LWATI: A Journal of Contemporary Research, 13(3), 124-140, 2016
ISSN: 1813-2227

A Philosophical Relection on the History of Science in India

John O. Inyang
Department of Philosophy
University of Calabar
Calabar-Nigeria
Email: :jesameasy2009@yahoo.com,
johninyan2672gmail.com.
+234 8039575856

Abstract

One of the major characteristics of science is the observation of facts in sense experience. Modern science has reckoned with this feature and it is a truism that this feature is indispensable to the notion of science in general. The challenges that confront empirical observations including fallibility and changeability among others not withstanding do not in any way reduce the imperativeness and pertinence of observation in science. In this paper, I have argued that the attitude of observing phenomena is as old as man himself who exhibits this attitude and whether he is conscious of what he observes or not, it remains significant that observation influences his life directly or indirectly. The conclusion reached is that our cultures and traditions may have started with the empirical observations of the environment we find ourselves and if this is the case then, it is arguable that science which is fundamentally anchored on observation is part of our culture and tradition and has gone a long way to mould man disparately in line with the ways he understands his immediate observed environment.

Introduction

Apparently, science before the modern period was part of the traditions of both philosophers and cultural people. This is found in both arts and crafts of the early traditions as well as in practical agriculture. One may not sound absurd in asserting that science is tied to tradition and arguably preceded civilization. According to S. F. Mason:

No matter how far back in history we go, there were always some techniques, facts and conceptions, known to craftsmen or scholars, which were scientific in character, though before modern times such knowledge in

general was subordinate to the requirements of either the philosophical or the craft tradition (ii)

Obviously, tradition is not universal in character, given the fact that the natural environments we find ourselves are not in uniformity and these environments largely make up our tradition. Thus, different people are identified significantly with different traditions and cultures. What gives a tradition or culture its significance and peculiarities include both its natural and man-made distinct features. It is on this idea of distinctiveness or peculiarities subsumed under the concept of relativity that makes it pertinent to critically investigate into the history of science in India. Of course this does not rule out that certain scientific elements or features run centrally in every traditional or cultural distinction. It is this central or common feature(s) that gives Indian tradition or world-view the perceived objectivity we find in science as a whole.

It can plausibly be argued that Western philosophical thinking has glorified to a very large extent the important scientific achievement of the ancient-Greeks not minding the parallel existence of this same achievement by other traditions nay their influence on Greek thought system. Examples are the Babylonian, Egyptian and Indian traditions. Suffice it to say that the history of science in India is fundamentally rooted in two sources. On the one hand is the technical tradition of the Hindus largely dominated by practical experiences and skills handed down in a conservative manner from one generation to another and on the other hand is the spiritual tradition with the dominance of human aspirations and ideas in it handed on and augmented.

These traditions can plausibly be argued, have "existed before civilization appeared, if we are to judge by the continuity in the development of the tools used by the men of the Stone Age...." (Mason ii). The growth in crafts and the corporations of priestly scribes amongst the Hindus is an evidence of continuity in the development of these traditions. Significantly, the convergence of the technical and spiritual traditions during the middle ages and early modern times resulted to a new tradition called science. Thus, in this chapter, we shall examine the historical development of science in Indian tradition and culture from ancient to contemporary age pointing out its significant contribution to modern science. Areas such as astronomy, mathematics, medicine, chemistry and related physical sciences shall dominate our concern, reason being that the Hindus tradition excelled in them.

Development of Philosophical Thought and Scientific Method in Ancient India

Historically, the Bronze Age culture of the Hindus people which flourished about 3000B.C, paved way for the development of science and civilization in India. The period was dominated by the use of a fast-spinning potter's wheel and alloyed copper and tin by the Hindus people in making bronze. Their civilization was remarkably different from others by 2000B.C. The development of an alphabetic script was quite an easy one because they had a pictographic script and a decimal numeral system. All these were in place prior to the age of Christianity. Fundamentally, the ancient systematic observations in India were predominantly in the area of astronomy which we shall examine in details later. Besides the Bronze Age and the observation of the celestial bodies (astronomy), it is largely perceived that Indian civilization has been largely concerned with the affairs of the spirit and after life. This position may be an erroneous one. However, it is a common view for people to perceive the Hindus as people who live with mysticism and spiritism given the fact that, their tradition and or culture are hardly discussed without a religious coloration and even magical powers.

Contrary to this popular perception, historical records in India suggests that some of the greatest Indian minds were much more concerned with the development of philosophical paradigms grounded in reality. Apparently, the parochial perception of other cultures by Western minds has devastating effects on these cultures which often were presented derogatorily in bad light. In this connection, we can infer that the premise that Indian philosophy is founded solely on mysticism and renunciation emanates from a colonial and oriental world view that seeks to obfuscate a rich tradition of scientific thought and analysis in India. Most polemical texts that are not normally thought of as scientific texts had much of the evidence of how India's ancient logicians and scientists developed their theories. Treatises on mathematics, logic, grammar and medicine that survived and many philosophical texts enunciating a rational and scientific world view can only be constructed from extended references found in philosophical texts and commentaries by Buddhist and Jain monks or Hindus scholars usually called Brahmins.

Undoubtedly these treatises are usually considered to be part of the religious studies of India. It should be pointed out that many of these treatises are in the form of extended polemics that are quite unlike the Christian or Islamic holy books. The treatises have a remarkable difference from religious texts, especially in attempt to debate the value of the real world in contrast with

the spiritual world. Equally, in the treatises is the attempt to counter the theories of the atheists and other skeptics and describe the competing rationalists and worldly philosophies anchored in a more realistic and scientific perception of the world. The methods adopted were that of debate, hypothesis, extension and elaboration of theory and that of flourishing proofs and counter-proofs. Remarkably, the Buddhist world view and the ancient Jains were originally and essentially atheistic and agnostic respectively. Equally within the broad stream of Hinduism, there were several heterodox currents that asserted a predominantly atheistic view. To buttress this position, Buddhism, Jainism, and Hinduism are major religions that have today dominated the India world view. In other words, these three thought systems were in ancient age not religions as we think of today since the modern understanding of religion presumes faith or belief in a super-natural entity. Thus prior to the era of religious conception, these philosophical schools felt the imperative to prove their exta-worldly theories using rationalist tools of deductive and inductive logic.

Furthermore, it should be noted that amongst the intellectuals of ancient India, atheism and skepticism must have been very powerful currents requiring repeated and vigorous attempts at persuasion and change. Over the centuries, the proponents of mystic idealism prevailed over the skeptics, such that at the popular level, each of these philosophies functioned as a traditional religion. No wonder the popular perception that Indian civilization was largely concerned with the affairs of the 'spirit' and 'after-life'. This could not have been in the absolute sense given the fact that, at no point were the advocates of "pure faith" ever powerful enough to completely and absolutely extinguish the rationalist current that had so imbued Indian philosophy.
The Age of Science and Rationalism in India.

The age spans from 1000 B.C. to the 4th century A.D and is described as a rationalistic age from where many different treatises of importance developed. It is plausible to state that from the earliest times and without any restriction to race, culture, tradition or religion, people have been curious about the world around them. According to The World Book Encyclopedia, "…people learned to count and tried to explain the rising and setting of the sun and the phases of the moon. They studied the habit of the animals they hunted, learned that some plants could be used as drugs and acquired other basic knowledge in nature. This achievement marked the beginning of science."(142). Of course the Hindus were not excluded from attaining this scientific feat.

Like in ancient Greek tradition, history has shown that in ancient India, the general structure and order of the cosmos was given a rational explanation. An analysis of Indian tradition reveals that the Indians have in many fields applied themselves to the effort of systematization which is not reflected in a classification of the sciences (Wiet et al 631). In other words less is known about science in India probably because not many scholars have investigated it. The "Lokayata" was one of the most ancient India's rationalist traditions. During its age "Lokayata" had an atheistic and scientific world view. Unfortunately, it maligned and was discredited by the evangelicals of mystical Buddhism and vedantic Hinduism. As a remarkable departure from religious influence, the "Lokayata" never believed in reincarnation or an after- life and in the indestructibility of the human soul. They refused to make artificial distinctions between body and mind. They rather saw the human mind as part of the human body and not as some separate entity that could have an independent existence from the human body. In addition they acknowledged the material universe around it. The sacrificial gift and offerings for the after- life as practiced by the followers of Brahmanical Hinduism in A.D 900 was totally rejected. Furthermore the 'Lokayatas' dismissed both the Vedic priest and their mantras as nothing but a means of livelihood for those lacking in genuine physical or mental abilities.

Of interest, the "Lokayatas" were primarily concerned with human sense perception and with the application of the inferential process (rationalism) by which they were able to develop their theories of how the world worked (http: India…2 of 4). Suffice it to say that the Lokayatas were keen observers of nature; this may be why they are presumed to be amongst the first to understand the nature of different plants and herbs including their usefulness to the well-being of man. With this, one can logically infer that Indian medicine gradually evolved from the early scientific knowledge and understanding of the Lokayatas. It is likely that the widely prevalent Indian custom of cremation originated from the Lokayatas since they believed that consciousness begins with the living human body and ends with death. Nothing like life after death.

With all these developments in ancient India and amongst the Lokayatas in particular, we cannot certainly say that there was an understanding of the world as elaborate as that of today's science. Primitive and inadequate will certainly be the description given to this ancient tradition of the Lokayatas and their formulations should we judge them by the standards of the 20th century science. However, there is no doubt that scientific elements and or traces were found among the Lokayatas and knowledge of science

undeniably has expanded considerably since their age. Principally, the point of emphasis in this development is that though there was a limited amount of scientific knowledge available to humanity at that time, their world view was given by a rational and scientific approach.

Accordingly, the period of rationality gave birth to some of the most fascinating series of debates concerning what constitutes the "scientific method". Also was the problem of "when does an observation of reality become accepted as facts and as scientific truth? How does one evaluate a hypothesis for its scientific merit? What is a valid inference and what constitutes a scientific proof?" these and other related questions were attacked with intellectual vigor. As keen observers of nature and human body, India's early scientists and philosophers studied human sensory organs, analyzed dreams, memory and consciousness. They understand change both in quantitative and quality terms. They even posited a prototype of the modern atomic theory. It was this rational foundation that led to the flowering of the Indian civilization.

The rational age in the history of science in India has been described as a period of intellectual ferment and vitality leading to discovery in scientific and technological innovation. This period also had its impact on the growth of other civilizations. Strongly stated, colonial history has attempted to usurp the total heritage of the colonized by making it exclusively euro-centric. This not withstanding, it is pertinent to add that both fundamental and significant discovery in science and innovations in technology have come from many different parts of the globe, although at different periods and levels of civilization of the world. In this regards, Indian tradition made its own contributions. However, we shall restrict ourselves to scientific contributions as we examine different scientific disciplines or endeavours in the history of India.

The Historical Development of Scientific Disciplines and Practices in Indian Culture.

Suffice it to say that scientific practices have been found to be inherent in Indian tradition and culture as far back as the ancient period. Generally speaking, the dynamic and inventive quality associated with the scientific method has had some influence upon human evaluation. The method described as essentially a means of discovering new theories, so that the sciences constitute an ever-expanding systems of knowledge, has enabled old theories to be overthrown constantly by new ones, so long as that

method is practiced (Manson 602-603). To talk about the historical development of science in Indian tradition could be viewed as one of a number of historical movements that have formed an interconnected complex, in which science before now was a minor force. Accordingly, Manson opines that "the science of a given age has belonged, not only to its own tradition with its own methods, values, and accumulated knowledge, but also to its own historical period in which other movements have made their own impact upon it"(603).

It is on this basis we shall examine historically the scientific development in India with its attendant methods, values, and accumulated knowledge as well as the impact upon it by other movements. Specifically the areas of concern we shall explore as earlier mentioned include astronomy, mathematics, medicine, chemistry, and other physically related sciences. We shall succinctly point out the influence of Indian scientific practices on modern science.

(a) Astronomy

Unarguably, the recording of scientific achievements in India started with astronomy. Astronomy as a field of study is the scientific study of the sun, moon, stars, planets, and in general celestial or heavenly bodies. It is pertinent to mention that, by the 6th century A.D., Indian astronomers had made significant discoveries about planetary motions. This was made possible with the help of ancient Greek and Babylonian influence coupled with Indian's peculiar ingenuity. Accordingly, the old nokshatra system was preserved, while the characteristic feature of classical Indian astronomy was the adoption of Greek and Babylonian zodiac astrology. Manson adds that;
The Hindus were acquainted with some of the science of the Greeks and perhaps that of the Babylonians though, due to the absence of records, it cannot be determined how and when the knowledge of science came to India. This could be as far back as between 150B.C. and A.D.140, given the fact that the Hindus astronomers knew of the work of Hipparchus but not that of Ptolemy, and that the route was the sea trade between the Roman Empire and Ujjain, the Indian trading center with the west (90).

In ancient India, attempts were made to explain rationally the general structure and order of the cosmos. Jean Filliozat in The Encyclopedia Americana International, writes that 'the concept of a natural law of the universe occurred to the ancient Indians because of their observations of the regular coming of the monsoons and the periodical return of the stars, the

sun, and the moon to the same positions.'(929), this buttresses the importance of observation as the first step in science which we discussed at the very beginning of this work. Aryabhata was the first Indian astronomer to describe the earth as a sphere that rotated on its own axis. In this connection, he further postulated that it was the earth that rotated around the sun and correctly described how solar and lunar eclipses occurred. Thus, it is well known that astronomy was studied for calendrical purposes with a view to setting time for both practical and religious task. Emphasis was primarily placed on solar and lunar motions, with the fixed stars serving only as a background against which these luminaries moved.

Almost every other scientific study of Indian tradition was influenced by astronomy; particularly as part of studying and understanding the world from the primitive stage of noting important regularities in nature and essentially celestial bodies. The city of Mysore in the South of India is historically revealed as the main centre of Hindu science and the Indian scientist Mahavira is known to have worked there, while at Patna, the Aryabhatas (A.D.475-550) worked there and in the city of Ujjain, Bhaskara, Brahmagupta, and Varahamihira were well known for their astronomical observations. It should be noted that Varahamihira presented the first acknowledged account of the Hindu astronomical works titled the 'Siddhantas' though five of such 'Siddhantas' had been before his time and four of the five were based on Greek astrology and the other one on ancient Vedic astrology(Manson 90).

In their astronomical survey, Varahamihira and other Hindu astronomers speculated that the earth was spherical, with the sun, moon, and planets, at distances from it which were proportional to their periods of revolutions. Accordingly, this view was predicated on the assumption that 'all the heavenly bodies moved in circles round the earth with the same uniform speed.'(Manson 91). Most of the Hindu astronomers could be interpreted as having the view that each body of the solar system possessed a proper motion of its own, caused by a wind, and at the same time, there was a larger aerial vortex which carried all of the celestial bodies round the earth once in twenty-four hours. Equally, there was the assumption that all of the heavenly bodies moved in circles round the earth with the same uniform speed.

Manson further explains how the complexity of the motions of the planets was accounted for. According to him; 'the Hindus used the Greek mathematical device of the epicycle, introducing void epicycles to obtain

more exact agreement. In dealing with the motions of the moon however, the Hindu astronomers employed methods which showed distinctive traces of Babylonian influence' (91). Indian astronomy in the early middle period recorded Aryabhata as the first astronomer. As part of his achievements, Aryabhata wrote an extremely concise resume of mathematics and astronomy from which mathematical results were taken. Gaston Wiet and co. adds that Aryabhata succeeded within a short time in "giving an enumeration of the most important astronomical numbers, a section on the determination of time and another on the terrestrial globe and the respective position of the sun, the earth and the moon (theory of eclipses)"(636). Though Ptolemy equally made his observations, Wiet notes that Aryabhata's observations were more accurate. Thus the invention of the epicycles was attributed to him and the theory explains the retrogressive movements of the planets which subsequently may have been interpolated in the Suryasiddhanta treatise. This not withstanding, Aryabhata's claim that the earth rotated suffered its non-acceptance during his age.

In another vein, it is pertinent to mention that Varahamihira who died in 587 was not an astronomer in the absolute sense, given the fact that he wrote several works of general interest and introduced little innovations in the area of astronomy. Though, his focus was on correcting the Siddhandata, he however, was described as the greatest of Indian astrology where he did some fundamental treatise on horoscopes (Wiet 637). This is supportive of the fact that, at a time, Hindu astronomy rapidly deteriorated into practical astrology. Besides Varahamihira, other notable Indian scientists such as Brahmagupta and Bhaskara made little contributions to the development of astronomy. For the former, he tried to demonstrate that, the earth was fixed; this was in opposition to the teaching of Aryabhata his predecessor. While for the later, he towed the general path of the Suryasiddhanta especially in the discussion of the opinions of his predecessors. Accordingly, Bhaskara 'explained the apparent movements of the planets by eccentrics and epicycles, and touched on the description of more numerous instruments than those previously mentioned by the Suryasiddhanta (Wiet 637).

(b) Mathematics

Apparently, the notion of counting in all historical cultures presupposes the existence of the mathematical system as far back as the ancient period given the fact that counting, the various methods or paradigms not withstanding, has been part of human existence and civilization. In other words, the mathematical system was first expressed in form of counting

including counting with the human fingers and other symbols. In this connection and as practiced by many traditions, different symbols were used to represent different definite numbers such as ten, twenty, fifty, hundred, etc. With the progress in human civilizations, various numbers were assigned specific numeral names and symbols or alphabetic letters such as in Roman culture.

Considering the history of science in India, it is pertinent to mention that significant advances in mathematics were made as far back as the ancient period with particular sophistication in geometrical and algebraic techniques. Accordingly, these geometrical and algebraic traditions were undoubtedly stimulated by the flexibility of the Indian system of numeration that later was to come into the west as the Hindu-Arabic numerals. It should be noted that in the history of science in India, the names of great astronomers are associated with that of great mathematicians indicating the influence of astronomy on mathematics. Thus it is plausible to assert that in the early years of the 6th century, mathematics was perceived as a product of astronomy in India. Though the former was for speculative purposes where great progress has been recorded.

Aryabhata one of the greatest astronomers in India history, wrote his treatises on mathematics and tells us the significant role mathematics played at the end of the Gupta era. Equally, his treatise on astronomy had a chapter devoted to arithmetic, algebra and the most basic and essential facts of trigonometry. Of much significance concerning the works of Aryabhata in the area of mathematics is the fundamental discovery of the rule for the extraction of square and cube roots. Weit and co. quotes the work of Aryabhata thus stating the rule for extracting a cube root as set forth in a stanza.

Aryabhata studied the summation of arithmetic series and also attempted to solve both quadratic and linear in determinate equations. He introduced the use of the sines of angels instead of the chords used by the Greeks. With this introduction, it marked the beginning of the study of trigonometry.

Some scholars have pointed out that “because astronomy required extremely complicated mathematical equations, ancient Indians made significant advances in mathematics in this respect of particular importance, is the “Differential equations” said to be the basis of modern calculus. These accordingly were all likelihood an Indian invention. Furthermore, Indian mathematicians were said to be “the first to invent the concept of abstract

infinite numbers, that is, numbers that can only be represented through abstract mathematical functions such as

infinite series in geometry or arithmetic. Equally, due to the Indians' advanced astronomy, they invented the modern numeral system often referred to as the Arabic numeral system in Europe.

This development may have influenced great mathematicians of western origin. Particularly, we are made to understand Pythagoras the Greek mathematician and philosopher of the 6th Century B. C. was familiar with the Indian Upanishads and learnt his basic geometry from one of the treatises the "SulvaSutras". This goes a long way to affirm the influence of Indian tradition or modern mathematics. To buttress this point, it is worthy to note that the Indian notational system was quite elegant, and it was this notational system of the Hindus people that spread to the western world through the Arabs and has now been accepted as universal. Acknowledging this fact, the French Mathematician Laplace is of the opinion that, the ingenious method of expressing every possible number using a set of ten symbols (each symbol having a place value and an absolute value) emerged in India. This invention may not be by accident given the fact that in India, almost everything was in place to favor such a development.

Thus, there was already a long established history in the use of decimal numbers, and philosophical as well as cosmological constructs which encouraged a creative and expensive approach to number theory. It is pertinent to mention that Aryabhata earlier discussed used mathematical knowledge in his revolutionary understanding of the solar system given the fact that is order to understand his calculations on Pi; he had to solve several mathematical problems that had not been addressed before including problems in algebra and trigonometry. In attempt to develop a precise mapping of the lunar eclipse, Aryabhata an astronomer and mathematician, was obliged to introduce the concept of infinitesimals otherwise called "tatkalikagati". This designated the infinitesimal or near instantaneous motion of the moon which was expressed in a basic differential equation.

Gaston Wiet opines that in the history of mathematics in India, the use of positional notation conditions all subsequent progress in mathematics. This fundamental discovery was given to the world by the Indians, but it is not known at what date, Furthermore, the calculation of interest was of practical concerned to the Indian mathematicians. Accordingly, Wiet presents Aryabhata as providing numerous examples.

Multiply the sum of the interest on the capital and the interest (on the interest) by the time and by the capital; add (to the result) the square of the half the capital; extract the (square) root; deduct one half of the capital and divide (the remainder) by the time. This gives the interest on the capital itself (632).

Besides the calculation of interest; Aryabhata was able to solve equations of the second degree. He also concerned himself with problems of indeterminate analysis.

In arithmetic, Jean Filliozat observes that the so-called "Arabic" decimal positional notation, with nine figures and zero, also was invented by the Indians. The rule given Aryabhate for the extraction of square roots implies the use of such a notation. The early use of the decimal system in India is evidenced by the verdict names for the multiples of ten …" (930).

Among other Indian traditional astronomers who delved into the area of mathematics was Brahmagupta. He developed the application of explicitly general algebraic methods to astronomical problems. He equally came up with the general methods for solving indeterminate equations of the first degree and for extracting one root of a quadratic equation. Also the invention of a formula for the area of any quadrilateral with two parallel sides was attributed to him.

Mahavira on the other hand, discussed the operations of addition, subtraction, multiplication and division, including the use of the zero. He maintained that the division of any number by zero gave zero as the result. At this juncture, it is necessary to mention that the earliest awareness of zero was found in a monument at Gwalior in A.D.876. Mahavira according to Wiet "wrote a relatively comprehensive treatise in verse covering the calculation of areas, volumes, and projections. He studied geometric progressions …" (634).

Bhaskara another Indian scientist expanded on the trigonometric equations provided by Aryabhata. He like his predecessor, rightly assessed Pi to be an irrational number. His most important contribution was his formula for calculating the sine function and was the first to work on indeterminate equations. Bhaskara was also the first to consider quadrilaterals with all the four sides unequal and more of the opposite sides parallel. It should be noted that Bhaskara was the first to point out that the division of any number by zero would not result to zero as insinuated by his predecessors.

Rather for him, the result will be infinity. Wiet acknowledges that "Arab scientists recognized their debt to the Indians, and through them European science was able to benefit from the discoveries of Indian mathematics" (635). This shows that Indian mathematics developed prior to any of the European and Arabic mathematics.

(c) Medicine

The treatment and understanding or study of illness and injuries (medicine) in India tradition took shape in the Gupta era. Some corpus of literary work indicates that medical science was one area where surprising advances had been made in ancient times in India. In specific terms, these advances were in the area of plastic surgery, extraction of cataracts, dental surgery etc. The most authoritative literary works on ancient medicine in India according to Jean Filliozat are that of Charaka and the Susruta. 'Charaka' is however, known to be "the most important text, as he clearly distinguished rational medicine from magic and religious treatment (930). Mason on the other hand declared the Bower manuscript dating as far back as the fourth century B. C. as the oldest Hindu medical work. Accordingly, Manson declares: "the manuscript consists of a list of drugs, and the lore (knowledge) of their use, and these are copied by later works, notably the Charaka, a medical compendium that has been placed in the second century A.D., and the Susruta, a fifth century treatise on surgery" (92). Here Mason apparently gives precedence or antecedence to the Bower manuscript.

Later works appear to have Greek influence and sources given that, the "Charaka" spelt out rules of syllogistic reasoning undoubtedly taken from Aristotle. Three vital processes in the human body are significantly distinguished in the "Charaka". These process are identified by Mason to include (1) The process due to the operations of air in the region below the navel (2) The process due to bile which control the region between the navel and the heart (3) The process of activity of Phlegm above the heart. These vital processes engendered the seven principles, chyle, blood, flesh, fat, bone, marrow and semen, health. Depending on the harmonious relations of the seven principles mentioned above, any disorder would result in a disease (Mason 92). In other words, sound health as it was believed, is experienced when the principles which have been further classified into water, fire and wind work or function in harmony. While any excess or deficiency of one or more of the active elements brings about ill health. The three active elements Filliozat opines are also known as "Tridosho" meaning the "three troubles" (930).

Gaston Wiet further writes that "Ayurveda" the knowledge of long life (longevity) is another name given to the works of Susruta and Charaka. Thus, the "Ayurveda" medicine accepted and expresses the material of the body to constitute "five usual elements", ether, water, earth, fire and air; which meant that there existed in the body liquids, solids, empty spaces, internal heat, and movement (638). Here, there is no doubt that physiology in India medicine is closely linked with a science of psychology.

It is on record that in terms of superiority, the surgical work, the "Susrut" is more superior to the 'Charaka'. The former describes some 121 surgical instruments and gives an account of most of the surgical operations known before modern times. The "Susruta" (Shushruta) was the first to study the human anatomy. It described in detail the study of anatomy with the aid of a dead body. Of importance is the fact that the connection between malaria and the mosquito was noted in the susruta as well as the voiding of sweet urine by diabetic patients. It is only in the susruta that you find a description of medical treatment as well as ophthalmic surgery (extraction of cataracts), and embryology. The drafting of skin largely practiced by a procedure even in the contemporary epoch is still known as "the Indian method". This suggests that the act of skin drafting generally owes debt and credence to the Indian procedure.

In the area of anatomy, Shushruta as he is sometimes called is said to be one of the earliest pioneers in surgery as well as one of the earliest ones to study the human anatomy. The practice was such that after a dead body has been cleaned that is, the intestine, the body must be wrapped in bast (the inner bark of trees), grass or hemp and placed in a cage (for protection against animals). The cage is then immersed carefully concealed in a river with fairly gentle current and the body left to soften. Seven days later, the body is then removed from the water and with the help of a natural grass root and brush-like tool and bamboo, one layer is brushed off one at a time, to the extent that the naked eyes can observe every large or small outer or inner part of the body, beginning with the skin as each part is laid bare due to the brushing.

Concerning surgery, the dissection of corpses as part of anatomy was an essential preparation for the practice of surgery. Wiet quotes from the Susruta "He who wishes to acquire a clear knowledge of surgery must prepare a corpse according to the accepted method and examine each part of the body by means of a careful dissection so as to acquire a dependable

knowledge (638). It is pertinent to mention that the cutting off of the nose and ears was one of the traditional common modes of punishment in the early Indian Kingdom. In this respect, Shushruta contributed immensely to plastic surgery by operation of rhinoplasty (restoration of a mutilated nose by plastic surgery) which he did with surgical skills, grace and success. This practice is dated around the 8th century B.C.

It should be equally noted that "the circulation of blood, rediscovered in Europe in the eighteenth century, was known to the Indians, and even the circulation of material body in the embryo. But oddly enough the role of the lungs seems to have escaped Indian physiologists" (Wiet 638). In terms of pharmacology, incipiency, methodology of preparation and application formed its various classifications. Traditionally, India is known for the use of plants and their efficacies. Many plants used by the Indians since the days of antiquity are still in use today: In respect of equipment, Indian surgery was quite remarkable especially those used in ophthalmology. The removal of cataract was equally highly developed.

During the medieval times Vagbhata was known to be the greatest Indian doctor with a reputation similar but not above that of Charaka and Susruta. While towing a great deal the path of Susruta, Vagbhata equally used other sources, and his work is seen as a synthesis of Indian medical knowledge. Vagbhata made his contribution to Indian medicine about the 6th or 7th century. Worthy of note is the fact that Indian medical science spread beyond India.

Magical practices for therapeutic purposes were current in India as in all cultures. Of significance is the practice of Yoga which is believed to allow modifications in normal physiology. The fundamentals of Yoga were systematically presented as early as 2100 years (2nd century) ago. This was credited to patanjali in his work titled "Yogasutra", that is Yoga Aphorisms. Yoga of note creates important modifications in normal physiology. For example, certain Yogi succeeds in reducing the circulation of the blood to the point where it is impossible to detect (Wiet 639). The practice of Yoga is seen as exercises for physical and mental nourishment as well as self-discipline which is a kind of therapy for the body.

Conclusion

The image of the past created by the play of the imagination and intellect on materials left by earlier generations is simply conceived as history. Thus the history of science is the description and explanation of the development and

systematization of positive knowledge about the physical universe. Science is generally viewed as a cumulative and progressive activity. Such a view, however, has profound philosophical and historical implications, and in fact the effort to define the nature of science is in itself part of the history of philosophy. The nature of science here covers the broad field of knowledge that deals with observed facts and the relationships among these facts. Hindu science is no doubt a different development especially when considered on the peculiar background of Indian tradition and culture.

As we have shown, the history of science in ancient India centres principally on astronomy, mathematics and medicine associated with the tradition of the Hindus. This does not suggest that the Hindus never delved into other science related disciplines. Apparently chemistry (alchemy), botany and zoology were linked directly with medicine and pharmacy. In India, the earliest applications of chemistry took place in the context of medicine, metallurgy, construction technology and textile production and dyeing. Physical sciences including physics and related disciplines were not left out as part of India science.

While arguing that religious beliefs including taboos and other indoctrinations towards mystical or magical phenomenon or adherence to superstitions has often posed as serious impediments to the advance of science, they however, on the other hand helped positively in shaping the Indian mind given the fact that progress of science in India was thus inextricably linked to challenges to the domination of priests, and resistance to the proliferation of rituals and sacrifices. Here, the role of rational observation of the Indian world was necessary in shaping human destiny. It is therefore no accident that by and large, developments in science and technology came in parallel with the advance of rational philosophy in India.

To buttress the point earlier made, Wiet argues that the study of Indian science often neglected in works dealing with Indian civilization as a whole, is as essential for knowledge of the Indian mind as that of philosophical systems. Furthermore, “though the unity of scientific thought in India was opposed by the extreme diversity of philosophical speculations, it is obvious that both cosmological and psycho-physiological theories in particular the pneumatic conception of physiology and physics, had shaped metaphysics since the Upanishad era (640). Thus, the presence of certain common trends constituted a family resemblance to systems in opposition with one another. This was predicated on the inevitable diverse religions and derived from this heritage, was a kind of immunity to the fluctuation of opinions.

It is of interest to note that the various scientific conceptions and practices in ancient Indian tradition have tremendous influence on the development and or progress of science up to the modern period. The civilization pervaded Asia and other continents. It is pertinent to also state that it was at the end of British rule over India that research institutes and scientific societies were established with largely theoretical achievements (Filliozat 929). During the post independence period, science in the area of electronics crystallography, solid – state technology and space meteorology was emphasized.

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