SPAWNING SEASON AND SITE LOCATION OF *GADOPSIS BISPINOSUS* SANGER (PISCES: GADOPSIDAE) IN A MONTANE STREAM OF SOUTHEASTERN AUSTRALIA.

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Summary

The spawning status of a population of *G. bispinosus* from Buffalo Creek in north-eastern Victoria was monitored over two consecutive spawning seasons. Spawning occurred in December of both years and coincided with increasing water temperature. Eggs were found deposited in artificial spawning tubes placed in the creek and in the stream substrate, under small, generally flat, boulders, confirming previous authors’ assumptions. The implications of this reproductive strategy include the susceptibility of the species to increased sedimentation and cold water pollution.

KEY WORDS: two-spined blackfish, *Gadopsis bispinosus*, spawning site, spawning season, Buffalo Creek, forestry

Introduction

The two-spined blackfish *Gadopsis bispinosus* (Sanger) (Jackson *et al.* 1996) is distributed in the north-eastern part of Victoria in tributary streams of the Murray River system, in south-eastern New South Wales and the Australian Capital Territory in streams of the Murray River above Lake Hume and in some tributary streams of the upper Murrumbidgee River (McDowell 1996). The species is closely related to the river blackfish *Gadopsis marmoratus* (Richardson) and while *G. bispinosus* occurs at higher altitudes than *G. marmoratus* the two species do occur sympatrically at the lower end of *G. bispinosus*’ altitudinal range (Jackson *et al.* 1996). *G. bispinosus* is distinguished from the *G. marmoratus* by having two dorsal spines (range 1-3) as opposed to 11 (range 6-13) and by having a prominent white fringe on the dorsal, anal and caudal fins (Sanger 1984).

Published literature on the two-spined blackfish includes information on taxonomy (Sanger 1984), distribution (Koehn 1990; Lintermans & Rutzou 1990), habitat (Koehn 1987) and biology (Sanger 1990). However, information on the habitat and spawning requirements of *G. bispinosus* including the spawning site, which has been speculated to be amongst cobbles and boulders in stream reaches without wood debris and logs, needs to be investigated. This paper is an account of the spawning season and site location of *G. bispinosus* in the Buffalo Creek in north-eastern Victoria and was undertaken as part of a larger study to investigate the impacts of forestry practices on forest dependant fish species.

Materials and Methods

Study site

Buffalo Creek is a third order stream that drains the northern slopes of Mount Buffalo. The creek rises at an altitude of 1300 metres elevation and flows in a north-westerly direction for approximately 25 kilometres to its confluence with the Ovens River near the township of Myrtleford. Observations were made in two sections of the stream located approximately 8 km (280 m elevation) and 11 km (300 m elevation) upstream of the township of Myrtleford (Fig. 1). Both sites consisted of alternating slow flowing pools and fast flowing riffles. At the downstream site (length 400 m, average width 5.7 m) the substrate consisted of cobble (65%), pebble (10%), boulder (10%) and...
(10%) and a gravel/sand mixture (15%) (substrate categories followed Anderson & Morison (1989). Substrate at the upstream site (length 300 m, average width 5.4 m) consisted of gravel (40%), boulder (20%), cobble (20%) and pebble/sand mixture (20%).

Figure 1. Geographical location of lower (36°38’31”S; 146°45’34”E) and upper (36°38’51”S; 146°46’18”E) study sites on Buffalo Creek in north-eastern Victoria.

Reproductive development and timing of spawning

The study was conducted in 1997 and 1998. In 1997 fish were sampled on the 15th October and on the 17th December. In 1998 fish were sampled on the 15th October, 17th November, 3rd December and the 22nd December. Fish sampling was conducted with a Smith Root Model 12 backpack electrofisher. Fish were weighed to the nearest 0.1 g and total length was measured to the nearest millimetre. Fish spawning status was determined using the arbitrary maturity stages described by Pollard (1972).

While fish reproductive condition was monitored as the primary indicator of fish spawning status, artificial spawning tubes were also placed in the stream in which it was hoped that fish would lay their eggs as an additional indicator of spawning having occurred. These spawning tubes were used as a method of indicating the occurrence of spawning in a previous study on river blackfish.
The tubes consisted of 400 mm lengths of white, polyvinyl chloride (PVC) with diameters of 25 mm, 50 mm and 90 mm. The tubes (positioned perpendicular to the water flow and sitting on the substrate) were attached to steel pegs that were driven into the substrate. Twenty-five artificial spawning tubes were placed in the stream in 1997 while 10 were placed in the stream in 1998.

Spot measurements of water temperature were measured in 1997, whilst, no discharge data were collected. However, in 1998 a Tain data logger was placed in the upstream study site on the 15th October and removed at the end of December 1998. The logger measured water temperature and river height.

![Graph showing water temperature and river height over time]

**Figure 2.** Maximum daily water temperature (---) and river discharge (-----) in the Broken Creek during the 1998 study period

**Spawning Location**

In both years following the detection of spent female fish the stream was inspected for spawning sites. During these searches any available habitat including hollow logs, undercut banks and substrate (on and under boulders and cobble) were examined for eggs. When a spawning site was found it was described and its physical and hydraulic parameters were measured.

**Results**

**Reproductive development and timing**

In 1997, 19 females were examined for spawning condition. No spent females were observed in the October sample, however, on the 17th December six spent females were observed. In 1998, 46 females were examined for spawning condition. No spent females were observed in the October or November samples, however, one spent female was observed on the 3rd December and 11 spent females were observed on the 22nd December (Table 1).
Table 1. Spawning status of female fish sampled from the Buffalo Creek in 1997 and 1998

| Date   | Non-spent females | Spent females |
|--------|-------------------|---------------|
| 15-10-97 | 10 developing     | 0             |
| 17-12-97 | 3 mature          | 6             |
| 15-10-98 | 11 developing     | 0             |
| 17-11-98 | 3 developing      | 0             |
|         | 13 mature         |               |
| 3-12-98  | 4 mature          | 1             |
| 22-12-98 | 3 mature          | 11            |

Water temperature and river discharge

In 1997 water temperature ranged between 14.4 °C on the 14th November and 18.7 °C on the 17th December (date when the first spent females were sampled). In 1998 when the first spent female was sampled on the 3rd December the maximum daily water temperature had reached 17 °C. (Figure 2). River height between October and early December gradually decreased with the exception of a single, short duration flush in early November that did not appear to coincide with any specific spawning activity (Figure 2).

Spawning site location

In 1997 four natural spawning sites were located between 17th -24th December. Additionally, in that same period, two of the 25 artificial spawning tubes that had been placed in the creek also contained eggs. In 1998 one natural spawning site was located on the 22nd December while no spawning was detected in any of the 10 artificial spawning tubes which had been placed in the creek (Table 2).

In four of the five natural spawning sites (all located within the substrate), and in the two artificial spawning sites (PVC tubes), an adult guarding fish was observed. Only on one occasion was the guarding fish able to be captured and it was a male. On the one occasion when no guarding fish was present (in a natural spawning site) the area around the site had been sampled using an electrofisher 30 minutes earlier and the guarding fish may have been disturbed or captured. When this egg deposition site was found there was a Murray spiny crayfish, *Euastacus armatus*, sitting on top of, and presumably feeding on, the eggs.

Table 2. Summary of natural and artificial (spawning tubes) spawning sites

| Date       | River width (m) | Depth (m) | Surface water velocity (ms⁻¹) | Egg number | Substrate type (at spawning location) | Adult present |
|------------|-----------------|-----------|-------------------------------|------------|--------------------------------------|---------------|
| 17/12/97   | 10.0            | 0.14      | 0.37                          | 50         | cobble/pebble/gravel                 | yes           |
| 23/12/97   | 13.0            | 0.11      | 0                             | 40         | cobble/pebble/gravel                 | yes           |
| 24/12/97   | 5.2             | 0.10      | 1.04                          | 15         | cobble/boulder                       | yes           |
| 24/12/97   | 4.2             | 0.07      | 0.41                          | 50         | cobble/pebble/gravel                 | no            |
| 22/12/98   | 5.0             | 0.40      | 1.05                          | 10         | cobble/boulder                       | yes           |
| +17/12/97  | 10.6            | 0.39      | 0                             | 120        | gravel/cobble                        | yes           |
| +17/12/97  | 7.4             | 0.34      | 0                             | 105        | gravel                              | yes           |

*artificial spawning tubes
Natural spawning site description

All natural spawning sites were located in the substrate under small, generally flat, boulders (typically about 0.4 X 0.2 X 0.1 m in dimension). Underneath the boulders there was always a hollow space where the guarding fish would sit above the eggs. The eggs were laid on the substrate (usually another boulder) underneath the surface boulder. However, on one occasion the eggs were laid on and in-between the interstices of a pebble/gravel substrate. The eggs were usually laid in a single flat layer, adhering to both the substrate and each other, except where they were found laid on the pebble/gravel substrate when eggs were found in groups of two to five.

Discussion

Although it has been speculated that the spawning site location of *G. bispinosus* may be in rocky substrates (Koehn 1987, 1990; Lintermans 1998), this is the first study to confirm this by direct observation. Furthermore, fish were also found to spawn in artificial spawning tubes indicating that *G. bispinosus* may also utilise hollow woody debris as potential spawning habitat. The use of hollow woody debris as spawning habitat has previously been documented in the closely related *G. marmoratus* (Jackson 1978).

Spawning of *G. bispinosus* in Buffalo Creek occurred in December of both years of the study in association with increasing water temperature. This result is consistent with Lintermans (1998) who found, in a study undertaken in the ACT, that fish spawn in late spring/early summer when water temperature had reached between 16-17°C. These findings also concur with those of Sanger (1990) in King Parrot Creek, Victoria, however, he also observed spawning as early as October in some larger females.

The verification of aspects of the spawning biology of *G. bispinosus* has important implications for the management of this species. The amount of instream cover, particularly cobble and boulder substrates, has been suggested as a limiting factor in populations of *G. bispinosus* (Koehn 1987). Consequently, the infilling of cobble and pebble substrates by sedimentation is likely to be detrimental to *G. bispinosus*. Increased sediment loads in upland streams may result from numerous activities, including land clearing for agriculture, grazing, logging activities, road construction and the desilting of dams (Campbell & Doeg 1989; Askey-Doran & Petit 1999). Sedimentation may decrease availability of spawning sites, decrease habitat availability for juvenile and adult fish and potentially smother young of year fish (Koehn & O’Connor 1990). Furthermore, artificial increases in sediment have been shown to decrease abundances of *G. marmoratus* (Doeg & Koehn 1994) while conversely reductions in artificial sediment loads have been shown to reinstate spawning in *G. bispinosus* populations (Zampatti unpublished data). The two-spined blackfish is found in areas typically used for forestry and agriculture (grazing), consequently, the most likely causes of sedimentation in these areas can be overcome by maintaining zones of adequate riparian vegetation and the fencing of river frontages to minimise stock access.

The association of the onset of spawning in *G. bispinosus* with a rise in water temperature may also render this species susceptible to coldwater pollution, a common occurrence in the upland reaches of a number of tributaries of the upper Murray River (Phillips 2001).

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