

## Reproductive seasonality in primates: patterns, concepts and unsolved questions

### ABSTRACT

Primates, like other mammals, exhibit an annual reproductive pattern that ranges from strictly seasonal breeding to giving birth in all months of the year, but factors mediating this variation are not fully understood. We applied both a categorical description and quantitative measures of the birth peak breadth based on daily observations in zoos to characterise reproductive seasonality in 141 primate species with an average of 941 birth events per species. Absolute day length at the beginning of the mating season in seasonally reproducing species was not correlated between populations from natural habitats and zoos. The mid-point of latitudinal range was a major factor associated with reproductive seasonality, indicating a correlation with photoperiod. Gestation length, annual mean temperature, natural diet and Malagasy origin were other important factors associated with reproductive seasonality. Birth seasons were shorter with increasing latitude of geographical origin, corresponding to the decreasing length of the favourable season. Species with longer gestation periods were less seasonal than species with shorter ones, possibly because shorter gestation periods more easily facilitate the synchronisation of reproductive activity with annual cycles. Habitat conditions with higher mean annual temperature were also linked to less-seasonal reproduction, independently of the latitude effect. Species with a high percentage of leaves in their natural diet were generally non-seasonal, potentially because the availability of mature leaves is comparatively independent of seasons. Malagasy primates were more seasonal in their births than species from other regions. This might be due to the low resting metabolism of Malagasy primates, the comparatively high degree of temporal predictability of Malagasy ecosystems, or historical constraints peculiar to Malagasy primates. Latitudinal range showed a weaker but also significant association with reproductive seasonality. Amongst species with seasonal reproduction in their natural habitats, smaller primate species were more likely than larger species to shift to non-seasonal breeding in captivity. The percentage of species that changed their breeding pattern in zoos was higher in primates (30%) than in previous studies on Carnivora and Ruminantia (13 and 10%, respectively), reflecting a higher concentration of primate species in the tropics. When comparing only species that showed seasonal reproduction in natural habitats at absolute latitudes  $\leq 11.75^\circ$ , primates did not differ significantly from these two other taxa in the proportion of species that changed to a less-seasonal pattern in zoos. However, in this latitude range, natural populations of primates and Carnivora had a significantly higher proportion of seasonally reproducing species than Ruminantia, suggesting that in spite of their generally more flexible diets, both primates and Carnivora are more exposed to resource fluctuation than ruminants.