

centration decreased with the time and completely mineralized after the 17th day. Retention time of parent compound was observed at 6.4 min.

Advantage of hairy roots over suspension culture has been shown for biodegradation of DDT, where the effectiveness of hairy roots for degradation of xenobiotics has been emphasized¹⁰. Although our basic knowledge of degradation of organic pollutants by plants lags behind that of bacteria and animals, plants can transform a wide variety of complex organics too¹⁵. Plant enzymes oxidize, reduce or hydrolyse a xenobiotic compound, thus introducing a reactive group for subsequent conjugation to moieties such as glutathione or glucuronate, after which these conjugated xenobiotics are stored in the cell either in the vacuole (soluble conjugates) or the cell wall (insoluble conjugates)¹⁶.

Biodegradation of chlorpyrifos has been reported in different systems, including soil, bacteria and fungi, where it showed similar pathways through formation of TCP. However, the present study shows that hairy roots have accelerated the process of biodegradation and metabolized chlorpyrifos to polar products. Whether these polar products are formed in the medium and are then taken inside or are formed within the roots is not clear. But these products were found to

be present in the plant roots as is evident from the increase in the bound activity in the roots. These findings were also supported by analysis using TLC as well as GC data. The accumulation of chlorpyrifos inside the roots and its consequent degradation over a period was evident during the experiment. Further studies are essential with a view to find the metabolites to which chlorpyrifos is converted.

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Spatial redistribution of *Soliva anthemifolia* (Juss) R. Br. – possible manifestation of changing climate

Soliva anthemifolia (Juss) R. Br., a diffuse, creeping, stoloniferous herb that bears characteristic sessile heads (Figure 1) belongs to the family Asteraceae and commonly occurs in South America and Australia. In India, the plant was reported for the first time in 1963 from Uttar Pradesh¹. In 1966, its extended distribution northward into the Himalayan states was reported from Dehradun (now in Uttarakhand), where it was growing at an altitude of 640 m asl (ref. 2). In 1973, it was reported as new addition to the Flora of Delhi³. Later, its extension to Jammu, where the plant was collected from an altitude of 400–700 m asl, was reported⁴. The plant was also reported from Rajasthan and Haryana^{5,6}.

Recently *S. anthemifolia* was observed growing in the mesic areas of Ranser

Island between 500 and 600 m asl and has been reported as a new generic addition to the flora of Himachal Pradesh (HP)⁷. Soon after, the plant was observed growing along water channels at an altitude of more than 1000 m asl in the Patti locality of HP. It should be noted that the higher limit of its distribution in the Himalayas has been mentioned to be 1000 m (ref. 8). Subsequently, the plant has now been observed in Palampur at an altitude of 1300 m (Figure 2).

The plant appears to be a new entrant to the area as earlier floristic surveys and inventories dedicated to Palampur^{9,10}, did not report its occurrence. This area is frequently visited by us and we had also not encountered this plant in our earlier surveys, until the recent one. This points to the fact that the plant has not been over-

looked during the previous surveys, but rather is a new colonizer (Table 1).

Range shift and spatial redistribution of species are amongst the best indicators of climate change in the mountainous regions of the world, such as the Himalayas^{11,12}. Changing distribution patterns, especially at upper altitudinal limits of species distribution, have been hypothesized as a strategy to mitigate temperature increase¹³. So, is the movement pattern of *S. anthemifolia* any indication of changing environmental conditions? As reported, Palampur has shown an increase of 0.6°C in temperature over the last three decades¹⁴, i.e. 1978–2008 (ref. 14). Also, Palampur is a relatively wet place that receives substantial rainfall. Both these factors are favourable for *S. anthemifolia* – a mesic habitat-loving



Figure 1. The characteristic heads of *Soliva anthemifolia* growing at an altitude of 1300 m asl in Palampur.

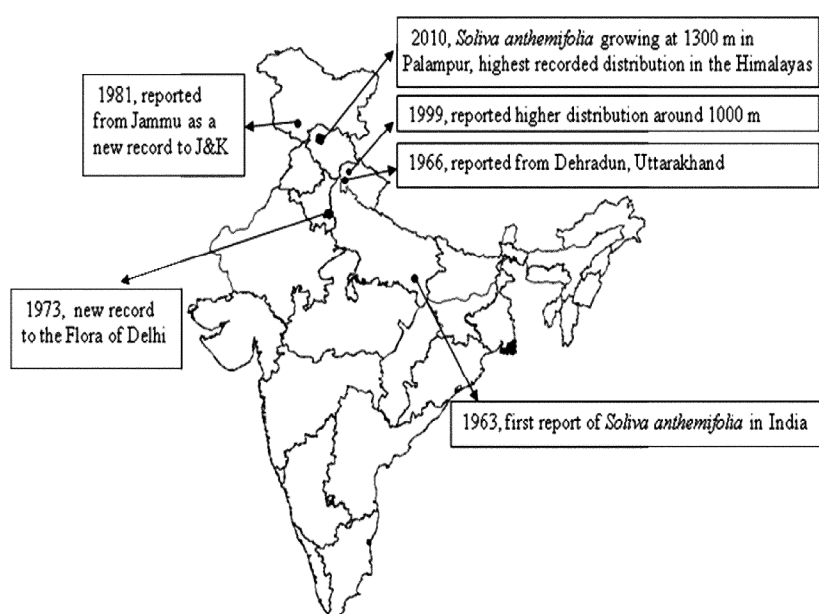


Figure 2. Schematic representation showing the distribution of *S. anthemifolia* in the western Himalayan zone after its first report from Uttar Pradesh.

Table 1. Localities in Himachal Pradesh, where *Soliva anthemifolia* was not observed earlier, but now grows profusely

Locality	Altitude (m asl)	Position
Patti	1047	32° 03'39.2"N, 76°31'58.1"E
Palampur	1314	32°06'02.4"N, 76°34'00.3"E

species of the warm regions. Furthermore, range shift patterns have been reported to be more pronounced in herbs with faster life-history traits, as in *S. anthemifolia*, compared to shrubs and trees¹⁵. Such patterns are now clearly visible and have been globally documented¹⁶. It, therefore, appears that *S. anthemifolia* is responding to the chang-

ing climatic conditions and showing an uphill movement pattern. Studies on its habitat requirements and dispersal mechanisms therefore become important.

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