

WRESTLING FOR REAL ESTATE: MALE-MALE INTERACTIONS IN BREEDING FOOTHILL YELLOW-LEGGED FROGS (*RANA BOYLI*)

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Abstract.—Male-male aggression is common among anurans competing for females at traditional breeding sites. We describe two male-male behavioral interactions observed between male Foothill Yellow-legged Frogs (*Rana boylei*) at a surrogate breeding habitat, with two different outcomes.

Key Words.—aggression; anurans; amplexus; behavior; breeding; competing, dam, lek, surrogate

For many anurans from temperate climates, annual congregations at breeding sites are a cauldron of male-male competition for mates (Wells 1977, 2007). The arrival of females intensifies selective pressure on the more numerous males to find a mate quickly, often pressuring males to grasp anything in an amplexal hold, including a different species, and sometimes even inanimate objects (Wells 2007; sensu Alvarez 2011). Males often mistakenly grasp conspecific males, but in most species the amplexed male emits a release call that is recognized by the grasping male, which often results in a timely release from amplexus (Wells 1977; Simović et al. 2014). Males may also aggressively defend display sites, often calling from stationary positions, which may include territories, or resources such as oviposition sites (Howard 1978; Wells 2007).

Foothill Yellow-legged Frogs (*Rana boylei*) historically inhabit coastal streams and rivers from Marion County, Oregon, to Ventura County, California, and inland along the Sierra foothills, south to Kern County, California (Zweifel 1955). They have a lek mating system and often return to certain lek sites within a stream year after year (Kupferburg 1996; Wheeler 2007). Males establish and defend territories within oviposition sites, calling from underwater (Davidson 1995; MacTague and Northen 1993) or from emergent rocks, where they shift position to vary the direction of their acoustic message. Male-male aggression in this species includes males vocally and physically defending specific sites that include above-water calling substrates within a breeding area (Stebbins 1951; Zweifel 1955; Wheeler 2007; Wheeler and Welsh 2008; Silver 2018). Wheeler and Welsh (2008) observed that calling by males elicited aggression from other males, and that males with a larger territory size engaged in more aggression interactions than males with smaller territories. Observed aggression included acoustic dueling, wrestling, chasing, or a combination thereof (Wheeler and Welsh 2008). Here, we describe observations of two types of male-male interaction in the unusual setting (atypical breeding habitat) of a small concrete dam impounding an artificial reservoir, a habitat

not considered typical for a stream obligate such as *R. boylei* (Jeff Alvarez and Jeffery Wilcox, unpubl. data).

Stewart Pond is a privately owned reservoir in eastern Sonoma County, California, used for irrigating vineyards and for recreation. At full capacity, the reservoir surface area is approximately 0.8 ha and it reaches a maximum depth of 8 m. A dam (approximately 10 m long and 1 m tall) on the northwest side of the reservoir impounds the water. The dam has a recessed, extended block that directs the water over the center of the dam (Fig. 1). On the evening 20 April 2017, while conducting a control project for American Bullfrogs (*Lithobates catesbeianus*; Jeff Alvarez et al., in review), we stopped at the outfall side of the dam to remove three *L. catesbeianus* from the outflowing stream at the base of the dam. After removing the bullfrogs, we withdrew to the nearby bank to process them and await nightfall. At the base of the dam, we noticed five *R. boylei*, three on the concrete footing and two at the top of the dam. The frogs (all approximately 40–50 mm snout-urostyle length) were on either side of the flow over the dam: some above, and some below (Fig. 2). Suddenly, one of the *R. boylei* turned to face the vertical dam wall, leapt approximately 0.3 m up the concrete face and began climbing. The dam face had an undulating surface from corrugated metal roofing material used to form the concrete during construction, and the wet surface was covered in a film of algae. Nevertheless, the frog was able to slowly climb the slick surface toward the top of the dam (Fig. 2). Near the top of the dam it slipped and fell, but repeated the effort and made it to a ledge in the face of the dam. The frog sat on the ledge for less than 1 min, and then suddenly leapt approximately 0.6 m to the top of the dam, landing on top of another, slightly larger, *R. boylei* that had been vocalizing.

The leaping frog (which had no line of sight on the vocalizing frog prior to jumping) immediately grasped the vocalizing frog in a partial amplexal hold (Fig. 3) such that it positioned its left front leg in pectoral amplexus and its right front leg in cephalic amplexus of the bottom frog, facing the posterior end of the bottom frog. What



FIGURE 1. Stewart Pond, a reservoir created by impounding three intermittent streams, at the foot (western slope) of Mount Saint Helena in Sonoma County, California. The dam measures approximately 1 m tall and 10 m wide. (Photographed by Jeffery T. Wilcox).

ensued was a 20-min wrestling match, with the bottom frog trying to throw off the top frog. Sometimes the amplexed (lower) frog vibrated violently, interspersing the vibrations with low croaking, and other times it spun, bucked, and tried to wipe the frog off with its right rear leg (Fig. 3). Bursts of struggling activity were followed by periods of inactivity, which presumably afforded a rest period. Over the 20 min, the scuffling frogs covered an area of approximately 0.5 m. They moved from the recessed area of the dam, nearly tumbled over the dam face, and then moved to the top of the dam and out of the water (Fig. 4).

Concurrent with the activities described above, on the other side of the dam another *R. boylii* climbed the dam face (Fig. 4) and amplexed a non-calling conspecific. In this case, the second frog was already situated on the ledge, so the climbing frog was able to see it before pouncing on it from a much shorter distance. In this interaction, no wrestling ensued, but the amplexed frog did vocalize and vibrate. After about 2 min, the amplexing (top) frog dismounted and moved a short distance away. After 20 min of observations, we left to continue catching *L. catesbeianus*. We returned after approximately 1 h had passed to find only one *R. boylii* on the dam. Therefore we do not know the fate of the first pair that we observed.

Our observations suggest that male *R. boylii* may use concrete dam sites as they would traditional lek sites in unaltered streams. In the first encounter, the length of the wrestling match suggests that the aggression was perhaps for the calling site itself. Both males vibrated and vocalized during the struggle, yet neither yielded during the observation. In the second, short-duration interaction, only the amplexed (bottom) male vocalized and vibrated, suggesting an incident of misdirected amplexus; the release call signaling the amplexing frog to release its hold.

Rana boylii populations are in decline in many areas of their native range due to the construction of



FIGURE 2. (Top) Locations (arrows) of three of the four Foothill Yellow-legged Frogs (*Rana boylii*) that were observed engaging in combative behaviors on the dam of Stewart Pond, Sonoma County, California. The upper left frog was vocalizing at the time of the photograph and prior to being amplexed by a second male. (Bottom) One of two *R. boylii* that climbed the vertical face of the concrete dam on Stewart Pond Sonoma County, California. Upon reaching the shelf, it settled for a moment and then leapt over the dam and on to the back of the calling male (arrow), apparently locating this conspecific by sound. (Photographed by Jeffery T. Wilcox).

large reservoirs and the regulation of flows from those impoundments (Lind 1996, 2005; Kupferburg et al. 2012). Recent reports, however, reveal that *R. boylii* may exhibit behavioral plasticity in using small reservoirs for mating, oviposition, tadpole rearing, and as dispersal habitat once non-native predators and competitors are removed (Jeff Alvarez and Jeffery Wilcox, unpubl. data). In the 3 y after numbers of *L. catesbeianus* were greatly reduced at Stewart Pond, we observed *R. boylii* egg masses, two generations of tadpoles, and three cohorts of post-metamorphic *R. boylii* (Jeff Alvarez and Jeffery Wilcox, unpubl. data). Our observations indicate that small concrete dams may be suitable as surrogate calling substrates for calling male *R. boylii*, and that *R. boylii* are excellent climbers; able to climb wet, slick, vertical surfaces. The climbing ability we documented may have management implications in situations where anthropogenic structures, such as dams and weirs, are placed within habitat used by *R. boylii*. The ability of this species to



FIGURE 3. (Top) Position of the amplexing male-male Foothill Yellow-legged Frogs (*Rana boylei*), which was followed by apparent combative behavior. Shortly after landing on the bottom male, the top male *R. boylei* appeared to grasp the bottom male, both frogs vocalizing during the struggle. Note the inflated vocal sacs of the top frog; concentric rings in the water indicate the pulsations of the vocal sacs of the lower frog. (Bottom) Combative behavior between two male *R. boylei*. Note the rippling water, which is produced by vibrations of the amplexed (lower) conspecific, which also used vocalization and rear leg movements to dislodge the amplexing (upper) male. (Photographed by Jeffery T. Wilcox).

climb should be considered prior to placing structures in riparian areas potentially occupied by this frog.

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FIGURE 4. (Top) Two male Foothill Yellow-legged Frogs (*Rana boylei*) in combat to the extent that they nearly fell over the face of the dam on Stewart Pond. (Bottom) A third male *R. boylei* (extended hind leg), climbed the dam face to pursue and combat a fourth male *R. boylei* (center right). (Photographed by Jeffery T. Wilcox).

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