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Externally attached radio transmitters do not affect the parental care behaviour of rock bass

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Turning, pectoral fin and caudal fin rates and time spent on the nest of male rock bass *Ambloplites rupestris*, engaged in parental care, were not affected after the attachment of external radio transmitters. Reproductive success was similar between treatment and control fish. Micro external radio transmitters can be used on small fishes for studying parental care duration and post-care movement without altering their behaviour.

Key words: *Ambloplites rupestris*; behaviour; methodology; rock bass; telemetry.

Telemetry is a useful tool for monitoring the extent of parental care as well as the movements and habitat use of fishes after care has been terminated. When engaged in parental care, parents provide protection and care for developing offspring. Removal of parents, even for short durations, may affect their reproductive success and lead to abandonment (Philipp *et al.*, 1997). Thus, if nest-guarding fishes are to be monitored with telemetry, care should be taken to release fishes quickly and in good condition to ensure they can provide parental care with appropriate intensity and duration. Use of internal transmitters is problematic for fishes with small body cavities and would generally require the use of anaesthetics that may retard parental care activity. External radio transmitter attachment is useful for rapidly affixing transmitters to non-anaesthetized fishes, and may be an effective means of monitoring fishes providing parental care.

The purpose of this study was to examine the effects of externally attached micro radio transmitters on the parental care activity and reproductive success of rock bass *Ambloplites rupestris* (Rafinesque). Rock bass is a small centrarchid species endemic to mid-west North America. Following spring spawning, the female departs, leaving the male rock bass to provide sole parental care for the offspring (Gross & Nowell, 1980). If this technique proved to be non-deleterious

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to the nesting male, externally attached transmitters could be used to study the parental care duration and post-parental care activity of this, and other fishes providing parental care. This would be particularly valuable for instances when turbidity or other conditions precluded the use of conventional snorkelling surveys.

During the spring of 2001, snorkellers located newly constructed rock bass nests in Lake Opinicon, Ontario on alternate days and marked the nests with individually numbered tiles. Underwater video cameras (S.J. Cooke & C.M. Bunt, pers. data) were positioned adjacent to eight randomly chosen nests. Following camera placement, fish were left undisturbed for at least 24 h to acclimate to the presence of the camera. All video recordings and transmitter attachment occurred during daylight hours between 1000 and 1500 hours. Tagging was standardized such that only fish with offspring in the egg sac fry stage had transmitters attached since parental care activity varies with stage of offspring development (Cooke *et al.*, 2002). Prior to transmitter attachment, video recordings were made of each nest for 5 min. A diver was then dispatched into the water to defend the nest in the absence of the fish during the attachment procedure (Cooke *et al.*, 2002). Small barbless jigs were used to angle the fish from the nest with conventional heavy spinning gear. Fish were landed within 5 s and immediately placed ventral side down on a wet sponge pad where they were measured for total length (L_T; mean $\pm$ S.E. $= 253 \pm 5$ mm; range, 238–274 mm). A wet cloth covered the head and caudal peduncle region of the fish while an assistant held the fish in place for transmitter attachment.

A neoprene backing plate was placed on two 22 gauge hypodermic needles mounted on 3 ml syringes and was pushed through the dorsal back musculature, ventral to the junction of the soft and spiny dorsal fins (Bunt *et al.*, 1999). From the opposite side, the transmitter attachment wires (surgical stainless steel, 20 gauge) that had already been threaded through the transmitter (Model BD-2G, Holohil Systems Inc., Ontario, Canada; mass in air $= 2{\cdot}1$ g, $14 \times 6 \times 4$ mm, 120 mm antenna wire) and a neoprene pad (2 mm) were inserted into the lumen of the needles. The wires were pulled out on the opposite side of the fish, and when the needles were removed, the neoprene backing plate was left in place to protect the body of the fish. The wires were twisted carefully, and trimmed prior to releasing the fish above the nest. The fish was out of water for <90 s. The diver continued to protect and monitor the nest until the fish had resumed parental care duties. Video recordings were then made at 1 and 24 h post transmitter attachment. A fish was considered reproductively successful if it raised a brood to the stage where the brood left the nest which is the standard functional definition for centrarchid parental care (Philipp *et al.*, 1997; Cooke *et al.*, 2002). Snorkelling observations were also conducted to evaluate the reproductive success of other rock bass ($n = 21$) that spawned within 10 days of the transmitter fish, to compare reproductive success with transmitter carrying fish. Videographic data were transcribed at a later date using the protocol described by Hinch & Collins (1991). Differences in parental care metrics among the treatment periods were assessed using Friedman two-way ANOVA by rank. Data for percentage of time away from the nest were arc sine transformed prior to analyses. χ^2 analysis was used to compare reproductive success among control and transmitter carrying fish. Significance was assessed at $\alpha = 0{\cdot}05$.

All fish returned to the nest following transmitter attachment and resumed parental care duties within 180 s of original capture. The snorkeller was essential for protecting the nest during the absence of the male while other small fishes attempted to consume eggs. The transmitter fish chased away potential predators and was particularly defensive for the first few minutes until the predators had departed. All of the eight rock bass attached with transmitters were still engaged in parental care at both 1 and 24 h post transmitter attachment. Parental care activity did not generally change at either 1 or 24 h post transmitter attachment. Turning rates [Fig. 1(a); $P = 0{\cdot}76$], pectoral fin rates [Fig. 1(b); $P = 0{\cdot}97$] and caudal fin rates [Fig. 1(c); $P = 0{\cdot}42$] did not differ between the three video recording monitoring periods (*i.e.* control, 1 h post attachment, 24 h post attachment). Similarly, time spent on the nest did not differ significantly between the three monitoring periods [Fig. 1(d); $P = 0{\cdot}46$]. During video recording observation periods, no predators were able to successfully depredate nests of the eight individuals monitored. Reproductive success for the eight rock bass monitored was 87·5% (seven of eight) and did not differ ($P > 0{\cdot}05$) from the reproductive success of control fish (17 of 21, 80·9%). The one fish with a transmitter that abandoned its nest did so after 12 days. Interestingly, this fish was the smallest monitored (238 mm L_T). Although fish were not weighed, using a length–mass equation developed for reproductive phase males in Lake Opinicon, the smallest fish tagged weighed *c.* 230 g. Thus, the tag weighed *c.* 0·9% of the body mass of the fish when out of the water.

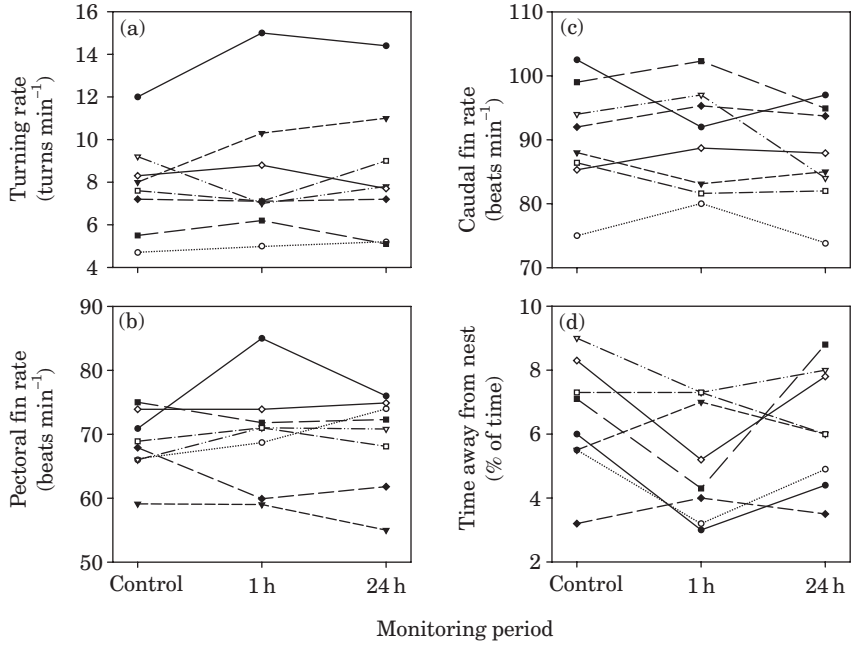

FIG. 1. Parental care metrics, (a) turning rate, (b) pectoral fin rate, (c) caudal fin rate and (d) time away from nest, for rock bass ($n = 8$) before (control) and 1 and 24 h post external transmitter attachment. All metrics were determined from 5 min periods of video recordings. Each line represents the response of an individual fish.

Although in this study externally attached transmitters had negligible results on the parental care activity or reproductive success of rock bass, this type of attachment does have some possible disadvantages relative to intraperitoneal implantation. External attachment is not viewed as a viable technique for the long-term monitoring of fishes due to the potential for fouling (Thorstad *et al*., 2001). In this study, rock bass occupied rocky areas; however, other species that occupy habitats with more vegetation may indeed become fouled or entangled. Snorkellers observed small fishes sometimes being attracted by the silver antenna wire despite the fact that it had been trimmed to only 12 cm in length (Brown *et al*., 1999). Perhaps more neutral antenna colours such as black or brown may reduce the conspicuousness of the antenna for small fishes and potential predators. Nonetheless, the use of externally attached radio transmitters does appear to be a viable means of monitoring small fish movements, without appreciably altering the behaviour. Turning and fanning rates are indicative of vigilance for potential predators, keeping the nest free of silt, and providing oxygenated water to the developing offspring. These results are particularly compelling considering that reproductive success is a clear indicator of fitness, and in this study, success rates were similar among control fish and those fish affixed with external transmitters. It was not possible, however, to determine whether the quantity of offspring differed among transmitter and control fish. Only two other studies have examined reproductive characteristics of transmitter carrying fishes (Crumpton, 1982; Richardson *et al*., 1995); however, both of those studies used intraperitoneal surgical implantation and tagged fishes prior to the reproductive period.

In this study, the transmitters were quite small, and only weighed $\leq 0{\cdot}9\%$ of the body mass of fish. Since this tag to body mass ratio is much lower than the accepted 2% rule (Brown *et al*., 1999), it is unlikely that the added mass could alter behaviour or affect energetic expenditure. Indeed, only when transmitters approached 3% of the body mass of fish did Lefrançois *et al*. (2001) observe increases in metabolic rate to compensate for the added mass. Furthermore, other studies employing external transmitters have observed no ill short-term effects of using transmitters that weighed *c*. the same proportion of body mass in larger fish (Thorstad *et al*., 2000). In addition to body mass, an important consideration is the shape of the transmitter. Problems with previous studies utilizing external transmitters have focused on the excess drag caused by the transmitter (Ross & McCormick, 1981), as well as fouling potential and risk of entanglement. The transmitter shape used in this study had rounded edges and was laterally compressed to minimize drag.

External transmitters can be attached rapidly, without the need for anaesthetics, which are known to require long recovery and clearing periods. Previous studies that anaesthetized fishes prior to external transmitter attachment noted clear impairments, *i.e*. loss of equilibrium, abnormal posture and hyperactivity (Beaumont *et al*., 1996), whereas in similar studies where fishes were not anaesthetized, fishes exhibited no obvious behavioural alterations (Bunt *et al*., 1999). Bunt *et al*. (1999) observed fishway ascents within hours of transmitter attachment on unanaesthetized smallmouth bass *Micropterus dolomieu* Lacépède using attachment techniques similar to those employed in this study. Care should always be taken to minimize air exposure duration as it results in

substantial physiological disturbance (Cooke *et al.*, 2001). In addition to rapid deployment and the ability to not anaesthetize fish, this technique can be used on small-bodied fishes or smaller life stages of fishes when the body cavity precludes the use of internal transmitters. The results of this study have obvious application for other studies of parental care activity and other life-history stages. The caveat is that this technique is probably best for short-term applications and less desirable for long-term studies.

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