teachers of university also participate. The Department of Extra-Mural Studies of the University, Bombay Natural History Society, World-Wide Fund for Nature, etc. are at the forefront in organizing these weekend studies of nature, enlisting services of well-informed and trained volunteers from the society. These programmes are received extremely well and prove beneficial to student participants and laypersons, as also for conservation of the interesting habitats that they visit.

On the basis of the above experience, I would like to suggest the following strategy aimed at educating students and teachers from schools and colleges and encourage them to inculcate the ethics of conservation in the society at large. This will benefit botanists of today and tomorrow, and also lead to conservation of species and their habitats.

(a) Botanical excursions should be called as field exercises and *not* collection tours.

(b) These should be conducted by teachers/guides who have undergone training/orientation in field studies and are conversant with the rigorous ethics of conservation.

(c) Universities should conduct such orientation courses for teachers under the auspices of UGC.

(d) Along with taxonomy, conservation bias should also be indoctrinated.

(e) 'Collection' of plants from fields should be prohibited and students indulging in plant collection should receive negative credit.

(f) Herbarium techniques should be taught to students using only abundantly available, cultivated or weedy plant species.

(g) Maintenance of field diaries should go beyond lists of plants spotted and should give due weightage to description of plants, their habitat and ecological status in the local plant community.

(h) Field studies should be conducted more frequently, students should consider them as 'a way of life' during their learning process, rather than an occasion for a picnic.

(i) A sense of 'compulsion' to attend field studies should be removed by making them optional or for volunteers only. Nature, requiring protection, has no place for reluctant visitors. At the same time, incentives for good field work may be considered.

(j) And last and very important, 'professional plant collectors' should be discouraged by patronizing only nurseries and research stations that maintain and regenerate plants for study.

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# Delhi iron pillar and its relevance to modern technology

Often, the relevance of studies conducted on ancient Indian science and technology is questioned because no direct applications can apparently be envisaged by the revival of ancient Indian technologies in the modern context. However, studies on ancient Indian science can open new lines of thinking which may prove beneficial, if applied appropriately, in modern times. In this letter, we present a new idea for the possible application of the scientific and technical knowledge that we have accumulated on the historically, culturally and scientifically significant Delhi iron pillar[1].

We begin by noting certain basic facts about modern iron and steel-making technology. The technologies dealing with both the extraction of metal from the ore in the blast furnace and its conversion to steel, are highly environmentally unfriendly. The emission of greenhouse gases and their role in causing deleterious climatic changes have been well documented. Therefore, there is an urgent need to adopt iron-making technologies that do not emit significant amount of greenhouse gases. The main culprit is, of course, coking coal used for extraction of iron. Interestingly, all the major coke oven batteries in existing iron and steel plants around the world are due for significant replacement in the very near future. The huge investment required for this activity has provided an opportunity to look afresh at the entire iron and steel making operations, in general. In this regard, the direct reduction process of iron making, which was in vogue in ancient India, may be relevant to solve the environmental pollution problem, especially if a clean reductant like hydrogen can be used for the reduction of the ore to metal. The iron produced from the direct reduction processes can be utilized for several large-scale applications. One important application is the production of corrosion-resistant iron. The specific environment in which corrosion resistance needs to be enhanced is atmospheric exposure. Huge investments are being currently made to prevent and control the atmospheric corrosion of iron objects. The Delhi iron pillar reveals that phosphoric irons would offer excellent resistance to atmospheric corrosion[2]. Therefore, production of phosphorus-rich iron from the output of direct reduction furnaces would be a major step that needs to be debated. In this regard, the relevance of puddling technology must be emphasized. In the puddling process, the interstitials (carbon, phosphorus, etc.) are reduced by reacting with iron oxides in the puddling furnace and the operation is carried out in solid state. The puddling process of manufacturing wrought iron, which has almost died, could be revived so that phosphoric iron can be produced in large quantities. Additionally, the slag composition can be controlled to allow higher P retention in iron. This can be easily achieved by minimizing limestone charge in the puddling furnace. This would also reduce the environmental pollution problems associated with limestone mining. The end product of the pudding furnace is phosphoric iron, which would be corrosion resistant in atmospheric exposure conditions. Moreover, the entrapped slag inclusions (mainly fayalitic) would not be deleterious to atmospheric corrosion resistance because the protective passive film covers the surface before the initiation of localized attack[3], due to the mild corrosivity of atmospheric environment. On the other hand, entrapped slag inclusions can be a blessing in disguise because adherence of the surface protective layers are superior on wrought irons[3]. Moreover, the entrapped slags would assist in down-line manufacturing processes by providing a self-contained flux for the operations.

The maintenance that would be required to preserve phosphoric irons against atmospheric corrosion is quite simple. If conventional surface coating processes like painting are employed, phosphoric irons would fare better than mild steel. The surface of phosphoric irons can be maintained in a pristine condition even without painting by suitably allowing the protective passive film to protect the surface. This can be easily achieved by periodic buffing operations on the iron surface. The superior qualities of the protective films that form on smoothly buffed surfaces are well recognized for stainless steels. The surface finish that develops on well-buffed phosphoric iron surfaces is truly amazing. By proper buffing operations, a golden hued surface with a shiny appearance can be developed because of the nature of the passive film that forms on phosphoric irons.

A great benefit will also accrue in the mining area with the possible large scale use of phosphoric irons for atmospheric exposure applications. At present, the high-phosphorus containing iron ores are not being deliberately mined. With the realization that superior corrosion resistant phosphoric iron can be produced from these ores, the great reserves of high-phosphorus iron ores can be exploited usefully. This would be very relevant in the Indian context because we possess large reserves of high phosphorus iron ores.

The oft-cited problem that phosphorus causes cold shortness (i.e. embrittlement during cold working) may not actually be the case if careful studies are conducted on the mechanical behaviour of phosphoric irons. Such studies have not been conducted on a large scale utilizing the sophisticated tools of modern scientific investigation because research in the early 1900s indicated the deleterious effect of P on mechanical behaviour. However, recent studies on the mechanical properties of phosphoric irons have revealed that the deleterious effect of significant phosphorus content in iron may actually be offset by the presence of a small amount of carbon[4]. Phosphoric irons possess adequate strength and ductility for manufacturing objects for normal atmospheric exposure applications (i.e. frames, non-critical structural members, etc.). It is interesting to note that ancient ironsmiths deliberately chose phosphoric irons over normal iron for their working operations as revealed by the high P contents in archaeological irons from different parts of the world[4].

An ardent plea is advanced, through this letter, to study the feasibility of drastically modifying existing iron and steel-making practices in order to produce and apply phosphoric irons on a large scale.


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# Recent findings on the Acheulian of Isampur excavations and its dating

Paddayya *et al.*[1] claim discovery of 'the oldest known (stone age) site in India' at Isampur, which is dated over a million year. Earlier, Mishra *et al.*[2] had claimed the site at Bori, near Pune, to be the earliest and 0.67 Ma old. Dating of these Acheulian sites[1,2] is suspect.

The Acheulian site at Isampur (16°30′N: 76°29′E) is set in a 20–30 cm thick calcareous silt above the Bhima Group limestone. Fragmentary vertebrate remains associated with the Acheulian tools have not been identified to specific levels and contain no Middle Pleistocene forms. Based on fresh condition of the artefacts, their occurrence at the raw material source, and the recovery of a large number of small-sized debitage fragments, the assemblage is assumed to have virtually escaped erosion and reworking before being buried under colluvially deposited silt[1]. Under such a setting, cultural elements and vertebrate remains lying on the limestone floor may belong to more than one age and get mixed up. This is corroborated by wide range of $^{230}Th/^{234}U$ radiometric dates on dental material from the Acheulian sites in the Hunsgi and Baichbal valleys, which ranges in age from 174 to > 350 ka. Such dating was not attempted on Isampur site, but electron spin resonance (ESR) dating was done on two fossil teeth. The early U uptake (EU) ages set the minimum age for the site at 730 ± 100 ka, while the recent uptake (RU) ages set its maximum possible age at 3.12 ± 0.40 Ma with a mean age of 1.27 ± 0.17 Ma assuming linear U (LU) uptake[3]. 'Considering the technological and typological features' the Isampur assemblage was assigned much older age (0.5–0.6 Ma) than the nearby sites. Its age was increased two fold further and the older average ESR age 1.27 Ma was chosen[3] without any additional reason. The inference that the Isampur site is the oldest Lower Palaeolithic site in the subcontinent is thus not convincing. The absence of any Mid-Lower Pleistocene faunal elements is also noteworthy.

Earlier, the Acheulian site at Bori was claimed to be the oldest from the Peninsular India[1,2,4,5], which was also strongly contended[6,7]. Highly discrepant radiometric ages (K–Ar[4,8], Ar–Ar[2], fission-track[8], TL[8]) were obtained from a differ-