



**Figure 1.** **a**, A sacred grove conserved by the local people in Bomdila. **b**, A destroyed forest in Naga-GG.

members of the community obey it. These sacred groves are under the vigilance of the village panchayat/council controlled by the headman. If anyone is found violating the rules, the village panchayat/council will take action, which includes a large penalty and in some cases the accused may be debarred from certain religious ceremonies. For good harvesting of agricultural products, good health, pure potable water, etc., the villagers make offerings annually to the deities whom they believe to be residing in the forest. Although there is restriction, collection of forest products such as fallen

leaves, few fruits, fallen twigs, etc. is allowed only during specific seasons. Besides these, there are also many forest patches near the Buddhist monasteries which are conserved by the lamas of the Gonpa authority. Many of these are made up of forest patches which are relics of past virgin forests and contain some important species such as *Taxus wallichiana*, *Gymnocladus assamicus*, as well as species that have disappeared from regions outside the grove.

Although these two ethnic groups contribute a lot to the conservation of biodiversity through their traditional ways, in

recent times with rapid modernization to cope with the expanded population, many forest areas have been destroyed (Figure 1 *b*). Therefore, it is important to involve the tribal communities of Arunachal Pradesh in formal biodiversity conservation strategies and encourage them to protect and expand the sacred groves through their cultural and religious beliefs.

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## Commercial revegetation of *Kappaphycus alvarezii* along Indian seas

Macroalgae are considered as ecologically and biologically important components in marine ecosystems and play a key role in overall coastal biodiversity. The macroalgae act as a microhabitat by providing nutrition and shelter to a variety of invertebrate groups. The epifauna provide a potentially important trophic link between fish and primary producers such as the host seaweed with its associated periphyton and phytoplankton from the surrounding water. Seaweeds are under threat in developing countries, where they are being disturbed by a variety of human activities. The direct introduction of seaweed species for aquaculture is an important vector, especially in the tropical regions<sup>1</sup>. Commercial cultivation of *Kappaphycus alvarezii* was started in 2003 along the Tamil Nadu coast. The ecological threat from *K. alvarezii* to coral species in the Gulf of Mannar (GoM) was first indicated by Pereira and Verlecar<sup>2</sup>. The Central Salt and Marine Chemicals Research Institute, Bhavnagar as a responsible national

laboratory that introduced *K. alvarezii* in India, is continuously monitoring the environmental impact of its large-scale cultivation and necessary surveillance mechanisms to keep in check its rate of encroachment over other native flora<sup>3</sup>. Bioinvasion of *K. alvarezii* on branching corals (*Acropora* species) in the Kurusadai island (GoM) was reported by Chandrasekaran *et al.*<sup>4</sup>. However, Mandal *et al.*<sup>5</sup> asserted that the invasive potential at Kurusadai island is remote taking into account the lack of functional reproductive cycle, low spore viability and absence of microscopic phases in the algal life cycle coupled with the abundant presence of herbivores.

The proliferation of non-indigenous *Kappaphycus* may lead to habitat alteration in a particular region due to the breaking up of a single vegetation type into smaller intact units. Altering habitat and involuntary spreading of farmed algae to nearby areas may affect many components of natural communities<sup>6</sup>. This concern centres on the disruption of

the once large continuous blocks of habitat into less continuous habitat and conversion of vegetation from one type to another. Seaweeds provide a habitat for myriad invertebrates and if native seaweed cover were to be entirely lost or recolonized with introduced species, this could be detrimental<sup>7</sup> or even beneficial to associated invertebrate epifauna and to larger invertebrates and fish that feed on seaweed-associated epifauna. The impact of non-indigenous seaweed on epifaunal assemblages depends on the host-plant specificity of the organisms and the similarities between native and non-native seaweeds<sup>8</sup>. Most of the previous studies have shown that the introduced seaweeds reduced the native macroalgal abundance, thereby negatively affecting the epifaunal diversity<sup>9</sup>. However, invasive seaweed may also provide more space for the epifauna and increase secondary production in the coastal systems<sup>10</sup>. Addressing these concepts in an intertidal study system, it is mandatory to test how *Kappaphycus* influences the associated

## CORRESPONDENCE

small mobile epifauna along the Indian coastline.

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## *Cordyceps sinensis*: fungus inhabiting the Himalayas and a source of income

*Cordyceps sinensis* is a parasitic fungus which infects the lepidopteran larva. The infected larva is commonly known as fungus caterpillar and is valued for its medicinal properties. In Uttarakhand it is locally known as 'keera jari' and is usually found in the meadows at a height of 3,500–5,000 m asl. The larva is infected by the fungus at the end of autumn; it slowly infects the whole body of the larva resulting in its death. During winter the larva remains buried in the soil. However, once the snow starts melting the fungus-infected larva sporulates giving rise to a shoot-like structure (Figure 1). Due to its potential medicinal value, *C. sinensis* has a huge market and is highly priced. Its collection therefore has become a good source of income for the locals. However, over-exploitation is alarming.

In Uttarakhand, *C. sinensis* is primarily found in Chiplakot, Ultapara, Brahmkot, Najari and Nangnidhura–Munshyari region of Pithoragarh district and Ghat, Dewal, Niti and Mana valleys of Chamoli



**Figure 1.** Fruiting body of *Cordyceps sinensis* with host larvae.

district. However, as the resource and collection of *Cordyceps* is rare and difficult, the supply often falls short of demand. In Central Himalaya, the harvesting season begins in April and continues up to May. The local collectors camp together with friends and family for collection, and then sell it to the authorized agencies such as the Forest Department Corporation. The non-residents (outsiders who migrate to the collection areas) are predominantly male, while local collectors display a more even male–female ratio. The collection method varies – some use a knife or dig a small hole to carefully pull out keera jari from the ground. The caterpillar fungus is more valuable before it sporulates or early during sporulation. In the final stages of sporulation the host larva becomes soft and undesirable and the upper part of the mushroom sometimes splits.

Well known for its medicinal value, keera jari contains chemically active compounds cordycepin (deoxyadenosin) and cordycepic acid<sup>1,2</sup>, which are known to increase the cellular ATP. Many complex polysaccharides, proteins, sterols, vitamins, nucleosides<sup>3,4</sup> and different types of sugars – mono, di and oligosaccharides are also found. It is often used by athletes to boost their stamina. Several studies have also indicated the use of *C. sinensis* in the Chinese and Tibetan systems of medicine against various diseases.

Due to its potential medicinal value, keera jari is highly priced. Depending on the quality and size of the larval host, the cost varies. A kilogram of the harvest is priced INR 4–5 lakhs in the Indian mar-

ket or INR 200–500 per piece. However, the international market offers US\$ 25,000/kg. This has enthused local collectors to collect keera jari on a large scale. The State Government, through Van Panchayats and the Forest Development Corporation, is also engaged in the collection and marketing of this important species. The Government offers INR 50,000/kg. Hence, the economic condition of this region has seen significant improvement. However, variation in the price offered by the Government and the market allows illegal collection. This calls for conservation and demands regulation to control over-exploitation. We suggest that the collection of keera jari should be done in alternate years. The Government of Uttarakhand should take stringent steps to curb illegal collection and supply.

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