0.1 Examples of fossil record simulations

0.1.1 From Silvestro et al. [2014]

Simulated data sets were generated based on six patterns of species diversification chosen to yield scenarios of varying species richness commonly observed in empirical data (Fig. 2 and Table 1; Sepkoski 1981):

- I. expanding diversity with constant speciation and extinction rates ($\lambda > \mu$);
- II. expanding diversity followed by a decline with all taxa going extinct before the present ($\lambda_1 > \mu_1, \lambda_2 < \mu_2$);
- III. expanding and then declining diversity followed by turnover at equilibrium ($\lambda_1 > \mu_1, \lambda_2 < \mu_2, \lambda_3 = \mu_3$);
- IV. expanding diversity followed by turnover at equilibrium due to a decrease in speciation rate ($\lambda_1 > \mu_1, \lambda_2 = \mu_2$);
- V. expanding diversity followed by turnover at equilibrium due to a decrease in speciation rate and increase in extinction rate ($\lambda_1 > \mu_1, \lambda_2 = \mu_2$); and
- VI. constant speciation rate and a mass extinction event ($\lambda_1 > \mu_1, \lambda_2 << \mu_2, \lambda_1 > \mu_1$).

Based on the complete birth–death realizations, fossil occurrences were simulated for each species. Along each lineage i a number of occurrences Ki was derived from a Poisson distribution with rate parameter qPOI = q(si − ei) where q is the preservation rate (cf. Equation 1), and si,ei are the true times of speciation and extinction. The preservation rate was assumed q = 3 unless stated otherwise. A number of fossils Ki were then randomly drawn from the PERT distribution for all species, resulting in a synthetic data set that mimics the fossil record. The shape parameter of the PERT distribution was assumed to be l = 4 (as in Equation 3) unless stated otherwise. The number of occurrences K depended only on the preservation rate q and on the species lifespan, i.e., it was not conditioned on being greater than 0. The lineages without a fossil record (K = 0) were disregarded in the analyses because of the condition stated in Equation (4). All extant species were then truncated at time 0 (i.e., the present). The number of extant species based on the complete birth–death realization (NOBS) was kept to construct the hyperprior of Equations (12–15).

0.1.2 From Foote [2000]

Preservation can be modeled in a number of realistic ways that include variation in time and space (Shaw 1964; Koch and Morgan 1988; Marshall 1994; Holland 1995; Holland and Patzkowsky 1999; Weiss and Marshall 1999). As a heuristic tool for understanding the behavior of diversity and rate measures, it is convenient to focus on the temporal aspect and to start by assuming time-homogeneous fossil preservation at a constant per-capita rate r per Lmy (Paul 1982, 1988; Pease 1985; Strauss and Sadler 1989; Marshall 1990; Foote and Raup 1996; Solow and Smith 1997; Foote 1997). This simple assumption will be relaxed below. In the time-homogeneous case, the proportion of lineages preserved is equal to r/(q 1 r) if p 5 q and if the fossil record is of effectively infinite length (Pease 1985; Solow and Smith 1997) (see Edge Effects, below). It is therefore natural for many problems to express preservation rate as a multiple of q. Throughout this discussion I will assume taxonomic homogeneity of taxonomic and pres- ervational rates. For modeling, this assumption can easily be relaxed by performing calculations for an arbitrary number of rate clas- ses and combining the results (see Buzas et al. 1982, Koch and Morgan 1988, Holland 1995, Holland and Patzkowsky 1999, and Weiss and Marshall 1999 for explicit treatments of taxo- nomic heterogeneity of preservation)

0.2 Other studies comparing methods in the FR

See:

- Alroy [2000]
- Alroy [2010]
- Alroy [2014]

Bibliography

John Alroy. New methods for quantifying macroevolutionary patterns and processes. *Paleobiology*, 2000.

John Alroy. *FAIR SAMPLING OF TAXONOMIC RICHNESS AND UNBIASED ESTIMATION OF ORIGINATION AND EXTINCTION RATES*, pages 55–80. The Paleontological Society, 2010.

John Alroy. Accurate and precise estimates of origination and extinction rates. *Paleobiology*, 2014.

Mike Foote. Origination and extinction components of taxonomic diversity: general problems. *Paleobiology*, 26(sp4):74–102, 2000. doi: /10.1666/0094-8373(2000)26[74:OAECOT]2.0.CO;2.

D. Silvestro, J. Schnitzler, L. H. Liow, A. Antonelli, and N. Salamin. Bayesian estimation of speciation and extinction from incomplete fossil occurrence data. *Systematic Biology*, 0(0):1–19, Feb 2014. ISSN 1076-836X. doi: 10.1093/sysbio/syu006. URL `http://dx.doi.org/10.1093/sysbio/syu006`.