Precedence in feeding and mounting in captive toads*

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Four groups of captive toads (*Bufo americanus*) in a sexually active state were forced to compete for mealworms as food. Development of resultant feeding hierarchies appeared retarded relative to prior research. Males remained in amplexus for several days during which they did not eat. Systematic preferences for females were not apparent, although males who mounted frequently also ranked high in frequency of aggressive behavior.

Among many vertebrate species social dominance is related to feeding precedence and mating success (Etkin, 1964). In amphibians that are territorial during the breeding season, pairing is influenced by characteristics of the male and the nature and location of the territory. Female bullfrogs, for example, usually bypass males calling from isolated territories and proceed to the center of the chorus. There they swim from territory to territory for several hours before approaching and touching a male, thereby initiating amplexus (Emlen, 1968). Favored territories, in the center of the chorus, are occupied by males successful in aggressive encounters.

Frogs (Haubrich, 1961; Boice & Witter, 1969) and toads (Boice, 1969) maintained in the laboratory under conditions too crowded to permit territory formation show feeding orders and apparent aggressive hierarchies that are stable over time. The existence of such orders suggests the presence of some degree of individual recognition (Collias, 1950). The present study was an attempt to determine if captive American toads (*Bufo americanus*) show preferences in sexual mounting and if such preferences are related to aggressive behaviors or precedence in feeding.

SUBJECTS AND

MAINTENANCE CONDITIONS

Forty American toads (*Bufo americanus*) were captured on rural roads in Boone County, Missouri, on two rainy nights (April 6 and April 17) during the spring of 1969. Toads were housed in groups of 10 (6 males and 4 females) in glass terraria (28 x 16 x 16 in.) with 3-in.-deep sand substrates and plastic water pans (9 x 6 x 3 in.). Temperature in the laboratory varied between 68°F and 75°F. Fluorescent ceiling lights were on 14 h a day, from 5 a.m. to 7 p.m.

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All Ss were weighed and measured immediately after capture. Identification of individual animals within groups was based on drawings of spot and wart patterns.

PROCEDURE

Three times a week Ss were fed mealworms that were dropped one at a time into the left front corners of the terraria. When a toad had eaten five mealworms, it was removed to a holding cage. Pairs in amplexus were removed when the female of the pair had eaten, since mounting males did not eat. Toads failing to approach the feeding area within 15 min were placed there by E. Order of removal from the terrarium was used as a measure of the feeding order within each of the groups. Ss that did not eat were ranked last. Aggressive encounters during the feeding sessions were recorded and filmed, using a scheme outlined elsewhere (Boice, 1969).

Before each feeding session, mounted pairs were noted and the water pans checked for eggs and cleaned.

Observations continued for 12 weeks for Groups 1 and 2 and 9 weeks for Group 3. After 4 weeks, Group 4 was accidentally left in the holding cage overnight without

water. All six males and one of the four females died of the resulting dehydration.

RESULTS AND DISCUSSION

Eggs were present in the water pans of Groups 1 and 2 (which were captured on April 6) every day for the first week of observation. No additional eggs were observed after this period. Females in Groups 3 and 4, which were captured on April 17, never ovulated in the laboratory.

In spite of the brief duration of egg-laying, males continued to mount females, with declining frequency, for the duration of the study (until June 11) (Table 1). Aronson (1944) previously noted the slow rate at which sexual activity declines among captive *Bufo americanus*. Group 3, in fact, showed increased sexual activity over time even though they were evidently captured near the end of the normal breeding season.

Only three of the males in each group were sexually active (mounted on 5 or more days) in Groups 1 and 2 and only one male in Group 3 consistently mounted. Group 4 is omitted from the remainder of the results because of the limited amount of data collected. Ordinarily these active males would remain mounted on a female for a period of several days to more than a week. This duration of amplexus is common when the female has not recently ovulated (Aronson, 1944). After dismounting, the males usually did not mount again for several days. There was no evident preference for any particular female, with the possible exception of Male 6 in Group 1, who was mounted on Female 1 during 14 of the 36 sessions. Most sexually active males mounted all of the females in their group over the course of observations.

Males in amplexus did not eat during feeding sessions, although they occasionally showed visual orientation to a larva and made the toe-twitching movements that

Fig. 1. Postures observed in encounters between American toads.

Table 1
Percent of Females Mounted by Males During Observation Sessions

Group	Blocks of 2 Weeks					
	1	2	3	4	5	6
1	70.8	75.0	45.8	29.2	20.8	25.0
2	58.3	50.0	45.8	37.5	12.5	16.7
3	—	8.3*	16.7	37.5	29.2	41.7
4	—	25.0*	25.0	0.0*	—	—

*Based on 1 week only

frequently precede feeding. Only twice did a mounted male dismount during a feeding session. In one instance Male 3 of Group 1, who was mounted on Female 4, showed signs (e.g., pupil dilation and head orientation) of watching the mealworms while Female 4 was eating. When she moved to the rear of the terrarium, away from the larvae, Male 1 then remounted sideways and eventually clasped the female backwards. Finally he dismounted and returned to the feeding area to eat.

Mounted females ate readily and in general seemed to ignore the presence of the male, although three instances of apparent attempt to dislodge a male were observed. These attempts involved the female's stretching her body and legs, twisting and stumbling about the terrarium. This behavior did not succeed in displacing the male in any of the observed attempts.

In comparison with studies that have reported the development of feeding orders in captive amphibians (Boice, 1969; Boice & Witter, 1969), feeding orders in the present study were somewhat less stable over time (Table 2). Although the Kendall coefficients of concordance (W) are significant ($p < .05$), the average rank-order coefficients (r_{sav}) are not impressive—especially for Group 2. These computations were based on the last 15 sessions when most of the Ss were eating readily. Cochran (1961) has suggested that memory is disrupted in amphibians during the breeding season due to a heightening of metabolic activity. Such disruption could explain the failure of the toads in this study to learn a precedence order. This possibility is supported by the fact that during the last 5 days of observation when mounting was least frequent, feeding order stability increased (Table 2).

americanus (Boice, 1969; Boice & Boice, 1970). The most obvious aggressive behavior is the tongue strike (Fig. 1A), which involved one toad striking another with its tongue. Striking, although similar to the feeding response, differs in the posture from which the response is initiated. Feeding (Fig. 1B) is initiated from a low posture and is ordinarily preceded by visual orientation and following of the target. Striking, on the other hand, is initiated from a high posture similar to the confrontation posture (Fig. 1C) also observed. Striking is not preceded by any apparent visual orientation. Other postures in interactions were the twisting confrontation (Fig. 1D), observed when one toad made a lateral approach to another, and facing (Fig. 1E) which appeared to be a low-intensity form of threat. The defensive posture (Fig. 1F) that has been reported by other workers (Noble, 1931) occurred primarily when a toad was repeatedly stricken by one or more other toads.

Unlike the Boice (1969) study, aggressive encounters in the present study were not frequent enough to permit statistical determination of hierarchies. In all the groups, however, females were more aggressive than males and received considerably fewer strikes than they gave. Among the males, total number of strikes given was positively correlated with mounting frequency in Groups 1 ($r = +0.77$) and 2 ($r = +0.61$) but not in Group 3 ($r = -0.26$). Most aggressive behaviors by males were directed at other males. There was no evidence that aggression was in any way related to an animal's rank in the feeding order, even through the most frequent cause of tongue striking was conflict over a mealworm.

Length and weight were unrelated to

Table 2
Kendall Coefficients of Concordance (W) and Average Rank-Order Correlation Coefficients (r_{sav}) Computed for Feeding Orders Over Last 15 Days and Last 5 Days of Observation

Group	Last 15 Days		Last 5 Days	
	W	r_{sav}	W	r_{sav}
1	.337*	.289	.591*	.489
2	.138*	.076	.323	.154
3	.321*	.272	.606*	.508

* $p < .05$

position in the feeding orders or to number of strikes given or received.

In general, the results of this study support and further the conclusions of previous studies of amphibian social behavior. Aggressive behaviors apparently do not mediate the formation of feeding orders. While there was a tendency (in two out of three groups) for the more aggressive males to mount more frequently, further observation is required to substantiate this finding.

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