vars and the FK506-treated seeds depicted lack of PPIase activity (Table 1). To rule out the possibility that the lack of PPIase activity in the extracts of inhibitor-treated seeds was not due to co-precipitation of FK-506, the ethanol-precipitated protein extracts of control seeds were incubated with 450 μM of FK506 followed by re-precipitation with ethanol. There was no significant change (data not shown) in the PPIase activity of the control extracts after re-precipitation, thus confirming that lack of PPIase activity in the extracts of inhibitor treated seeds was due to absence of PPIase enzymes rather than due to the presence of co-precipitated FK506. Since FK-506 binds specifically to FKBPs[7], the FK506-induced inhibition of seed germination is likely to be due to inhibition of PPIase activity of FKBPs whose contribution to total PPIase activity is substantial (55–88%) in the control germinated seeds. The FK506-insensitive PPIase activity observed in the control germinated seeds can be attributed the parvulins and another class of immunophilins, cyclophilins, which bind to the immunosuppressive drug, cyclosoprin-A[8].

Germination is associated with changes in gene expression which lead to synthesis of new proteins[9]. By virtue of their chaperonic and *cis–trans* isomerase activity[1,3] the FKBPs may be facilitating the correct folding of the newly synthesized proteins required for germination. It is also likely that as reported for mammalian cells[1], the FKBPs through their interaction with other proteins may be playing an important role in the signal transduction pathway(s) required for seed germination. This speculation is supported by the fact that binding of FKBPs to other proteins by tetratricopeptide repeat domains is a conserved interaction between plants and animals[10].

During the past few years, a growing number of immunophilins have been characterized from mammalian and also from higher sources ranging from bacteria to higher plants[1,11]. However, their role *in vivo* is still a matter of conjecture. Our studies are the first to reveal that inhibition of FKBP-associated PPIase activity results in total inhibition of seed germination in different cultivars of sorghum, thus implying that FKBPs are playing a critical role in seed germination. Further studies are in progress to identify the specific FKBP(s) which regulate the germination process.

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Germinability, productivity and economic viability of *Rheum emodi* Wall. ex Meissn. cultivated at lower altitude

Current estimates by the Threatened Plants Species Committee of the Survival (TPSSC) of IUCN indicate that 1 in 10 species of vascular plants on earth is endangered or threatened due to commercial exploitation and international trade. It has been pointed out that nearly 60,000 plant species may be in danger of extinction leading to gene erosion during the next 30–40 years[1]. *Rheum emodi* is among the top of that list, particularly for Garhwal Himalaya; it has been identified as a top-priority species for conservation and cultivation.

Rheum emodi Wall. ex Meissn. is a perennial stout herb, distributed in the temperate and subtropical regions of Himalaya from Kashmir to Sikkim, between an elevation of 2800 and 3800 m (Figure 1). In Garhwal Hima laya it is generally found between 2800 and 3600 m in an alpine zone on rocky soil, between boulders and near streams.

The history of rhubarb dates back to ancient China and the Mediterranean region as a highly popular laxative drug and a general tonic[2]. Indian rhubarb is used as purgative and astringent tonic; its stimulating effect combined with apparent properties renders it especially useful in atonic dyspepsia. Powdered roots are sprinkled over ulcer for healing and also used for cleaning teeth. Leaf stalks are eaten either raw or boiled, sprinkled with salt and pepper. Leaves and flowers are

also edible. Due to these properties, the species has excessive demand, which leads to illegal over-exploitation from natural habitat, resulting in habitat destruction and now this species is on the verge of becoming a rarity.

Information on taxonomy, distribution, ecophysiology, analysis of active contents and uses of *R. emodi* is readily available for the Himalayan region[3–5]. However, information is still lacking regarding (1) effect of soil texture and manure treatment on germinability under natural and hothouse conditions during different months, (2) raising sufficient germplasm, determination of transplantation age, time and methods for cultivation, (3) survival and yield under different farmyard manure and forest litter treatments, (4) yield and to optimize maximum yield conditions and observe active contents at lower altitude, and (5) economic viability of cultivation of *R. emodi*, especially at lower altitude near the vicinity of villages. This practice will lead to extra income-generation and self-employment to local people as well as conservation of natural habitat.

Keeping in view the importance of cultivation of wild and rare medicinal plants and availability of land near the vicinity of villages, cultivation of *R. emodi* was carried out at two sites, viz. Tala (1800 m asl) between 30°31′N lat and 79°07′E long and Pothivasa (2200 m asl) between 30°28′N lat and 79°16′E long in Rudraprayag district of Garhwal Himalaya, India. The region has sub-montane climate with annual maximum temperature reaching up to 35°C (May–June) and minimum temperature below 0°C during winter months, with occasional snowfall. Annual precipitation is between 345 and 459.5 cm and most of the rainfall is observed during the monsoon period (August–September). The soil at Tala is slightly acidic (pH 5.76–6.73), brownish–black in colour, sandy textured and poor in moisture. Soil organic carbon percentage is low. The soil at Pothivasa is acidic (pH 4.67–5.01), black and sandy loam in texture with rich organic carbon (1.04–1.23%) and soil moisture. Nitrogen, phosphorus and potassium content are also higher than those of Tala.

Figure 1. *Rheum emodi* Wall. ex Meissn growing at 1800 m.

Seed germinability (Table 1) was tested under different soil compositions and litter treatment. Styrofoam seedling trays were filled with nursery soil (NS) and treated with farmyard manure (FYM) and forest litter (FL) in different ratios and kept inside a polyhouse. Germination study was conducted during October, immediately after collection and drying of the seeds followed by winter month (January), onset of favourable growth period when air and soil temperature slightly increased (March) and during June at the time of commencement of the monsoon. Each experiment contained 24 seeds and three replicates. Seeds were also sown in open beds during these months to observe the effect of polyhouse and open-bed conditions on seed germinability as well as to standardize the best conditions and time for maximum germination. Soil texture classes were determined with soil sieves having meshes of known diameter corresponding to sand, silt and clay (as proposed by the US Bureau of Soil). Different soil compositions were prepared, viz. sandy soil, sandy loam, sandy silt and sandy clay. During the study period, temperature inside the polyhouse was recorded 8–40°C, while air temperature for open environment ranged between 5 and 30°C at Tala. Temperature ranged between 6 and 36°C inside the polyhouse and air temperature was recorded between 0 and 25°C at Pothivasa during the study.

After land preparation through digging or ploughing, manure of livestock, i.e. buffalo manure (BM), sheep manure (SM) and forest litter (FL) was added into beds before plantation. Three concentrations described in the text as BM1, BM2, BM3; SM1, SM2, SM3 and FL1, FL2 and FL3 (1, 2 and 3 indicate 20, 40 and 60 kg respectively) were placed into 2 m × 2 m area plots represented by three replicates for each treatment. Six seedlings were transplanted approximately at 2.22 ft distance during April 1998 into each bed represented by the aforesaid treatments. At Pothivasa, yield was observed only in SM and FL treatments, as BM was not available at the site. Each treatment was examined for survival of plants and yearly yield after completion of the growth period for four years. For yield observation, four plants from each experimental bed were harvested and dried up to constant weight after completion of the vegetative growth phase for four years. Fresh and dry weight was measured and yield was determined for experimental beds. Further, productivity per acre was estimated according to the yield of beds and total number of plants grown in one acre of land. Since plants were cultivated at lower altitude, the mortality rate was also taken into consideration for determining the total yield. Cost–benefit analysis was calculated on the basis of total output in the form of cash and total investment estimated for one acre of land for site development, fencing, land preparation, labour charges and manure cost for three years.

Four active contents, i.e. emodin, rutin, chrysophanol and chrysophenic acid were analysed in the plants cultivated at 1800 and 2200 m altitude and were compared with natural pockets. Further, active contents were also analysed for plants of different age groups. The standard HPLC system (125 Beckman System Gold) consisted of a normal phase ODS column (4.5 mm × 250 mm) with methanol water (MeOH : H_20, 60 : 40) being a mobile phase at a flow rate of 1 ml/min. Next 0.01 mg of crude extract was dissolved in 10 ml of HPLC mobile phase and from this stock solution 1, 2, 4, 8, 10 and 20 ppm solutions were prepared with standard solutions of reference compounds (emodin, rutin, chrysophanic acid, Sigma). Solutions were filtered through a milipore filter (0.45 μm) and used for HPLC analysis. Contents were quantified by standard peak area method. Calibration of response factors for identification was made using the sample table with the standard containing mixture. Calibration standard was run to find the retention time of the peaks of interest. Peak identification table with peak retention time, concentration range

Table 1. Seed germination potential of *R. emodi* during different months in a nursery at Tala

Condition/ treatment	October			January			March			June		
	%G	DRG	Ist LI	%G	DRG	Ist LI	%G	DRG	Ist LI	%G	DRG	Ist LI
Polyhouse												
Control	30.5 ± 4.50	12 ± 2.00	22 ± 6.12	25 ± 4.15	22 ± 4.00	24 ± 6.12	35 ± 7.00	10 ± 2.54	10 ± 1.00	36 ± 7.00	10 ± 2.00	12 ± 1.50
NS + litter												
1 : 1	55 ± 5.50	10 ± 3.25	19 ± 2.20	20 ± 2.35	15 ± 2.33	22 ± 4.54	60 ± 5.12	9 ± 4.15	13 ± 1.33	58 ± 4.50	7 ± 2.00	10 ± 0.50
1 : 2	68 ± 4.25	11 ± 1.00	18 ± 4.52	19 ± 4.15	18 ± 1.85	22 ± 6.12	63 ± 3.33	8 ± 4.16	12 ± 0.50	58 ± 6.15	9 ± 1.33	10 ± 0.33
2 : 1	53 ± 2.30	12 ± 3.33	20 ± 1.33	15 ± 2.25	22 ± 0.50	24 ± 2.33	55 ± 2.00	10 ± 4.16	11 ± 0.45	51 ± 2.33	10 ± 2.25	10 ± 1.00
NS + FYM												
1 : 1	50 ± 4.20	9 ± 4.12	18 ± 2.25	12 ± 1.33	20 ± 2.33	20 ± 3.21	45 ± 2.33	9 ± 0.82	13 ± 0.45	55 ± 4.15	8 ± 0.50	10 ± 1.50
1 : 2	52 ± 2.33	11 ± 3.25	18 ± 4.52	15 ± 0.87	18 ± 1.50	24 ± 4.45	50 ± 4.15	8 ± 2.00	13 ± 0.40	55 ± 5.50	8 ± 1.00	10 ± 0.50
2 : 1	46 ± 1.52	11 ± 1.00	20 ± 2.12	10 ± 1.00	22 ± 4.15	24 ± 4.15	43 ± 0.55	9 ± 0.50	14 ± 1.33	52 ± 5.12	9 ± 2.00	12 ± 2.25
In open beds												
Control	20 ± 6.12	22 ± 1.33	35 ± 2.33	0.0	–	–	32 ± 3.65	18 ± 2.00	29 ± 4.10	35 ± 3.33	15 ± 1.50	20 ± 2.15
LT	45 ± 3.33	18 ± 2.33	30 ± 3.12	0.0	–	–	40 ± 5.15	15 ± 1.00	25 ± 3.33	42 ± 2.25	12 ± 2.25	18 ± 1.50
FYMT	30 ± 4.50	20 ± 0.85	30 ± 3.12	0.0	–	–	35 ± 4.15	16 ± 2.10	28 ± 2.25	39 ± 3.45	13 ± 3.35	19 ± 1.33

%G, Per cent germination; DRG, Days required for germination; Ist LI, First leaf initiation; LT, Litter treatment, FYMT, Farmyard manure treatment.

Figure 2. Development of seedlings in styrofoam seedling trays.

levels and replicates was obtained. The standards were run with actual injection or from the disk, and calibration curves were plotted to get a good linear curve to confirm the content concentration of each solution.

Distribution range of *R. emodi* in nature is restricted to a few pockets and it is difficult to collect rhizome for initial multiplication. Hence, the first task is to develop sufficient seedlings, and germination study is quite important. Under laboratory conditions seed germinability is up to 80% under GA_3 treatment in light and at 30°C temperature conditions, and germination takes place within 7–10 days[6]. Seed viability remained 50–60% for one year when seeds are stored in plastic or cotton bags at 4–5°C temperature under dry conditions. At nursery sites, seed germinability was observed by using natural soil (NS), different soil texture groups and treatment with FYM and FL during different months. Under polyhouse conditions, when NS was treated with litter (1 : 2) maximum germination (68%) was recorded during October followed by June (65%). However, only seven days are required for germination during June. First leaf initiation was also earlier during June, followed by March and October. Seed germination in NS treated with FYM was maximum, i.e. 55% during June (Figure 2), and germination as well as first leaf initiation were also earlier. In open beds treated with FL, maximum germination (45%) was recorded during October and a minimum of 18 and 30 days is required for the onset of germination and first true leaf initiation respectively. Minimum germination, maximum days required for germination and first leaf initiation were recorded during January inside the polyhouse; no germination was observed during this month when seeds were sown in open beds even after FYM and FL treatments (Table 1). Further, when germination was observed inside the polyhouse under different soil texture compositions, sandy soil was found to be the best, with 58% germination during October. However, maximum germination (70%) was recorded in sandy soil treated with litter in 1 : 2 ratio during October. As mentioned by Nautiyal *et al.*[7], sandy soil is loose-textured and thus has less pressure rescued earlier protuberation of seedling emergence. Proper aeration is another factor, prevents decaying of seeds and increases seed germinability. Since the best period of seedling transplantation was determined during the onset of favourable environmental conditions in March–April, seed sowing during October is suggested at 1800–2200 m altitude. Seedlings raised during October are well developed for transplantation during March–April.

Survival and production were observed under different manure and FL treatments. Transplanted seedlings were observed for four years at Tala and Pothivasa separately for comparative production at both sites. Survival of seedlings was observed maximum (75%) at Tala under FL2 and FL3 treatments followed by FL1, SM and BM treatments. Maximum survival (80%) was recorded at Pothivasa in FL2 and FL3 treatments, while 75% survival was observed in FL1 treatments. Survival was higher in SM and BM treatments at Pothivasa than at Tala. Variation in survival percentage in different doses of the same treatment ($F = 16.67$, $P > 0.001$) as well as in different treatments ($F = 14.44$, $P > 0$) was found significant on the basis of ANOVA at both the sites. On the basis of these observations it was concluded that FL is suitable for plant survival as it retains moisture for a long time. Further, decomposed litter mixed

with soil rapidly and fulfils the nutrition requirements for growing seedlings immediately after transplantation. At Pothivasa where soil is rich in organic carbon, lower concentration of litter is required (FL1 and FL2) than at Tala. Mortality rate was high and production was low in beds treated with SM and BM during the first year. The second year onwards productivity increased in the beds treated with SM and BM, as manure decomposed and mixed well with the soil. It is suggested that SM and BM manuring should be done only after complete decomposition. Further, these beds needed excessive watering/irrigation to decrease the mortality rate. At lower altitude, growth was fast and vigorous in comparison to the natural habitat, and flowering occurred in some plants after four growth phases. Seed productivity was recorded, 450 and 620 seeds/plant at Tala and Pothivasa respectively. Spraying pesticides and insecticides can increase seed productivity, as plants were infected by insect pests during maturation of seeds.

Production during the first year by seedlings was highest from the fields treated with high FL doses. Moisture content of rhizome/root was estimated maximum (70–78.32%) at Tala. Plant yield increased after the second year of seedling transplantation in both sites and treatments. At Tala, rhizome dry weight was estimated between 12.33 and 21.52 g/plant. The lowest value corresponds to control conditions followed by BM, SM and litter. After the third growth period, yield increased 7–8 times compared to the second year, and there was significant correlation ($r = 97$, $P > 0.01$ for BM; $r = 76$, $P > 0.001$ for FL) of yield with increasing doses, with 95 and 58% variation respectively. SM-treated beds did not show any significant relation. After four years, plants completed vegetative growth phase and yield was recorded between 337.72 and 373.0 g/plant. There was nearly three times increment in yield compared to the third year. There was significant increase in yield of four-year-old plants compared to the third year, with $r = 98$, 92 and 84 due to variation of 96, 92 and 71% in yield in different doses of BM, SM and FL treatments respectively. Maximum yield of 44.66 g/plant was observed after the second year, 194.33 g/plant after the third year and 615.00 g/plant after the fourth growth period at Pothivasa. There was significant correlation between yield and dose during the second and third year ($r = 96$, $P > 0.1$ and $r = 66$, $P > 0$ for different doses of SM and FL respectively). In general, production at Pothivasa was nearly 1.5 to 2 times more in SM and FL-treated beds respectively, than at Tala during the second, third and fourth year.

Total production on dry weight basis of rhizome/root was estimated on the basis of experimental replicates, spacing distance of 2.5 ft which was found suitable for plain beds, and survival percentage of transplanted seedlings. In experimental beds, six seedlings were transplanted approximately at a distance of 2.22 ft. Total number of seedlings/plants was estimated to be approximately 9105 and 7180 for transplantation at 2.22 ft (experimental distance) and 2.5 ft distance respectively, for one acre of land. Yield was observed between 1.12 and 1.96 q/acre at Tala and 1.81–4.06 q/acre at Pothivasa after the second growth period (Table 2). During the third year a similar trend was observed for all treatments, with 14–15% increase in total production at Tala and 10–12% at Pothivasa. In general, production was between 30.14 and 33.96 q/acre at Tala and 52.39 and 55.99 q/acre at Pothivasa after the fourth year. High production values correspond to higher litter dose-treated beds. As observed, production was nearly same in all treatments of SM and FL at Pothivasa. On the basis of these observations, higher concentration of FL (60.70 q/acre) was recommended for Tala and 18.04–40.46 q/acre SM or FL manure is recommended for maximum production.

Maximum projected yield was estimated 26.78 q/acre for Tala and 44.15 q/acre for Pothivasa after maturation of plants (Table 3). To estimate actual production, the mortality of transplanted seedlings was also accounted with plant yield for the estimation of production after the fourth growth period. Maximum yield per acre was estimated as 20.08 q/acre at Tala and 35.32 q/acre at Pothivasa.

The active constituents present in the roots of *R. emodi* gradually increased with the age of the plant. Minimum value of emodin was recorded 0.32% in the first year, 0.94% in the second year, 1.67% in the third year and maximum (1.92%) in fourth year. Similarly maximum rutin content of 0.61% was observed in the fourth year followed by 0.41 in the third year, 0.27 in the second year and minimum of 0.16% was observed in the first year. However, cultivated crop at lower altitude has low active ingredients than the natural population.

Table 2. Productivity*/acre (in q) under different concentrations of FYM and litter treatments at 1800 and 2200 m

		After second growth period (third year of transplantation)		After third growth period		After maturation of plants	
Treatment	Dose	Tala	Pothivasa	Tala	Pothivasa	Tala	Pothivasa
Control		1.12	1.81	8.77	15.93	30.14	52.39
Buffalo manure	1	1.35	–	9.50	–	32.19	–
	2	1.34	–	9.71	–	32.44	–
	3	1.55	–	10.73	–	32.87	–
Sheep manure	1	1.43	1.98	9.48	16.58	31.92	54.93
	2	1.35	2.44	10.78	16.76	32.45	55.29
	3	1.55	3.37	11.09	16.90	33.09	55.24
Forest litter	1	1.82	3.71	11.26	17.66	33.02	55.93
	2	1.94	3.79	11.46	17.58	33.64	55.99
	3	1.96	4.06	12.35	17.69	33.96	55.99

*Based on sampling of plant dry weight and total number of transplanted seedlings.

Table 3. Projected and estimated production (q/acre) at Tala (1800 m) and Pothivasa (2200 m)

Treatment	Dose	Tala		Pothivasa	
		Based on spacing distance[a]	Based on mortality[b]	Based on spacing distance[a]	Based on mortality[b]
Control		23.77	8.31	41.32	16.53
Buffalo manure	1	25.38	14.21	–	–
	2	25.58	14.06	–	–
	3	25.92	15.03	–	–
Sheep manure	1	25.16	16.35	43.32	28.16
	2	25.59	17.40	43.61	27.47
	3	26.09	14.48	43.56	27.88
Forest litter	1	26.03	18.74	44.11	33.08
	2	26.53	19.89	44.15	35.32
	3	26.78	20.08	44.15	35.32

[a]Spacing distance of 2.5 ft; [b]Mortality rate of transplanted seedlings.

Table 4. Cost–benefit analysis of *R. emodi* cultivated at two sites after four years of growth

Location	Treatment	Total investment (Rs)	Total production (q/acre)	Total income (@ Rs 85/kg)	Benefit* (in Rs)
Tala	BM1	58,500	25.92	2,20,320	1,61,820
	BM2	58,500	15.03	1,27,755	69,255
	SM1	58,500	26.09	2,21,765	1,63,265
	SM2	58,500	17.48	1,48,580	90,080
	FL1	58,500	26.78	2,27,630	1,69,130
	FL2	58,500	20.08	1,70,680	1,12,180
Pothivasa	SM1	60,400	43.61	3,70,685	3,10,285
	SM2	60,400	28.16	2,39,360	1,78,960
	FL1	60,400	44.15	3,75,275	3,14,875
	FL2	60,400	35.32	3,00,220	2,39,820

*Maximum production was used to determine cost-benefit analysis.

As discussed earlier, production of *R. emodi* has been worked out through seedlings at two altitudes (at Tala and Pothivasa). Total investment, including land preparation, fencing, labour and manure charges and post-harvesting costs was calculated. Cultivation cost was slightly higher for Tala since plants of *R. emodi* need more irrigation and care at this elevation. Further, more germplasm and seedlings are required, as survival is low. Total cost for fencing and land preparation, including irrigation facilities was estimated as Rs 30,000, manure cost Rs 600 for each year and post-harvesting cost, including harvesting and packing Rs 5000. Labour charges (@ Rs 75 per day) were estimated on the basis of 6, 5, 5 and 3 days/month for Tala and 5, 4, 4 and 3 days/month for Pothivasa during the first, second, third and fourth year respectively. These values are the cost of cultivation carried out in one acre of land. Total benefit was analysed on the basis of total investment during cultivation and present market cost (Rs 85/kg) for maximum production observed from both sites (Table 4). Maximum benefit was observed to be Rs 2,39,820 and Rs 1,12,180 at Pothivasa and Tala respectively, on the basis of the present observations. Projected benefit was calculated up to Rs 3,14,875 for Pothivasa and Rs 1,69,130 for Tala. Earlier, Nautiyal[7] estimated nearly 44.10 q/ha yield of *R. emodi* from nature. It is clear that under cultivation even at lower altitude, more yield can be obtained than from nature. However, efforts are needed to decrease mortality of seedlings after transplantation and growing plants during winter months. On the basis of the present observations, altitude up to 2200 m is found best for maximum yield and can be cultivated up to 1800 m altitude. Successful cultivation also depends on climate and soil features beside location.

On the basis of the above observations the following facts are endorsed for cultivation of *R. emodi*. (1) To raise maximum seedlings, polyhouse conditions, sandy soil with litter treatments (1 : 2) during October and June with higher moisture and 15–35°C temperature are optimum conditions. Since the seedlings are transplanted during March–April at lower altitude, best seed sowing time was observed during October just after collecting and drying the seeds. In October, seed viability is maximum and seedlings are well developed by the end of February or in March and suitable for transplantation. Germination is fast and the first leaf emerges within a short period without any hormonal treatment and can be adopted easily by local growers and farmers. (2) For cultivation it requires sandy, porous soil with rich rotten manure and can be cultivated up to 1800 m. (3) FL was found suitable for maximum production, although manure

requirements can vary from site to site and at different altitude. (4) Although plant survival, productivity and active contents decreased at lower altitude, cultivation was found to be cost beneficial. (5) Mature plants had maximum percentage of active contents and hence 4–5-year-old plants are recommended for harvesting. Further, production per plant is also high and local people can cultivate this plant as a cash crop and as an option for self-employment.

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Aconitum fletcheranum G. Taylor (Ranunculaceae) in eastern Himalayas: Occurrence and conservation

Aconitum L. (Ranunculaceae) is a diverse genus with nearly 300 species worldwide, mostly in temperate and alpine regions of northern hemisphere[1]. Recently, Rao and Chaudhary[2] suggested 26 species and 2 varieties in India amounting to 28 taxa. The rest are distributed in Japan[3–5], central Europe, East Asia[1], and Eastern[6] and North-western America[7,8]. In India, the genus is restricted only to the Himalayan region, and interestingly the species found in eastern Himalayas are not known from western Himalayas and vice-versa[9].

Although some species of *Aconitum* may have different vernacular names[10], almost all having drug value are collectively known as 'bikhma' or 'bish' in India. Tuberous roots of *Aconitum* spp. are commonly known as 'aconites' or 'monkshood'. Aconite is one of the most deadly poisons. Chakravarty and Chakravarti[11] identified 13 species of *Aconitum* that have drug value and traded in India under the name 'aconite'. In most cases, it is difficult to precisely link a traded aconite to its genuine species as they are commonly considered to have originated from *A. ferox* that is actually not the case. This is evident from huge variation in alkaloid percentage from 0.38 (*A. heterophyllum*) to 4.5 (*A. chasmanthum*) in aconite samples collected from the market[12]. In ancient times, the juice of the roots of *Aconitum* was used as an arrow poison. Many tribes in Arunachal Pradesh use arrow poison for hunting even today.

Habitat and distribution of Indian *Aconitum* spp. is meagrely known. Here, I present some observations arising out of a field trip in search of aconites in West Kameng and Tawang districts of Arunachal Pradesh in August 2001. A rare *Aconitum* was sighted which was identified as *A. fletcheranum*. The identification of the species was difficult since only a couple of specimens of this species are preserved in Indian herbaria. In the following, I present the excerpts from the history of the discovery of *A. fletcheranum* as a new species, review its status in Indian literature, update taxonomic description of the species, derive a distribution map and provide the photographs of the species in a newly recorded locality.

In 1949, F. Ludlow and George Sherriff travelled to the Eastern Himalayan ranges in Bhutan and sent a consignment of collected plants to Natural History Museum, London via Calcutta airport. Fletcher[13], Anonymous[14], Taylor[15] and Fletcher *et al.*[16] published reports on these plants. Taylor[15] reported two dwarf species of monkshood (*Aconitum*) both with deep violet flowers and between 13,500 and 15,000 ft. One of these was identified as *Aconitum pulchellum*. The other monkshood was first thought to be *Aconitum hookeri*, but a critical examination proved it a distinct new species. Taylor[15] named it in honour of H. R. Fletcher as *A. fletcheranum* G. Taylor (Ranunculaceae). In fact, Ludlow and Sherriff had collected this species even earlier in 1933 from various localities in Bhutan and neighbouring parts of southeast Tibet, but it remained unidentified (Table 1). Kingdon-Ward also recorded it in Upper Assam (now Arunachal Pradesh) in 1938. Taylor[15] believed that this species is restricted to the southern slopes of eastern Himalayas and is visible only in monsoon.

In Indian literature, *A. fletcheranum* has got mention at two places only, i.e. in Rau[17] and Hajra *et al.*[18]. In both, the species has been erroneously spelt as '*fletcherianum*'. Although both the sources report its distribution in eastern Himalayas (Arunachal Pradesh), Hajra *et al.*[18] describe it between 3000 and 4500 m, and Rau[17] between 4000 and 4700 m. This is confusing. Taylor[15] provided a list of the specimens of *A. fle-*