

## Coalescence can be very recent in exploding populations

Consider a binary family tree starting with one ancestor where each individual in any generation gives rise to two individuals in the next. In such a tree there will be  $2^n$  individuals in the  $n$ th generation. Now choose two of these  $2^n$  individuals of the  $n$ th generation at random and trace their lines of descent back in time till they meet, i.e. coalesce, and call that generation number  $\chi_n$ , the coalescence time. Then  $\chi_n$  is a random variable such that the probability  $\chi_n$  is less than  $k$  (for  $k \geq 1$ ) equals

$$\frac{b^k (b^k - 1) b^{n-k} b^{n-k}}{b^n (b^n - 1)},$$

which is approximately  $(1 - b^{-k})$  which for  $n$  large. In particular, for any  $k \geq 0$ , the probability that  $\chi_n$  equals  $k$  converges to  $b^{-k}(1 - b^{-1})$ . That is, for  $n$  large, coalescence of two randomly chosen individuals from the  $n$ th generation occurs in the remote past. This suggests that if the tree was generated by some random mechanism as long as it is growing rapidly, coalescence should occur in the

remote past. It turns out that this need not hold if the growth is too rapid. In fact, the following result holds.

Result 1: Consider a family tree starting with one ancestor where every individual in any generation gives rise to  $j$  offspring in the next generation with probability  $p_j$  for  $j \geq 1$ , where  $\sum_{j=1}^{\infty} p_j = 1$  and all individuals produce offspring independent of each other and the past history. Suppose  $\sum_{j \geq k} p_j$  decays with  $k$  at the rate  $k^{-\alpha}$  for some  $0 < \alpha < 1$ . That is,  $k^\alpha \sum_{j \geq k} p_j$  converges to  $c$ ,  $0 < c < \infty$  as  $k$  goes to infinity. (An example:  $p_j = (d/j^{3/2})$ ,  $j \geq 1$ ,  $d^{-1} = \sum_{j=1}^{\infty} j^{-3/2}$ . Here  $\alpha = 1/2$ ,  $c = 2d$ .) Then, for such a tree the coalescence time  $\chi_n$  goes to infinity as  $n$  gets large and for any  $k \geq 1$ , the probability  $n - \chi_n \leq k$  converges to some  $\pi_k$  as  $n$  goes to infinity and  $\pi_k$  goes to 1 as  $k$  gets large.

That is, in this case coalescence takes place close to the present time  $n$  as  $n$  gets large.

Result 2: If the probabilities  $p_j$  are such that  $p_0 = 0$  and the mean  $m$  of the number of offspring per parent satisfies

$1 < m \equiv \sum_{j=1}^{\infty} j p_j < \infty$ , then the coalescence time  $\chi_n$  does go back to the remote past. That is, for  $k \geq 0$ , probability  $(\chi_n \leq k)$  converges to  $\pi_k$  as  $n \rightarrow \infty$  and  $\pi_k$  goes to one as  $k \rightarrow \infty$ .

It may be noted if  $\sum_{j \geq k} p_j$  decays like  $k^{-\alpha}$  for some  $0 < \alpha < 1$  as  $k$  gets large, then  $m = \sum_{j=1}^{\infty} j p_j = \infty$ .

The proofs of both these results can be found in Athreya<sup>1</sup>.

1. Athreya, K. B., *Ann. Probab.*, 2010 (submitted).

Received 3 July 2010; accepted 30 July 2010

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## Genetic fidelity of long-term micropropagated plantlets of *Valeriana wallichii* – an endangered medicinal plant

*Valeriana wallichii* (synonym *Valeriana jatamansi*; family Valerianaceae), commonly called the Indian valerian, is found among the ground flora in deciduous–coniferous mixed forests across the Himalayan regions between 1500 and 3000 m and also in Afghanistan and Pakistan. It has been an ingredient of herbal medicine in the Indian systems of medicine and is used as a substitute of the European *Valeriana officinalis*. It is used in more than 50 ayurvedic and unani preparations<sup>1</sup>. It is also used in the treatment of obesity, skin disease, insanity, epilepsy and snake poisoning. The crude drug from the roots/rhizomes and Valerian-derived phytomedicines are used as mild sedatives in the pharmaceutical industry<sup>2</sup>. The roots/rhizomes are highly aromatic and as a result Valerian oil is in great demand. The sedative and tranquilizing properties are attributed to

the presence of iridoid esters called valepotriates.

Although conventionally the plant is seed-propagated, it is not an attractive practice as the seeds remain dormant for a long time (five months moist stratification needed) and germinate slowly. Commercial cultivation of the herb is still not an organized activity in India. The market supply is being met by collection from natural populations. Ruthless exploitation of these natural reserves could result in extinction of this valuable plant. To meet the increasing demand of *V. wallichii* roots, it is imperative to devise alternate strategies for its conservation and generating quality planting material for its commercial cultivation<sup>3</sup>. Tissue culture-based methods of micropropagation hold immense promise and potential in this context. Maintaining genetic uniformity is one of the major

concerns of the tissue culture industry because variation within the progeny results in serious losses to the end-users, thus making quality control of tissue culture-raised plants mandatory. For commercial mass propagation where cost-effectiveness is a major checkpoint, the technique of randomly amplified polymorphic DNA (RAPD) being relatively cheaper than other molecular techniques, will definitely encourage scientists to adopt it worldwide for quality assurance.

*V. wallichii* material was obtained from Almora (India). The plants were brought to Lucknow and established under glasshouse conditions. Freshly excised nodal segments (0.5–1.0 cm) obtained from the glasshouse-maintained plants were thoroughly washed in running tap water to remove soil particles. They were then treated with 1% cetavlon (v/v) for about 5–10 min and there-