

- Ecosystem: Structure and Function* (ed. Golley, F. B.), Elsevier, Oxford, 1983, pp. 183–215.
8. Faegri, K. and van der Pijl, L., *The Principles of Pollination Ecology*, Pergamon Press, Oxford, 1979.
  9. Raven, P. H., *Evolution*, 1972, **26**, 674.
  10. Baker, I. and Baker, H. G., *Allertonia*, 1982, **3**, 25–37.
  11. Bolten, A. B. and Feinsinger, P., *Biotropica*, 1978, **10**, 307–309.
  12. Carpenter, F. L., In *Handbook of Experimental Pollination Biology* (eds Jones, C. E. and Little, R. J.), Van Nostrand Reinhold, New York, 1983, pp. 215–234.
  13. Subramanya, S. and Radhamani, T. R., *Curr. Sci.*, 1993, **65**, 201–209.
  14. Jaegar, P., *The Wonderful Life of Flowers*, Trans. J. P. M. Brenan, E. P. Dutton and Co, Inc, New York, 1961.
  15. Solomon Raju, A. J., Rao, S. P., Zafar, R. and Roopkalpana, P., EPTRI-ENVIS Newsl., 2003, vol. 9, pp. 2–5.
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## Biodiversity in the Western Ghats: The discovery of new species of caecilian amphibians

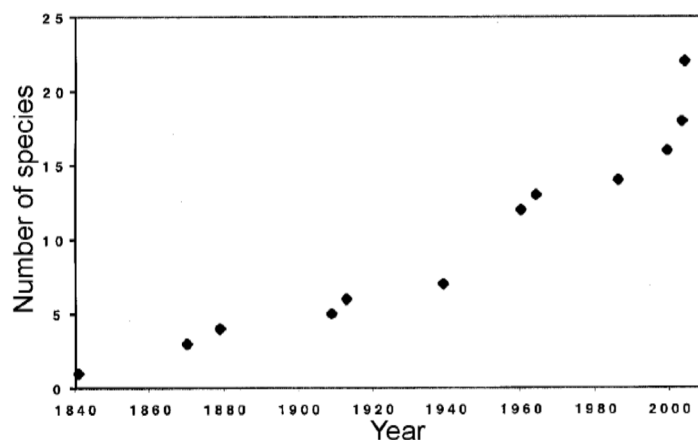
The suggestion<sup>1</sup> that the fauna of the Western Ghats (a recognized biodiversity hot spot<sup>2</sup>) includes many species of amphibians that await formal scientific description, has proven controversial<sup>3</sup>. The controversy largely revolves around whether these undescribed taxa are only now being recognized because of changes in taxonomic philosophy and methodology, or simply because of increased work that is uncovering biological reality. A recent article in this journal<sup>4</sup> used a plot of cumulative species descriptions over time to support the latter explanation, by

showing that the species discovery curve has yet to reach an asymptote. It is noteworthy that the debate thus far, while cast in terms of amphibian diversity, has focused almost exclusively on frogs. We think it useful to broaden the empirical basis for the debate by considering also what is known of the taxonomy and biodiversity of the other order of amphibians that occur in the Western Ghats, the caecilians (Gymnophiona).

The species accumulation curve for the Western Ghats caecilians (Figure 1) indicates that the number of described spe-

cies is undergoing rapid expansion in this group, with no sign of reaching a plateau. That there remained many species of caecilians to be discovered and described from the Western Ghats was previously predicted<sup>5</sup> on the basis of species encounter rates during survey work. Note that at the time that particular study was published (1997), the plot in Figure 1 had reached a plateau that can now be interpreted as a hiatus in discovery.

Why might so many Western Ghats amphibians still await discovery and description after more than 200 years of re-



**Figure 1.** Historical pattern of description of caecilian amphibian species of the Western Ghats. We did not include *Ichthyophis glutinosus*<sup>9</sup> or *I. sikkimensis* (the only caecilian species described from Northeast India that possibly occurs also in the Western Ghats<sup>9</sup>). Separate plots for Indian caecilians endemic and non-endemic to the Western Ghats were not produced because except for a couple of reports<sup>10</sup> of records from the Eastern Ghats that require reassessment, all 22 species in the region are endemic. The datapoint for 2004 includes new species descriptions by the present authors that are in press or currently under review.

search? We are certain that for caecilians, as has been suggested for frogs<sup>1</sup>, the cause is a lack of study, both in the field and the laboratory. The adults of all Indian caecilians are apparently predominantly burrowers in the soil, and special digging effort is usually required to sample them<sup>6</sup>. At least half of the eight new (an increase of 57%) species described after 1998 are known to occur in gardens and/or plantations, but nonetheless they had gone unnoticed by science. Even less work has been carried out to sample caecilians in their presumably native forest habitats. There is no evidence that the recently discovered caecilian species are the product of splitting or of changes in methodology or philosophy, and we predict there are many more species to be discovered.

Caecilian taxonomy worldwide is unstable<sup>7</sup>. The intrinsic biology of caecilians makes their study challenging, and little effort has been applied. For Indian caecilians and systematists, the challenge has been compounded by extrinsic factors, most notably a deficit of arrangements for international loans and exchanges between Indian and Western collections and scientists. We hope that this practical difficulty proves to be temporary.

Species discovery curves can be influenced by many factors and must be judged on a case-by-case basis. However, it should be possible to test the general hypothesis that the diversity of many

Western Ghats organisms is not as well known as previously thought, by comparative study of discovery curves for a wide range of taxa. Comparisons with other regions should also be informative. For example, between 1978 and 2002, the number of recognized amphibian species in Europe rose by 65%, largely through the application of new techniques and also as a result of greater study and knowledge of amphibian natural history<sup>8</sup>. It might be noted that the proposed increase in Western Ghats amphibians is based thus far on mostly traditional taxonomic data, and that the impact of molecular techniques remains to be seen.

9. Ravichandran, M. S., *Hamadryad*, 2004, **28**, 98–104.
10. Pillai, R. S. and Ravichandran, M. S., *Occas. Pap., Res. Zool. Surv. India*, 1999, **172**, 1–117.

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1. Biju, S. D., *Occas. Publ.*, 201, ICSB, TBGRI, Thiruvananthapuram, 2001.

2. Myers, N., Mittermeier, R. A., Mittermeier, C. G., da Fonseca, G. A. B. and Kent, J., *Nature*, 2000, **403**, 853–858.

3. Chaitra, M. S., Vasudevan, K. and Shanker, K., *Curr. Sci.*, 2004, **86**, 897–899.

4. Aravind, N. A., Uma Shaanker, R. and Ganeshaiah, K. N., *Curr. Sci.*, 2004, **86**, 1471–1472.

5. Bhatta, G., *Curr. Sci.*, 1997, **73**, 183–187.

6. Measey, G. J., Gower, D. J., Oommen, O. V. and Wilkinson, M., *Appl. Soil Ecol.*, 2003, **23**, 43–53.

7. Nussbaum, R. A. and Wilkinson, M., *Herpetol. Monogr.*, 1989, **3**, 1–42.

8. Arnold, E. N. and Ovenden, D. W., *A Field Guide to the Reptiles and Amphibians of Britain and Europe*, Collins, London, 2002, 2nd edn.

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## MEETINGS/SYMPOSIA/SEMINARS

### DST Short term training programme on Mathematical Model of Groundwater Flow and Mass Transport

Date: 9–12 November 2004

Place: New Delhi

This training programme is meant for young lecturers and research scholars belonging to Earth system sciences.

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### Workshop on Analytical Instrumentation in Pharmaceutical Sciences

Date: 26–30 October 2004

Place: Ahmedabad

This workshop focuses on theoretical as well as hands-on training to modern equipment like UV-VIS spectrophotometer and fluorimeter, IR spectroscopy, HPLC, GC, HPTLC, etc.

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