Patterns of species discovery in the Western Ghats, a megadiversity hot spot in India

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Even since Linnaeus, naturalists and taxonomists have been systematically describing species new to science. Besides indicating gaps in taxonomic effort, understanding the temporal patterns of species discovery could help in identifying drivers that determine discovery. In this study we report the patterns of discovery of eight taxa – birds, butterflies, frogs, tiger beetles, grasses, asters, ferns and orchids – in the Western Ghats, a megadiversity centre in India. Our results indicate that the discovery curves for birds and butterflies have been saturated while those for frogs and grasses continue to increase. Within each taxon, the major drivers of discovery were commonness of the species and their size. The average years taken for discovery across taxa were directly related to the per cent endemicity and species richness of the taxa. We discuss the trajectories of discovery with respect to rarity or endemicity of the species and life history features, and the implications these might have for strategizing the discovery process in India.

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1. Introduction

In the recent past, the Western Ghats of India, one of the 34 biodiversity hot spots of the world, has been the focus of attention for the discovery of new species. For example, it has been suggested that in the Western Ghats there may be more than 100 new species of frogs still awaiting scientific identity, mostly from the genus *Philautus* (Biju 2001), and five new species of the legless amphibian (Giri *et al* 2003; Ravichandran *et al* 2003; Bhatta and Prashanth 2004; Bhatta and Srinivasa 2004; Giri *et al* 2004). More recently, a Gondwana land relic frog family, Nasikabatrachidae, was discovered from the Western Ghats (Biju and Bossuyt 2003; Dutta *et al* 2004). These findings have indicated that the region might represent a hot spot of amphibian radiation and that there could be many more species waiting to be discovered, both amphibian and others (Dasappa and Swaminath 2000; Aravind *et al* 2004; Gower *et al* 2004; Zacharias and Priyadarsanan 2004a,b). These recent discoveries have generated considerable interest in analysing species discovery patterns in this region (Aravind *et al* 2004; Gower *et al* 2004). For example, while analysing the temporal discovery pattern of frogs in the Western Ghats region, Aravind *et al* (2004) showed that the curve is not yet saturated and there is a possibility that more species of frogs will be discovered.

Species discovery patterns have been under study since the past decade, though mostly pertaining to the neotropics (Diamond 1985; Gaston and May 1992; Vuilleumier *et al* 1992). Gaston and others have examined the factors that determine the probability of a species being described and hence discovered (Gaston and May 1992; Gaston *et al* 1995a). The rate of species discovery has been related to body size in British beetles (Gaston 1991b), to body size and range in neotropical mammals (Patterson 1994) and in North American butterflies (Gaston *et al* 1995a). In South

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American oscine passerine birds, the date of discovery was influenced by geographic and altitudinal ranges, abundance and body size (Blackburn and Gaston 1995). In bumble bees, widespread species were discovered earlier than those with a narrow distribution (Williams 1998).

Despite the excellent taxonomic literature available for India in general, and the Western Ghats region in particular, which spans over two hundred years, not much is known about the species discovery patterns in India. In this article, we report the patterns of discovery of eight taxa (birds, butterflies, frogs, tiger beetles, grasses, asters, ferns and orchids) in the Western Ghats of India. We discuss the trajectories of discovery with respect to the endemicity of species and life history feature determinants, and the implications these might have on strategizing the species discovery process in the country.

2. Materials and methods

2.1 *Data compilation*

The year in which a species was first described was taken as the year of discovery (Reed and Boback 2002). The dates of description of species belonging to eight taxa, four animal groups (birds, butterflies, frogs and tiger beetles) and four plant groups (asters, grasses, orchids and ferns) in the Western Ghats region were collated from various published sources (table 1). For widespread species occurring in the Western Ghats (but not endemic to this region), the year it was first described, irrespective of the region from where it was first reported, was taken as the year of discovery. Thus for example, if *Bufo melanostrictus* (a widespread toad) was described in 1897 from the Aravallis, but happens to be in the Western Ghats as well, for all comparative purposes we have taken the year of discovery to be 1897.

Table 1. Sources of information for different taxa selected for the study

Taxa	References
Birds	Ali and Ripley 1983; Grimmett *et al* 2000 –see refs]
Butterflies	Moore 1893–1896; Bingham 1905 and 1907; Talbot 1939, 1947; Wynter-Blyth 1957
Frogs	Biju and Bossuyt 2003; Dubois *et al* 2001; Krishnamurthy *et al* 2001; Chanda 2002
Tiger beetles	Acciavatti and Pearson 1989
Asters	Vajravelu 1990; Ramachandran and Nair 1988; Keshava Murthy and Yoganarasimhan 1990
Grass	Bor 1960
Orchids	Rao 1998
Ferns	Rajagopal and Bhat 1998; Nayar and Geevarghese 1989

Three of the taxa, namely, birds, butterflies and orchids, are generally regarded as charismatic owing to their conspicuousness. Unlike charismatic taxa, non-charismatic groups are relatively less visible and thus it is likely that these are described and discovered slowly compared with charismatic taxa (Tangley 1984; *http://biology.usgs.gov/s+t/noframe/a000.htm*). In this study we examine explicitly if charismatic taxa are indeed described earlier than non-charismatic ones.

Species were selected based on the availability of relevant literature and the clarity of their taxonomic status. In cases where the name of a species has been revised successively and has synonyms, the reference to the earliest description of the species (basionym) was taken as the year of discovery (Gaston 1991a; Gaston *et al* 1995b; Reed and Boback 2002).

For all groups, species were classified as endemic or non-endemic and common (widespread and abundant) or rare (less abundant and narrow/localized distribution but not endemic) based on the available literature (table 1). Endemic species are those with a relatively restricted or ‘narrow’ distribution compared to non-endemic ones which are characterized by a more ‘widespread’ distribution (*www.wordreference.com*). Keeping everything else constant, it could be predicted that endemic species would be slower to be discovered compared with non-endemic species. In a similar manner, rare species (less abundant or sparse distribution) would be discovered more slowly (Drury 1974, 1980; Mayr 1963) compared with more common ones (more abundant). Since the analysis in the study draws upon secondary information, it is not possible to clearly distinguish the effect of abundance and distribution of species on their time to discovery. However, where possible, we have controlled for the distribution by analysing the effects of abundance (rare vs common) by considering only the endemics (representing only one type of distribution, namely restricted).

For the three charismatic taxa—birds, butterflies and orchids—we examined the influence of several life history features in determining species discovery. Several earlier workers had reported the influence of body size, colour, etc. on species discovery patterns (Gaston 1991b; Patterson 1994; Blackburn and Gaston 1995; Gaston *et al* 1995a; Williams 1998). In this study, for birds, information on body size, number of colours on the plumage, habitat occupancy (viz. terrestrial and aquatic), feeding guilds (viz. omnivore, carnivore, nectarivore, grainivore, insectivore and frugivore) and altitudinal range of the species was compiled from the literature (Ali and Ripley 1983; Grimmett *et al* 1999). For butterflies, information on body size (wing span), number of colours on the wings, family and the altitudinal range of the species were compiled (Moore 1893–1896; Bingham

1905, 1907; Talbot 1939, 1947; Wynter-Blyth 1957). In case of orchids, data on the number of flowers in the inflorescence, size of the flower, length of the inflorescence and habit (whether epiphytic or terrestrial) were compiled (Rao 1998).

2.2 *Data analysis*

(a) *Mean and median year taken to discovery:* For each taxon, we plotted the temporal pattern of species discovery beginning from 1750, and calculated the mean and median years to discovery. The mean year to discovery was computed as the sum of the calendar years taken for the discovery of each species in the group divided by the number of species discovered in that group. The median years to discovery indicates the calendar year by which 50% of species in a given group were discovered. This was computed using Microsoft Excel by arranging the years of discovery in ascending order and then arriving at the calendar year by which 50% of the species in a group were discovered.

For each of the three charismatic groups—birds, butterflies and orchids—we analysed the differences in time taken to discovery of species belonging to distinct categories, namely, common vs rare and endemic vs non-endemic using a Mann–Whitney U test (Zar 1999). Additionally, for birds, we analysed differences in the species discovery between terrestrial and aquatic species and for orchids between terrestrial and epiphytic species using a Mann–Whitney U test (Zar 1999).

Besides the above, for birds, we also analysed the differences in the mean years for discovery of species belonging to different feeding guilds (eg. omnivore, carnivore, nectarivore, grainivore, insectivore and frugivore). For butterflies, we analysed the mean years for discovery of species belonging to different families and body size using a Spearman rank correlation as there were only five data points (Zar 1999).

(b) *Probit analysis and estimation of D_{50}:* We used probit analysis to compute the years taken for 50% of the species of a group to be discovered (D_{50}) using the MStat C software. This analysis is an alternative to logistic regression; it considers qualitative information which is binary, and is often used to analyse data from bioassay experiments. Probit analysis is also used to estimate percentiles, survival probabilities and cumulative probabilities for distribution (Finney 1964).

(c) *Step-wise regression analysis:* For each of the three charismatic groups (birds, butterflies and orchids), we used a forward step-wise regression model to analyse the major predictors of species discovery. The independent variables used in the model for the three different taxa are given in table 3. The model was run using Statistica (Ver 4.5; Statsoft Inc.) to determine the best predictor of the year of discovery (table 3). A significance level of 0.01 was added to the model (Zar 1999).

3. Results

3.1 *Patterns of species discovery in the Western Ghats*

Of the eight taxa studied, the discovery curves of only birds and butterflies have been saturated (figure 1); the last bird and butterfly species from the Western Ghats were described in 1944 (maroon-breasted sunbird, *Nectarinia lotenia*) and 1911 (small long-branded bush brown, *Mycalesis igilia*), respectively. The discovery curve for ferns, tiger beetles and asters have attained an asymptote. For frogs and grasses, the discovery curve is almost linear indicating that there are more species yet to be discovered in these groups. While for most of the taxa the discovery curve appears to be continuous, for certain taxa (e.g. frogs and tiger beetles) there are sudden spurts of discovery; 16 new species of frogs were reported in 1937 by Rao and 26 new species of tiger beetles were reported in 1989 by Acciavatti and Pearson (1989). Among the four animal groups analysed here, birds were the earliest to be described (mean year to discovery 1820 [45.59 years]) while frogs were the last (mean year to discovery 1904 [154.45 years]; table 2). Among plants, orchids were the earliest to be described (mean year to discovery 1866 [49 years]) while grasses were the last (mean year to discovery 1876 [75 years]).

We analysed the number of years taken to describe 50% of the species in each of the groups (abbreviated as D_{50}). D_{50} was the least for birds; by 1816 (66 years), 50% of all bird species reported so far in the Western Ghats had been described. On the other hand, the D_{50} value for frogs was the highest; 50% of all the frog species known today were discovered by 1891 (141 years). Interestingly, the D_{50} for relatively less conspicuous groups such as the grasses, ferns and asters was 1825 (75 years).

Unlike for birds and butterflies, the species discovery curve for frogs in the Western Ghats has not yet reached a plateau (figure 1). Analysis of the discovery profiles of endemic and non-endemic frogs showed that the species discovery pattern of common (non-endemic) frog species reached a plateau almost a century ago while for endemics, the curve appears to be still in the log phase (figure 2; Aravind *et al* 2004). The number of years for discovery of endemic species (161 years) was significantly higher compared with that for non-endemic species (105 years; Mann–Whitney U test: $P < 0.0001$). In fact, it took nearly 90 years after Linnaeus for the first endemic species of frog to be discovered (1838) in the Western Ghats, compared to ~40 years for the first non-endemic species (1799).

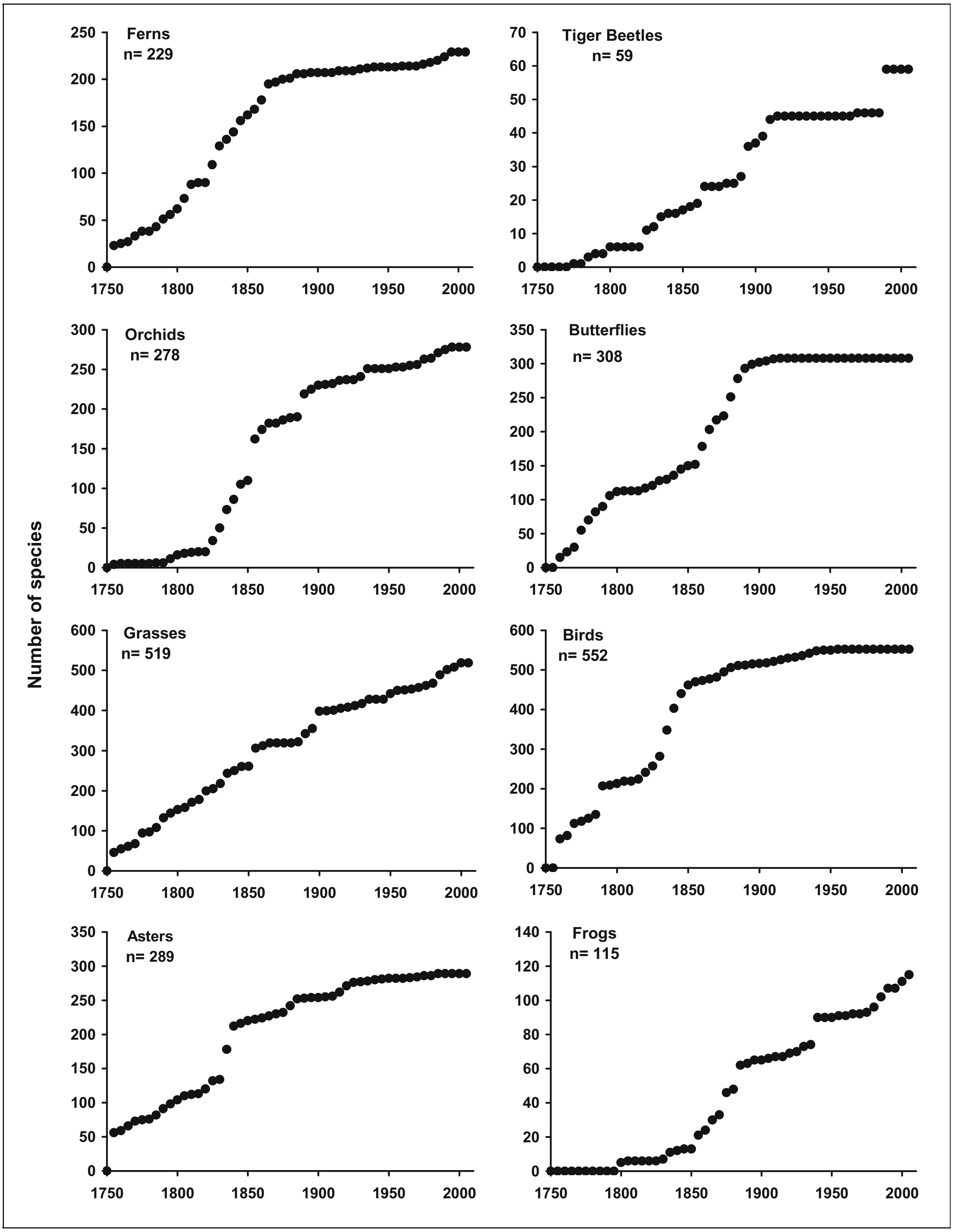

Figure 1. Discovery curve for eight different taxa (*see* text for details) in the Western Ghats. 'n' refers to the total number of species in each group.

Table 2. Mean and median year of discovery of different taxa and total number of species in each group

Taxa	Mean year	Years*	Median year	Total number of species	D_{50}**
Asters	1824.85	56.50	1834	289	75 (1825)
Ferns	1831.63	57.24	1828	229	75 (1825)
Orchids	1866.12	49.42	1851	278	103 (1853)
Grasses	1876.55	75.39	1845	519	75 (1825)
Birds	1820.08	45.59	1830	552	66 (1816)
Butterflies	1834.19	46.61	1857	308	95 (1845)
Tiger beetles	1890.86	65.05	1893	59	125 (1875)
Frogs	1904.45	154.45	1882	115	141 (1891)

*Mean number of years (calculated from 1750) for the discovery of species in a given taxa.
** D_{50} refers to the number of years taken for 50% of the species in the given taxa to be discovered. Values in parentheses refer to the calendar year for 50% of the species to be discovered.

3.2 *Determinants of species discovery in the Western Ghats*

3.2.1 *Birds:* Non-endemic species of birds were discovered earlier (1819 ± 25.29) than endemic species (1837 ± 46.12; Mann–Whitney U test [two-tailed]: U = 3025.5; $P = 0.003$; non-endemic, $N = 438$ and endemic, $N = 22$). However, there was no significant difference in the rate of discovery between common and rare birds (Mann–Whitney U test [two-tailed]: U = 8139.5; $P = 0.131$; common, $N = 339$ and rare, $N = 55$). Within endemics also, there was no significant difference between common and rare birds (Mann–Whitney U test [two-tailed]: U = 17; $P = 0.083$; common, $N = 15$ and rare, $N = 5$). Among the different habits, aquatic birds, especially those belonging to the family Anatidae (swans, ducks and geese) were discovered earlier than terrestrial ones (Mann–Whitney U test (two-tailed): U = 18413; $P < 0.0001$, terrestrial, $N = 405$ and aquatic, $N = 147$). Among feeding guilds, frugivore/herbivore birds tend to be discovered earlier compared with species from other guilds. The year of discovery was significantly positively correlated with the body size of birds (r = 0.166, $P < 0.001$; df = 486). The altitudinal range of bird habitats and colour of the feathers did not affect the dates of discovery of birds (table 3).

3.2.2 *Butterflies:* There was a significant difference in the mean year of discovery of endemic (1831 ± 46.68) compared with non-endemic (1871 ± 25.55) species of butterflies (Mann–Whitney U test [two-tailed]: U = 1674; $P < 0.0001$; non-endemic, $N = 284$ and endemic, $N = 24$). Common species were discovered earlier than rare ones (Mann–Whitney U test [two-tailed]: U = 6463; $P < 0.0001$; common, $N = 142$ and rare, $N = 63$). Within endemics, there was no significant difference between common and rare species (Mann–Whitney U test [two-tailed]: U = 69.50; $P = 0.931$; common, $N = 13$ and rare, $N = 11$). Colourful butterflies such as the Papilionids and Nymphalids with large wingspan were described relatively earlier compared with the rather dull-coloured and small Hesperids ($r_s = 0.800$, $P = 0.133$, df = 4; figure 3). Overall there was a negative correlation between the size (r = –0.273, $P < 0.01$, df = 289), number of colours in the butterfly species (r = –0.15, $P < 0.01$, df = 128) and the altitudinal range (r = –0.31, $P < 0.05$, df = 128) with the year of discovery. Smaller-sized butterfly families such as Hesperids and Lycaenids were discovered later than Papilionids and Nymphalids. According to the regression model, three factors—altitude ($P < 0.0009$), size ($P < 0.0002$) and commonness ($P < 0.007$)—play a significant role (table 3) in the discovery of butterflies.

3.2.3 *Orchids:* In orchids also, non-endemic species were discovered much earlier (1836 ± 136.55) than the endemic species (1890 ± 55.32; Mann–Whitney U test [two-tailed]: U = 5058; $P < 0.0001$; non-endemic, $N = 158$ and endemic, $N = 151$). Further, common orchids were described significantly earlier compared to rare ones (Mann–Whitney U test [two-tailed]: U = 6567.5; $P < 0.0001$; common, $N = 147$ and rare, $N = 132$). Within endemics, common species were discovered earlier than rare species (Mann–Whitney U test [two-tailed]: U = 1258; $P = 0.0001$; common, $N = 49$ and rare, $N = 72$). Terrestrial orchids were discovered earlier (1859 ± 39.63) compared to epiphytic ones (1869 ± 53.48; Mann–Whitney U test [two-tailed]: U = 5647.5; $P = 0.066$; terrestrial, $N = 124$ and epiphytic, $N = 106$). Species with large flowers tend to be discovered earlier than those possessing smaller flowers (r = 0.22, $P < 0.05$, df = 127). The regression analysis for orchids shows that rarity and inflorescence length contributes significantly to species discovery (table 3).

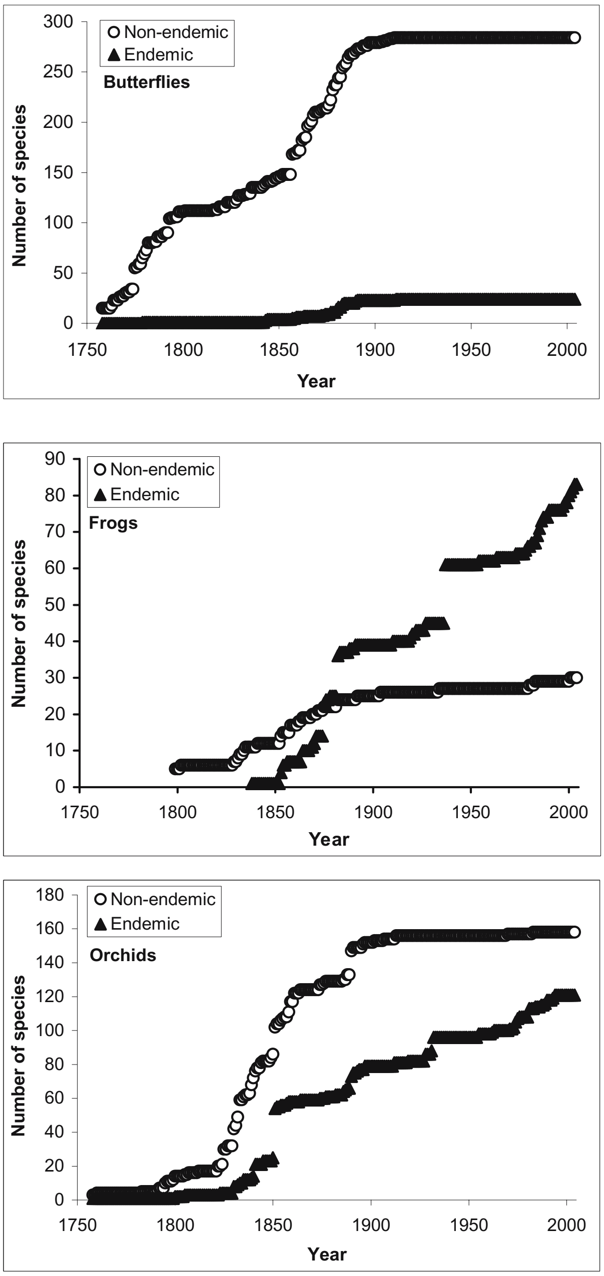

Figure 2. Species discovery patterns of non-endemic and endemic species of butterflies, frogs and orchids in the Western Ghats.

4. Discussion

4.1 *Patterns of species discovery in the Western Ghats*

In India, since the start of the East India Company and later British occupation in the year 1757, there has been a rich history of documentation of plant and animal diversity. Thus, for almost the entire period following the Linnaean binominal nomenclature, there is a wealth of information based on which discovery patterns could be analysed. However, despite the richness of information, only a few attempts have been made to analyse the temporal patterns of discovery of species in India (Aravind *et al* 2004; Gower *et al* 2004). Analysis of the patterns of discovery can have profound implications for identifying gaps in the discovery of particular taxa and thus in restructuring and strategizing the discovery process itself. We analysed the temporal discovery pattern of species in the Western Ghats, a megadiversity centre in south India. Both during the pre- and post-Independence period, the region has been a site of intense taxonomic activity (as evidenced by the publication of *Fauna of British India* and later *Fauna of India* by the Zoological Survey of India, Kolkata). The region contributed to the publication of van Rheede's *Hortus Malabaricus* (1678–1693; 12 volumes) and a series of books on regional floras along the stretch of the Western Ghats (*Flora of Coorg*, *Flora of Hassan District*, *Flora of Udupi*, *Flora of Tamil Nadu*, *Flora of Maharashtra*, to name a few).

Analysis of species discovery curves including four plant and four animal groups indicated a mixed set of patterns. For the charismatic animal species—birds and butterflies—the discovery curve was saturated, indicating little prospect for further discovery in these two groups. Indeed, as mentioned elsewhere, the last bird and butterfly species to be described from the region were in 1944 and 1911, respectively. These results uphold the prediction that charismatic animals, which are relatively more conspicuous, generally tend to be discovered earlier than non-charismatic or obscure species. On the other hand, for orchids, which are also considered charismatic, the discovery curve has not yet attained an asymptote. In the past fifty years (1950–2000), more than 27 species of orchids have been reported from the Western Ghats. However, the latter are mostly endemic species and most often arboreal and thus despite their conspicuousness are not easily sighted and discovered. For two groups, the grasses and frogs, the discovery curve was distinct with an almost monotonic increase in the rate of species discovered. Since 1750, nearly 100 new species of grasses have been reported every 50 years. In frogs, after a nearly 100-year lag, there has been a dramatic increase in discovery. In other words, the species discovery curves for each of the taxa best represent the cumulative historical factors that have led to the description and discovery of species in the group. To reconstruct the temporal path of discovery of species, it would be interesting to analyse these factors and examine the immediate reasons for spurts and plateaus in the discovery patterns. From the point of prioritizing taxonomic

Table 3. Forward step-wise linear regression analysis of life history attributes determining species discovery in birds, butterflies and orchids. Only those variables indicating significant effects are included in the model

	Beta	SE of Beta	B	SE of B	T	*P* level	*N*
Birds							
Intercept			162.85	7.13	22.85	0.000	
Size	0.19	0.064	00.37	0.13	02.88	0.004	493
Commonness	0.10	0.064	10.19	6.33	01.61	0.109	493
r= 0.198, R^2= 0.039, Adjusted R^2= 0.031; F (2,238) = 4.860,P = 0.009, SE: 44.88							
Butterflies							
Intercept			95.10	13.22	7.19	5.45×10^{-11}	
Altitude	0.28	0.08	00.01	0.00	3.39	0.0009	128
Size	0.30	0.08	00.60	0.16	3.84	0.0002	290
Commonness	0.22	0.08	20.82	7.60	2.74	0.0070	293
r= 0.482, R^2= 0.232, Adjusted R^2 = 0.214, F (3,123) = 12.403, P = 0.000, SE: 41.43							
Orchids							
Intercept			137.85	8.55	16.13	3.70×10^{-27}	
Rare	–0.29	0.106	–28.57	10.43	–2.74	0.008	279
Inflorescence length	0.18	0.106	00.49	0.28	**1.73**	0.087	123
r= 0.320, R^2= 0.1022, Adjusted R^2= 0.080, F (2,82)=4.668, P= 0.012, SE: 47.51							

F-ratio computed from ANOVA.
β is the slope of the regression model.
B is a partial regression coefficient estimating *β*.
T is the *t* for testing $H_{0.}$
SE is the standard error.

*For butterflies and birds, median size (in cm) was considered. For butterflies the maximum wingspan was considered as size of the species. Number of colours in the plumage (birds) and wings (butterflies) was also included as a variable. In case of orchids, size of the flower (in mm) and number of flowers in the inflorescence was studied. For all the three taxa, commonness and rarity was given a rank of 3 and 1, respectively, and the maximum altitude for each species was also recorded.

**Independent variables used for regression analyses were altitude, commonness and rarity, size (in case of orchids size of the inflorescence) and number of colours.

search for newer discoveries, our results indicate that it might be more promising to look for newer species in taxa such as grasses and frogs than birds and butterflies. We argue that building even simple temporal discovery curves for as many taxa as possible could be a worthwhile national exercise, especially to draw attention to the taxa that need more effort, attention and taxonomic treatment for newer discoveries. However, a caveat is that even when diversity asymptotes are clearly indicated (as for many vertebrate groups), it does not necessarily follow that existing diversity has been fully uncovered (Patterson 1994). For example, in Australian scarab beetles, long after the species discovery attained asymptote during the 1920s, there have been many recent descriptions (Allsopp 1997). The flurry of discovery in such cases might be due to, among others, better resolution of species distinctiveness (such as sharper taxonomic criteria) or even renewed interest in a group.

4.2 *Determinants of species discovery in the Western Ghats*

Within a taxon, several broad patterns of species discovery seem to be consistent. First, endemic species tend to be more slowly described compared with non-endemic species. Second, species that are rare (low abundance) tend to be described slowly compared with widespread species (high abundance). In other words, both the distribution (endemicity) and abundance (rarity) of species appear to significantly influence the rate of discovery. Analysing the effects of abundance alone for the three taxa (birds, butterflies and orchids) by considering only the endemics, we found that there was a significant difference in the time of discovery between the common and rare species for orchids, but not for butterflies and birds. The immediate causal explanation for the observed patterns in time of discovery of endemic vs non-endemic and between rare

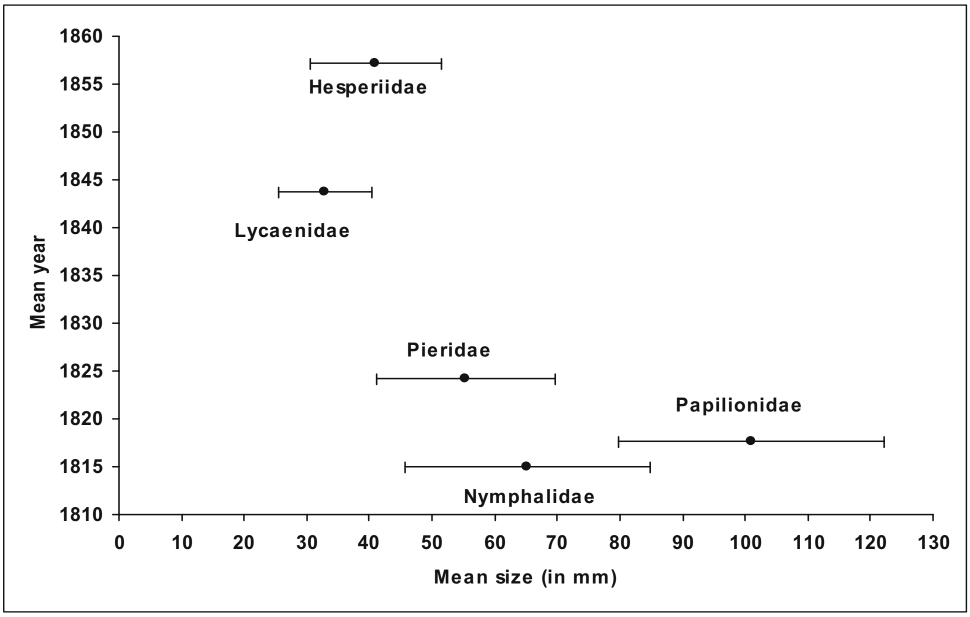

Figure 3. Relationship between mean year of discovery and mean size of five butterfly families.

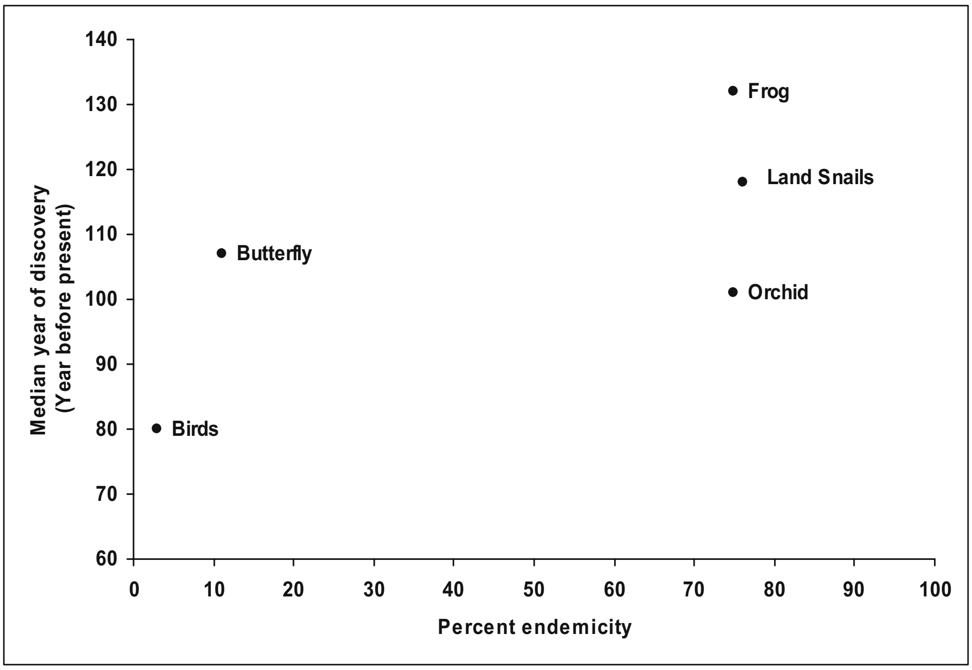

Figure 4. Relationship between per cent endemicity vs median year of description for five taxa in the Western Ghats. Data on land snails was obtained from Aravind (2005).

vs common species is not clear. For example, are species that are endemic in distribution and rare in abundance not discovered because of the relative difficulties in sampling a large number of sites (for endemic species) and in sighting them (for rare species)? While both of these reasons are extremely plausible, it is beyond the scope of this paper to address them.

Differences in the discovery curve among taxa may arise due to a combination of factors including skewed taxonomic attention, charismatic nature/conspicuousness of the taxa, geographical range of the taxa, per cent endemicity of the taxa, etc. (Diamond 1985; Gaston 1991a,b; Blackburn *et al* 1993; Gaston and Blackburn 1994; Blackburn and Gaston 1995; Gaston *et al* 1995a,b). Our study shows that charismatic species tend to be discovered much earlier than non-charismatic ones. However, the observed results might also be significantly influenced by one or more confounding variables such as the relative geographical range or per cent endemicity of the species contained within a group. For example, the median years to discovery of a species was weakly positively correlated with the per cent endemicity of species in the taxa ($r_s = 0.656$, $P = 0.133$; figure 4). Thus, in groups such as birds and butterflies in which the endemicity was less than 15%, the median years to discovery were much less compared with groups such as frogs and land snails, which have over 70% endemicity. Interestingly, though orchids are also distinguished by very high levels of endemism, the median years taken for their discovery are comparable with the more widespread groups (birds and butterflies).

Within taxa, the patterns of discovery largely confirm the major predictors (body size, geographic range, abundance and visual conspicuousness) reported earlier (Diamond 1985; Gaston 1991a,b; Gaston and Blackburn 1994; Gaston *et al* 1995a,b). In our study of birds, butterflies and orchids, the size (inflorescence length in case of orchids) and commonness were the most important determining factors. This result is in concordance with previous studies on birds (Diamond 1985), North American butterflies (Gaston *et al* 1995a) and beetles in Great Britain (Gaston 1991a). Thus, species body size and year of description were strongly correlated. However, for South American oscine passerine birds, the geographical range of the species was found to be the better predictor of probability of discovery of a species than altitudinal range and body size (Blackburn and Gaston 1995). Geographical range was found to be a good predictor of the date of discovery of species, explaining over 60% of the variation in species discovery when taxonomic relatedness is controlled for (Blackburn and Gaston 1995). However, Reed and Boback (2002) showed that for North American and Australian herpetofauna, body size is a poor predictor of the description date, hence they cautioned against using a body size/description date relationship for estimating species remaining to be discovered. It is evident that in all the three taxa chosen for this study, size is a common and most important determining factor for species discovery. Within each group such as frogs, orchids and butterflies, endemic species were discovered significantly later than non-endemic ones. Clearly, as evidenced by the recent spurt of discoveries of frog species in the Western Ghats, increased effort needs to be made to search for those taxonomic groups known to have higher levels of endemism. Strategic plans can be put in place to enable the accelerated discovery of endemic species in both well known and lesser known taxa.

The results reported in this study are for one region only, the Western Ghats. In the context of our study, it would be interesting to analyse the species discovery profiles for other sites as well and accordingly reallocate efforts to discover species in areas that have not yet reached an asymptote. Finally, it might also be profitable to undertake predictive modelling (such as log–log, log–linear and Michelis–Menten) based on the existing datasets to forecast the number of species yet to be discovered.

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