Activity Rhythms and Light Intensity Preferences of *Micropterus salmoides* and *M. dolomieui*

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ABSTRACT

Activity rhythms and light intensity preferences of largemouth (*Micropterus salmoides*) and smallmouth (*M. dolomieui*) black basses were investigated in laboratory experiments designed to elucidate aspects of niche separation between these sympatric congeners. Both species exhibited crepuscular activity, but *M. salmoides* also showed a mid-day activity peak. *M. dolomieui* avoided bright light, and their peak activity periods occurred at the beginning and end of the dark periods. Activity of *M. salmoides* was much more depressed during the dark periods, and rose sharply at the onset of light periods. Activity records in constant light conditions showed these activity rhythms to be endogenous.

Largemouth [*Micropterus salmoides* (Lacépède)] and smallmouth (*M. dolomieui* Lacépède) black basses (Centrarchidae) occur sympatrically throughout much of their ranges, frequently occurring in the same bodies of water. This fact poses the question of how these closely related and generally similar predators organize their activities in space and time so as to minimize interspecific competition. We have conducted a series of laboratory experiments designed to elucidate factors involved in the niche separation of these species. Results of investigations concerning the thermal preferenda of these species are reported elsewhere (Reynolds and Casterlin 1976a; Reynolds et al. 1976). This report concerns our findings regarding locomotor activity rhythms and light intensity preferences of bass.

METHODS

The experimental device is a four-chambered aquarium in which the fish swim through a light beam in passing from one chamber to another (Reynolds and Casterlin 1976a). Photocells and relays connected to an eight-channel event recorder gave a continuous record of the positions and activity of the fish. The fish were able to simultaneously regulate water temperature along one axis, while choosing between a greater (1,000 lux) or lesser (10 lux) light intensity along the other axis. Total activity was measured as the total number of events for both axes.

The exogenous light:dark cycle used was LD 12:12, with the lights on from 1200 to 2400 h eastern standard time. During the dark period (0000 to 1200 h), dim light (1 lux) was provided by scattered light from the photocell beams; intensity directly in the beams was 80 lux. Free-running experiments were conducted in either constant light or constant darkness to examine the endogenous nature of the activity rhythms. As a further refinement of the light intensity preference experiments, some fish were allowed to control the lights, switching them on or off by their movements through the light beams (Reynolds and Casterlin 1976b).

Five fish of each species were used, ranging in standard length from 10 to 15 cm. All were obtained by electrofishing in the Susquehanna River near Berwick, Pennsylvania, in October 1974. Experiments were conducted from October through January.

Only one fish was tested at a time. All fish were allowed to acclimate to the experi-

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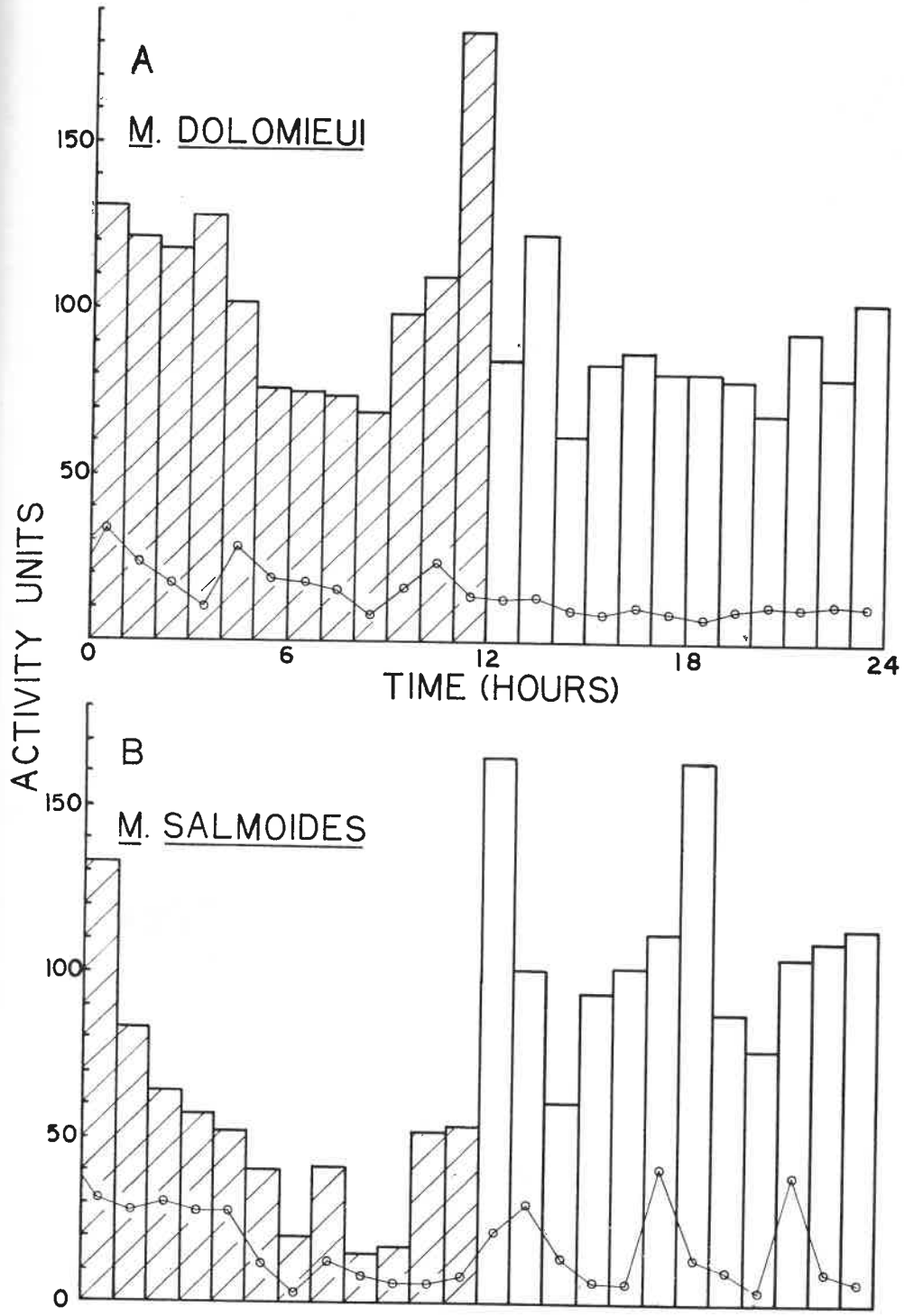
FIGURE 1.—*Pooled activity records for smallmouth (A) and largemouth (B) black basses. Shaded bars represent dark period, open bars light period. Activity units represent numbers of times fish broke photocell light beams. Representative free-running activity records for single fish of each species in constant light conditions are superimposed (circles).*



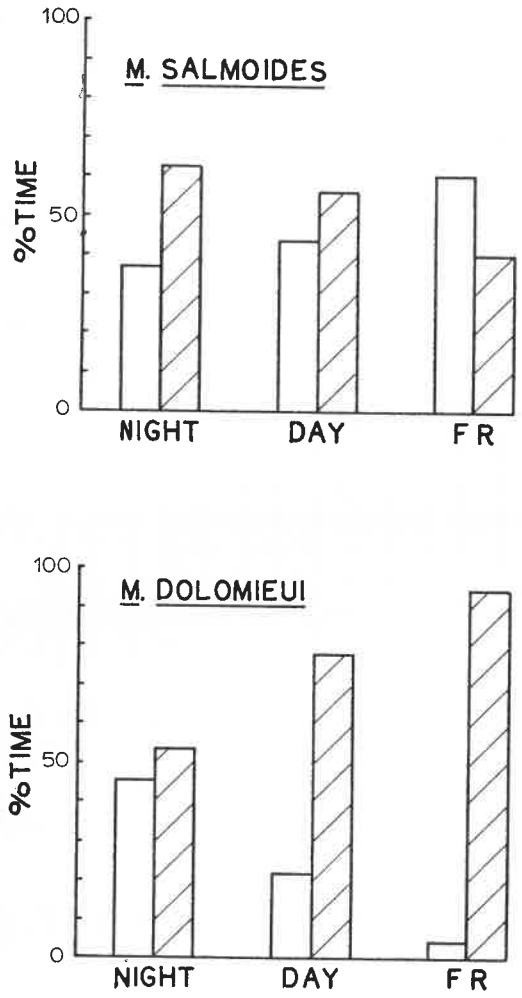


FIGURE 2.—*Light intensity preferences: % of time spent in lighted (during the day) and unlighted chambers at night, during the day, and during periods when fish controlled the lights (FR). Shaded bars represent time spent on dark side, open bars represent time spent in chambers which were lighted during the day.*

mental milieu for 48 hours prior to acquisition of activity data, as the activity was found to stabilize within this time period. Free-running and light-switching experiments were conducted following 2–4 days of exogenous (LD 12:12) recording. Prior to testing, the fish were held in aquaria for at least 1 week at 22 C and LD 12:12, and were given food at random times during the light period. Fish were not fed during the experiments.

RESULTS

Activity of both species was essentially crepuscular (Fig. 1), with activity peaks at "dawn" and "dusk" (beginning and end of light or dark periods). The largemouth showed an additional diurnal activity peak at midday, and night activity was more depressed than in smallmouths. The morning largemouth peak occurred following the onset of the light period, while the morning smallmouth peak preceded onset of the light period and declined sharply at the onset of the light. In both species, the evening peaks were less pronounced than the morning peaks. The endogenous nature of the activity rhythms was indicated by free-running experiments in which the rhythms persisted in constant light conditions (Fig. 1).

Light intensity preferences (Fig. 2) differed considerably between the two species. During the light period, *M. salmoides* spent 44% of the time on the brightly lighted (1,000 lux) side, compared to 22% for smallmouth. When the fish controlled the light switch, largemouth kept the light on (by staying on the light side) 60% of the time, while smallmouth kept the light on only 4% of the time.

DISCUSSION

The essentially crepuscular nature of *M. dolomieui* as manifested in our experiments is confirmed by the field studies of Emery (1973). Their preference for cover affording an area of darkness is supported by the experiments of Haines and Butler (1969). Hubbs and Bailey (1938) and Cleary (1956) have remarked that smallmouth bass are extremely shelter-oriented during daylight hours. The present experiments would seem to indicate that largemouth bass are somewhat less shelter-oriented and more active during daylight. A possible qualification is that the fish we used were sub-adult; younger and older fish might behave differently (Kwain and MacCrimmon 1969), and seasonal changes might also occur (Vogele and Rainwater 1975; Warden and Lorio 1975).

The observed differences in light intensity preferences in relation to activity rhythms embody a potential mechanism for niche

separation of these congeneric species in space and time (Gibson and Keenleyside 1966). Our data predict that smallmouth bass should reach their peak activity earlier in the morning and later in the evening than largemouth bass, and should tend to remain near cover affording an area of darkness during the day. Because of character displacement (to the extent that these responses are hereditary), and/or possible learning, these differences should be most pronounced in areas of sympatry; it is possible that populational differences in these traits could occur.

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