surest signs of human agency. Retouches or rough marginal chipping may be produced by natural agencies, tending to press or break off small splinters, but the marks here described can only be produced by a hammer striking one point of the surface, and not penetrating into the matrix.



Figs. 1 and 1A.



Figs. 2 and 2A.

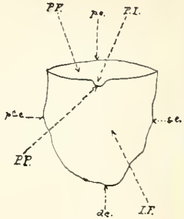
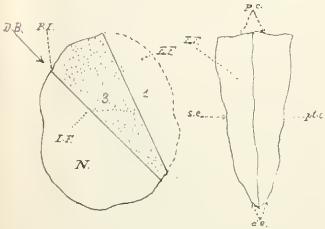
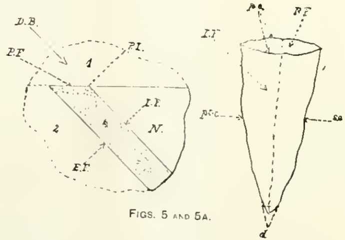


Fig. 3.



Figs. 4 and 4A.



Figs. 5 and 5A.

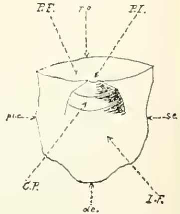


Fig. 6.

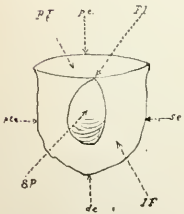


Fig. 7.

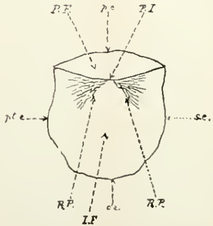


Fig. 8.

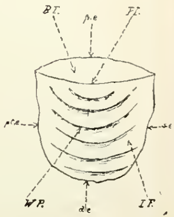


Fig. 9