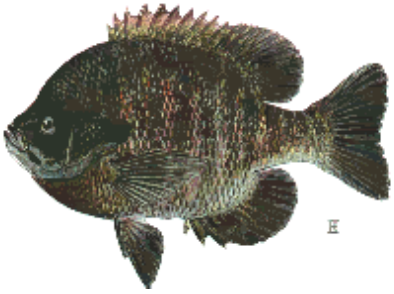
ScienceWatch – Father Knows Best

Ask any fisherman and he will tell you that pound for pound the bluegill, a native sunfish of North America, is the fiercest freshwater fighter. Ask Bryan Neff, an evolutionary ecologist at the University of W. Ontario, Ontario, Canada and he will tell you that the bluegill (*Lepomis macrochirus*) knows Shakespeare's line from *The Merchant of Venice*: "It's a wise father who knows his own child." Neff has been studying bluegills in an Ontario lake for over a decade and has found that they make perfect subjects for asking questions about how parents decide how much care to give their young. Evolutionary biologists agree that, since the goal of every organism is to promulgate its DNA, the degree to which a father invests time and energy in caring for young should be in direct proportion to their relatedness to him.

Bluegills are good subjects for studying parental care because they have evolved alternative reproductive behaviors. During the summer breeding season adult males, at least seven years old and called "parentals", gather in the shallows where they form colonies, each male making a depression nest of sand and gravel. The best locations are in the colony center, where predators rarely venture, and larger, dominant males typically man these sites. The females, smaller than the males, arrive after all the jockeying for sites has subsided, and swim above the colony deciding on which male to court. Spawning consists of a series of dips into the nest where the female deposits about 30 eggs per dip that are simultaneously showered with sperm. Several females may spawn with the same male, and he is left to fan the thousands of eggs, guard the nest and protect the fry that hatch about four days later. The fry become independent on about the tenth day, and until then the parental forgoes eating and loses about 15% of his body weight. Fry that are not defended from predators don't survive.



Smaller males called "cuckolders", that mature several years earlier than the parentals, eschew the responsibilities of fatherhood and cuckold the parental males in one of two ways. Young cuckolders, called "sneakers", hide near a nest until a female begins laying. The sneaker then darts in and deposits some sperm, a risky venture that could result in death. Interestingly, as he grows older and larger the sneaker begins to resemble a mature female and now is called a "satellite". A satellite sidles up to a courting pair, he on one side of the female the parental male on the other. Quivering like the female and matching her in size and coloration, he is tolerated long enough to deposit his sperm.

About 20% of males are cuckolders, and DNA analysis by Neff and his colleagues have shown that when a cuckolder can sneak in during a female's dip, his sperm fertilizes about 80% of the eggs released. However, all is not lost for the parental male. He may eat the eggs or abandon a cuckolded brood altogether and save his energy for the next batch. Obviously, the male cannot perform DNA testing on his offspring. So how does

he know when they aren't his? Writing in the April 17, 2003 issue of *Nature*, Neff shows that nest-tending parentals base their decision on the presence or absence of cuckolders near the nest as well as olfactory cues provided by the fry once they hatch. You can also find a summary of this and Neff's other bluegill studies in the February, 2004 issue of *Natural History* magazine.

Two experiments were performed in which Neff manipulated paternity, as it was perceived by nesting parental males during spawning. In the first experiment four sneakers in clear plastic containers were randomly placed around the nests of 34 parental males in a colony. The parentals could see the competition, but the sneakers could not fertilize any eggs. As a control, empty containers were placed among the nests of 20 other males. After spawning all bags were removed. The parental males were tested for their intensity of nest defense by placing a pumpkin seed sunfish (*Lepomis gibbosus*), a common brood predator, near the nest for 30-second intervals. Each defending male was quantified with respect to number of aggressive displays and nips directed at the pumpkinseed. During the egg stage, defensive behavior exhibited by experimental males, who had seen sneakers and believed they were cuckolded, was significantly less than that shown by the control males, who had not. However, once the eggs hatched into fry, experimental males were just as aggressive as controls. Evidently, each parental used the presence of sneakers as a cue that he was cuckolded and was less aggressive in egg defense. But the fry provided him with an olfactory cue that he truly was the father so he acted accordingly.

The role that odor plays in parental behavior was confirmed by performing an egg swap in which a third of the eggs from each of 20 nests was removed and replaced with those from nests of unrelated males. For each of 15 control nests, eggs were removed and then put back in the same nest. Defense by the parental against a predator was now quantified at three stages: 1) before the egg swap to form a baseline, 2) the day after the egg swap, and 3) the day after the eggs hatched. As we might expect, both groups increased their nest defense from baseline during the egg stage; however, during the fry stage males whose eggs were switched exhibited significantly less defensive behavior than males whose eggs were not switched. Eggs have no odor, but fry do and once the parental males could detect the odor of the foreign fry they realized they had been "cuckolded" and invested less energy in them.

Kinship recognition by smell, also called the "armpit effect" has been observed in mammals, birds and fish. For bluegill parentals it provides a defense against caring for another's offspring. However, cuckolders' fry do survive as long as they are few among many true offspring. Neff believes that the parental male decreases his care level in direct proportion to the concentration of foreign odor. Humans would probably be better at this if we stopped bathing and avoided perfumes, but for us deciding paternity disputes by DNA analysis is a lot more palatable.

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