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**BUFO SPINULOSUS PAPILLOSUS (NCN). TADPOLE BEHAVIOR.** Gregarious tadpole behavior has been described for several anuran species (Wassersug 1973. In Vial [ed], *Evolutionary Biology of the Anurans: Contemporary Research on Major Problems*, pp. 273–297. Univ. Missouri Press, Columbia). Aggregates are classified as asocial or simple aggregates (reacting to stimuli other than conspecifics) and biosocial aggregates or schools (reacting to stimuli of conspecifics) (Bragg 1948. Wasman Collector 7:65–79; Wassersug 1973, *op. cit.*).

In this note we describe for the first time gregarious behavior in tadpoles of *Bufo spinulosus papillosus*. Its distribution covers Patagonian forests and steppes, and it typically breeds in ephemeral and semi-permanent environments during spring. We studied a population in a semi-permanent pond in northwestern Patagonia (41°10'S, 71°19'W; 906 m elev., Río Negro Province, Argentina). Observations began when clutches appeared in the austral spring. We recorded water depth, temperature (inside and outside the aggregate), and the characteristics of the substrate and vegetation where the aggregates were found. Aggregation sites were identified and marked. Aggregate density was measured using a ring of known surface area (380 cm<sup>2</sup>), and aggregates classified as: low tadpole density ( $\leq 20$  individuals), medium (20–50), and high ( $> 50$ ). Tadpole behavior within the aggregates was recorded and classified according to three categories: feeding on the substrate, swimming, and resting on the bottom. The composition of developmental stages was analyzed (Gosner 1960. *Herpetologica* 16:183–190).

Thirteen clutches were found during 5–6 October 2001. After hatching at Gosner Stage 18, individuals remained on the pond sediment under the gelatinous string remains. During the first week, tadpoles reached Stage 24, characterized by active swimming very near the hatching site, without feeding or aggregating. Aggregates were formed at two weeks, when the tadpoles were predominantly Stage 28, on sunny days, when the body of water was thermally stratified. The tadpoles from all 13 clutches formed 9 aggregates that remained together until metamorphosis (Stage 42). Of the 9 aggregates, 3 were high-density, 4 medium-density, and 2 low density. Aggregates were located in the shallowest, warmest zones with silt on the bed (except for two cases where there were pebbles and stones on the bed). Aggregates were found either lined up at the shore or forming irregular patches. Aquatic and paludal vegetation was almost absent from the aggregation sites except at one site where there was a dense stand of rushes. Mean temperature at the aggregation sites was  $25^{\circ}\text{C} \pm 1.5$  ( $24$ – $28^{\circ}\text{C}$ ). The temperature within the aggregate was over  $1^{\circ}\text{C}$  higher than that of the surrounding water. The tadpoles had a daily migration cycle. During the morning, they were at the bottom of the pond under the vegetation (metaphyton and aquatic plants, e.g., *Myriophyllum*). When the temperature in the shallow zones rose, the tadpoles swam towards the shore and grazed actively on rocks or aquatic plants.

Between 1200–1300 h there was maximum tadpole activity during feeding. At about 1400 h, the aggregates formed in the shallow zones, with the tadpoles resting on the substrate near the shore. Aggregates did not form on cloudy days, when the temperature was homogeneous throughout the pond.

Our results suggest that temperature is an important factor in the formation of *Bufo spinulosus papillosus* aggregates, which could therefore be classified as asocial aggregates. Moreover, since these tadpoles are very dark and uniformly colored, and inhabit shallow, sunny environments, their aggregates could fulfill a thermal regulation function, as suggested for other species by Brattstrom (1962. *Herpetologica* 18:30–46). Nevertheless, we cannot dismiss the possibility that other factors might act synergistically on aggregate formation in this species.

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**COCHRANELLA GRANULOSA (NCN). FIGHTING BEHAVIOR.** In many species of anurans, vocalizations are sufficient to ward off an intruding male, but physical fighting might also be an important aspect in spacing of individuals at breeding sites (Duellman and Trueb 1986. *The Biology of Amphibians*, McGraw-Hill Co., New York. 670 pp.). Species of Centrolenidae breeds in mountain streams of the Neotropics where male frogs exhibit intraspecific spacing and defend territories through vocalizations, and sometimes physical fighting (McDiarmid and Adler 1974. *Herpetologica* 30:75–78). Because of the lack of observations on centrolenid behavior, very few species have been observed in physical, intraspecific fighting. Fighting behavior has been reported in 5 of the  $>136$  species (Guayasamin and Bonaccorso 2004. *Herpetologica* 60:485–494), and two of the three centrolenid genera. Males of *Hyalinobatrachium fleischmanni*, *H. valerioi* (McDiarmid and Adler 1974. *Herpetologica* 30:75–78), *Centrolenella prosoblepon* (Jacobson 1985. *Herpetologica* 41:396–404), *C. griffithsi* (Duellman and Savitzky 1976. *Herpetologica* 32:401–404), and *Cochranella buckleyi* (Bolívar-G. et al. 1999. *Alytes* 16:77–83) have been observed fighting during the breeding season. Aggressive behavior in Centrolenidae includes vocalizations directed towards the intruder, charging, kicking, shoving, grappling, and wrestling (Duellman and Savitzky 1976, *op. cit.*; Jacobson 1985, *op. cit.*), and such behaviors can be energetically costly and physically damaging Bolívar-G. et al., *op. cit.*). Herein we report on the fighting behavior of *Cochranella granulosa* and provide a brief description of aggressive vocalizations emitted during the fighting.

We observed two male *C. granulosa* engaged in a fight on 21 Sept 2001 at Río Tigrillo, Conte, Puntarenas Province, Costa Rica ( $\text{N}8^{\circ}26'27.6''$ ,  $\text{W}83^{\circ}01'30.0''$  elev. 52 m), near the Panamanian border. Cattle pastures, oil palm plantations, and scattered native trees and leafy herbaceous undergrowth (Heliconiaceae and Marantaceae) bordered the stream. The encounter was filmed using a Sony SONY CCD-TR940 video camera with night vision capabilities, and vocalizations recorded with a Marantz PM 222 shotgun microphone. The two individuals were first observed at

1944 h hanging 2.5 m above the stream, and our observations were concluded at ca. 2215 h. We did not observe the initiation of the bout and were unable to identify the intruder, the resident frog, or the true duration of the bout. When first observed, the frogs were hanging upside down belly-to-belly, one frog was hanging from the leaf by the right foot, while the other frog was hanging by both feet. We heard and/or saw at least 5 additional males calling from the same leafy bush. The typical advertisement call for this species has been described as a high pitched, three-note "creek-creek-creek" (Ibáñez et al. 1999. *The Amphibians of Barro Colorado Nature Monument, Soberania National Park and Adjacent Areas, Panama*, Editorial Mizarachi y Pujol). The first 24 minutes passed with both animals making soft "peep" calls at different intervals until the frog with both feet on the leaf started using its right foot to kick the second frog's foot off of the leaf. This behavior continued until both frogs, with arms wrapped around one another, fell ca. 1.0 m onto a lower leaf.

At this point the fight became more active and aggressive as both frogs jumped towards each other, collided, and wrestled. Throughout the fighting we observed pushing and kicking of the head and body, with some blows directed directly towards the eyes. Sporadically, after small wrestling bouts, the two frogs would separate for a couple of minutes and then jump towards each other again, repeating the colliding and wrestling. While the frogs were separated between bouts each frog would emitted a short, single-noted "creek" vocalization similar in pitch to the species typical "creek-creek-creek" advertisement call. As one frog produced the "creek" vocalization the second frog became aggressive and attacked the vocalizing frog. During the bout the frogs were continuously falling down to lower leaves until finally they were ca. 1.5 m above the stream. After descending to this point the fighting stopped temporarily as the frogs climbed back up the plant to higher perches. This did not happen simultaneously, but instead one male climbed first, and after several minutes the second male followed suit. Once at this perch, where the two frogs were originally observed, they began the physical fighting again.

During the second bout the frogs wrestled until they were hanging upside down, again apparently trying to knock the other frog off of the leaf. The two frogs fought in the same manner as described above until they were again ca. 1.5 m above the stream. At this point, 2 h and 24 min after the initial observation, the two frogs separated and ceased aggressive, physical combat. As they separated, one of the male frogs climbed through the vegetation near the original perch and began to emit the normal "creek-creek-creek" advertising vocalization. The other male frog, presumably the loser, hopped horizontally into the denser vegetation where we lost sight of him.

During our observations at this site we noticed three distinct calls from *C. granulosa*, including two that are previously undescribed. They were: 1) the advertisement call of "creek-creek-creek"; 2) a short, soft "mew" as the males were grappling belly-to-belly; and 3) a single-noted call—"creek"—similar in pitch to the normal advertisement call, which was heard during times of slight separation. The "mew" call has been described to function as an encounter call in other centrolenid species (McDiarmid and Adler 1974, *op. cit.*; Wells 1977. *Anim. Behav.* 25:666–693; Greer and Wells 1980. *Herpetologica* 36:318–326), and appeared to serve the same function in this observation. This is the sixth species of

centrolenid known to exhibit fighting behavior, and the second observation in the genus *Cochranella*. Of the other centrolenid species that exhibit fighting, two have parental care in which males guard egg clutches, and three do not have parental care, including *C. granulosa*. In *Hyalinobatrachium*, males repeatedly guard multiple clutches on the same leaf (Jacobson 1985, *op. cit.*, Hayes 1985. Unpubl. PhD. Diss., Univ. Miami) and it could be surmised that the protection of offspring would facilitate fighting behavior. We suspect that in *C. granulosa* fighting behavior is used to establish and defend territory or a calling perch that attracts mates and leads to male–male spacing. It might be possible, as more behavioral observations are documented, to use fighting behavior as a phylogenetic character to organize species relationships in this diverse Neotropical frog family, and to understand how aggressive behaviors affect fitness and the social system of anurans.

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**CONRAUA GOLIATH** (Goliath Frog). **SKITTERING LOCOMOTION**. Typically, anurans are specialized for saltatory locomotion. This is an excellent mechanism to avoid encounters with potential predators. In frogs, escape behavior usually consists of a single long leap to a secure place, such as from land into water, which is characteristic for ranids (Duellman and Trueb 1986. *Biology of Amphibians*, McGraw-Hill, Inc., New York 670 pp.). An alternate escape behavior is the unusual skittering locomotion; "bouncing" on the water surface without sinking (Gans 1976. *Ann. Zool.* 12:37–40), from a perching site on land as described for *Hoplobatrachus occipitalis* (Chabanaud 1949. *Copeia* 1949:288), *Acris crepitans* (Blair 1950. *Copeia* 1950:237; Hudson 1952. *Copeia* 1952:185), and *Hyla cinerea* (Janson 1953. *Copeia* 1953:62).

We observed skittering behavior in *Conraua goliath* along riverbanks of the Nkebe River, Littoral Province, Cameroon (04°50'N, 09°55'E) during March–April 2004. Generally, frogs were perched on rocks and gravel banks within the river or on solid rock at the edge of large rock pools. Sizes varied from recently metamorphosed froglets (3–4 cm SVL) to juveniles and large adults 20 to  $\geq$  30 cm SVL. When we approached *C. goliath* within a few meters, most showed a ranid-typical escape behavior of jumping into larger bodies of water with one powerful leap. However, some individuals exhibited a straight-line series of five to seven short leaps in even intervals which kept them on the water surface before finally diving into the water. Frogs always escaped into the water as opposed to land even when approached from the "water side." The frogs' bodies were supported on the water surface by repeatedly and simultaneously striking the surface with both feet, which are fully webbed and possess an exceptionally large surface area. The distance covered on the water surface was 2.5–3.5 m in adults and was comparatively smaller in juveniles and recently metamorphosed individuals. We observed this locomotion during most times of the day and at night (0930–