SOME REFLECTIONS ON MAN'S PAST AND FUTURE*

PHILLIP V. TOBIAS, D.SC., PH.D., M.B., B.CH., F.R.S.S.AF., *Head of the Department of Anatomy, University of the Witwatersrand, Johannesburg*

'We, mankind, contain the possibilities of the earth's immense future, and can realise more and more of them on condition that we increase our knowledge and our love.'[1]

Sir Julian Huxley

Man's past and future—the title summarizes 2 of the most agonizing questions with which modern science grapples: whence our origins, and whither our destiny? We who ask these questions are trying to take a god's-eye-view of man's evolution—yet we are ourselves evolving men, part of the very process we are trying to study. This fact lends truth to Huxley's felicitous comment, 'In modern scientific man, evolution is at last becoming conscious of itself'.

In looking for leads to the future of man, we are immediately beset by thoughts of the population explosion, organ transplantation, eugenics, AID and the pill. Yet we find no lead from these current trends as to the kind of man we are to produce. Will he resemble the automata of George Orwell's *1984* or of Aldous Huxley's *Brave New World*? Or will he be permeated by the gentler spirit of Robert Graves's *Watch the North Wind Rise* and of Teilhard de Chardin's *The Phenomenon of Man* and *Le Milieu Divin*?

In our striving to visualize, and to plan for, tomorrow's man, the only sure guide is to trace the route by which man has travelled hopefully out of the past into the present. This may provide the signposts which will help us to plot his course to the future. For tomorrow's man is the extrapolation of today's man—and what is today's man but the child of yesterday's man? If only we can read the lines of development linking man of the past with man of the present, we shall have a basis for extending such lines into the future.

We have already learnt much about the past. Within the borders of this Republic of South Africa are among the world's richest sites bearing on man's origins. Some of the most significant contributions to the world's stockpile of knowledge on human evolution have been made by scientists working in this part of the globe. For decades, these sites, these fossils and these scientists have drawn to South Africa scholars of distinction from many parts of the world. Here is one field in which South Africa is uniquely placed to lead the world. The ground is favourable for the establishment here of an international school of human evolutionary studies. Not only our fossil sites and facilities point up this need. With our diverse populations, differing in their frequencies of genes, in nutrition, in form and level of economy and education, in climatic and physical environment, we have almost unrivalled opportunities for the study of *ongoing* human evolution.

At this moment of evolutionary self-consciousness, let us survey the road we have traversed, to see whether we can discern any shapes, any signposts, any pathways.

*A condensed version of the Vth Annual Raymond Dart Lecture delivered in the Great Hall of the University of the Witwatersrand on 5 March 1968, and repeated by invitation as a public lecture delivered to the University of Stellenbosch on 21 March and to the Wits. Alumni Club of the Western Province on 22 March. The full version of the lecture has been published by the Institute for the Study of Man in Africa.

THE PROOF OF HUMAN EVOLUTION

It is now just over 43 years since Professor Dart discovered the famous fossil skull of Taung,[2] which was to change man's very concept of the nature of man. The species represented by the child skull Dart called *Australopithecus africanus*. He claimed that the creature was basically an ape, which, nevertheless, showed many departures from typical apes. These departures were in a human direction. The young Taung child showed more hominizing features than any of the known living or extinct man-like apes. Dart claimed that it had reached the threshold of humanity. Later, with more specimens, detailed studies of them, and knowledge of the variability of other higher primates, most scientists have come to agree that *Australopithecus* should be classified as a member of the family of man, that is, a hominid.

It is no exaggeration to claim that the discovery of the Taung skull and Dart's recognition of its true status provided the world with its first proof that the theory of evolution applied to man himself. Of course, there had for a long time been a reasonable presumption that man had evolved from non-human origins. The detailed structure of man's body showed hundreds of points of resemblance to that of apes and other primates. These common anatomical patterns spoke strongly in favour of common descent and common ancestry. Further, the stages traversed by a modern human embryo and foetus so faithfully repeat the developmental history of other vertebrates that, again, a common ancestral history seemed clearly to be indicated. Indeed, Charles Darwin in his book, *The Descent of Man*, in 1871, had assembled a great number of facts strongly suggesting that man, too, was a child of evolution and had been subject, like all other living things, to the action of natural selection.

All this was, however, indirect evidence. Man's evolution remained an inference from observations on living beings. The actual fossilized embodiment of man's non-human ancestors remained elusive. Yet, the fossil evidence would be the acid test: for the fossils themselves are, after all, the hardest of the hard facts of evolution. Far too many scientists, then as now, have contented themselves with pronouncements on hominid evolution, without ever having handled and studied the fossils themselves. Far too many have adopted standpoints and postures based on first principles and indirect reasoning. First principles in any field of scientific endeavour are important, but their application must be tempered by the cold steel of the facts.

At the time of Dart's discovery of the Taung fossil in November 1924, some human fossils were indeed known. But none of the earlier discoveries, such as those of Neandertal Man in Europe and of *Homo erectus* in Asia, provided the crucial proof that man had evolved from animal origins. These earlier remains were simply extinct races or species of man—their manhood was unquestionable. It was still possible to believe, as many did, that, while other animals had evolved, man had been a special creation. The theory of evolution, as applied to man, remained unproved. What was needed to demonstrate man's evolution was a fossil or group of fossils, so thoroughly intermediate in structure between man and other animals, that it would be difficult to decide on which side of the line it fell.

Exactly such a specimen was the Taung skull. It was yet earlier than *Homo erectus*. The cave deposit has been assigned to the Lower Pleistocene. It was yet lowlier in anatomical structure, so much so as at first to leave serious doubts whether it was indeed in the hominid family, or whether it was simply another ape. Its borderline position is testified to by the very fact that controversy over its status has raged about its little head for 25 years!

The passage of time provided abundant confirmation that Dart was right and that *Australopithecus* was an early hominid. Perhaps future historians of science will see the Taung discovery in this perspective and will recognize it, and what Dart made of it, as South Africa's greatest contribution to world science. It was a breakthrough so significant and so far ahead of its time that it can fairly be claimed the world was not ready for it; much as the world had not been ready for Mendel's discovery of the laws of heredity in 1865.

LOOKING BACK ON MAN'S ORIGINS IN AFRICA

All that followed simply represented a filling-in of fine details; a collecting of further evidence with which to confirm Dart's hypothesis. The confirmation of the hypothesis might have waited for decades had it not been for the efforts of such people as Broom, the Leakeys, Robinson, Le Gros Clark, Zuckerman, Brain, Hughes, Kitching, and many others. Australopithecine fossils are today known from 11 or 12 sites in Africa (Table I). Five are in the Republic of South Africa: they are Taung, Sterkfontein, Kromdraai, Makapansgat and Swartkrans.

TABLE I. DATES OF DISCOVERIES OF AUSTRALOPITHECINE FOSSILS (COMPILED MARCH 1968)

South Africa	
1924	Taung
1936 - 1968	Sterkfontein
1938 - 1954	Kromdraai
1947 - 1961	Makapansgat
1948 - 1967	Swartkrans
Tanzania	
1939	Garusi
1955 - 1969	Olduvai
1964	Peninj
Kenya	
1965	Kanapoi
1965	Chemeron, Lake Baringo (?)
1967	Lothagam (?)
1968	East Rudolf
Ethiopia	
1967 - 1968	Omo

(?) = probable australopithecines.

The Taung deposit is no longer in existence, having been removed by lime-working activities. Three of the remaining 4 sites are being actively worked at present.

The Makapansgat site has been studied by the University of the Witwatersrand continuously since 1945 - 1946, when, as a student, I led an expedition which recovered extinct baboon fossils from the lime-works. Two years later, a cranial part of an *Australopithecus* came to light at Makapansgat, followed over the years by several dozen others. Today, 21 years later, we are still excavating the site; extracting fossil bones from the hard, bone-bearing breccia; studying the fossils, and bone and stone tools which Maguire and others have been amassing down the years.

At Swartkrans, Dr C. K. Brain started a new and systematic excavation in April 1965, and this is still continuing. Already important new australopithecine specimens have fallen into his hands.[3]

At Sterkfontein, Alun R. Hughes (of the Anatomy Department) and I started a new large-scale and long-term excavation in December 1966, and here, too, work is actively under way. At all 3 sites, enough unexcavated material remains to keep us busy for many years ahead.

Kromdraai is not at present receiving attention but abundant material remains for further excavation.

Countries Outside South Africa

In East Africa, there are 3 australopithecine sites in Tanzania—the incomparable Olduvai Gorge, and two lakeshore sites, Garusi near Lake Eyasi and Peninj near Lake Natron. Three more probable australopithecine sites occur in Kenya. One is the Chemeron locality near Lake Baringo in Central Kenya. The others are Kanapoi and Lothagam near the south end of Lake Rudolf. The remains from these 3 sites are fragmentary. From Chemeron has come an isolated temporal bone, whose exact affinity I concluded we could not determine without further material being uncovered, though it could well be australopithecine.[4] The Kanapoi find is a part of a humerus or arm-bone and its describers have concluded that it is australopithecine.[5] From Lothagam has come a piece of lower jaw-bone.

Finally, near the northern end of Lake Rudolf in Ethiopia, a recent multinational expedition has, in its first field season, recovered hominid remains including an australopithecine mandible and isolated teeth.[6,7]

Thus, an appreciable length of the Great Rift Valley, from Tanzania in the south to Ethiopia in the north, has yielded early hominid remains. Some of the fossils from this area have been dated by the application of a radioisotope technique, the potassium-argon method, as well as by an independent technique, the study of fission-tracks. Contrary to earlier ideas that the ape-men lived about 600,000 to 1,000,000 years ago, it is now known that their antiquity is 2 or 3 times as great! *Australopithecus boisei*, the exceptionally robust and beautifully preserved specimen from Bed I in Olduvai Gorge, lived about 1·75 million years ago. Even older are the hominids from further north: the Kanapoi humerus is dated at 2½ million years and the Omo mandible at about 2·6 million years. Yet most of these are in deposits formerly classified on their contained animal bones as Pleistocene. Thus, the lower boundary of the Pleistocene geological epoch has been pushed back from 1 million to about 3 million years.

Unfortunately, none of the 5 South African sites contains volcanic materials on which the potassium-argon technique has been so successfully employed in East Africa. Our procedure here has been based on two methods of relative dating: the analysis of animal fossils found in the same deposits as *Australopithecus* and the analysis of the deposit itself by methods applied by Brain.[8] The impression gained so far from faunal comparisons is that the oldest South African australopithecine sites are probably somewhat older than Olduvai Bed I. That is, Taung and the basal part of Sterkfontein seem to be older than 1·75 million years. We have no idea of the age of the South African sites relative to the Lake Rudolf sites, which are about 2½ million years old. Yet much hinges on the relative ages of the East and South African sites. We have therefore set as a major target in our new excavation programme a search for suitable heavy metals in the South African sites, from which radio-isotope or even fission-track dating might be obtained.

Parallels in South and East Africa

Both in South and in East Africa, at least two kinds of australopithecine have been found. One is more robust, with big premolar and molar teeth, heavy muscle markings, and a low forehead; the other is more gracile, has somewhat smaller cheek-teeth and muscle markings, and a higher forehead. In both parts of the continent, the gracile fossils occur in the earlier deposits and the robust ones in the later deposits. In South Africa, faunal dating separates our 5 sites into 2 distinct groups: the earlier (Taung, Sterkfontein Lower and Makapansgat) contains gracile australopithecines (*A. africanus*); while the later group (Swartkrans and Kromdraai) contains robust australopithecines (*A. robustus*). In East Africa, of 3 sites dated by potassium-argon, the earlier 2 (Kanapoi and Omo —2·5 million years) contain specimens most similar to our gracile *A. africanus*, while the later one, Olduvai Bed I (1·75 million years), contains an exceptionally robust australopithecine (*A. boisei*). Another still later site is Peninj and here, too, a robust australopithecine has been found (Table II).

TABLE II. SEQUENCE OF AUSTRALOPITHECINE SITES IN SOUTH AND EAST AFRICA

Australopithecine sites	*South Africa*		*East Africa*	
Later sites	Kromdraai, Swartkrans	*A. robustus*	Peninj, Olduvai (Bed I)	*A. boisei*
Earlier sites	Makapansgat, Taung, Sterkfontein (Lower)	*A. africanus*	Omo, Kanapoi	cf. *A. africanus*

Table II does not mean to suggest that the ages of the South African and of the East African 'earlier sites' are the same; nor of the 'later sites'. That would be premature before we have any 'absolute' dates for the South African sites. All it means to convey is that, within each of the two parts of the continent, present evidence suggests that the gracile australopithecines preceded the robust australopithecines. The same sorting has been arrived at by faunal comparisons in South Africa and radio-isotope dating in East Africa. The convergence of the two sets of results obtained by two entirely different techniques in two different parts of the continent, on to a single end-pattern, is remarkable.

A further interesting parallel is the fact that two kinds of hominid, *Australopithecus* and *Homo*, are present side by side only in the later sites. At Swartkrans, alongside *A. robustus*, we have a contemporary whom most workers accept as a member of *Homo*. Similarly, among the later sites in East Africa, Olduvai Bed I contains 2 hominids. They are *A. boisei*, the hyper-robust australopithecine, and a small-toothed, more hominized hominid which has been called *Homo habilis*.[9]

Yet a third interesting parallel is the fact that cultural stone tools have been excavated only in the later deposits: at Swartkrans, Olduvai Bed I and Peninj. No stone tools have, on the other hand, been excavated in the earlier Pleistocene deposits. Only Makapansgat, of the earlier sites, has yielded signs of implemental activities, both in bone and stone. But the fauna of Makapansgat is later than those of Taung and Sterkfontein, though not as late as that of Swartkrans.[10] Further, the australopithecine of Makapansgat is not purely gracile, but shows some affinities with *A. robustus*: and, too, there is a possible suggestion of a second hominid.[11] Thus, Makapansgat is in a special position, intermediate in time and in characteristics, between the earlier sites and the later (Table III). Again, Table III reflects a sequence of occurrences in each of the two major areas, *not* a necessary time equivalence between corresponding sites in South and East Africa.

The evidence adds up to a provisional hypothesis that the gracile australopithecines lived earlier and the robust ones later; that regular tool-making became a feature of life in the latter part of the early period; that by the later phase, two kinds of hominid were present, somewhat over-specialized australopithecines (*A. robustus* and *A. boisei*) and more highly hominized creatures who may be regarded as members of *Homo* and who were cultural tool-makers. The further tentative hypothesis is suggested

TABLE III. DISTRIBUTION OF EARLY HOMINIDS AND IMPLEMENTS IN AFRICA

Australopithecine sites	*South Africa*			*East Africa*		
	Site	*Species*	*Tools*	*Site*	*Species*	*Tools*
Later	Kromdraai	*A. robustus* + ?	?	Peninj	*A. boisei* + ?	+
	Swartkrans	*A. robustus* + *Homo*	+	Olduvai (Bed I)	*A. boisei* + *Homo*	+
Intermediate	Makapansgat	? *A. africanus* + ?	+			
Earlier	Sterkfontein (Lower)	*A. africanus*	—	Omo	cf. *A. africanus*	—
	Taung	*A. africanus*	—	Kanapoi	cf. *A. africanus*	—

that a gracile *Australopithecus* is the common ancestor of the robust *Australopithecus* and of *Homo*.

This hypothesis is supported by the evidence of yet earlier hominids in India and Africa, called *Ramapithecus*. The teeth and jaws are more similar to those of the gracile *A. africanus*, and not to those of the robust australopithecine. This supports the hypothesis that a gracile form like *A. africanus* is ancestral, and not, as Robinson[12] believes, a robust form.

We are fortunate in possessing remains representing the early *Homo* at Olduvai, probably at Omo and at Swartkrans, and possibly at Makapansgat and in the later Sterkfontein breccia. We have called this hominid *Homo habilis*.[9] There is evidence supporting the view that he was the first maker of stone tools of a set pattern, although he undoubtedly inherited the tool-making tradition from his ancestor, *Australopithecus africanus*.

TOOL-MAKING AMONG THE EARLY PLEISTOCENE HOMINIDS

Of the various components of human behaviour, preeminent is man's development of a complex culture. Modern man's cultural facilities provide him with a remarkable mechanism of adaptation to really extreme conditions. The degree to which he displays and, indeed, relies on this feature distinguishes him from all other animals.

Even by the time our Upper Pleistocene fossil ancestors emerged, two sets of interrelated changes had occurred: changes in man's biological equipment—such as bodily structure and function—and changes in his cultural potentialities, achievements and dependence.

Were the Lower Pleistocene hominids cultural animals?

Australopithecus was undoubtedly hominized in bodily structure to a certain degree. Was he also culturally hominized? Did he not only look like a hominid, but act like one? The evidence has built up a picture of *Australopithecus* as a cultural primate, already showing a good measure of cultural hominization. This inference is based upon many lines of evidence, some indirect, some direct.

Indirect Evidence for the Cultural Adaptation of Australopithecus

The argument from ecology. Remains of *Australopithecus* have been found in drier areas, as well as in somewhat moister zones. The evidence suggests that they were well adapted to life in open savannah country. In contrast, the African great apes are confined to more sheltered forest and woodland. It is not reading too much into this ecological fact to suggest that, to survive in open country, the relatively defenceless *Australopithecus* would have had to depend on his wits, inventiveness and resourcefulness to a far greater extent than would an ape in forest terrain.

The argument from teeth. The absence of large canines strongly suggests that *Australopithecus* must have used alternative mechanisms for solving those sorts of problems for which apes use their large canines, such as aggressive and defensive display, biting and tearing.

The argument from brain-size and brain-shape. Although the average capacity of the brain-case of *Australopithecus* was similar to that of the gorilla, we have enough of the skeleton to indicate that his body-weight was probably far less than that of a gorilla. In other words, the ratio of his brain-size to body-size was higher than that of the biggest-brained species of living great apes. The relative enlargement of the brain was a most significant characteristic of hominid evolution during the Pleistocene, even though we are not able to say exactly how a bigger brain is correlated with ever more complex human behaviour and cultural capacity.[13]

Then, too, the external form of the brain of *Australopithecus* showed a number of man-like features. Since the brain is the seat of cultural behaviour, it is likely that a brain, which was more hominized in size and shape, was likewise more hominized in its fine internal structure, density of nerve-cells, complexity of nervous pathways and connections, and other microscopical features, permitting more complex patterns of behaviour to emerge.

The argument from upright posture. The foot, knee, thigh and pelvis of *Australopithecus* show anatomical adjustments to upright stance. *Australopithecus* was essentially bipedal; he did not depend upon his hands in locomotion to the same extent as the apes. Likewise, when at rest, he undoubtedly possessed the primate habit of sitting upright with hands freed. Thus, whether he was sitting, standing, walking or running, the hands of *Australopithecus* were free and available for manual and implemental activities, for far more of the day than were those of other primates, whose hands were liberated only during the process of sitting upright. In contrast, the occasional and non-habitual bipedalism of apes does not occupy any significant period of time within the day; it is of interest chiefly in indicating how widespread among the primates is the capacity for uprightness. Yet only the hominids specialized in it and made it a part of their peculiar and specific adaptations.

The capacity for implemental activity was at least enhanced by uprightness. If nothing else, the creature could spend more of its time on manual activities. There is, however, something else. The freeing of the hand led to, or was accompanied by, a change in its structure and functioning. The hand became more capable of oppositional movements between thumb and other fingers than are the hands of apes, and so precision movements became anatomically more feasible and easier.[14]

The argument from other primates. The basic requirements for implemental activity comprise brains of sufficient quantity and quality; a strong element of learnt behaviour, rather than exclusively or mainly instinctual behaviour; stereoscopic vision; a grasping hand capable in some degree of a precision grip; and forelimbs which were freed for short or long periods, as in sitting upright. This potential for implemental activities is widespread among primates. Many recent studies have shown that non-human primates are capable of a far greater range of implemental activities than had previously been suspected. These include not only tool-using, but rudimentary tool-making.

Australopithecus was structurally more hominized than other primates, especially in those features relevant to implemental activities. It follows that his potential for implemental and cultural activity exceeded that of the living apes. For this reason, it is crucial to know how far apes can go in implemental activities, for at the very least *Australopithecus* could do as much. If chimpanzees can 'fish' for termites and make sharpened crowbars for opening banana-boxes, so could *Australopithecus* have done in similar circumstances. If gorillas can make comfortable, sprung beds, so might *Australopithecus*. If chimpanzees can break a circular disc of wood to make a narrow stick, with which to extract food from a cylinder, so too could *Australopithecus* have done in a similar problem situation. The new information on the cultural capacity of non-human primates led Kortlandt and Kooij[15] to classify the great apes and man as 'cultural primates', while gibbons, monkeys and the rest would be 'instinctual primates'. *Australopithecus* would clearly have fitted with apes and man among the cultural primates; and he must have been able to go further even than these intelligent actions of the apes. In fact, as more information has accumulated about the implemental activities of apes, so has there been a gradual decline in opposition to the idea that *Australopithecus* made or even used tools.

Direct Evidence for Cultural Adaptation of Australopithecus

With due allowance for the uncertainties of all archaeological interpretation, we have reason to believe that we are approaching some knowledge of the cultural life of *Australopithecus*.

Cultural objects of bone, horn and tooth. Since our first excavations began at Makapansgat, 200 miles north of Johannesburg, 22 years ago, every single specimen of fossilized bone developed from the tough matrix has been kept. We now have over 100,000 extracted pieces of bone from this ape-man-bearing site. A study of some of these specimens first convinced Dart[16,17] that many of them had been used as tools. Closer study revealed consistent patterns of breakage in many specimens. They suggested to Dart that these bones had been deliberately modified, to provide better tools. This is not far-fetched when we know that chimpanzees will whittle away the end of a stick to make a sharp point for prising, as in a crowbar; or will modify the form of a piece of wood, to make a serviceable tool. Yet, Dart's claims aroused much opposition, especially from those who had not studied the original specimens. Some of his fellow scientists, it would seem, have been more ready to accept that *Australopithecus* made stone tools, than that he modified and used a material always to hand, namely the bones of animals eaten.

A few points relevant to the bone-tools hypothesis are as follows:

1. The Makapansgat deposit contains mountainous accumulations of bone. Over 100,000 pieces have thus far been developed; yet they represent only a fraction of the accumulations apparent *in situ* in numerous exposures within the cave earth. No natural accumulations of bone by scavengers or predators have ever been found to equal this for sheer quantity.

2. Tooth-marks of animals are conspicuously absent from all but a handful of the thousands of bones.

3. Statistical analysis has shown definite evidence that certain bones have been selected and others neglected. Thus, the ratio of arm-bones to thigh-bones is over 5:1. Some selective agency has clearly been at work.

4. Large concentrations of ungulate arm-bones and other long bones show damage inflicted before fossilization.

5. Many bone flakes show differential wear and tear along one edge, or at one end, but not at the other.

6. Special cases include horn-cores and smaller bones rammed and lodged up the marrow cavities of broken larger bones.

7. Small bone and even stone flakes have been wedged between the condyles of long bones.

8. Numerous long bones show signs of having been broken by a spiral or torsional stress.

9. Many bone objects can be classified into categories of recurring patterns. No-one has been able to demonstrate similar regularities and

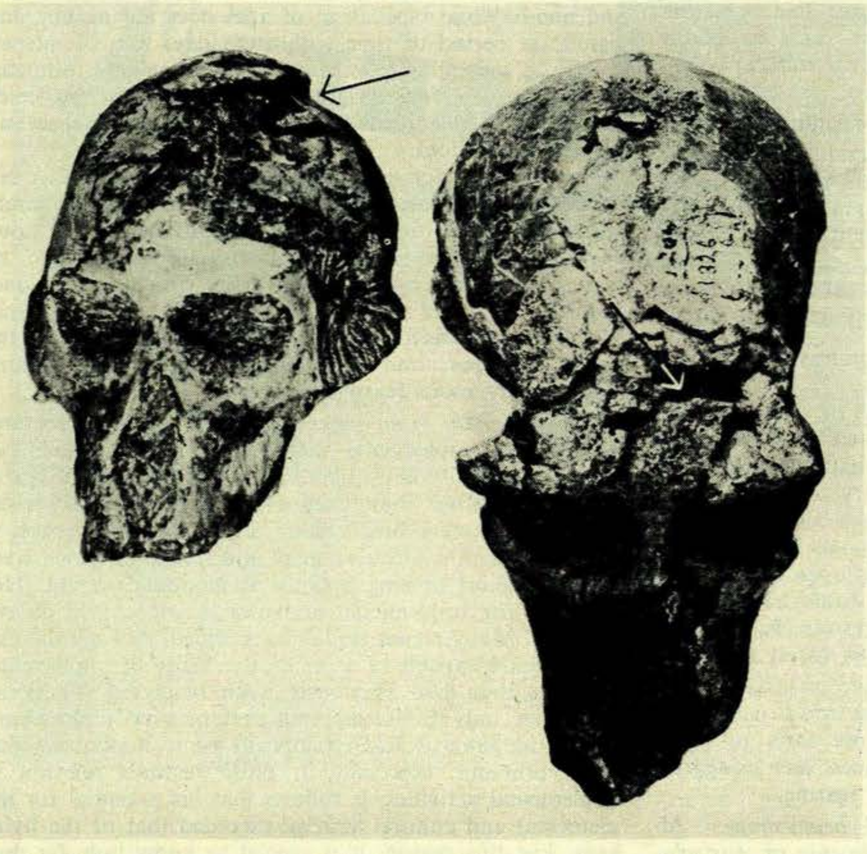

Fig. 1. Two baboon crania with depressed fractures (arrowed). These baboon crania come from Makapansgat Limeworks and are dated to the Lower Pleistocene. It is believed that the fractures were deliberately inflicted by *Australopithecus*, the African fossil ape-man.

constant patterns among the bone debris of carnivores.

10. In one analysis, 80% of over 50 baboon crania from Taung, Sterkfontein and Makapansgat show signs of damage by localized violence, such as a single depressed fracture, or perhaps 2 adjacent fractures (Fig. 1). Some of the ungulate arm-bones have damaged epicondyles which fit certain fracture depressions on the baboon crania.

11. There is evidence of stone-collecting habits: a small number of quartz and quartzite fragments have been found in the breccia.

12. Another material readily to hand—stalactite and stalagmite—has been found broken off in the deposit, and some fragments were further fractured transversely and longitudinally.

Comparable masses of what Dart calls osteodontokeratic objects have not yet been reported from Taung or Sterkfontein; but at both sites, not more than a fraction of the breccia has been thoroughly searched for broken bone fragments. And there are numbers of fractured baboon crania at both sites. Thus, the mere absence of hitherto detected osteodontokeratic objects from other South African sites does not weaken Dart's claims based upon Makapansgat alone.

Dart's standpoint may be restated thus: the simplest hypothesis which at once explains all the above facts is that some primitive hominids, most likely *Australopithecus*, were responsible for the bone accumulations and had a well-developed cultural life based primarily upon the use and modification of bone. We know already that the manufacture of such artefacts was probably well within the bodily capacity of *Australopithecus*. No other single hypothesis can explain more than a proportion of the above facts.

Bone-tool activities need not have characterized all early hominid populations of the Lower Pleistocene. The Southern African australopithecines of this time may have been an exceptional and atypical group: their peripheral and ecologically difficult situation may have elicited, or retained, bone tool-making as one of several possible solutions to the challenge of their environment. In East Africa, it has yet to be shown whether or not this type of cultural solution was resorted to by the australopithecines. Indeed, the bone artefacts of Makapansgat may even represent the persistence in Southern Africa of a yet earlier phase of cultural hominization, in much the same way as the *cul-de-sac* of the African sub-continent has so often preserved, and indeed still conserves, archaic species of animals long after they have become extinct in more northerly latitudes.

Stone culture. Primitive stone tools were manufactured in Africa during australopithecine times. Opinion has been divided as to whether *Australopithecus* was their maker. In an analysis of the combined occurrences of early hominid fossils and stone implements in South and East Africa,[18] I was able to show that, in 15 such combined occurrences, at every australopithecine locality with stone tools, there is evidence of the coexistence of a more advanced hominid; wherever we find *Australopithecus* together with a more advanced hominid, there too we find stone tools; wherever early stone tools are found with hominid remains, the skeletal remains include a more advanced hominid, with or without *Australopithecus* as well; and every early locality, which has yielded a hominid more advanced than *Australopithecus*, has stone tools in addition.

Although it is dangerous to speculate on the identity of the early stone tool-maker from negative evidence, these correlations from 15 localities may suggest a balance of probabilities. Unless we resort to a series of special pleas, the most reasonable hypothesis to explain these data would seem to be that *Australopithecus* was *not* the maker of the earliest cultural stone implements, but that more advanced hominids almost certainly were. The nature of such more advanced hominids is suggested by the recently-described species, *Homo habilis*, from Olduvai.[9]

Tentatively, I have concluded from the direct evidence that *Australopithecus* was a tool-user and that, at least in Southern Africa, he made tools of bone, horn and tooth and, occasionally, of stone.

Summation on Australopithecus and the Cultural Life

When we combine the direct and indirect evidence, a general inference seems permissible. It is that *Australopithecus* was indeed characterized by greater cultural, as well as biological, hominization than the great apes. In apes, tool-using and tool-making are infrequent and not habitual. The apes' way of life and survival do not depend upon such implemental means, but rather on formidable natural defence mechanisms, and on a sheltered forest habitat.

Australopithecus, on the other hand, lived in a habitat providing little protection and he had no natural weapons of offence, defence and threat, like large canines. His implemental activities must have come to loom very largely in his life. This, I suggest, is the great step forward of *Australopithecus* over the apes. He learnt to exploit a mental and manipulative capacity, a cultural potentiality, so effectively that in time his offshoots became dependent on it for survival. Cultural capacity was the greatest evolutionary asset of *Australopithecus*. In his economy there had already begun that gradual transfer of emphasis from purely genetic mechanisms to largely cultural modes of adaptation, which is the most striking feature of the subsequent evolution of man.

FROM AUSTRALOPITHECUS TO THE PRESENT

From the beginning of the Middle Pleistocene onwards, we have two distinct and parallel sets of events. Brain-size became progressively greater, until well into the Upper Pleistocene. At the same time, cultural advancement became more and more striking.

The two sets of events—increase in brain size and presumably in quality, and cultural advancement—went side by side. We cannot doubt but that there was a relationship between them, perhaps a reciprocal feedback, as Dobzhansky[19] and Bielicki[20] have suggested. It seems that this reciprocal benefit eventually spent itself. By the Upper Pleistocene, brain-size reached a peak and then diminished somewhat. Beyond a certain stage, we have no evidence that further increment of brain-size in any way improved man's adaptive abilities. At that point, it seems, culture and social benevolence began to take the place of brain-size as an insurance policy against extinction.

A few strong highlights illumine the way we have come, some dealing with our physical development and some with our cultural evolution.

Our Two Kinds of Inheritance

More than any other animal, our lives have come to be governed by two kinds of inheritance. One we share with the rest of the animal kingdom: it is all those things we inherit through our genes and chromosomes. It is based upon information encoded in DNA. It is our genetic system of heredity and we are still subject to it, despite our exalted status on earth. Although we are able to compute, write, compose, we can do none of these things if something goes wrong with our genes—a lowly genetic mutation, a single jump of an atom to change a gene, can con-convert us from a Shakespeare, Newton or Beethoven into a gibbering idiot with no more intellect than a very young chimpanzee.

Our genetic inheritance, we know, is far from perfect. It took millions of years to evolve our body's system of defences against infectious diseases. Whenever a foreign substance enters the tissues of an animal, an immunological reaction takes place. Yet, this same system of antibody-formation swings into operation when organs are transplanted from one body to another; this mechanism may cause a transplanted kidney or other organ to be rejected. What is normally a blessing may under these circumstances become a curse.[21]

Again, this beneficial immunological mechanism gets out of hand when mothers produce antibodies against their unborn children, as though they were foreign bodies or grafts. In consequence, about one in 150 newborn children has a serious haemolytic disease. In effect, it is an immunological repudiation by the mother of her young.[21] This is a blunder to which our genetic inheritance has made us heir. We are given two wonderful mechanisms: the body's immunological reactions and the nourishment of the foetus inside the mother's body. Put these two mechanisms together and it is clear they are not yet entirely reconciled to each other.

Even more serious is the newly-recognized class of auto-immune diseases, in which the body produces antibodies against itself and destroys some of its own constituents.

So, the genetical mechanisms we have inherited are far from perfect. In fact, as Medawar[21] says, '... genetical evolution, if we chose to look at it liverishly instead of with fatuous good humour, is a story of waste, makeshift, compromise, and blunder'. That is our first pattern of inheritance.

Our second kind of inheritance is non-genetical, based upon certain properties of our brains. It is transmitted not by genes, but by education; by it, a man can affect future generations by transmitting information, which is not coded in the DNA of our chromosomes.

We human beings have developed this non-genetical system of transmission so that it is predominant in our lives. We have come to depend on exosomatic aids to survival. For example, in cold weather, our species no longer needs to grow a mantle of hair or a coat of blubber to survive; we simply don another jersey or turn on the central heating. Our culture teaches us how to throw a switch and so increase the chances and the comfort of survival.

This mechanism has a long history. Far back, we discern its early strivings in the first bone and stone implements, extracorporeal digits as they have been called. Inexorably, over these 3 million years, our dependence on this cultural adjustment has increased. There is evidence already in *Australopithecus* of a change from virtually complete reliance on the genetic mechanisms to a shared dependence on both genetic and cultural mechanisms.

Man is pre-eminent among the beasts in his degree of dependence upon cultural mechanisms for survival. As Teilhard de Chardin[22] put it, 'Evolution went straight to work on the brain, neglecting everything else, which accordingly remained malleable'. Somewhere, in the line of ever-warming consciousness, 'a flame bursts forth at a strictly localized point. Thought is born.'[22] 'Hominization,' he says, 'can be accepted in the first place as the individual and instantaneous leap from instinct to thought ...' Thus, although the anatomical leap from non-man to man is small and insignificant, it is a change marked by the birth of a new sphere, that of thinking. With man, we have entered 'the psychozoic era'. We reached a kind of climax in the last century, with the acceptance and gradual understanding of the process of evolution. In this little time, '... we have become conscious of the movement which is carrying us along ...', and therein De Chardin echoed the concise expression of Julian Huxley, that man discovered *he is nothing else than evolution become conscious of itself.*

Man's Evolution in the Psychozoic Era

If we drew graphs of our patterns of evolution over the past 3 million years, we should see several crossing lines (Fig. 2). The graph of physical change is high in the early Pleistocene: our animal nature was still predominant. Then, progressively during the one million years from the Middle Pleistocene to the present, physical features and change became less and less important; the graph drops steeply downwards. A big-browed man can make just as good a hand-axe as a small-browed man, and we still have not resolved the rival claims of an early Asian *Homo erectus* and an early European *Homo sapiens* to have been the world's first fire-maker. Even differing brain-

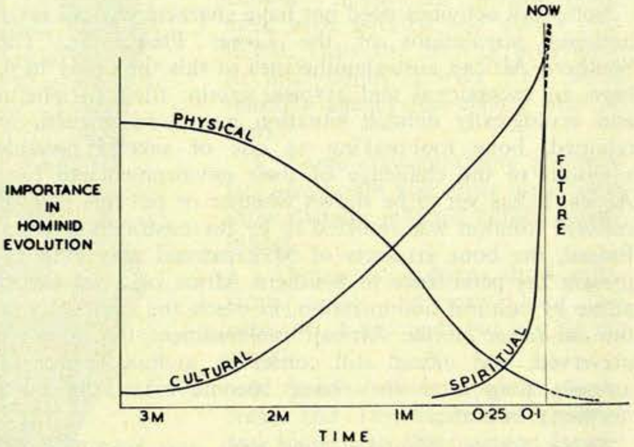

Fig. 2. Patterns of hominid evolution over the past 3 million years.

sizes make little difference to a man's chances of survival and procreation.

On the other hand, we have seen early glimmerings of cultural evolution in *Australopithecus*. The graph of cultural activities and intellectual ability has risen steeply. Somewhere late in the Lower Pleistocene, or early in the Middle Pleistocene, the rising graph of cultural skills overtook and crossed the declining graph of physical change. From this point onwards, man's evolution has been less and less physical and more and more cultural. The crossing of this crucial point opened up boundless possibilities for human evolutionary progress. The already evolved hominid brain lent a flexibility and variability to man's behavioural responses; it provided a range of inventiveness, educability and adaptability which permitted man to devise endlessly diverse solutions to the challenges of an ever-changing environment. Man's evolutionary potential and success came to depend almost entirely on his intellectual possibilities, and hardly at all on physical variations.

For the last 100,000 years, a third graph rises into the picture, a graph of what we may call man's spiritual progress. In the early and hesitant beginnings, we see such signs as burial of the dead; coating of human remains with red ochre, the sign of blood; head cults and brain-eating rituals; which have persisted in one form or another to the present day.

Perhaps the oldest sign of ritual is the mutilation of the base of the skull by *H. erectus*[23] (Fig. 3). Pekin Man, as long ago as 300,000 years, regularly opened the base of the cranium. A clue to the motivation for this practice emerges if we follow it down the ages. Early and late Neandertal Man likewise mutilated the base of the skull; and so did some men of the European Bronze Age. The later mutilations are neater and more expert jobs than the earlier ones, but the general pattern is the same. This disfigurement is identical with that practised by present-day head-hunters of Borneo and Melanesia. The object there is to extract the brain and to eat it for ritual and social purposes. So, skull mutilation and ritual cannibalism have a long history, which continues to the present day.

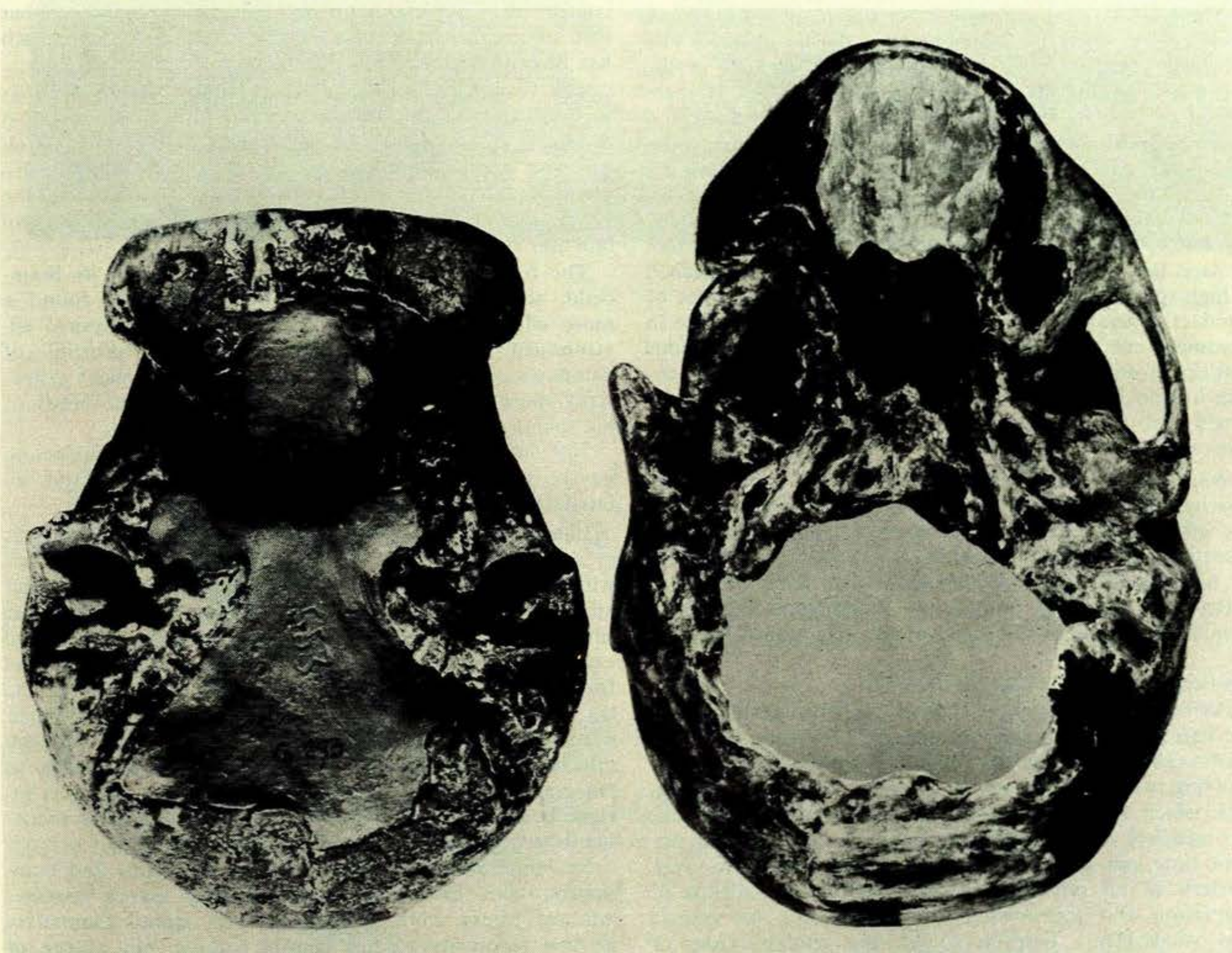

Fig. 3. Mutilation of the cranial base in two early human fossils. *Left*: cranium of Pekin Man (*Homo erectus pekinensis*), who lived about 300,000 years ago. *Right*: cranium of Neandertal Man of Monte Circeo near Rome, probably over 50,000 years old. The part of the occipital bone surrounding the foramen magnum is lacking in each skull.

Another practice of great antiquity is that of coating the remains of the dead in red, the symbol of blood.[23] The oldest use of the red colour for funerary purposes is that of red ochre in burials of the Upper Palaeolithic, Mesolithic and Neolithic. In Greek, Etruscan and Roman times, tombs and sarcophagi bear traces of red paint inside. Homer speaks of the dead being buried in red shrouds, a practice found among the nobles of Florence in the 15th century. Today, the custom survives, as far as is known, only in the conservative funerary ritual of the Vatican; a dead pope is swathed in a red shroud; and among Hindus, who shroud their female dead in red before cremation.

A third example is the burial of the dead. The practice goes back for perhaps 75,000 years. Early examples of deliberate burials are that of the skull of the Neandertal Man of Monte Circeo (Italy), surrounded by a circle of stones and ritually mutilated, and that of the skeleton of the Neandertal boy of Teshik-Tash (Uzbekistan), surrounded by a palisade of fossil horn-cores of the Siberian mountain-goat. Burial of the dead is but one of our modern ritual observances which go back far beyond recorded history.

The rise of ritual life, with its concomitant assumptions, such as the belief in an afterlife, in mystic qualities and elements, and in codes of behaviour, culminated in the great religions of the early historical period. All of them aimed to regulate the relations between man and his god or gods, and between man and man. Ethical systems, codes of social conduct, brotherhood, love and compassion, arose as the graph of man's spiritual evolution in the last 10,000 years climbed steeply, after a long, slow beginning. By today, the graph of man's spiritual evolution has, too, crossed that of his physical development and has reached a high-spot alongside the graph of intellect. The codes of conduct generated by the spiritual evolution have come to dominate our social life, going far beyond the gregarious instinct of antelopes and baboons. They have come to endue human life with a quality of sacredness which transcends such instincts. Compassion has entered into man's way of life.

Waddington has called man, 'the ethical animal'.[24] By this he means that man's second mechanism of evolutionary advance, the cultural or non-genetic, contains, as an essential ingredient, the capacity to entertain ethical ideas, or 'to go in for ethics'. In this sense, man is an ethical or, better, an ethicizing animal, as Waddington calls him, capable of ethical thinking and of forming ethical systems.

Intellect, Compassion and the Future

Perhaps we already have sufficient leads to prognosticate the nature of the threads leading into the future. I have tried to show that man has attained his present position by evolving two main lines of development, cultural and spiritual, which I shall summarize as two fundamental qualities, intellect and compassion. Intellect, from a very ancient time, has given him extracorporeal aids to survival, mastery of his environment, non-genetic mechanisms of adaptation and transmission of information, his plunge into what Henri Bergson called 'the endless risks of thought'. Compassion has enabled him, especially since the Upper Pleistocene, to develop societies, codes of conduct, ethics, rules for the road of life.

If we extend these graphs into the future, we see that man's development is likely to be only slight in the physical realm, but overwhelming in the psychological, intellectual, cultural and spiritual spheres. Of course, our genetic heritage will undoubtedly continue to change, as it has done for millions of years. In fact, there is little doubt that the growth of man's knowledge is already enabling him to take a hand in his own future physical evolution. As Dobzhansky[25] has pointed out, 'in giving rise to man, the evolutionary process has, apparently for the first and only time in the history of the cosmos, become conscious of itself... this opens at least a possibility that evolution may some day be directed by man...'.

Recent developments have brought us to the brink of a breakthrough in knowledge no less significant, and perhaps in the long run far more valuable, than the conquest of space. It is well to stress these hopeful developments, because 'Cassandras prophesying doom attract public attention more easily than do those who hold the unspectacular view that a disaster is not around the corner, and not even inevitable'.[26]

So even our physical evolution of tomorrow may be controlled by our evolution in the intellectual sphere. What then of man's psychological and spiritual evolution, which has already assumed an all-important role?

The two main threads of man's future development as a global and perhaps cosmic species will be an unimagined flowering of his mind and blossoming of the spirit: intellect and compassion will be the dominant motifs. This prediction is the logical consequence of drawing the evolutionary lines out of man's past and extending them into the future.

The future flourishing of the intellect and of its brain-child, science, is assured. For man has never found a more effective mechanism for mastering his physical environment. I suggest that the future of the principle of compassion is no less likely, for it represents man's potentially most effective mechanism for meeting the needs of his social environment.

Not only does this seem on past and present evidence to be the probable course of the future, but it is, too, an intellectual and philosophical necessity.

Intellect and compassion have become central themes in modern man's life. They are complementary. Science without ethics is potentially a dehumanizing force—after all, what Aldous Huxley and George Orwell did was simply to take the then manifest scientific trends and extrapolate them into the future. But they failed to extend forwards the other strand of human psychozoic evolution, the spiritual, with the stark consequences which their writings vividly portray. Contrariwise, compassion without intellect, ethics without science, would be as unrealistic as the continued eating of raw meat long after fire was invented, or the use of stone arrowheads long after metal-smelting had been discovered; it would simply not survive.

No, the two forces—intellect with its fruits, and compassion with its humane outlook—will march together into the future. Both trends may well express themselves in new forms we cannot readily foresee, but a core of ethicism will be there if man's past is any guide to his future.

For so long has the principle of love been subscribed to by this ethicizing man that it has become no less vital an ingredient of his make-up than his intellect. If we project the two lines into the future, we cannot but conclude that these psychozoic principles will play an ever more important part in man's adjustment and generate undreamed levels of psychical and spiritual activity.

With both lines of psychical development extending forwards, we have a vision of evolutionary hope. If evolution engenders a sense of optimism for the future, such optimism stems solely from the idea that the future good in the material sense will coincide with the future good in the ethical sense.

Compassion and intellect are our signposts pointing to man's long future without despair: that is the irresistible message of Yesterday's Man to the Man of Tomorrow.

SUMMARY

The australopithecine fossils of South and East Africa have provided evidence of an early stage in physical and cultural hominization. The two main trends of development, which have engendered modern man, are his cultural and spiritual evolution. Man's future development is likely to be only slightly in the physical sphere, but overwhelmingly in the intellectual and spiritual realms.

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