A Partial Description of the Tadpole of Rana areolata circulosa and Notes on the Natural History of the Race

Hobart M. Smith, C. William Nixon
Department of Zoology and Physiology, University of Illinois, Urbana
Philip E. Smith
Department of Parasitology, Johns Hopkins University
Baltimore, Maryland

In 1939 one of us (Philip Smith) while enrolled at Southern Illinois Normal University at Carbondale, intensively pursued a field study of *Rana areolata circulosa* under the direction of Dr. Fred R. Cagle. Actual work on it, concentrated in the vicinity of Herrin, Illinois, began in 1938, and was continued through 1940. Unforeseen developments prevented completion of the project, although in 1942 Cagle published excerpts from the data then accumulated.

The notes recorded during the study are available at the present time, in addition to a small portion of the preserved materials. Among the latter are five mature and transforming tadpoles, especially valuable since the larval stage of this species has never been described. With our description of the tadpoles, we include certain apparently novel materials from Smith's notes.

Unfortunately all the small jars containing stomach contents and tadpoles at various stages of development were completely dry when reexamined in the summer of 1947 after a few years of storage. The material would have been a total loss had it not been possible to restore it partially by the technique described recently by Van Cleave and Ross (1947). In fact Dr. Van Cleave kindly treated the dried specimens for us. The tadpoles were rendered flexible enough to permit manipulation, although they remained shrunken in appearance. The mouth disks appear normal, but body proportions are unquestionably distorted; accordingly, while the description of the mouthparts may be considered more or less accurate, the measurements are undoubtedly subject to correction on the basis of fresh material.

Field Observations

A summary of part of the field observations, as stated previously, appeared in a report by Cagle (*loc. cit.*). A few additional notes follow.

Emergence was observed as early as the third week in February (1938). Not infrequently specimens were found in shallow water at temperatures so low that activity was greatly inhibited and no sexual expression whatever was evident. In 1939, breeding activity extended over a period of some 35 days. In 1938, almost exactly the same period was involved, although it began later (about March 12). During the first 5 or 6 days, the males appeared to predominate at the breeding congresses, and after then most frogs migrating to the breeding pools were observed to be females. The females apparently left the pools shortly after ovipositing, since very few were observed about the pools after 12 days from the first evidence of breeding. For a time after all specimens had left the ponds, males could be heard calling occasionally, under favorable conditions, from their holes in the fields. As early as April 19, 1938, specimens were being plowed up in fields at depths of about 6 inches.

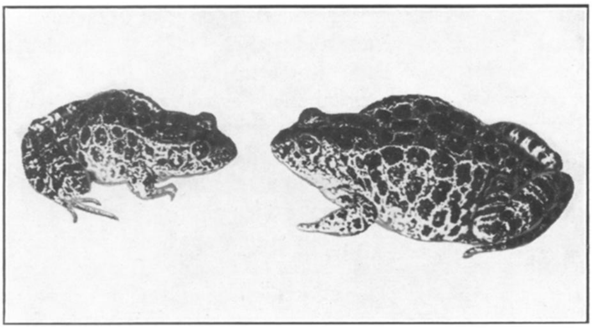

Fig. 1.—*Rana areolata circulosa* from Herrin, Illinois. Both specimens are females.

In six egg masses the minimum count of eggs was 3192, and the maximum 6807.

Air and water temperatures of about 10° C. appear to be the critical optimum for *R. areolata*. Breeding activity does not begin until they reach about 8° C., and is not active until about 12° C. When well under way, the breeding activity lessens markedly by reduction of temperatures to 10° C., and virtually ceases at 6° C. or less.

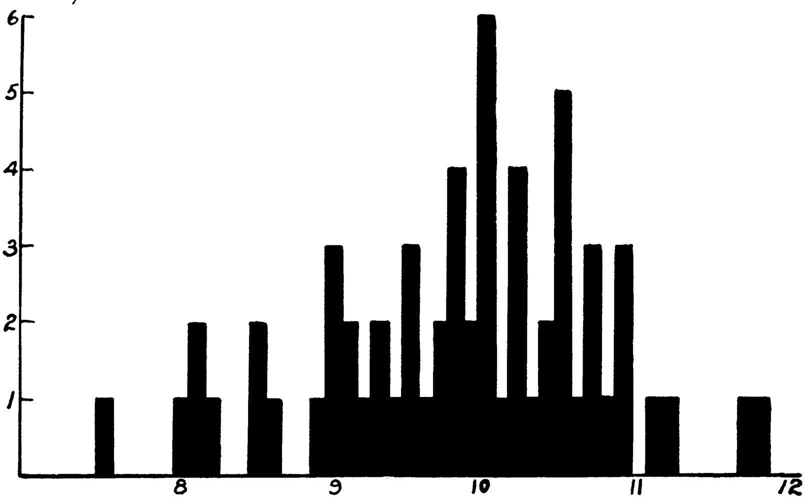

Fig. 2.—Histogram showing frequency distribution of snout-vent lengths by millimeters in males. Lengths are plotted by millimeters on the abcissa (the figures refer to centimeters), number of individuals on the ordinate.

This is one of the few Ranas of the United States, apparently, whose breeding activity is closely correlated with rainfall. Warm weather (exceeding 10° C.) in spring is insufficient alone to stimulate breeding activity; a certain amount of rainfall is required in addition. Records available do not indicate the optimum quantity or violence of the rains.

A series of 432 specimens was collected on two successive nights and sexed, measured (snout to vent) and weighed. The accompanying figures (Figs. 2-5) summarize these data. These tabulations reveal presence at the choruses of surprisingly small, presumably sexually mature individuals; 6.4 cm. snout to vent (0.5 ounce) was the minimum recorded in males, 7.5 cm. (2 ounces) in females. The largest recorded was 11.7 cm. in a male (6 oz.) and 11.8 cm. in a female (6 oz.). A difference between the sexes is indicated for the minimum as well as the average (length, ♂ 9.3, ♀ 9.8; weight, ♂ 2.6, ♀ 3.4) breeding sizes, but the maximum sizes and weights appear little different. In both sexes the weight becomes disproportionately greater as the length increases; the curve is almost identical in males and females.

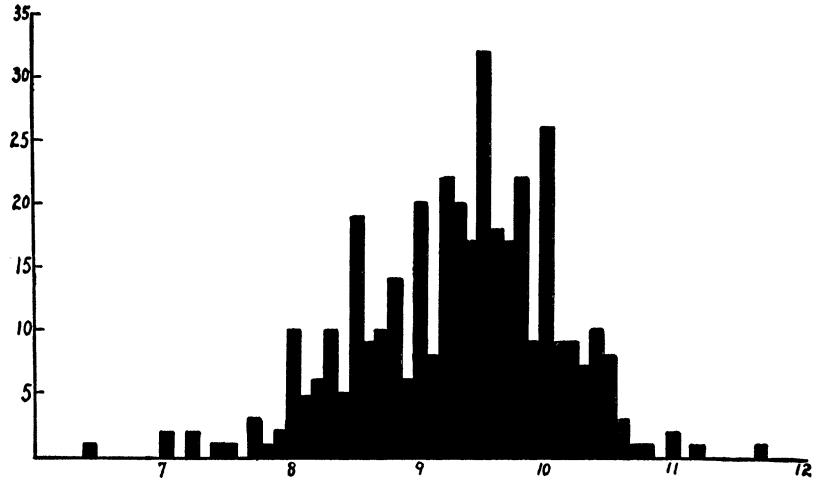

Fig. 3.—Frequency distribution of snout-vent lengths in females plotted as in Fig. 2.

The series of 143 collected on the first night (March 10, 1939) was selected for calling males, but the group collected the following night (289) was assembled indiscriminately so far as sex and call were concerned. Despite that fact the sex ratio strongly favors the male (371:61 or 6.08:1). We suspect that, although no conscious selection was exerted in accumulation of the second series, behavior of the frogs effected a selection of more males than females.

Stomach contents of about 18 specimens taken in the breeding season of 1941 include small numbers of beetles and beetle larvae (carabids, tenebrionids), millipedes, centipedes, and small crayfish.

EGGS

The details of egg structure of *Rana areolata* in eastern Kansas have been described by Smith (1934:479, pl. 12, fig. 7), who also recorded observations on the egg masses as a whole. Cagle (1942:182) records further observations (from data furnished by Philip E. Smith) on the egg masses (wrongly assigned to *R. a. areolata* by Livezey and Wright [1947:208]; the eggs of the latter race are as yet not recorded). Observations on egg masses in Kansas and Illinois reveal no discrepancies, but the details of egg structure appear to differ markedly. In Kansas, eggs were measured with vitelli 2.46 to 2.5 mm.

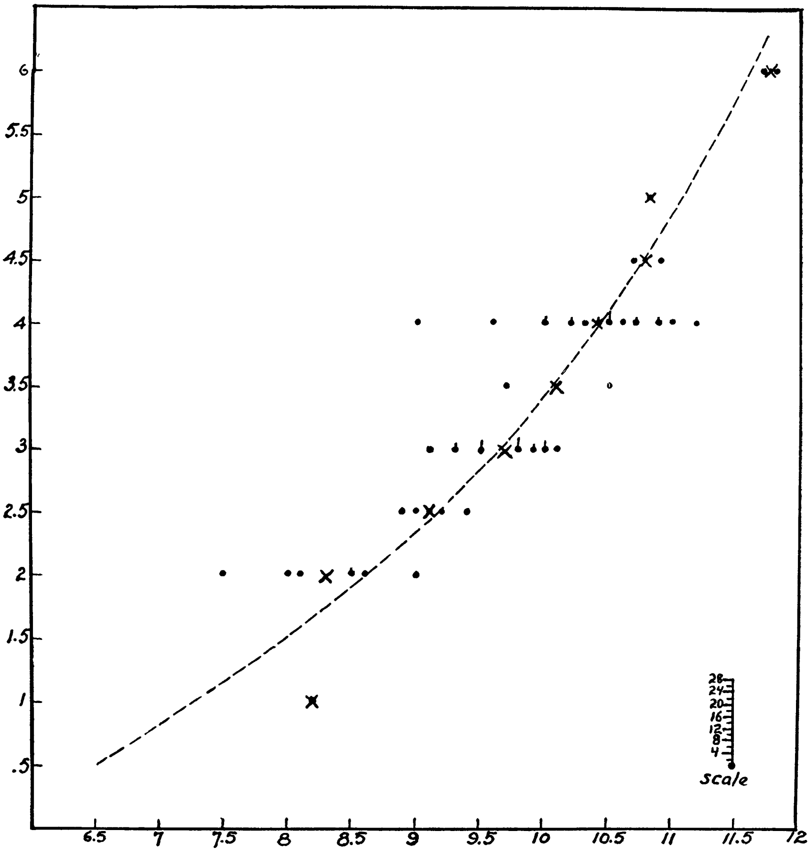

Fig. 4.—Graph showing relationships between snout-vent lengths (in tenths of centimeters on the abcissa) and weights (in half ounces on the ordinate) in males. Number of individuals possessing a given combination is indicated by a vertical line from the appropriate point; the scale for number of individuals is indicated in the lower right corner of the graph. Average lengths of individuals with a given weight are indicated by an X. The portion of the curve provided by significant points is indicated by a solid line; the remainder, obviously hypothetical, is indicated by a dashed line.

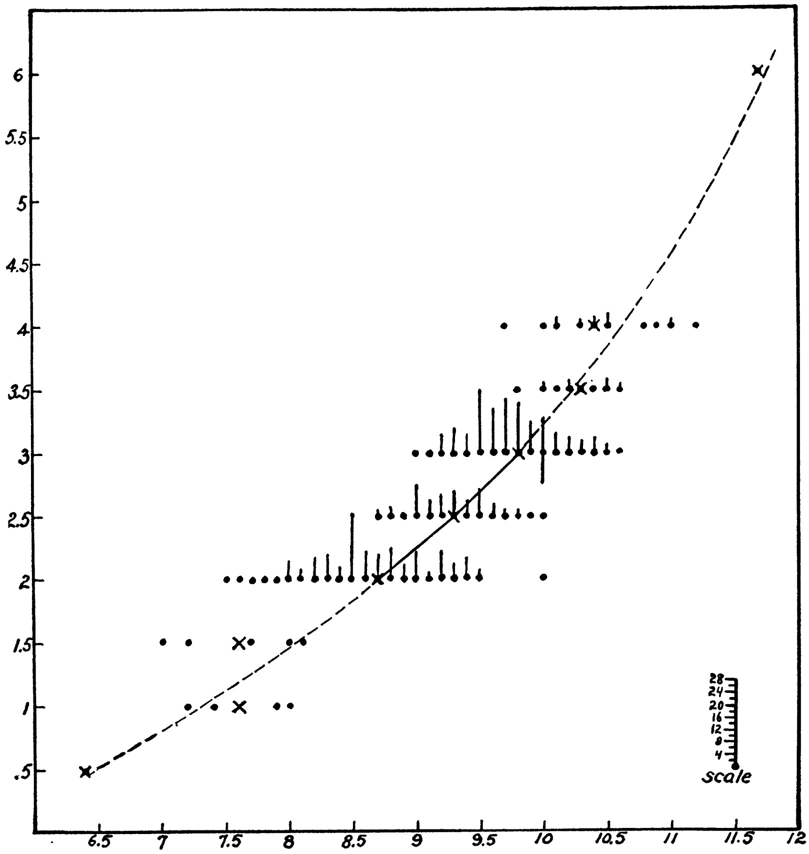

Fig. 5.—Weight and snout-vent relationships in females, plotted as in Fig. 4.

in diameter, inner envelopes about 3.15 mm., and outer envelopes about 4.5 to 5.0 mm. in diameter. Illinois eggs have vitelli 1.91 to 2.18 mm. in diameter (average 2.05 in 12), inner envelopes 2.3 to 3.1 mm. in diameter (average 2.53 mm. in 7), outer envelopes 3.9 to 4.3 mm. in diameter (average 4.03 in 6). The Illinois eggs had been preserved in formalin for 7½ years prior to measurement and study, while the Kansas eggs were measured when fresh. The discrepancies thus may well not be inherent. Furthermore, actual measurement of the Illinois eggs was difficult to perform accurately since the envelopes and even the vitelli were distorted.

The most reliable difference between the eggs of *R. pipiens* and *R. areolata* appears to be in size of the vitellus, which is almost invariably larger in the latter species.

TADPOLES

General Appearance.—A medium-sized tadpole, maximum total length before metamorphosis about 65 mm.; tail tip somewhat attenuated and elongate, sharply pointed; dorsal crest extended forward to the level of the rear edge of the spiracle; latter sinistral, on the lateral axis, directed posteriorly and somewhat upward. Tail fins equally pigmented above and below; spots on tail small (about 1 mm. in diameter) diffuse, scattered irregularly at intervals about equal to their own diameter. Pattern of body indecipherable.

Mouthparts.—Labial teeth in $^2/_3$ rows. Entire disk surrounded by a fringe of papillae except a median zone of the upper labium but little shorter than the outer row of teeth; papillary fringe indented laterally; inner row of teeth in upper labium divided medially by a space about $^3/_7$ the length of either half. Tooth rows in lower labium subequal in length (the outer slightly the shortest) but little shorter than the outer row of the upper labium.

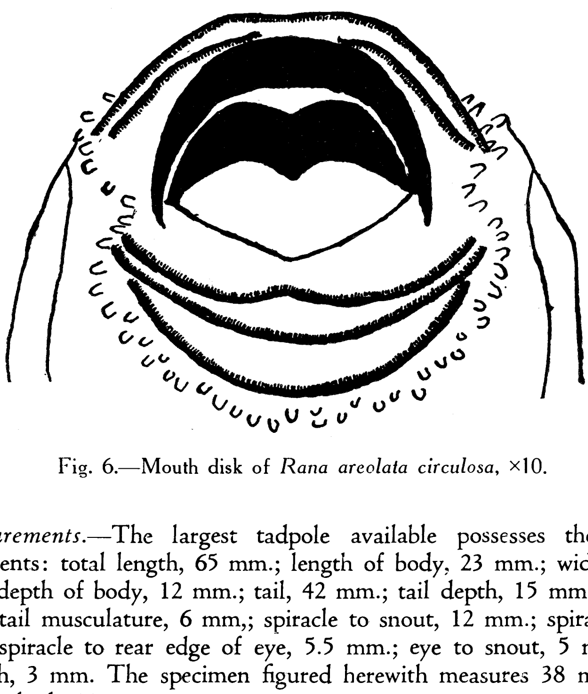

Fig. 6.—Mouth disk of *Rana areolata circulosa*, ×10.

Measurements.—The largest tadpole available possesses the following measurements: total length, 65 mm.; length of body, 23 mm.; width of body, 15 mm.; depth of body, 12 mm.; tail, 42 mm.; tail depth, 15 mm.; maximum depth of tail musculature, 6 mm,; spiracle to snout, 12 mm.; spiracle to vent, 11 mm.; spiracle to rear edge of eye, 5.5 mm.; eye to snout, 5 mm.; mouth disk width, 3 mm. The specimen figured herewith measures 38 mm. in total length, the body 18 mm.

Comparisons.—Condition of the body of these tadpoles is such that no comparisons with other species are warranted. The mouthparts, however, furnish details sufficiently unaltered that differences observed may be considered reliable.

The chief distinction between the mouthparts of this and other species appears to be the relatively very narrow interruption between the two halves of the inner row of teeth of the upper labium. In no other *Rana* of the United States with a labial formula of $^2/_3$ is that space less than the length of either half of the tooth row; *R. sphenocephala* represents perhaps the closest approach, with a reduction of the space to $^1/_2$ of the length of either half of the tooth row. All other species are readily eliminated on the basis of this character and the formula of $^2/_3$ labial teeth.

Among the three mature tadpoles available, one possesses a median space in the second upper row about $^4/_7$ the length of either toothed half; in both other specimens the space is much shorter. However, in two transforming tadpoles with well-developed hind legs but no external evidence of forelegs, the median space is even longer than either half of row 2. We attribute the condition in the latter two to the labial degeneration that accompanies metamorphosis, inasmuch as the upper labium in both specimens is reduced in size.

It may perhaps safely be stated then that the median space in the second labial row of *R. areolata circulosa* varies under normal conditions from about $^2/_7$ to $^4/_7$, and is usually less than $^1/_2$, the length of either toothed half.

From *R. sphenocephala,* no doubt, many specimens could be distinguished by the very short median space, but fortunately another character apparently will readily distinguish all specimens: the relative length of the fifth (lower) row of teeth and the mandible. They are subequal or the row of teeth is longer in *R. areolata circulosa,* while in *R. sphenocephala* the row is always shorter than ($^1/_6$ to $^1/_5$) the horny beak.

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