

Spawning and Raising the Bantam Sunfish, *Lepomis symmetricus*

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The Bantam Sunfish, *Lepomis symmetricus*, is a small sunfish that's similar to the sunfishes of the genus *Enneacanthus* (especially the Banded Sunfish, *E. obesus*). The Bantam Sunfish's natural range is defined by the Mississippi embayment (Page and Burr, 1991), where I have found it is most frequently associated with dense stands of submerged aquatic plants (coontail, *Ceratophyllum demersum*; elodea, *Elodea canadensis*; giant elodea, *E. densa*; water milfoil, *Meriophyllum heterophyllum*) and floating plants (duckweeds of the family Lemnaceae). These locations are typical of lowland streams with nearly continuous, but low, flow rates. Typical sunfish associates are Warmouth *Lepomis* "*Chaenobryttus*" *gulosus*, Redspotted Sunfish *L. minatus*, Bluegill *L. macrochirus*, Dollar Sunfish *L. marginatus*, Orangespotted Sunfish *L. humilis* (northern part of range), and Flier *Centrarchus macropterus*. I have found Bantam Sunfish to be most consistently associated with young Warmouth, both of which spend a considerable amount of time in the heaviest vegetation.

Field Observations

While snorkeling in water (temperature upper 60s) with approximately 5 ft (1.5 m) visibility, I observed nesting Bantam Sunfish during late April in Winters Pond, Union Co., Illinois. Timing for reproduction was consistent for the general location (Burr, 1977). Nests were constructed approximately 18" below the water surface as depressions in the substrate, nearly as deep as the occupying male was long. Several nests were placed roughly 16 inches from their nearest neighbor in the shade of a large clump of spadderdock *Nuphar luteum*. Nesting males allowed me to approach within about 4 ft (1.2 m)

before they swam off between stems of spadderdock. While watching from a distance I could see males fanning, digging (based on head movement and ejected substrate material), and having border disputes. Nests were in sight of each other. Nesting males were darker than other Bantam Sunfish present and drove away encroaching lighter-colored conspecifics. Nesting males were the largest (total length) Bantam Sunfish observed that day and tended to be very thin.

Aquarium Observations

I made several unsuccessful and successful attempts at breeding this species before coming across two distinct phased methods that worked consistently with multi-male and single-male arrangements.¹ The multi-male method was safer for the female and resulted in the most natural behavior, while the single-male method gave me greater control over parentage and timing.

Conditioning Phase

Adults were held in aquariums and fed daily a varied diet of artificial feed, frozen brine shrimp, frozen blood worms and chunks of earthworms. Temperature during the early conditioning phase was in the lower- to upper-middle 60s (15-19°C) with a photoperiod of 10 hours light/14 hours dark. Lighting was full-spectrum fluorescent that varied considerably in terms of exposure intensity. Duration of the

¹ Observations are based on wild-caught animals from Running Lake Ditch, Union County, Illinois, and three captive-reared generations from Louisiana.

early conditioning phase could be as short as 30 days or longer than six months. Bantam Sunfish from Illinois seemed to require conditioning for a longer duration. Two weeks prior to the beginning of the breeding phase the temperature was increased to approximately 72°F (22°C). Photoperiod was increased abruptly to 16 hours light/8 hours dark with a supplemental light source (250-watt light) to facilitate photography/filming. The supplemental light source enabled temperature variation without use of a heater and appeared to promote the ripening of both sexes.

Territory and Nest Set-up Phase

Multi-male method Two males and as many as four females were held in aquariums (20-gallon long or 29-gallon high) with conditions similar to those of the late-conditioning phase described above. Males ripened only if they could exclude other sunfishes from a roughly 1 ft² (0.15 m²) area. A partition was installed long enough for both males to exhibit territorial behavior. Males needed to be of similar size or the larger male tended to usurp the smaller male after the partition was removed. The aquariums were equipped with a 2 in (5 cm) layer of pea-gravel and two rooted plants centered at opposite halves of the aquarium to obstruct the males' view of each other when both were on their nests. Males were not averse to nesting in close proximity to plants and may even prefer to do so.

The partition also enabled some control over the location of territorial boundaries. The partition needed to extend only about 2 in (5 cm) above the substrate to be effective. Inter-male interactions seemed to be confined to near the substrate along the territory boundary. Interactions elsewhere, particularly prolonged ones, often led to one male usurping the other. A mass of submerged plants (live or artificial) provided refuge for females. The optimal placement of the submerged plants used by the females was above the territorial boundaries where skirmishes between males would break out if either male pursued females into the refuge. As a result, males would be less persistent in their aggression against females.

Once territorial boundaries were defined most male-male aggression was mediated through display. Territorial males adopted a dark color pattern (see Notes on Variation, below) and approached each other at the territory boundary. Low-intensity interactions involved males swimming parallel to each other along the territory boundary with one or both males subtly presenting the vent region to the other. More aggressive encounters involved biting, with the males facing

each other head-to-head, extending their opercula (with opercular tabs at their darkest), and bending their bodies into an S-shape. Biting attacks were directed at the target's flank. High-intensity displays at one of the combatant's nests usually involved the resident nearly "standing on his tail" as he proceeded to transition into the previously mentioned S-shaped display often followed by intense biting. Low-intensity interactions occurred between males with longer-term territorial boundaries. Higher intensity interactions occurred more frequently between newly established male(s) and when a ripe female was present. Male aggressiveness also increased the closer it was to the time of larval exodus (when larvae move *en masse* away from the nesting area into the water column). Typical territorial violations were restricted to when ripe females approached a male's nest site and when rival males briefly entered the nest site to lure a female away. Cuckoldry (when males fertilize eggs but provide no further parental investment), if it occurs in Bantam Sunfish, is likely associated with the previously described typical territorial violation and similar to that described for Northern Longear Sunfish *Lepomis megalotis peltastes* (Keenleyside, 1972).

Nests were prepared by the typical digging method of sunfishes. Initially the male spent more time near where the nest would ultimately be constructed. He swam with his belly just above the bottom and rotated his eyes so that the iris nipple (see Page and Burr, 1991, p. 134) was directed towards the substrate. Gray bars developed on his sides (see Notes on Variation) and then he commenced digging. This color change always preceded bouts of digging. The time interval between bouts of digging ranged from hours to a couple of minutes. The presence of ripe females promoted the latter extreme.

Single-male method Males were kept singly in completely filled 10-gallon (37.8 L) or 29-gallon (109.6 L) long aquariums with females held in a separate tank. Aquariums were bare-bottomed and contained a prefabricated nest. The prefabricated nest site was a glass observation bowl, 4 in (10 cm) in diameter and 1.5 in (3.7 cm) deep, two-thirds full of pea gravel. (Larger containers can also be used.) Males usually preferred the prefabricated nest to a gravel bottom (something about a circle gets the males going!). A mass of submerged plants gave the female refuge from an overly aggressive or ardent male. In smaller tanks, females were removed immediately after spawning. Parental duties of the male tended to restrict his aggression towards females in the area of no more than about 6-7 body lengths from the nest unless the female presented herself in full view up to 10 body lengths away.

Spawning Phase

A reproductive bout commenced when a female ripened (multi-male method) in the breeding male's aquarium, or when a ripe female was introduced (single-male method). A ripe female approached the nest by swimming just above the substrate, subtly displaying her abdomen to the male as he approached. The ripe female's coloration included *dark eyes* and a blanched color pattern with light bars similar to the digging male's color pattern except that they extended no more than halfway down the female's sides (see Notes on Variation). Smaller females, which normally had an ocular spot on the posterior dorsal fin, lost the spot at this time. Females that were not ripe rotated their dorsum towards the approaching male often with anterior dorsal spines erected and swam away. Ripe females seemed to have little trouble spotting the nest and usually swam directly towards it. Males had no trouble distinguishing ripe females.

Male courtship behavior varied greatly between single- and multi-male methods and the proximity of the female to the nest. When a female approached a male's territorial boundary (near the bottom), the male rapidly swam towards her with his opercula flared. Then he displayed himself laterally as he swam around her, transitioning to an exaggerated manner (increased amplitude of lateral undulation of body) while swimming back to the nest. The male's coloration darkened even more, with light grey spots becoming bluish, especially when the male faced away from me (the bluish coloration was less apparent under subdued light).

At the multi-male territory boundary, females usually had two suitors but usually proceeded to only one nest. At this time male-male violence often erupted but was of short duration. Upon reaching the nest the female would engage in "rock biting," in which she appeared to be tasting and gently bouncing along the substrate. From this point on, spawning behavior is similar to that of other sunfishes, with the female periodically "vent-rubbing" the male as she swims within the perimeter of a circle defined by the male moving along her side. After a few "dry" vent rubbings with no obvious gametes, "wet" vent rubbings began, resulting in several to a couple dozen eggs visibly extruding and falling gently into the nest where they promptly stuck. Vent rubbings occurred every 3-5 seconds with occasional pauses when the male left the nest to attack other fish in the tank. Usually the female remained on the nest as the male made his excursions. Every time a male entered the nest from the adjacent territory, the female sat calmly on the nest even as the males battled on or

near her. If cuckoldry occurred, it was during these skirmishes and was not disguised by female mimicry (when cuckolding males gain access to the nest by looking and at times behaving like a female) or sneaking (when a small non-dominant male fertilizes eggs as he darts suddenly onto the nest site). Spawning duration ranged 20 minutes to more than a couple of hours with the longer duration associated with lower temperatures and more interruptions.

Male coloration in the multi-male setting is similar to that of Banded Sunfish males, including bluish spots that were particularly noticeable when the male faced away from the observer. Male coloration in the single-male setting was not as intense except for when the male first noticed the female; thereafter males exhibited the coloration they have when digging.

Olfaction appeared to play a major role in males becoming aware that ripe females were present; when I moved water from a tank containing ripe females into a tank containing territorial males, the males began to dig. Vision is also important. Among a small group (female and/or male), males could swim several body lengths and single out the only ripe female in the group.

Eggs are transparent, with little color except for a light yellow-to-orange oil globule within the yolk. Based on counts of larvae at exodus, females produced over 500 eggs per reproductive bout.

After spawning, the female left or was driven away. Post-spawning parental males sometimes engaged in brief bouts of digging (observed only in fish from Louisiana), which likely dislodged embryos to fall into the interstitial spaces of the nest substrate. Shortly after spawning, parental males frequently engaged in bouts of fanning, during which they changed their orientation in terms of where they "blew" the water. Males divided their time between aggression against tankmates and fanning. Males in the multi-male setting seemed to spend more time fanning while the neighboring parental males seemed to incite less aggression than other fish. Generally, the male adopted a coloration that minimized contrast with the background, but he rapidly reacquired breeding dress when a ripe female presented herself. Parental males readily accepted one brood on top of another despite disparities in age.

Early development of embryos (ending with hatch of pro-larvae) was usually complete by 36 hours after fertilization at 73°F (23°C) while pro-larval development thorough exodus varied greatly as a function of temperature. Broods incubated at 75°F (24°C) were ready for exodus by 156 hours after fertilization, while those incubated at 66°F (19°C) required

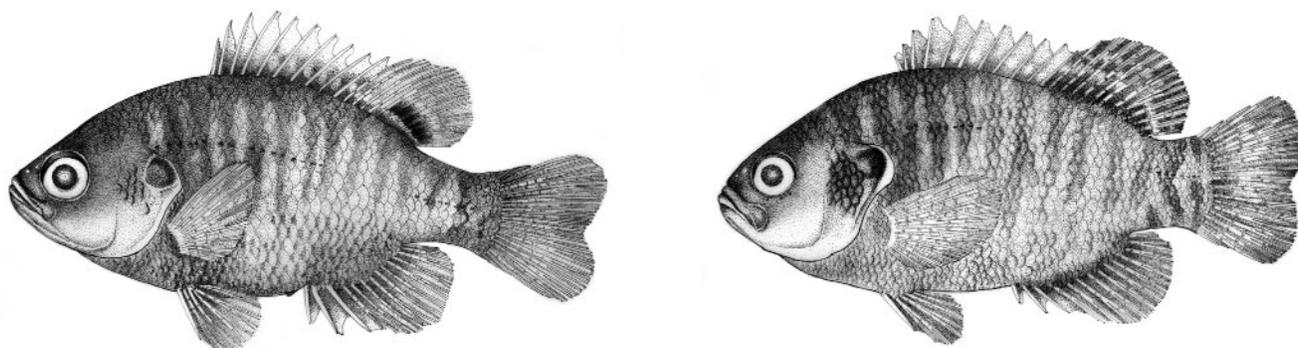


Fig. 1.
Female (left) and male (right) preserved adult Bantam Sunfish, *Lepomis symmetricus*, showing approximate base coloration. Specimens collected as juveniles from Running Lake Ditch, Union Co., Illinois. Illustrations by Uriel Buitrago.

240 hours. Larval exodus from the nest begins approximately one hour after dusk. Earlier in the day, pro-larvae and larvae made short excursions into the water column but quickly returned to the wriggling mass over the nest. Male aggressiveness peaks near dusk, with the parental male continuing to defend the nest site as the larvae swam up into the water column. The parental male did not appear to eat any of his offspring as they depart. Instead, he protected the larvae until they rose into the vegetation where they dispersed to begin feeding. By the following morning the larvae had moved to just outside the vegetation where they formed a slow-moving school. I repeatedly raised broods of Bantam Sunfish through sexual maturity with the parental male present, although I consider this to be an artifact of confinement. Other Bantam Sunfish in the tank, including mothers, do not hesitate to eat the larvae.

Larval Rearing Phase

Larvae were reared in their natal tank or moved to another tank dedicated to that purpose. I moved the larvae using a low-head siphon before their exodus from the nest. During early larval rearing I reduced mechanical filtration. Supplemental aeration was supplied by a diffuser placed at one end of the tank. The larvae oriented as a group against the current and tended to move outside of the vegetation. To control cretinism caused by poor water quality I replaced approximately 25% of the water volume daily with aged and lightly salted water (1 ppt).

First-feeding fry were small but capable of consuming freshly hatched *Artemia* naupilii or rotifers. After about three days they were able to consume 12-hour-old naupilii. I enhanced the nutritional value of older brine shrimp and

rotifers by adding prepared dry feed (i.e., Bio-Blend, INVE, Bio-Kiowa) roughly 10 minutes before the live food was offered. A rotifer-only diet resulted in poor growth and survival. Brine shrimp enhanced with dried feed was offered until the fry stage was reached (approximately 21 days post-exodus). Fry I raised at home were fed in the early morning (06:00), immediately after work (18:00) and just before lights out (22:00). Larvae grew reasonably well with just three feedings, but when feeding started at the same time with subsequent applications at two-hour intervals through 20:00, they grew much faster with less within-brood size variation. Unless fry can be fed more often than three times a day, I recommend that the tank contains an aged gravel substrate that provides both bio-filtration and a reservoir of occasional prey. I raised approximately 150 quality larvae to the fry stage in a 10-gallon (37.8 L) aquarium using three feedings daily, or as many as 1000 larvae in the same volume under the more intensive feeding regime (with daily siphoning of the tank's bare bottom).

Fry Rearing Phase

The fry stage saw a change in swimming orientation from against the current away from the tank's bottom and structure (i.e., plants) to swimming into plant clumps and foraging on the bottom and near the tank's glass sides. This change occurred roughly 21 days post-exodus under the less intensive larval feeding regime described above, and in as little as 10 days under the more intensive feeding regime. Over the course of about one week I gradually increased the amount of dry feed in the morning and after-work feedings. The late feeding was mostly brine shrimp, which the fish consumed even when the lights were turned down. Thereafter, dried feeds were directly applied twice daily. I always reduced the number of fry to

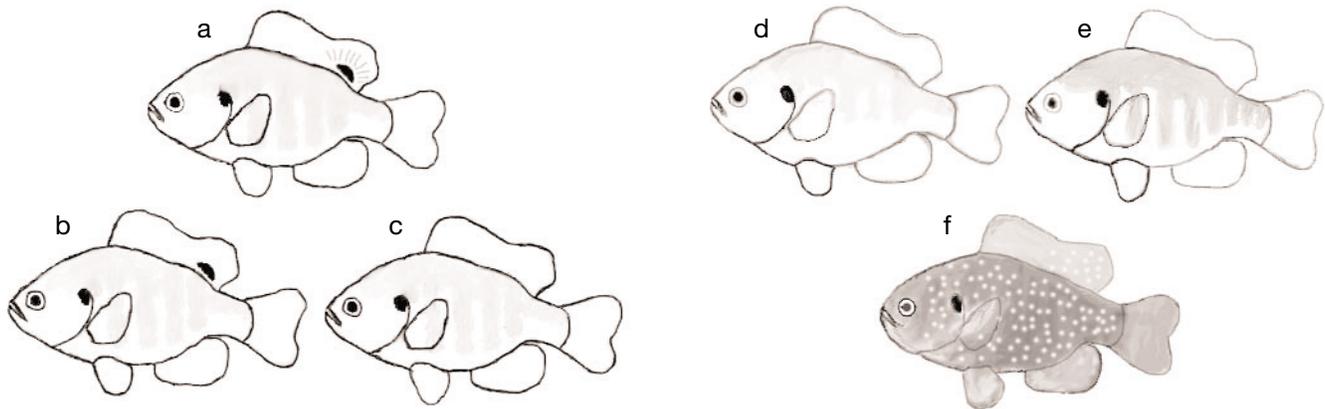


Fig. 2.

Color patterns of a) juvenile, b) adult female, c) adult male, d) courting female, e) nesting/brooding male, and f) courting/excited territorial male Bantam Sunfish, *Lepomis symmetricus*. Illustration by the author.

about 75 animals per 10-gallon (37.8 L) aquarium for subsequent rearing.

Sub-adult Rearing Phase

Sub-adults were fed appropriately sized dry feed once a day. Live chunks of earthworms were offered roughly twice weekly and freshly hatched brine shrimp were readily consumed. Sexual maturity was reached in as little as five months, although most fish were not large enough to breed until seven months. Poorly fed sub-adults took more than a year to reach adult dimensions.

Notes on Variation

Bantam Sunfish exhibited morphological and color variations depending on gender, developmental stage and reproductive status. Morphologically, males of a given age are larger than females. Adult males appear to have longer pelvic fins, and the posterior margins of their dorsal and anal fins appear to be more flowing, just overlapping the rays of the caudal fin. The base coloration of adult females could be differentiated from similar-sized males by the presence of an ocellus spot in the posterior dorsal fin (Fig. 1). The fry acquired the ocellus with an orange halo (Fig. 2a) when they reached a total length of approximately 10 mm. As the fish mature, females lose the orange halo (Fig. 2b) and males lose the ocellus (Fig. 2c). Sexually ripe (courting) females temporarily lose the spot, blanch, and sport darkened eyes (Fig. 2d). Territorial (nesting/brooding) males develop distinct bars, while the rims around their eyes become white,

especially when aggressive (Fig. 2e). Amorous (courting/excited) males darken considerably with pale spots temporarily changing to a bluish tint (most obvious in full-spectrum light as the male swims away; Fig. 2f). Amorous male coloration closely resembles that of Banded and Bluespotted Sunfishes of the genus *Enneacanthus*, but differs from *Lepomis* (excepting Warmouth) where spots are darker than the base coloration.

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