Sunset-Related Timing of Flight Activity in Neotropical Bats*

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Summary. The times of onset and completion of the hunting flights of three colonies of neotropical bats, each comprising 100–200 individuals, were observed for nine months. The colonies were of different species: *Molossus ater* (*M.a.*) and *Molossus molossus* (*M.m.*) of the Molossidae, and *Myotis nigricans* (*My. n.*) of the Vespertilionidae. Individuals of *Phyllostomus hastatus* (*P.h.*., Phyllostomidae) were also observed. All the bats roosted in a building near Restrepo, Colombia (4°16′N, 73°34′W). Times of emergence in the evening and the return of the last animals in the morning were recorded on 2 to 3 successive days each month. For all bats, the emergence time changed in parallel with that of sunset, and the return paralleled sunrise (Fig. 1). Accordingly, the duration of the activity period is positively correlated with the duration of the night. No annual periodic changes in phase (re sunset/sunrise) of the onset and end of flight activity could be demonstrated, but there was a close relationship between the timing of activity and particular light intensities during twilight (Fig. 4). The first flyers of *M.a.* appear at the highest intensity (30–300 lx) and those of *My. n.* at the lowest (0.1–5 lx); the last flyers to return appear in the opposite sequence. For each species, the return to the roost usually occurs at a lower intensity than the departure. These findings, made with four neotropical bat species, differ from those of Subbaraj and Chandrashekaran (1977) with the emballonurid bat *Taphozous* that they studied at 9°58′ N in India. The ecological factors that may play a role in timing the flight activity of tropical bats are discussed. “Sunset-related timing”, based on the combined effect of (a) the circadian oscillation in “arousal” and (b) the transition during twilight to a light-intensity range with reduced inhibition of activity (light-sampling behavior), tends to be the rule in tropical bats; “time-of-day-related timing” is the exception.

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Introduction

Most bats are night-active animals. During the day they remain in their roosts, emerging late in the evening twilight to hunt for food. Experiments done under constant conditions in the laboratory have shown that the "overt" activity cycle is based on a circadian rhythm with period length differing from 24 h, synchronized with the external 24-h periodicity primarily by the daily alternation between light and darkness (Griffin and Welsh, 1937; Rawson, 1960; Menaker, 1961; DeCoursey and DeCoursey, 1964; Erkert, 1970; Bay, 1976; Subbaraj and Chandrashekaran, 1977; Erkert and Kracht, 1978). The biological periodicity maintains a particular phase relationship with the LD timing signal, depending on the light-intensity ratio and the relative durations of the light and dark periods, as well as upon the duration of the intervening transition phase—the duration of twilight. At higher latitudes, where the parameters of the timing signal can change greatly over the course of the year, there are distinct annual changes in both phase and precision of the timing of the daily activity period, in both light- and dark-active species (Aschoff, 1969; Aschoff et al., 1970; Daan and Aschoff, 1975). Under quasi-natural light conditions near the equator in Colombia, recordings of the activity of golden hamsters, bats, and birds revealed—as expected—hardly any such seasonal changes in the phase relationship between the activity and timing-signal periodicities (Erkert, 1974, 1976 and in preparation). By contrast, Subbaraj and Chandrashekaran (1977) found that near Madurai in India, at 9°58' S, the Indian bat Taphozous began its hunting flight at a time of evening that was nearly constant throughout the year. This results in a seasonal change in the phase relationship between departure and sunset, which these authors ascribe to a "rigid internal timing mechanism" and annual variation in the sensitivity of the animals to sunlight. But the observations on four neotropical bat species described here, carried out in the field over a period of nine months in Colombia, lead to quite a different picture of the timing of the daily activity phase of tropical bats.

Methods

Field observations of the onset and end of the activity phase were carried out with one colony of each of three insectivorous species—*Molossus molossus* (M.m.), *Molossus ater* (M.a.), both Molossidae, and the vespertilionid *Myotis nigricans* (My. n.)—and with single individuals of the omnivorous phyllostomid *Phyllostomus hastatus* (P.h.). The site was near Restrepo, Departamento Meta, Colombia, which lies at 4°16' north latitude and 73°34' west longitude in the foothills of the Eastern Cordillera, about 500 m above sea level. Day length there varies during the year from 11 h 53 min to 12 h 22 min, the duration of civil twilight ranging from 21 to 23 min. Observations took place between August 13, 1971, and April 6, 1972.

The bats roosted in a narrow system of cavities between the double walls of a seminary for Salesian priests about 1 km outside Restrepo. *M.m.* and *My.n.* inhabited the front wall of the chapel; captures indicated that their colonies comprised both sexes, with a great predominance of females. *M.a.* were observed to emerge chiefly from the ventilation slits located above the upper windows at the northeast corner of the main building. An observation point was chosen between church and main building, so that the departures and returns of all four species could be monitored simultaneously.