Diurnal Periodicity of Luminescence in Three Basidiomycetes

Abstract. Evidence is presented showing that intensity of light emission in dikaryotic cultures of *Panus stipticus, Armillaria mellea,* and *Mycena polygramma* follows a diurnal pattern. The lowest values appear between 6 and 9 A.M. and the peak intensities occur between 6 and 9 P.M. This pattern is consistent regardless of whether the cultures are grown in total darkness, under constant illumination, or exposed to a normal day-night cycle.

The light emission of luminous fungi and bacteria, unlike that of animals, is continuous night and day and independent of stimulation, either internal or external (*1*). The work of Hastings (*2, 3*) on the biological "clock" *Gonyaulax* led me to study with advanced photometric techniques whether there was a diurnal rhythm of luminescence intensity in the following fungi: *Armillaria mellea, A. fusipes, Clitocybe illudens, Mycena galopus, M. polygramma, Panus stipticus,* and *Omphalia flavida.*

Armillaria mellea, Mycena polygramma, and *Panus stipticus* showed definite evidence of a constant endogenous diurnal periodicity of light emission intensity. The other species evidenced no such recognizable pattern.

Fourteen-day-old dikaryotic mycelial cultures, maintained in the dark at 22°C on 10-percent bread crumb agar, were used throughout most of this study after determination that cultures grown in total darkness give off about a 10-percent brighter light and are easier to maintain. Data were also obtained on cultures originally maintained under constant illumination and cultures under a 12 hour–12 hour dark-light condition, and since the results were identical to those of cultures started in total darkness the latter were used.

All measurements were made in a light-tight chamber by using a photomultiplier tube suspended and centered 4 cm above the level of the agar in Petri dishes, so as to record the light emission of cultures up to 9 cm in diameter. Values were obtained at 3-hour intervals except at the time of highest and lowest intensities, when readings were taken 30 minutes apart to determine the low and high points.

Fourteen-day-old cultures were approximately 4 cm in diameter, and in the five subsequent days total area of the colonies averaged 9 cm in diameter. Cultures between 14 and 21 days old exhibit the highest light intensities. No correlation appears to exist between total colony size and light emission intensity, since the central portion gets dimmer in time.

For all samples (Fig. 1) the highest intensities appeared between 6 and 9 P.M. (zonal sun time) with the peaks usually arriving at 7 P.M. and maintained for an hour or longer. The lowest levels were reached between 6 and 9 A.M., most frequently at 6:30 A.M., and sometimes maintained for 2 hours or more. This rhythm was detectable (bottom curve, Fig. 1) as early as 48 hours after inoculation, and is maintained in detectable intensities for as long as 7 weeks until extinction is reached because of lack of nutrients and accumulation of by-products.

There was also no apparent correlation between peaks of light intensity and accelerated cell divisions as determined by the increase of the total colony area at different times of day. This independence of the luminescence rhythm from the growth rhythm has also been found in *Gonyaulax* (*3*).

The rises and falls in light intensity during any 24-hour period were as high as 35 percent. Yet this substantial range of daily light emission has escaped notice, because it cannot be detected visually by the dark-adapted eye, and also, probably, because of lack of sensitive photomultipliers and short-term observations. Further studies are in progress to determine the effects of a number of external factors in varying this diurnal rhythm.

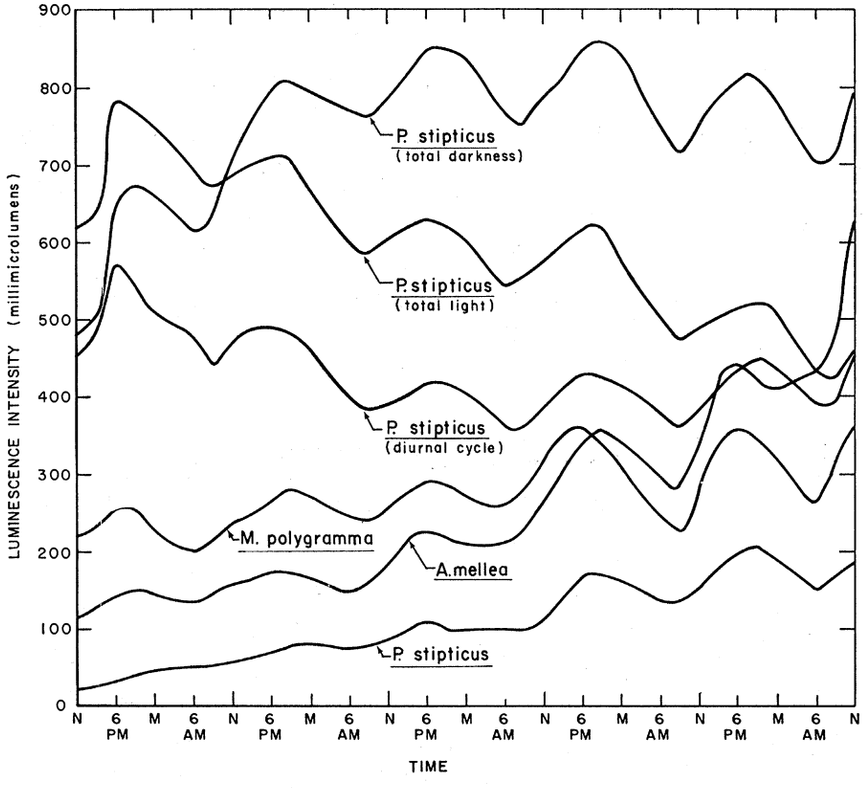

Fig. 1. Typical light intensity curves of 14-day-old cultures of *P. stipticus* kept in total darkness prior to the experiment (except bottom one, for which values were recorded 24 hours after inoculation). The curves for *A. mellea* and *M. polygramma* represent cultures kept in the dark throughout the experiment. Constant illumination was under a 100-watt bulb at 4 feet. The "normal" diurnal cycle was one of 14 hours of daylight and 10 of darkness.

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References and Notes

1. E. N. Harvey, *Bioluminescence* (Academic Press, New York, 1952).
2. J. W. Hastings, *Ann. Rev. Microbiol.* **13**, 297 (1959).
3. ———, in *Photoperiodism*, R. B. Winthrow, Ed. (AAAS, Washington, D.C., 1959).
4. The cultures of *Panus stipticus* and *Armillaria mellea* were supplied by Dr. Ruth Macrae, and that of *Mycena polygramma* by the Central Bureau voor Schimmelculture.

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