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# Annual chronotypes functionally link life histories and life cycles in birds

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## Abstract

© 2018 The Authors. Functional Ecology © 2018 British Ecological Society Life-history responses to ecological selection pressures can be described by a slow-fast life-history axis. Along this axis, fast-living animals usually invest in high breeding output, whereas slow-living ones prioritize their own survival. Birds may solve the trade-off between reproduction and survival by optimizing their seasonal schedules. Breeding early tends to facilitate reproductive success, whereas breeding late increases the chances to survive. On the basis of this argument, short- and long-lived birds should benefit from initiating spring activities earlier and later, respectively. The timing of seasonal activities, all else being equal, depends on the architecture of endogenous circannual clocks. Particularly, the length of the circannual period relative to the 365-day environmental year either facilitates the anticipation of seasonal activities (in case of periods shorter than 365 days) or represents a responsive mode (when periods are longer than 365 days). The two alternatives will be manifested by early or late annual chronotypes, respectively. We hypothesize that in birds, annual chronotype will correspond with position on the “pace-of-life scale.” Species with low survival probability, and thus a poor chance of breeding in a next season, should show early annual chronotypes facilitated by circannual-clock periods shorter than 365 days. In contrast, species with high survival rates should benefit from relatively long circannual periods. We predicted that circannual-period lengths should correlate positively with species-specific adult annual survival rates. Using published data for 16 wild bird species, we confirmed the predicted correlation. In our analysis, we accounted for the possible metabolic nature of circannual clocks, a correlation between rate of metabolism and survival, and phylogenetic relationships. On the basis of our finding, we propose that evolutionary responsive circannual clocks help birds cope with temporal variation in the environment in ways that are most appropriate for their life-history and life-table attributes. A plain language summary is available for this article.

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## Keywords

annual chronotype, circannual rhythm, life cycle stage, metabolic rate, pace-of-life, reproduction-survival trade-off, seasonal migration, slow-fast life-history continuum

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