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Annual pattern of reproduction of the bagre, *Arius guatemalensis* (Pisces: Ariidae), in El Salvador

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Resumen: Se estudió el ciclo reproductivo del bagre, *Arius guatemalensis*, de la Laguna de Olomega, El Salvador. Hay tres picos de actividad gonadal, en los dos sexos (estación lluviosa en abril y agosto, y otro que no está sincronizado a fin del año). Esta actividad fue mínima durante enero y febrero. Un período de pos-desove siguió el pico de agosto, lo cual sugiere que el período reproductivo principal ocurrió durante la estación lluviosa. La cantidad de grasa en la cavidad abdominal llegó a su nivel mínimo de julio a octubre. Las hembras maduras tienen protuberancias carnosas laterales en las aletas pélvicas y alcanzaron su desarrollo máximo durante el período de desove.

Key words: fisheries, reproduction, *Arius*, seasonality.

To date, many studies of piscine reproductive cycles have concentrated on temperate species in which seasonal variations of temperature and day length typically play major roles in their regulation (de Vlaming 1974, Burns 1976). However, with the increasing number of studies on tropical fish reproduction, it has become evident that such synchronizers may not play major roles in the regulation of many tropical species. The environmental factor in tropical habitats that shows the most marked variation seasonally is the alternation of dry and rainy seasons. Some tropical species, such as the weakly electric gymnotids (Kirschbaum 1984), reproduce exclusively during the rainy periods, while others show peaks of reproductive activity during that time (Burns & Flores 1981).

The bagre, *Arius guatemalensis,* is a commercially important species in El Salvador and is commonly found in habitats ranging from coastal estuaries to freshwater rivers and lakes. The present study on the reproductive cycle of *A. guatemalensis* was based on monthly collections from Lake Olomega, a freshwater lake in southeastern El Salvador.

During each month from November, 1977, to December, 1978, male and female *A. guatemalensis* were collected by seining from Lake Olomega, Departments of La Unión and San Miguel, El Salvador, Central America (13° 18'N, 88° 03'W). The number of males per sample varied from 9 to 15 (total for year: 175), while that for females varied from 13 to 21 (total for year: 233). Upon capture the fish were quickly frozen. In the laboratory they were thawed, weighed to the nearest hundreth of a gram, external characteristics noted, and standard lengths measured to the nearest tenth of a millimeter. Upon dissection the relative abundance of fat in the abdominal cavity was visually estimated using a scale of 0 to 3. All gonads were removed, fixed in Bouin and weighed. Gonadosomatic index (GSI) = weight of fixed gonads x 100 x body weight^{-1}.

The water temperature was measured twice daily (around 7:00AM and 4:00PM), near the collection site at a depth of 15 cm, and used to calculate monthly mean temperatures (Fig. 1). Values for monthly precipitation (Fig. 1) were obtained from the meteorological station located in the town of Olomega (courtesy of the Servicio Meteorologico Nacional de El Salvador). The values for day length were calculated from tables in Pallman (1972).

Both sexes showed peaks of gonadal activity in April and August, while a third peak, which was not synchronous, occurred during November 1977 and December 1978 in females and December 1977 in males (Fig. 2, Table 1).

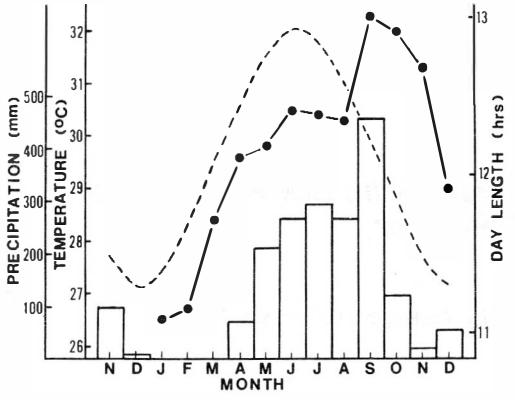

Fig. 1. Monthly day length (broken line), average water temperature of Lake Olomega, El Salvador (solid line), and precipitation (bars) to which *A. guatemalensis* was exposed (November, 1977, to December, 1978).

However, all reproductive peaks occurred during months when at least some rainfall was recorded (Fig. 1). On the other hand, during the rain-free months of January and February, no fish of either sex with enlarged gonads was collected. These months were also characterized by low water temperatures and shorter days (Fig. 1). The month of March when individuals with enlarged gonads reappeared was also rain-free, but day length and temperature had begun to increase sharply. Finally, the relatively distinct post-spawning period from September through November was characterized by continued rainfall and high temperatures but decreasing day lengths. Kirschbaum (1984) states that tropical species may retain a "latent photoperiod or temperature sensitivity" in addition to other cues that they are known to use, such as rainfall.

Our data indicate a greatly protracted reproductive season for *A. guatemalensis,* with three peaks during the year. The least amount of gonadal activity occurred during January and February. The period from April to August, which comprises the main rainy season, appears to be the principal reproductive season based on the observation that for several months following this period most females exhibited spent ovaries. Furthermore, if fat reserves are used for reproductive purposes, the decreased amount of abdominal fat that we observed during the interval from July to October further points to this period as the main reproductive season.

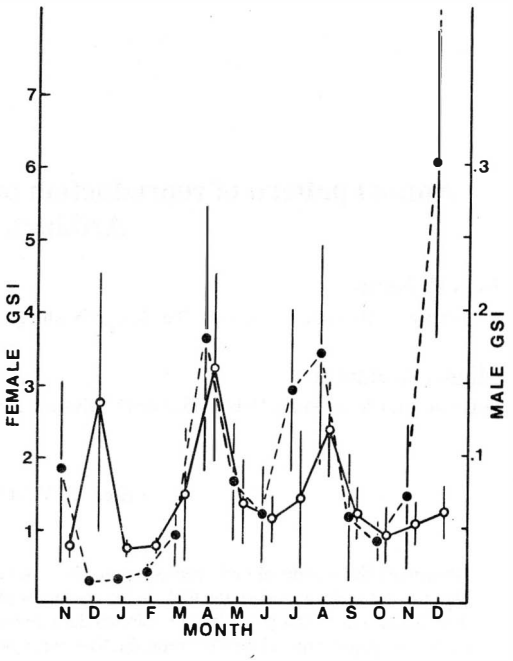

Fig. 2. Monthly values of gonadosomatic index (GSI) for male (open circles, solid line) and female (closed circles, broken line) *A. guatemalensis* from November, 1977, to December, 1978, from Lake Olomega, El Salvador. Vertical lines represent 95% confidence intervals.

TABLE I

Monthly averages of the gonadosomatic indexes ± 95% confidence intervals for male and female A. guatemalensis *from Lake Olomega, El Salvador. Numbers in parentheses refer to the number of specimens in the sample.*

Date of collection	Males	Females
Nov. 10, 1977	0.040 ± 0.008 (14)	1.82 ± 1.26 (14)
Dec. 17, 1977	0.139 ± 0.089 (14)	0.29 ± 0.05 (14)
Jan. 17, 1978	0.038 ± 0.006 (9)	0.31 ± 0.05 (17)
Feb. 14, 1978	0.040 ± 0.005 (12)	0.41 ± 0.06 (17)
Mar. 15, 1978	0.075 ± 0.046 (14)	0.94 ± 0.45 (16)
Apr. 15, 1978	0.162 ± 0.065 (15)	3.64 ± 1.84 (15)
May 17, 1978	0.069 ± 0.029 (15)	1.67 ± 0.82 (13)
Jun. 16, 1978	0.058 ± 0.016 (14)	1.23 ± 0.66 (16)
Jul. 18, 1978	0.071 ± 0.047 (9)	2.94 ± 1.13 (21)
Aug. 17, 1978	0.119 ± 0.033 (14)	3.43 ± 1.51 (16)
Sep. 29, 1978	0.061 ± 0.018 (12)	1.19 ± 0.87 (17)
Oct. 27, 1978	0.046 ± 0.019 (9)	0.86 ± 0.27 (21)
Nov. 17, 1978	0.053 ± 0.015 (11)	1.47 ± 1.00 (19)
Dec. 15, 1978	0.061 ± 0.018 (13)	6.06 ± 2.39 (17)

The only other ariid catfish that has been investigated in any detail in El Salvador is *Arius jordani*. Phillips (1983) studied an estuarine population of this species and found that

spawning occurred during most months with the exception of October to December. Based on the abundance of young in the collections, peak reproduction occurred from May to July, during the rainy season. A study of another catfish from El Salvador, the freshwater pimelodid, *Rhamdia guatemalensis,* also included individuals with mature gonads during most months, with peak reproduction occurring from May to August, again coinciding with the rainy season (Gutiérrez Agreda 1977). Thus, all three of these species of catfishes from El Salvador have greatly protracted reproductive seasons with their peak reproductive activity coinciding with the rainy season.

The reproductive cycles of some ariids from other localities have also been investigated. A study on a Mexican population (Lat. 18° N) of *A. melanopus* revealed that the main reproductive season occurred during August and September, coinciding with the rainy season (Lara-Domínguez *et al.* 1981). Another Mexican ariid, *A. caerulescens,* had a greatly protracted reproductive season, with peak activity during May and October, again occurring during the rainy season (Yánez-Arancibia 1978). *A. spixii* from Venezuela (Lat. 11° N) was characterized by a single spawning period from July to October (Etchevers 1978). *A. thalassinus* from the Arabian Sea spawned once a year from November to March in one area, and from October to May in another, each period occurring principally during the northeastern monsoon season (Dmitrenko 1970). However, some fish with large eggs were found from May to October as well. Finally, *A. (Osteogeniosus) militaris* from India exhibited maximal GSI's during April-May and July-August, with a minor spawning from January to March (Bhimachar 1959). The presence of two major and one minor peak of gonadal activity resembles our data for *A. guatemalensis.* It appears that most ariids, particularly those from lower latitudes, spawn mainly during rainy periods. The data from some species, however, indicate that some reproduction can occur in nearly all months. The year-end resurgence of gonadal activity in *A. guatemalensis* warrants further investigation.

We observed that the pelvic fins of female *A. guatemalensis* developed large, fleshy protuberances as spawning condition approached. These formed trough-like structures leading to the gonopore. Similar structures have been reported for other ariid species (Dmitrenko 1970).

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