from broth cultures of the various strains of rhizobia grown in YEM media. The uninoculated served as the control. The pots were irrigated on alternate dates with dil, nitrogen-free McKnight[1] solution or water. The plants were grown in a heated glass-house with a photoperiod of 11–13 hr and a daily maximum and minimum temperatures of 27 and 22°C. Plants were harvested after 8 weeks of sowing. Roots were examined for nodulation and nitrogenase activity of nodules were measured by acetylene reduction assay using Packward Model 419 Backer Gas Chromotograph (table 1). The results of the infection test with these 5 strains show clearly that the response to inoculation by various lines of *H. coronarium* are quite marked (figure. 1) compared to uninoculated which remained free of nodules. The CC 1335 (Australia-Canberra) seems to have a better nitrogenase activity.

TABLE 1

Acetylene reduction assay of H. coronarium nodules following inoculation with different strains

Strains	mg. d.w. ×plant	$nMC_2H_4 \times plant^{-1} \times h^{-1}$ (Aver. 1,2,3, hr)
Control	0.02328	22.9
CC 1335 (Australia-Canberra)	0.03045	319.6
CC 1337 (Australia-Canberra)	0.03186	205.1
HCNTI (Pisa)	0.04000	59.1
RH-19 (Sicilia-S. Italy)	0.03150	237.9
HCNA (Volterra--Pisa)	0.04536	162.5

The roots were exposed to 10% acetylene in air at 25°C for 1, 2 and 3 hr.

Figure 1. Effect of inoculation with different strains on the growth of *Hedysarum coronarium* (Top L.R.). strains CC 1335, RH. 19. RH-Bact (Middle) strains HCNA Control, CC 1335 $CaCO_3$ pelleted (Bottom) strains CC 1337, HCNTI, CC 1335 $CaSO_4$, pelleted.

Figure 2. New Fodder Legume—*Hedysarium coronarium* growing in saline-alkali soil of Karnal.

It is interesting to note that this fodder legume was able to grow well in our saline-alkali soils of Karnal, Haryana (figure 2). Further investigations are in progress.

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LATE QUARTERNARY FOSSIL BONE FROM GOA

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THE quarternary formations of Goa includes, coastal beaches tidal flats, the riverine alluvium, gravel and laterites. Though the laterites (less than 100m) have been tentatively dated as early quaternary and the other formations to the late quaternary, accurate

dating of the formations has not been possible. This is mainly due to the absence of any datable material in this 'leaching dominant environment'. Although, a single date of the Vagator beach (Guzder; personal communication) and two dates of the shelf surface sediments from the adjoining coast[1] are available, no data from inland Goa have ever been reported.

In this context a discovery of a fossil bone, about 14km inland, seems to be of substantial importance. The fossil bone, was found at a bridge construction site at Chandar (15° 15'35" N&70° 3'30" E). The bone was found at a depth of about 1.5m, below the surface of the alluvial terrace of Kushavati river (a tributary of Zuari river). The overlying alluvium is red-brown, acidic clayey silt.

The fossil bone was identified as the 'synsaerum of Bos indicus' (Badam; personal communication).

The chemical analysis of the fossil bone was carried out to obtain information about the degree of fossilization of the bone through the ages and to know the effect of the environment on the process of bone mineralization.

The chemical analysis was mainly oriented in deriving the percentage of fluorine and the fluorine to phosphate ratio ($100F/P_2O_5$). These values are often used for the relative dating and have been successfully attempted by Oakley[2].

The inorganic content of a bone is a phosphatic material hydroxyapatite $Ca_{10}(PO_4)_6(OH)_2$. This is altered during burial through progressive substitution of fluorine, resulting in fluorapatite, $Ca_{10}(PO_4)_6(F)_2$. The element fluorine occurs in almost all ground waters in the form of soluble fluorides. Therefore, with the passage of time, bones in permeable deposits accumulate fluorine progressively. Hence, this slow irreversible change involving permanent substitution of fluorine provides a basis for the relative dating of fossil bone; and has therefore been, employed here. The nitrogen content in a bone is an indicator of the conditions for bone preservation and hence the nitrogen content was also calculated for the fossil bone.

The analysis revealed that the fluorine and nitrogen content of the Chander bone were 0.25% and 2.37% respectively. The fluorine to phosphate ratio was found to be 1.92.

The bones of the chalcolithic period, found in Maharashtra, M.P. and Gujrat, have a fluorine content lower than 0.1%. Hence, the present value of 0.25% is appreciably high. The fluorine to phosphate ratio of 1.92 was found to be closer to the value of a bone, collected from a microlithic site at Tarsang, in Gujrat.

The nitrogen content of the Chandar fossil bone is 2.37% as compared to 4% nitrogen in a fresh bone. This value reflects that the conditions for the preservation of the bone were favourable at Chandar.

Granting the fact that the geological formation of the area affects the fluorine content, the value of 0.25% is quite high. This suggests that the fossils bone belongs to a period earlier than the chalcolithic. However, the samples from pre-chalcolithic Inamgoan (Pleistocene) site give a value between 0.7 and 1.0%. Hence, it is evident that the fossil bone discovered at Chander is definitely older than chalcolithic and could be tentatively dated to the early Holocene (c. 10,000–8,000 B.P.).

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ANNOUNCEMENT

INDIAN INSTITUTE OF CHEMICAL ENGINEERS AWARDS

Dr. B. D. Kulkarni of National Chemical Laboratory, Poona, has been awarded the Amar Dye-Chem Award for excellence in research and development. Dr. R. A. Mashelkar, Deputy Director, National Chemical Laboratory, Poona, has been awarded the Herdillia Award for excellence in basic research in Chemical Engineering.