SPAWNING IN SYMPATRIC ALPINE GALAXIAS (*GALAXIAS PAUCISPONDYLUS* STOKELL) AND LONGJAWED GALAXIAS (*G. PROGNATHUS* STOKELL) IN A SOUTH ISLAND, NEW ZEALAND, HIGH-COUNTRY STREAM

M.L. BONNETT

Freshwater Division, National Institute of Water and Atmospheric Research Ltd, P.O. Box 8602, Christchurch, New Zealand.

(Received 9 March 1992; revised and accepted 27 May 1992)

ABSTRACT

Bonnett, M.L. (1992). Spawning in sympatric alpine galaxias (*Galaxias paucispondylus* Stokell) and longjawed galaxias (*G. prognathus* Stokell) in a South Island, New Zealand, high-country stream. *New Zealand Natural Sciences* 19: 27-30.

The spawning season and fecundity of the alpine galaxias, (*Galaxias paucispondylus* Stokell), and the longjawed galaxias (*G. prognathus* Stokell), were examined from samples collected in the Rangitata River and in Deep Creek, in the central high-country of the South Island of New Zealand. Both species are small (maximum recorded total length of 112 mm and 87 mm, respectively), slender fish with entirely freshwater life histories. A gonadosomatic index, expressing the weight of gonads relative to the weight of the body, was calculated for each fish from samples collected in different months. The seasonal differences in gonadosomatic indices indicated that alpine galaxias spawned from August to October, whereas longjawed galaxias spawned from March to May, and also from October to November. When approaching maturity, alpine galaxias females contained 78-225 eggs of up to 2.2 mm in diameter; longjawed galaxias females contained 98-280 eggs of up to 1.8 mm in diameter. The numbers and sizes of eggs are typical of galaxiid species which have entirely freshwater life histories.

KEYWORDS: Alpine galaxias - *Galaxias paucispondylus* - longjawed galaxias - *G. prognathus* - spawning - fecundity - freshwater fish - Rangitata River.

INTRODUCTION

The alpine galaxias (*Galaxias paucispondylus* Stokell) and the longjawed galaxias (*G. prognathus* Stokell) are endemic New Zealand species found in shallow, fast-flowing streams of the central South Island high-country. The alpine galaxias has been recorded from 35 locations in 10 catchments, from the Oreti River in Southland to the Wairau River in Marlborough, and the longjawed galaxias from 12 locations in 5 catchments, from the Waitaki River in South Canterbury to the Buller River on the West Coast (Ministry of Agriculture and Fisheries unpubl. data). Thus these species are neither common nor widely distributed compared to other galaxias species.

Along with the dwarf galaxias (*G. divergens*) both alpine galaxias and longjawed galaxias belong to a group of small, slender-bodied, alpine species that have wholly freshwater life-cycles (McDowall 1970). Longjawed galaxias may reach 87 mm in total length, but are commonly 60-70 mm (Bonnett *et al.* 1989). Alpine galaxias are slightly larger, commonly 70-80 mm, although fish up to 112 mm in length have been recorded (Stokell 1949).

Until recently, the life histories and ecologies of the alpine and the longjawed galaxias had been little studied. Bonnett *et al.* (1989) described their diets, and Bonnett (1990) reported on their age and growth. Apart from some comments by Stokell (1955) and McDowall (1970), knowledge of the spawning and fecundity of these species is limited. The present study aimed to determine the spawning season and fecundity of alpine and longjawed galaxias in a high country stream.

STUDY AREA

Fish were collected from Deep Creek, a small (estimated annual mean discharge *c.* 3-4 m^3s^{-1}) high-country spring-fed stream with substrates consisting mostly of gravels and cobbles. Deep Creek flows for about 6 km through an area of alluvial gravel covered by open tussock grassland before joining the Rangitata River, a large (mean annual discharge *c.* 90 m^3s^{-1}) gravel substrate river on the east coast of the South Island. The study area was fully described in Bonnett *et al.* (1989).

Deep Creek is known as a salmonid spawning and rearing stream, and at least three salmonid species are present; quinnat salmon (*Oncorhynchus tshawytscha*), brown trout (*Salmo trutta*), and rainbow trout (*Oncorhynchus mykiss*). It also supports populations of the common river galaxias (*Galaxias vulgaris*) and the upland bully (*Gobiomorphus breviceps*).

METHODS

The frequency of sampling was constrained by the need to conserve populations, and by the difficulty of accessing the study area. Samples were obtained from Deep Creek on 9 occasions: 21 August 1986, 29 September 1986, 30 October 1986, 27 May 1987, 8 July 1987, 11 August 1987, 1 March 1988, 25 January 1989, and 27 April 1989. A sample of longjawed galaxias collected on 12 December 1985 from the mainstem of the Rangitata River (*c.* 20 km downstream of Deep Creek) has also been included.

On each date up to 52 fish of each species were collected using a portable electric fishing machine. Immediately after capture, fish were identified, total length measured to the nearest mm, and preserved in 10% formalin. Samples taken on 1 March 1988 were preserved in 70% ethanol, so that otoliths from these specimens could be examined.

Sex was determined by examination of the gonads. Some 10% of the fish were not sexed because the gonads were insufficiently developed. After removal of stomach contents, gonads were separated from the bodies; bodies and gonads were dried at 70°C for 24 h and weighed to the nearest 0.1 mg.

For each fish, a gonadosomatic index (GSI) was calculated using the following equation from Cadwallader (1976):

$$GSI = \frac{\text{Gonad dry weight} \times 100}{\text{Body dry weight}}$$

GSI was expressed as a percentage, so that for a fish with a body weight of 1 g and a gonad weight of 0.5 g, GSI would be 50%.

Mean GSI values by species and sex were calculated separately for each of the samples, except for the August 1987 and August 1988 samples, which were pooled. Mean values of GSI were plotted against time of year in which samples were collected.

Female fish approaching maturity contained eggs of uniform size, and the maximum egg diameter was measured to the nearest 0.1 mm before drying to constant weight. The number of eggs (N) was calculated using the following formula:

$$N = \frac{\text{Total ovary weight} \times 10}{\text{Weight of 10 eggs}}$$

RESULTS

A total of 302 alpine galaxias and 316 longjawed galaxias were examined. GSI values were calculated for all fish except those that were unsexed (29 alpine and 30 longjawed galaxias). The maximum GSI recorded for alpine galaxias males was 35.3%, and for females 71.5%. For longjawed galaxias the maximum GSI recorded was 38.7% for males and 62.9% for females. Peak of mean GSI for both male and female alpine galaxias occurred during winter (July and August). There were two peaks in the GSI of longjawed galaxias; one during early autumn (March) and the other in spring (September) (Fig. 1).

Eggs up to 2.2 mm maximum diameter were found in female alpine galaxias, and the fecundity of this species ranged from 78 to 225. Eggs of longjawed galaxias were slightly smaller (maximum diameter 1.8 mm), and the fecundity was slightly higher, ranging from 98 to 280 (Fig. 2). For both species fecundity varied considerably for fish within the limited size range sampled, and no significant relationship was found between fecundity and size. Despite a thorough search on 9 August 1988 no eggs of either species were found in Deep Creek, and spawning sites could not be determined.

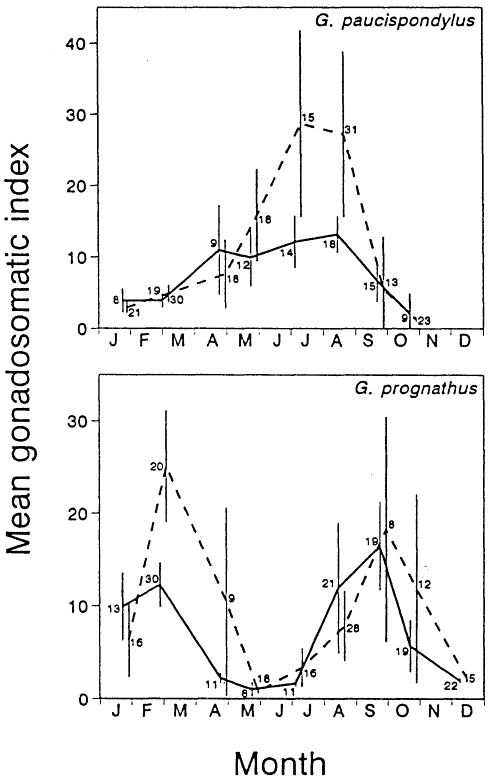

Figure1. Mean gonadosomatic indices of male (solid line) and female (dotted line) alpine and longjawed galaxias in samples collected from Deep Creek from 21 August 1986 to 27 April 1989, and from the Rangitata River mainstem on 12 December 1985. Vertical bars represent 95% confidence limits, and sample sizes are presented next to plots. Plots are offset for clarity.

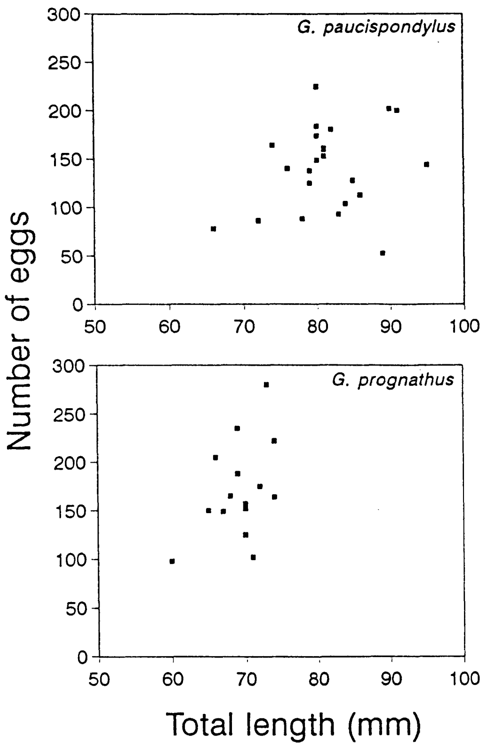

Figure 2. The relationship between fecundity and total length in 23 alpine galaxias and 15 longjawed galaxias females collected in Deep Creek.

DISCUSSION

The decline in the mean relative gonad weight of samples of alpine galaxias collected from August to October presumably coincides with spawning. Thus spawning probably occurs during late winter and early spring.

Stokell (1955) reported that spawning of alpine galaxias occurred in March and April, but he gave no supporting data. McDowall (1970) found both ripe and spent adult alpine galaxias in samples collected during October, and, in light of Stokell's report, suggested they may have prolonged breeding from spring through to the summer and autumn. However, he also found that the ovaries of fish collected in June were in moderately advanced stages of maturation, whereas others collected in December were invariably spent or had immature ovaries. If the spawning of this species is more prolonged than the Deep Creek data suggest, it seems more likely to be from autumn through winter until spring.

The pattern of changes in relative gonad weight of longjawed galaxias suggests that spawning in Deep Creek occurred in autumn (March, April, and May) and in Spring (October and November). It is not clear whether individual fish spawned twice in one year, or whether there were two spawning populations. The two separate spawning seasons accounts for the disparity between reports of Stokell (1940), who considered that longjawed galaxias spawned in the autumn, and McDowall (1970), who suggested they spawned in spring.

In Deep Creek, the spawning seasons of alpine and longjawed galaxias appear to overlap slightly in October. Both species may overlap with the spawning of *G. vulgaris*; Benzie (1968) found that *G. vulgaris* spawned during spring and early summer in a snow fed stream in Canterbury, but Cadwallader (1976) reported that this species spawned from late winter to early spring in a stream at lower altitude, and he suggested that spawning was probably temperature controlled. For both alpine and longjawed galaxias, the mean gonadosomatic indices of samples collected in August 1986 were similar to those collected in August 1987, which suggests that for each species, spawning may occur at the same time each year in Deep Creek.

The samples collected in March 1988 were aged from sagittal otoliths, and although alpine galaxias up to age 4+ and longjawed galaxias up to age 3+ were found, for both species the majority of fish were age 0+ and 1+ (Bonnett 1990). Some longjawed galaxias spawn in their first year, as some of the age 0+ fish in the March sample had GSI values >15%. The 0+ alpine galaxias had GSI values <7%, suggesting that fewer, if any, reached sexual maturity in their first year. Cadwallader (1976) reported that some male *G. vulgaris* matured and spawed as 0+ fish; presumably most males and all females matured at ages >0+. Many, perhaps all, *G. divergens* matured early in their second year (Hopkins 1971).

The size and number of eggs in female alpine and longjawed galaxiids is consistent with other galaxiid species with wholly freshwater life cycles. Hopkins (1971) reported 145-252 eggs of up to 2.0 mm in diameter in *G. divergens*, and Cadwallader (1976) reported 284-1911 eggs of 1.36 mm mean diameter for *G. vulgaris*. The tendency for these species to have few, relatively large, eggs compared to diadromous species such as *G. maculatus*, has been discussed by Benzie (1968) and McDowall (1970), who found that egg number and egg size were related to life history pattern.

Although they have quite different spawning seasons, alpine and longjawed galaxias have many similar features in their biology, *eg*. fecundity, egg size, diets, and age structure of their populations. They both also show a close relationship to other galaxiid species which have wholly freshwater life cycles, particularly the dwarf galaxias (*G. divergens*) and the common river galaxias (*G. vulgaris*). Such a close relationship may be indicative of common ancestry. The fact that three species with similar biology can co-exist in Deep Creek suggests that there may be some features of behaviour which lessen the potential for interspecific competition.

ACKNOWLEDGEMENTS

I gratefully acknowledge the funds provided for this project by the Department of Conservation. I also thank staff of the Ministry of Agriculture and Fisheries who assisted with the field work, and Don Jellyman and Bob McDowall for their constructive comments. Thanks also to Ceri Hopkins and two anonymous referees for reviewing the manuscript.

REFERENCES

Benzie, V.L. (1968). The life history of *Galaxias vulgaris* Stokell, with a comparison with *G. maculatus attenuatus*. *New Zealand Journal of Marine and Freshwater Research* 2: 628-653.

Bonnett, M.L. (1990). Age and growth of alpine galaxias (*Galaxias paucispondylus* Stokell) and longjawed galaxias (*G. prognathus* Stokell) in the Rangitata River, *New Zealand. New Zealand Journal of Marine and Freshwater Research* 24: 151-158.

Bonnett, M.L., Sagar, P.M. & Docherty, C.R. (1989). Diets of alpine galaxias (*Galaxias paucispondylus* Stokell) and longjawed galaxias (*G. prognathus* Stokell) in a South Island. *New Zealand, high-country stream. New Zealand Journal of Marine and Freshwater Research* 23: 453-458.

Cadwallader, P.L. (1976). Breeding biology of a non-diadromous galaxiid, *Galaxias vulgaris* Stokell, in a New Zealand river. *Journal of Fish Biology* 8: 157-177.

Hopkins, C.L. (1971). Life history of *Galaxias divergens* (Salmonoidea: Galaxiidae). *New Zealand Journal of Marine and Freshwater Research* 5: 41-57.

McDowall, R.M. (1970). The galaxiid fishes of New Zealand. *Bulletin of the Museum of Comparative Zoology Harvard University* 139: 341-431.

Stokell, G. (1940). A new species of Galaxias. *Transactions of the Royal Society of New Zealand* 69: 422-424.

Stokell, G. (1949). The systematic arrangement of the New Zealand Galaxiidae Part II. Specific classification. *Transactions of the Royal Society of New Zealand* 77: 472-496.

Stokell, G. (1955). Fresh Water Fishes of New Zealand. Simpson and Williams, Christchurch. 145 p.