EARLY ACHIEVEMENTS BY DIFFERENT NATIONS IN SCIENCE*

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This article explores the early scientific achievements of different civilisations. It focuses on the contribution of Egyptian, Babylonian, Indus Valley, and Chinese cultures. The roots of western science and arithmetic are explored in the article. The paper also examines the transmission of scientific knowledge through traditions and the influence of different cultures on the progress of science. The role of Arabic culture as a bridge between Eastern and Western scientific traditions is emphasised, along with the significant contributions of Indian and Chinese civilisations to mathematics, medicine, and technology. The article also discusses certain philosophers that made significant contribution in shaping the field of modern science. The paper points out that while Europe has had scientific development going on for over 500 years, India has had it for only 60 years, and thereby has a long way to go.

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The famous English historian A.J. Toynbee, several years ago concluded that at least, 21 great civilisations rose and fell during the last 6000 years of human progress. From a detailed historical survey, he was convinced that the next big World War is likely to start roundabout Tibet. Undoubtedly, these civilisations developed arts and crafts considerably.

Along with the Chinese civilisation, about 4000 years ago, three other big civilisations; the Egyptian, the Babylonian and the Indus Valley were in full swing, and marked progress in useful arts and craftmanship was achieved. With improvement in arts and crafts, the rudiments of science and medicine made their appearance.

The invention of writing was contemporary with the early days of the Egyptian civilisation and soon afterwards, treatises on crafts were written and these formed the nucleus of recorded applied science. Prof. J.R. Partington, in his, *Origins and Development of Applied Chemistry* (1931), has recorded the early achievements in the production and uses of numerous inorganic and organic materials in Egypt, Babylonia, Assyria, the Aegean, Asia Minor, Persia (Iran), Syria and Palestine. He was unable to take up Indian and Chinese contributions as he felt that adequate information was not available due to these countries being very far from Europe.

The eminent Belgian specialist in the history of sciences, Prof. G. Sarton, in his book, *The Guide to the History of Science,* has emphasised that the history of ancient and medieval science is largely a history of tradition. A good deal of the achievements of

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alchemists, physicians and craftsmen was transmitted by manual examples to their pupils. The Teacher would say: "Watch me, see what I am doing and how I am doing it and do the same". Acharya P.C. Ray, in his, *History of Hindu Chemistry,* had laid stress on the same aspect of the development of applied science.

Science in Different Civilisations

Sarton has drawn the following graph (Fig. 1) symbolising the progress of science in different civilisations.

The roots of western science are Egyptian, Mesopotamian and to a much smaller extent, Iranian and Hindu. The new arithmetic and the new trigonometry were due to the mutual fertilisation of two very different streams of thought, the Greek and the Hindu. The graph shows that the Arabic achievement is not only a continuation of Greek science but also of Iranian and Hindu ideas. It is interesting to note that, Sarton is definitely of the opinion that western science was not influenced by the Chinese.

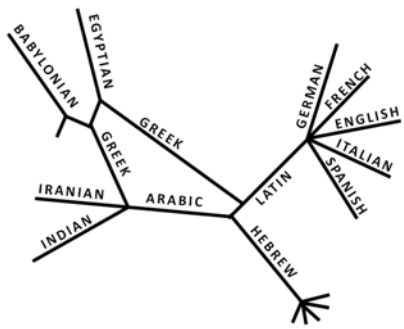

Fig. 1. Progress of science in different civilisations

Regarding Arabic progress, G. Sarton has stated: "The best Arabic scientists were not satisfied with the Greek and Hindu sciences, which they inherited. They facilitated the evolution of Algebra and Trigonometry, and prepared the way for the European algebra of the 16th century. The Arabic culture is a bridge, the main bridge, between the East and the West. It is through that bridge that the Hindu numerals, sines and cosines and the Chinese silk, paper, porcelain reached Europe. Latin culture was western, Chinese culture was eastern, but Arabic culture was both."

There is no doubt that under the inspiration of the Prophet and his followers, Arabic culture, science and technology made tremendous progress, and have spread in the East and West. Similarly, in the Buddhist period, there was a grand creation of new knowledge and its applications in India and these were carried to many Asiatic countries and took roots in the soils of foreign lands.

H.M. Leicester and H.S. Klickstein, in their book *Source Book in Chemistry* 1400–1900 (1950), have observed: "With the decline of the Alexandrian culture, the learning of the Greeks passed by way of Syria to the Arabs. They received ideas not only from the West but also from India and China. A Chinese form of alchemy had existed from almost the same period as the Greek and the Chinese sages sought to prepare a medicine from which gold could be formed. This may have been the origin of the idea of the Philosopher's Stone, which is not mentioned by the Greeks. In the 12th and 13th centuries, the science of the Arabs passed at an increasing rate back to the western Europe."

The astronomy of the ancients consisted chiefly in observing the position of the

heavenly bodies and the Egyptians and Babylonians were interested in astronomical observations as aids to astrology and preparation of calendars. The practical needs of architecure and surveying led to the study of Geometry, and areas and volumes were computed. Babylonian arithmetic was well-advanced. Logic and interest in pure knowledge started with the Indians and Greeks. Biology began with Aristotle (4th century BC), but the practice of medicine and surgery was in vogue from time immemorial. In Egypt, as early as 3000 BC the physician was highly respected.

F. Sherwood Taylor, in his book, *A Short History of Science*, 1950, has recorded: "It is quite certain that a high state of intellectual development existed between 700 BC and 500 AD in India. In Sanskrit, the Indian had a language capable of expressing with accuracy the most subtle shades of meaning. The Indian genius was psychological and no other people has evolved so systematic a vocabulary of terms for the expression of the states of mind. The first philosophical system may have come into being at much the same time as the beginning of the Greek philosophy, namely, between the 8th and 5th century BC Indian medicine had a long armoury of drugs, many of which seem to have been potent. The real merit of the Indian scientific culture is to be found in its mathematics. The Indian genius tended towards arithmetic and algebra rather than geometry. The Arabs certainly gained mathematical knowledge from India before they had access to any of the great Greek mathematical authors".

Describing the Chinese achievements, Taylor observed: The Chinese culture arose at an early date, which may be in the region of 3000 BC. The genius of the Chinese has not proved itself a scientific one, though from the earliest times, they have excelled in arts and technology. The influence of India on China was, of course, considerable. The Chinese mathematicians never reached the standard of their Indian teachers. As we have been now forced to be very alert about China, the foregoing observations are of considerable significance to ourselves for our uplift.

Contributions from India

It appears, therefore, that in the early days of our civilisation, say about 400 BC, India produced almost as good thinkers as Greece. We had, at this time, Kanada and Kapila whilst Greece had Aristotle and Democritus. All these seers speculated on the ultimate particles of matter known as atom. But as there was no experimental support for their views, not much progress was achieved. Our Jivaka, about 2 AD and Nagarjuna, 750 AD were perhaps better scientists than those existing in Europe up to 7th or 8th century AD, especially from the practical point of view.

The iron pillar used in the Qutab Minar and those in other parts of India, forged and constructed about the 8th century A.D. or earlier, consist of practically pure iron. They have attracted universal admiration and even great modern scientists like Prof. H. Le Chatelier of Paris and Sir Robert Hadfield of England have recorded their great appreciation of this Indian achievement. Sir Robert has stated—Indeed, it is only within the last century or so that any European iron master could have undertaken to produce such a forging.

The result of the analysis by him is as follows:

Carbon	Silicon	Sulphur	Phosphorus
0.08%	0.046%	0.006%	0.114%
Manganese	**Iron**	**Specific gravity**	
Nil	99.72%	7.81	

Similarly, the preparation of caustic alkali and the internal use of iron and mercury compounds as medicine were known in India, earlier than in Europe. But the difficulty for the historians in India has been aptly put by A. Sprengler in his famous book, *Decline of the West* that the Hindu has not recorded anything, even if the matter is of a great national or cultural importance, whilst the Egyptian has put down all his progress and achievement.

China and Greece

It is well known that the Chinese knew of gun powder in the 6th century AD, and the use of coal before the Europeans. It is believed that the Chinese were good at bridge building, hydraulic engineering and in enamel and lacquerware. It is interesting to note that the Greeks, who were the acknowledged leaders of thought, philosophy and culture in Europe, continued their mental vigour between the 6th century BC and the decay of the Alexandrian Museum in the 2nd century AD. The history of the Byzantine Empire showed that the Hellenic world was intellectually stagnant for 1000 years as it happened perhaps in India and China. It is known precisely that there was no progress in Italy during the Roman period but it became very fertile since the renaissance of learning. The English mind was fairly bright in the 7th and 8th centuries AD but remained dormant for nearly 700 years and started reshining in the 15th century. Moreover, the ability of the Arabs was very apparent for 150 years after the appearance of Islam but remained inactive almost uptil now. The Chinese continued their inventiveness in their art.

Aristotle was the tutor of Alexander the Great for several years in the Court of Alexander's father, Philip of Macedonia. Aristotle anticipated Bacon and the modern scientific movement as he was a great pioneer in observing nature in all its phase and drawing conclusion from observations. Other men followed the easy path of speculation. His pupil, Alexander the Great, contributed hundreds of talents (1 talent is equivalent to £240) for carrying on experimental observation by Aristotle and his pupils that numbered 1000, distributed in Greece and Asia for collecting materials for his natural History. This seems to be the beginning of organised scientific enquiry. In Egypt, at the Alexandrian Museum, this work was continued after Alexander's death for some time. Unfortunately, this method of obtaining new knowledge by pain- staking observations and experiments was not continued in Greece after the 4th century BC The Stoics and Epicureans only cared for ethics, that is, the practical question how a man should order his life, and neglected experimental inquiry which is difficult and laborious. Thus again, speculation and discussion ruled the world of learning till the experimental methods were reorganised in north-west Europe in the 13th and 14th centuries.

Before this development, political, economic and religious conflicts between Europe and Western Asia were rife and intellectual effort was frustrated. The Semitic people

rose against the Aryans and replaced Greek culture and civilisation by Arab influence. All Western Asia and almost half of Europe came under the Mongolian rule but this influence of invasion did not last very long in Western Europe as it did in India.

In the field of the revival of intellectual efforts and freedom of thought, notably in the Universities of Paris, Oxford and Bologna, Peter Abelard (1079–1142), Albertus Magnus (1193–1280), Thomas Aquinas (1225–1274) and specially Roger Bacon (1210–1293), a clever Franciscan monk of Oxford, who studied both in Oxford and Paris universities, played a very important role. He insisted upon the need of experimentation and collecting knowledge on the same lines as Aristotle. He shouted to mankind and said: 'Cease to be ruled by dogmas and authorities. Look at the world'.

After the 8th century AD, we in this country never carried on experiments and never accepted the experimental method of science. This seems to be the main reason why we are backward and not so honest in our efforts and actions as an European, who has developed more method and honesty in everyday life. We have been very unlucky because invaders came repeatedly to our land and enslaved us. Instead of following the path of truth, progress and science, we succumbed to moral and mental slavery, and I am sorry to say, this mental slavery seems to be persisting.

Experimental Methods

During the 15th and the 16th centuries, the experimental method of science was gradually established in Europe by Paracelsus, Bacon, Boyle, Palissy and many others. They were followed by Black, Scheele, Priestley, Newton, Cavendish, Davy, Berzelius, Bunsen, Mendeleef, Darwin, Mendel, Dumas, Bossingault, Faraday, Pasteur, Ross, Koch, Madame Curie and others, who made tremendous sacrifice in pursuing scientific endeavour and experiments. They applied science to all problems of life and developed their natural resources, improved their agriculture and made Europe prosperous. There was marked progress of science and technology for nearly 500 years.

The age of modern science in India is approximately 60 years whilst in North-West Europe scientists have toiled for nearly 500 years. Hence, we have to be patient and work hard for our national uplift.