BREEDING PATTERNS OF THE INDIGENOUS CICHLIDS *ETROPLUS SURATENSIS* AND *ETROPLUS MACULATUS* IN AN ESTUARY IN SRI LANKA

JAYAMPATHY I. SAMARAKOON
Department of Zoology, University of Kelaniya, Kelaniya, Sri Lanka.

ABSTRACT

Breeding of the cichlid fishes *Etroplus suratensis* and *Etroplus maculatus* occurs during the dry seasons when water is clear and current speed insufficient to disturb bottom sediment. This temporal pattern of breeding ensures that the Asian cichlids reproduce at a time when parental behaviour can be effectively expressed. An experiment supported the view that an increase in turbidity and current speed inhibits breeding behaviour of *E. suratensis*.

Keywords: Etroplus, cichlid, breeding, Sri Lanka.

INTRODUCTION

*Etroplus suratensis* and *Etroplus maculatus* are the only cichlids indigenous to Asia. They primarily inhabit estuaries in Sri Lanka and in India. Recently they were introduced into freshwater irrigation reservoirs in Sri Lanka (Fernando and Indrasena, 1969). However, they were not recorded from rivers that connect freshwater habitats with estuaries (Radda, 1973). Evidently the distribution of these cichlids within a particular estuary is restricted by the sea on one side and by the flowing water of feeder rivers on the other.

The estuaries inhabited by these fishes are subjected to heavy river discharge during monsoon seasons when the estuarine environment becomes unstable as compared to the benign conditions that prevail during the dry seasons. In this paper the relationship of temporal breeding patterns of the Asian cichlids to the seasonal environmental changes have been described and the pertinent data given in detail elsewhere (Samarakoon, 1981) have been reviewed.

MATERIALS AND METHODS

The study was carried out at a site one hectare in extent situated in shallow water in the western part of Negombo Lagoon. Despite its name, Negombo Lagoon is a bar-built estuary situated on the south-western coast of Sri Lanka. It is permanently connected to the sea by a single opening at its northern extremity. Two rivers flow into it at the southern end. The study period from August 1976 to December 1977 included three rainy seasons and two dry seasons although data from December 1976 to November 1977 only are given in this paper.
Nest construction was monitored by inspecting the entire study site at intervals of three days while swimming with face mask and snorkel. The locations of nests were marked on a map of the study site made on water resistant paper. A nest once discovered was observed daily until it was abandoned. All family units consisting of parents and juveniles were also recorded as they were encountered under water. Family units seen on the same day were distinguished on the basis of appearance of adults, appearance of juveniles and the number of juveniles in a brood.

Samples of adults of both species were collected at monthly intervals for analysis of gonads. Classification of gonads was according to an eight-point maturity scale (FAO, 1972).

Secchi Disc visibility, depth, temperature, salinity, dissolved oxygen, pH and free carbon dioxide were determined between 1000 and 1200 hours at intervals of two weeks. Diurnal changes in these parameters (except visibility) were determined at intervals of three hours once in a month. Chemical determinations were made with a La Motte Field Kit (La Motte Chemical Products Company, Maryland, U.S.A.). Rainfall and photoperiod data were obtained from the Meteorological Department, Colombo.

RESULTS AND DISCUSSION

Seasonal changes in some physical and chemical factors

Negombo Lagoon is influenced predominantly by river discharge during the rainy seasons and by tides during the dry seasons. River discharge that produces marked changes in the estuary usually occurs during mid-April to early June and from mid-October to mid-December. These are the times when rainfall is heaviest in the drainage basins of the feeder rivers. The pattern of local rainfall (Fig. 1) is similar to that which occurs in the drainage basins. This pattern of rainfall is unusual because more rainfall occurs before and after the south-west monsoons than during the actual monsoon months, June to September (Pieris, 1977). Each of these rainy seasons lasts from 45 to 60 days. Two relatively dry seasons alternate with the rainy seasons. These dry seasons are from mid-December to mid-April and from mid-June to mid-October. Each dry season lasts approximately 120 days. The local rainfall that occurs sporadically during the dry seasons do not produce marked changes in turbidity or in current speed.

Physical and chemical factors were markedly affected by river discharge during the rainy seasons because of a drastic increase in volume of discharge as well as in suspended silt load. In the middle of each rainy season Secchi disc visibility decreased to 15 cm. At the same time the swift current that swept over the study area dislodged rooted vegetation and transformed bottom contours. Salinity decreased to less than 3% in the middle of a rainy season. At this time the variation in pH was 5 to 6; free carbon dioxide from 5 to 15 ppm; and dissolved oxygen from 50 to 90% saturation.
River discharge diminished with the onset of the dry season. Physical and chemical factors thereafter were influenced predominantly by tides. In the middle of a dry season Secchi disc visibility exceeded 2 m. Flow of water did not noticeably disturb rooted vegetation nor bottom sediment. At this time the variation in salinity was from 10 to 30%o; pH from 7.5 to 8.5; free carbon dioxide from 10 to 35 ppm and dissolved oxygen from 80 to 120% saturation.

Surface water temperature measured at midday varied between 28.5 and 33.0°C during the study period. The maximum range within which temperature varied during the year was, therefore, 4.5°C. A minimum diurnal variation of 5.5°C for the study period was recorded in February 1977. The maximum diurnal variation of 7.0°C was recorded in July 1977. Thus, even the minimum diurnal variation exceeded the maximum annual variation. Photoperiod varied by less than 30 minutes from the 12L/12D cycle for the study period.

Turbidity at the study area increased progressively during a rainy season. The initial inflow of silt-laden river water was signalled by a yellow-brown streak that bisected the estuary along a N-S axis. As discharge persisted the sediment in suspension was dispersed laterally. Consequently breeding behaviour of the Asian cichlids could be monitored at the study area even as the turbid front approached.
Seasonal pattern of nest construction

Nest construction is an essential prerequisite for reproduction of Asian cichlids. Therefore, nests provided the surest indication of breeding. The seasonal pattern of nest construction is shown in Fig. 1. Nest construction began 1–4 weeks after river discharge from the previous rainy season receded. At this time underwater visibility was between 75 and 100 cm. Peak nest construction occurred when underwater visibility exceeded 2 m. Nest construction ended 3–7 days after the onset of a rainy season. Nests that were constructed at the beginning of a rainy season are abandoned after underwater visibility diminished to 50 cm.

Underwater observations were not made during the major part of a rainy season. Therefore, it is not possible to state with certainty that nests were not constructed during that period. Nevertheless, if breeding occurred during the rainy season, offspring born at that time should have been seen as juveniles when observations recommenced toward the end of that rainy season. But juveniles were not observed despite careful inspection of the study area. This provided circumstantial evidence for absence of breeding during a rainy season.

The temporal pattern of breeding for the Asian cichlids was therefore associated with seasonal environmental changes. Breeding in teleosts depends on endogenous factors as well as environmental factors (de Vlaming, 1974; Peter and Crim, 1979). In temperate species, gonadal recrudescence is generally linked to temperature and photoperiod which are predictive of the seasonal environmental cycle. In the case of the Asian cichlids gonadal state appeared to be independent of environmental factors.

Seasonal influence on gonadal state

Equal proportions of females with mature and gravid ovaries occurred in samples obtained in the rainy seasons as well as the dry seasons. Similar findings were previously reported for *E. suratensis* (Rita Kumari and Padmanabhan, 1976) and for *E. maculatus* (Amaranath, 1979). Evidently, gonadal maturation does not depend upon the responsiveness of these fish to environmental factors. The temporal pattern of breeding in these fish, therefore, cannot be defined with reference to gonadal state as in temperate species. Furthermore, Asian cichlids do not have a refractory period. The same pair may breed repeatedly. Pannikar (1924) induced a pair of *E. suratensis* to spawn five times at a mean interval of 19.2 days merely by removing the previous brood. Similarly several pairs of *E. maculatus* were induced to spawn several times (Samarakoon, 1975). Therefore it appears that these fish are able to maintain readiness to breed throughout the year. Nevertheless it is clear that the Asian cichlids in nature adjust the time of breeding to environmental factors.
The environmental factors that regulate breeding behaviour

Three components of the physical and chemical environment of the estuary changed markedly with the seasons. They were turbidity, current speed and ionic balance. Both species of Asian cichlids have been collected from the Negombo Lagoon when salinity exceeded 18%o and transferred into freshwater aquaria after brief periods of acclimation. Both species have bred readily under those circumstances. Clearly a drastic change in ionic balance does not inhibit breeding behaviour. Therefore, the influence of turbidity and current speed remained to be tested experimentally. If it is assumed that an increase in turbidity and current speed inhibited breeding behaviour, it may be suggested that reversal of these factors would induce the Asian cichlids to resume breeding during the rainy season. This was tested and confirmed with E. suratensis as follows:

During the middle of the October/November rainy season of 1976 a brackishwater culture pond was prepared for stocking with E. suratensis collected from Negombo Lagoon. The pond was drained, the sluice gate was barricaded and the bottom was allowed to dry and harden. At this time there was no local rainfall although river discharge was heavy. After a week the pond was refilled with murky water from the estuary and the sluice gate again was barricaded. Within a week the water became clear because the suspended silt flocculated and settled as salinity increased by evaporation. 140 specimens of E. suratensis in the size range 15-25 cm (total length) were collected from the estuary and released in the pond. On the fourth day after release courtship began. Within a period of 26 days 20 pairs constructed nests and spawned. The mean interval between release and spawning was 15.2 days (n = 20; S.E. = 3.47). This result supported the suggestion that increased turbidity and current speed inhibited breeding behaviour of E. suratensis. Experiments are now being conducted with E. maculatus to separate the influence of these factors.

Functions of seasonal breeding

Successful reproduction by the Asian cichlids rests upon effective parental behaviour (Ward and Wyman, 1977; Ward and Samarakoon, 1981). One aspect of parental behaviour that contributes to survival of eggs and eleutherombyos is nest construction. Nests of these fish consist of pits dug in the substratum. The number of pits and their arrangement contribute to safety of nestlings (Samarakoon, 1981). Nest construction is possible only when rate of water flow is insufficient to disturb bottom sediment. The second aspect of parental behaviour that is essential for successful reproduction is family cohesiveness which enables parents to guard the freeswimming juveniles. Cohesion of a family is maintained predominantly by visual communication (Cole and Ward, 1969, 1970). Such communication can be effective only when the water is not turbid. Therefore, responsiveness of the Asian cichlids to turbidity and current speed ensures that reproduction occurs only at a time when parental behaviour is feasible.
ACKNOWLEDGEMENTS

The major part of this study was supported by NSF grant BNS76-01448 to Prof. J.A. Ward, Biology Department, Illinois State University, Normal, Illinois. The author is grateful to Prof. H.H. Costa and Mr. M.J.S. Wijeratne, Department of Zoology, University of Kelaniya for going through the manuscript.

REFERENCES


