Southeastern Fishes Council Proceedings

Number 25 (March 1992)

3-1-1992

Water Currents in Spawning Areas of Pebble Nests of *Nocomis Leptocephalus* (Pisces: Cyprinidae)

Eugene G. Maurakis

William S. Woolcott

Mark H. Sabaj

Water Currents in Spawning Areas of Pebble Nests of *Nocomis Leptocephalus* (Pisces: Cyprinidae)

Southeastern Fishes Council
PROCEEDINGS
DEDICATED TO THE PRESERVATION OF SOUTHEASTERN FISHES

Number 25 March 1992

WATER CURRENTS IN SPAWNING AREAS OF PEBBLE NESTS OF *NOCOMIS LEPTOCEPHALUS* (PISCES: CYPRINIDAE)

Eugene G. Maurakis, William S. Woolcott, and Mark H. Sabaj

Biology Department
University of Richmond, Virginia 23173

Breeding males of *Nocomis leptocephalus* construct pebble mound nests for spawning in slow to moderate water currents during spring. Eggs and sperm are deposited in spawning pits on the upstream slope of nests where males clasp females (Maurakis et al., 1991a). Reduced current velocities in the spawning pits result from interrelated physical characteristics of nests and streams. It is hypothesized that this reduction in current is related to mound construction and is ultimately important to survival of fertilized eggs.

Methods

Pebble nests of *N. leptocephalus* were studied in streams in Virginia, North Carolina, and Georgia from 1986-1990. Locality data are available upon request.

Measurements of physical characteristics of 17 nests in 12 streams were made with a meter stick. Water current velocities (1 cm above mound nests and 1 cm above substrates) were measured with a Marsh-McBirney current meter. Velocities were recorded 0.5 m upstream of the mound, 0.5 m downstream of the mound, above the crest of the mound, and in spawning pits (Table 1; Fig. 1). In addition, the same parameters were measured at three artificial nests that were constructed by us.

Means were calculated for each parameter (Table 1). Ratios were calculated to determine the significance of synergistic effects among pertinent characteristics. Backward stepwise regression (SAS, 1985) was used to evaluate the relative contributions of physical characteristics of nests and streams on water current in spawning pits.

Results

Current velocity ($\bar{x}$0.006 m/sec) in spawning pits that are concentrated a midpoints of upstream slopes of active nests of *N. leptocephalus* was significantly less (F=8.51, df=17) than values recorded downstream of nests($\bar{x}$0.087 m/sec), above the mound crest ($\bar{x}$0.11 m/sec), and upstream of the mound ($\bar{x}$0.11 m/sec) (Table 1). Empirical data for current velocity in spawning pits on upstream slopes of nests that were constructed in a stream (avg. flow 0.14 m/sec) by us were lowest (0 m/sec) at the mound base, intermediate (0.01 m/sec) at the midpoint of the upstream slope of the mound, and highest (0.03 m/sec) at the crest.

Five factors are associated with reduced water current velocities in spawning pits: length and angle of the upstream slope of a mound, water depth at a nest, stream flow upstream of a nest, and water depth at the midpoint of the upstream slope of a mound (Table 2).

Discussion

The intermediate location of the spawning pit on the upstream slope of a nest and its reduced current velocity probably serve to enhance reproductive success in *N. leptocephalus*. The reduced current velocity may optimize retention of gametes, and consequently fertilization in the pit. As eggs of *N. leptocephalus* are neither adhesive nor cohesive, decreased current velocity in pits reduces the chance that the demersal, fertilized eggs will be swept out of pits by breeding activities of fishes over nests (i.e. ♀ + ♂ *N. leptocephalus* and nest associates). Similarity of nest construction among other *Nocomis* species suggests that water currents in the pits (e.g. *Nocomis biguttatus*) and spawning trough (e.g.. *Nocomis micropogon*) of their nests are comparable to those in the pits in nests of *N. leptocephalus*.

A spawning pit is covered with pebbles collected by a breeding male *N. leptocephalus* after a spawning episode (Maurakis et al., 1991a). The pebble covered pits are usually located near

midpoint of the upstream slope of mounds where the water current is less than that at the crest of the mound but greater than that at the base of the mound. Faster currents at the crest may damage eggs; slower currents at the base limit gas exchange. The mid-slope location is apparently a compromise between these two locations, optimizing conditions in interstices during development of buried eggs and post-hatch larvae.

Nest construction and spawning behaviors in *Nocomis* spp. differ from those of species in other pebble nest-building cyprinid genera (i.e. *Exoglossum* and *Semotilus*). However, the reduced current velocity conditions in spawning pits of *N. leptocephalus* are similar to those (0.04 m/sec) in spawning pits of pit/ridge nests of all recognized species of *Semotilus* (Maurakis et al., 1990). Reduced water current velocities (0.04 m/sec) similarly occur in spawning areas on upstream slopes of nests of the two species of *Exoglossum* (Maurakis et al., 1991b). Males of the three pebble nest-building genera cause reduced current velocity for egg deposition by physically modifying an area of streambed. The reduced flow, a result of their nest building activity, may provide a selective advantage to individuals of each group.

Acknowledgments

Funding was in part by University of Richmond Faculty Research Grants, Robert F. Smart Undergraduate Research Award, and research awards from Highlands Biological Station, North Carolina. We thank Virginia Power Water Quality Laboratory for use of a water current meter.

Literature Cited

Maurakis, E.G., W.S. Woolcott, and J.T. Magee. 1990. Pebble nests of *Semotilus* species. Southeastern Council Fishes PROCEEDINGS 22:7-13.

____, ____, and M. H. Sabaj. 1991a. Reproductive behavioral phylogenetics of *Nocomis* species-groups. American Midland Naturalist 126:103-110.

____, ____, and ____. 1991b. Nest construction and reproductive behavior of *Exoglossum* species. Bulletin Alabama Museum Natural History 10:11-16.

SAS Institute, Inc. 1985 *SAS User's Guide: Statistics*. Version 5. SAS Institute, Inc., Cary, North Carolina. 956 p.

Table 1. Stream (n=12) and nest (n=17) characteristics of active *Nocomis leptocephalus* nests. Capital letters in parentheses following characteristics are used in ratios.

Characteristic	Mean	S.D.	Range
Stream (cm)			
Depth (D)	24.59	6.96	13-37
Width	410.00	225.97	100-650
Mound (cm)			
Length	74.35	25.56	40-120
Height	12.01	4.73	4.50-20.70
Width	62.85	15.24	29.0-86.0
Length of upstream slope (L)	49.18	16.56	24.50-80.70
Water depth at midpoint of upstream slope (Y)	18.59	6.99	7.50-32.85
Angle of upstream slope (degrees)	17.6	5.0	11.0-25.1
Pit (cm)			
Depth (K)	2.77	1.55	0.50-7.00
Length (J)	7.07	3.85	2.00-15.00
Width	6.53	3.99	1.00-15.00
Water Current (m/sec)			
Upstream of mound	0.111	0.555	0.04-0.21
Over ridge	0.109	0.094	0.04-0.33
Pit	0.006	0.021	–0.03-0.05
Downstream of mound	0.087	0.085	0.02-0.30
Ratios			
K/L	0.058	0.035	0.013-0.160
D/K	12.726	10.516	3.250-46.000
Y/L	0.424	0.211	0.133-0.836
D/J	4.314	2.039	1.333-9.000

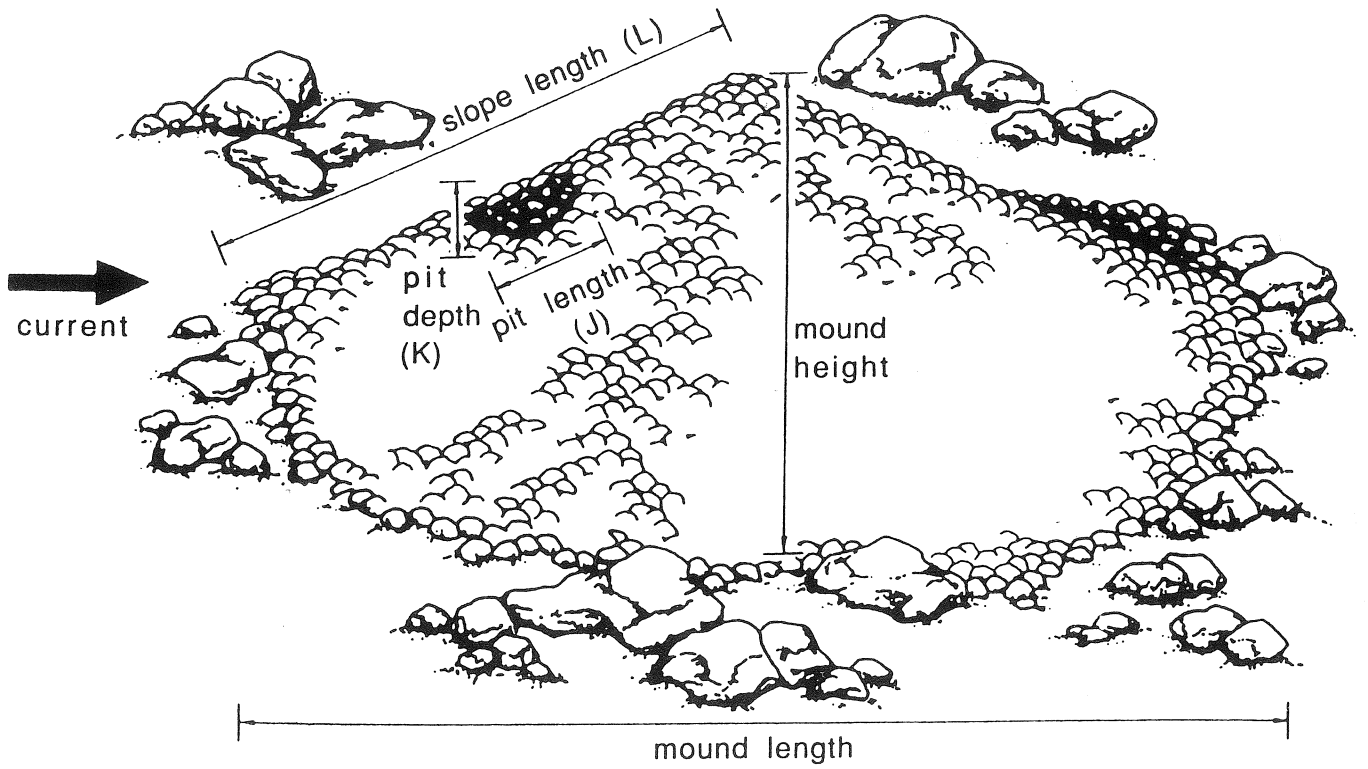

Fig. 1. Mound characteristics of *Nocomis leptocephalus* pebble nests. Mound width, not illustrated, was measured at widest part of nest.

Table 2. Results of backward stepwise regression (SAS, 1985) for effects of water depth and current velocity, and nest characteristics on current velocity in spawning pits on upstream slopes of pebbles nests of *Nocomis leptocephalus*. Widths of streams, nests, and pits are not applicable.

Characteristic	Estimate	Error	Sum of Squares	F	Prob>F
Intercept	0.31808135	0.14359135	0.00212328	4.91	0.0488
L	-0.00591095	0.00256533	0.00229729	5.31	0.0417
D	0.00936488	0.00410182	0.00225548	5.21	0.0433
Y/L	-0.59841891	0.26303164	0.00223966	5.18	0.0439
Angle	-0.23427993	0.11680643	0.00174070	4.02	0.0701
Water current (upstream of mound)	0.69314644	0.34858703	0.00171086	3.95	0.0722
D/K	–	–	–	0.73	0.4211
K/L	–	–	–	0.32	0.5879
J	–	–	–	0.27	0.6229
D/J	–	–	–	0.20	0.6655
K	–	–	–	0.10	0.7631
Y	–	–	–	0.002	0.9638