THE WASMANN JOURNAL OF BIOLOGY

VOL. 12, NO. 3 FALL, 1954

A Second Season with Rana areolata in Oklahoma

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In a recent study (Bragg, 1954) observations on the distribution and habits of the little known crayfish frogs, *Rana areolata areolata* Baird and Girard and *R. a. circulosa* Rice and Davis, were reported; the eggs and tadpoles were described in *R. a. areolata* for the first time; breeding sites were studied; intergrading between the two forms was discussed; and the rate of tadpole development in *R. a. areolata* in one natural pool was given as measured. Furthermore, measurements and ratios on forty-three adult specimens indicated that the length of the tibio-fibula of adults cannot be used consistently in separating individuals of the two sub-species as indicated by Goin and Netting (1940), at least in Oklahoma; but it was recognized that *R. a. areolata* does have, on the average, a shorter tibio-fibula than that of *R. a. circulosa*. It was also clear that the ratios found applicable to the taxonomic separation of the *species* in the *Rana areolata*-group of frogs (Goin and Netting, 1940) are not applicable in separating subspecies within *R. areolata* as found, at least, in the Oklahoma specimens examined. More data are needed in this matter, however.

During the spring of 1950, fifteen long week-end trips to eastern Oklahoma were made between February 9 and May 30. During these, I studied and collected these frogs at every opportunity. This paper, therefore, reports the results of a second season with these frogs and gives additional information not

Received for publication December 12, 1951.

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available for the first paper. Observations merely confirming the earlier statements are not repeated except for special reasons, but additional measurements (tables 1 and 2) are presented and anything new is discussed.

Observations on Breeding Congresses and Breeding Sites

In one place where two adjacent pools, essentially alike, occur, *R. a. areolata* utilized one of them in 1949, the other in 1950. At two other sites where eggs were abundant in 1949, none were produced in 1950. On the other hand, one pool examined several times without results in 1949 had tadpoles in 1950. Many other sites were utilized for breeding during both seasons.

These observations suggest strongly that which pools are used at any given time of breeding depends upon where males first begin calling. In further support of this idea, it was noted during both years that on nights of active breeding if only a few males were calling in any one pool, they tended to be scattered in a haphazard manner. When, however, many were active they almost invariably occurred in groups, several males calling together in a limited space. Since these phenomena were also noted in the case of *R. a. circulosa,* it seems probable that this explains the many cases of egg masses produced in groups. Males tend to aggregate (perhaps in reference to each other's calls), the calls attract females, and eggs are produced near the calling sites of the males.

One new type of breeding site was noted certainly for *R. a. areolata.* In Le Flore County, a cold spring-run in a deep valley of the Ouachita Mountains had eggs of this frog. Embryos were also found in Cherokee County in the valley of the Illinois River beside Oklahoma Highway 10 in a similar spring-run. These constitute a new county record for *Rana areolata* but I could not determine which subspecies. The location is just over the theoretical line drawn in the earlier study marking the northern edge of the intergrading zone and, therefore, could be *R. a. circulosa,* especially since this frog was taken in prairie southwest of Talaquah. On the other hand, the ecological picture here is much more typical of the habitat of *R. a. areolata.* The site is in a fairly deep rough valley, wooded but with small cleared fields and pastures along the river. This valley could easily serve as a highway up

stream from the Arkansas River along which *R. a. areolata* occurs farther southward. On the whole, I am inclined to interpret these embryos as being those of *R. a. areolata,* principally on ecological grounds, since the former study clearly indicated that this frog follows several valleys high in the Ouachita Mountains in the southeast. On this interpretation, both subspecies occur in Cherokee County but in different ecological communities.

The question of breeding season was clarified somewhat by the recent observations, especially for *R. a. circulosa.* No evidence of breeding activity of this species was found till March 25. On this date a single mass of eggs occurred at the junction of highways 10 and 66 just southwest of Miami, Ottawa County; but in Craig County, a few miles to the west, large masses of early embryos were present. No eggs were in a pool about midway between these other two. That evening, just after complete darkness, a single male called briefly at the first-mentioned site. At the Craig County pool, however, there was a very large congress and at the pool between them I found what was apparently the first breeding of the season for this particular population. Dozens were migrating from a large pasture, avoiding a large cattle tank to cross the highway to a temporary pool where males were already calling. There must have been several hundred frogs in this mass movement, including many females among the males. In this instance, there was no question whatever about a selection of a breeding site—none stopped in the tank which some either had to go around or swim across to reach the shallow, vegetated pool across the road and it was quite evident that some at least circled the large pond rather than swam it.

The rainfall reported at Miami, the nearest U. S. weather station (± 2 miles away) was only 1.11 inches for March, as a whole, distributed as follows: .70 on the 11th, .20 on the 12th, .10 on the 16th, .07 on the 19th and .04 on the 20th. Thus, it was five days between the last bit of rain and the observation of this congress, and much longer since any rain of consequence had occurred. Furthermore, the embryos observed in Craig County were too young to have been the result of stimulation of breeding by the .70 inch of rain on the 11th or even the .90 inch on the 11th and 12th together. But, of course, it may have rained more here; there are no records to tell. Thus, two conclusions can be drawn: (1) rain is not a necessary stimulus for initiating the breeding activity of this

frog and it, like other common frogs, has either the mesic or mixed breeding pattern as defined recently (Bragg, 1950), almost certainly the former; (2) different adjacent populations do not necessarily breed at the same time. Further evidence for both these conclusions was obtained on April 8, in this same region. Large congresses (including mated pairs) were studied at the Craig County site and at highways 66 and 10, but none occurred in the intermediate pool. There had been no rain since the .11 inch on March 19 and 20 except .07 on April 2, 1.23 on April 3, and .45 on April 4. The frogs nearest Miami had had four nights in which to produce eggs if stimulated by the latest rain and had not done so till the fifth night.

A single observation incidental to the above is also of interest. One female migrating across the road with others on March 25 was observed to ooze eggs from the cloacal opening soon after capture and while being handled. This clearly shows that ovulation had already occurred, not only prior to the clasp of the male but even sometime before the female reached the water. Special interest attaches to this observation because of the comments of Noble and Aronson (1942) on my interpretation of the function of the clasp of the male in prairie-limited forms (Bragg, 1941). The observations show that *R. a. circulosa* is similar to *R. p. pipiens* as studied by Noble and Aronson and not like the prairie forms discussed by me. This is in accordance with my whole idea of the difference between the xeric- and mesic-breeding patterns (Bragg, 1950:68–69).

I emphasize this evidence that rain is not a necessity for breeding in the case of *R. a. circulosa* in Oklahoma because it contradicts the indications of Smith (1950) who, without giving evidence, says: "Equally unique as the habitat, so far as species of *Rana* in this country are concerned, are (1) the formation of breeding congresses (of *R. circulosa*) in response only to heavy rains, and (2) utilization by the congresses of temporary pools. These features identify the xeric (arid) type of breeding pattern, and suggest that in the distant past the frogs were subject to much more arid conditions than they are now." As pointed out both in the present paper and in the previous one, shallow and temporary pools *are* the characteristic breeding sites of *R. a. circulosa,* but I find in Oklahoma that this is the only feature of the habits which suggests the xeric pattern of breeding. Further-

more, maybe ovulation before reaching a breeding site is not to be expected in forms with the xeric breeding pattern (Bragg, 1941).

For *R. a. areolata,* the relation of rainfall to breeding is not yet evident. Several congresses were observed, all no later than four days after rain and eggs and embryos in pools in every case showed that some breeding had occurred after rain. A local resident near Idabel who spent part of the evening of February 10 with me watching these frogs breeding told me that they were also calling there certainly on February 5, 6, and 7, and prob-

TABLE I

Snout-vent length (SV), tibio-fibula length (tf) in mm. and ratio, sv/tf, of 19 specimens of R. a. areolata *from McCurtain County, Oklahoma, compared with comparable figures for eight specimens taken in the intermediate region between the two subspecies (Sequoyah County). All from breeding congresses. Measurements made on live specimens (except 2) all to nearest mm.; ratios expressed to nearest 0.1 mm. M= mean value. All are males except R. a. areolata #9, which was taken as the female of a mated pair clasped by #8. Items 18 and 19 are two preserved males from the Okla. A. & M. College Collection. All measurements made in the manner of Bragg (1954).*

	R. a. areolata			R. areolata *subspecies (Probably intergrades)*		
Item	*SV*	*Tf*	*Ratio*	*SV*	*Tf*	*Ratio*
1	96	43	2.2	100	42	2.4
2	93	41	2.2	95	41	2.3
3	84	38	2.2	89	42	2.1
4	95	40	2.4	78	40	2.0
5	95	38	2.5	91	41	2.2
6	79	34	2.3	85	38	2.2
7	90	38	2.4	96	44	2.1
8	89	38	2.3	83	38	2.2
9	80	35	2.3			
10	95	41	2.3			
11	91	40	2.3			
12	81	38	2.1			
13	80	36	2.1			
14	88	38	2.3			
15	71	33	2.2			
16	87	38	2.3			
17	78	25	3.1			
18	76	36	2.1			
19	67	32	2.1			
M	85.00	36.36	2.30	89.63	40.75	2.19

TABLE II

Ranges (R), means (M) and ratios derived from measurements of 36 breeding males and 11 breeding females of R. a. circulosa. *One female from Osage County and two males from Muskogee County, Oklahoma, are preserved specimens in the collection of Oklahoma A. & M. College, Stillwater.* All of the others were collected from three breeding populations in Craig County near Welsh and in Ottawa County near Miami, Oklahoma, Spring 1950, and were measured while alive. Sv=Snout-vent length, tf=tibio-fibula length with knee and ankle joints fully flexed, hw=width of head at posterior to angle of jaws, hl=length of head to posterior border of tympanum. Measurements were made to nearest mm. and individual ratios figured to nearest 0.1. Means given are of these values.*

	sv		*tf*		*hw*		*hl*		*M*		
	R	*M*	*R*	*M*	*R*	*M*	*R*	*M*	$\frac{SV}{tf}$	$\frac{SV}{hw}$	$\frac{SV}{hl}$
Males	84–122 (N=36)	96.89 (N=36)	33–55 (N=36)	47–67 (N=36)	27–37 (N=32)	32.31 (N=32)	25–34 (N=33)	29.85 (N=33)	2.01 (R=1.9–2.4)	3.07 (R=2.6–3.3)	3.26 (R=3.0–3.6)
Females	93–122 (N=11)	107.36 (N=11)	45–54 (N=11)	47.79 (N=11)	30.36 (N=10)	31.40 (N=10)	27–33 (N=10)	31.20 (N=10)	2.16 (R=2.1–2.3)	2.77 (R=2.9–3.2)	3.39 (R=3.0–3.8)
Total	84–122 (N=47)	99.55 (N=47)	33.55 (N=47)	48.17 (N=47)	27–36 (N=42)	32.01 (N=42)	25–34 (N=43)	30.16 (N=43)	2.05 (R=1.9–2.3)	2.98 (R=2.6–3.3)	3.29 (R=3.0–3.8)

*I express my appreciation to Dr. Bryan Glass for the loan of these specimens and for two others of *R. a. areolata* mentioned in table I.

ably before. There had been three days of rain (January 31, February 1 and 2) totaling 2.52 inches. Other observations were comparable, both here and elsewhere.

It is interesting to note that rather cold temperatures do not inhibit breeding in the intergrading zone of the two subspecies. On February 18, 1950, I found a lively breeding congress 3.3 miles north of Sallisaw, Sequoyah County, when the air temperature was 4° and the water 9° C. The temperature was falling as a high north wind was bringing light rain. I have had no opportunity to determine the relation of breeding to low temperatures *per se* in either subspecies. However, in both years, the breeding activity of *R. a. areolata* has come well before that of *R. a. circulosa* where I have observed them. Since the characteristic sites studied mostly for the two are some 200 miles apart, north-south, cooler temperatures to the north may make the difference.

The data given in tables 1 and 2 essentially supplement those published in the earlier paper and therefore need no special comment.

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