The Status of *Hyla phaeocrypta* with Notes on its Variation

By M. B. Mittleman

NOT long ago I had occasion to examine the tree frog currently referred to *Hyla avivoca* Viosca, and was struck by the marked similarity between this species and *Hyla versicolor* LeConte. Wright and Wright (1933: 109) consider these frogs to be distinct species, whereas Burt (1938: 344) does not find the diagnosis very convincing, conceding only the difference in voice in *avivoca*. The Wrights give a few ratios tending to separate *avivoca* and *versicolor,* and make mention of certain characteristics of color, which, unfortunately, are difficult to discern in many preserved specimens. I now believe that the earlier name, *Hyla phaeocrypta* Cope, must be applied to the species described by Viosca.

Thinking that biometric analysis might yield a more concrete definition of the species, I endeavored to borrow as much of the preserved *avivoca* material as possible, and also to obtain a few living examples. In all, not including type material, I had available 101 preserved *avivoca,* and four living specimens, which were ultimately preserved. For comparative purposes I had 66 *versicolor,* chiefly from the Mississippi Valley states wherein *avivoca* is known to occur. From each of these specimens eleven measurements of limbs and other structures were taken, and in turn from these data thirteen ratios were computed. With these data, plus certain other information, it was found possible to diagnose and limit *avivoca* definitively. The status of *Hyla versicolor phaeocrypta* Cope relative to *avivoca* and *versicolor* afforded the next problem. Mr. Karl P. Schmidt suggested that the problem of the status of *phaeocrypta* might be solved by biometric comparisons of the type with my data. The type of *phaeocrypta* was accordingly studied in detail for this purpose.

Cope's description of *phaeocrypta* was based on a single preserved frog (USNM 12074), collected by Lucien M. Turner at Mt. Carmel, Wabash County, Illinois. His comments (1889: 375) are brief, and beyond some references to color and pattern, and the statement that in its integument and feet it is of the *versicolor* kind, not very much can be derived from the description. Other than to state that in its dimensions it bears a general resemblance to *Hyla femoralis,* Cope offers no mensural data on his new form. He named it *Hyla versicolor phaeocrypta.* Various writers from time to time either listed the name provisionally, or used it in a nominal sense for various superficial varieties of *versicolor.*

As Viosca reported in 1928, the type of *phaeocrypta* is not well preserved as to color, and is somewhat soft. It is in much better condition than many of Cope's types, however, and despite fading it still shows some traces of pattern and may be measured with accuracy. Viosca (*op. cit.*) considered the type of *phaeocrypta* to be a "fairly typical specimen of *Hyla versicolor* . . . well within the range of individual variations normally exhibited by that species." It is, despite its imperfect preservation, manifestly a smooth-skinned frog. Probably at no time did it ever bear the warts and rugosites so characteristic of *versicolor,* even allowing for the exigencies of indifferent preserva-

tion. If it is compared with specimens of *versicolor* that have been preserved for an equal length of time, these latter, while smoother in general appearance than freshly preserved material, still have a characteristically pustulose and papillar dorsal surface. Secondly, the type is a male, and although the viscera are somewhat displaced because the stomach is crammed almost to the bursting-point with insects, the gonads can be observed to be large and well developed. Without doubt, the type represents an adult male frog, taken during or near the breeding season. This fact, coupled with a snout-anus measurement of 30.7 mm., eliminates the animal from the *versicolor* category; the latter form is not sexually mature in the male until a length of about 40 mm. or slightly more is attained, as I gather from material I have examined.

The *phaeocrypta* type has, as Cope pointed out (*loc. cit.*), the subocular light spot and general form and structure associated with *versicolor*. By elimination, Cope's frog can only be *versicolor* or the species subsequently described as *avivoca*. The subocular light spot is common to both forms. In the type of *phaeocrypta* definitive color is lacking, the specimen being of a fairly uniform light brown, save for some barely discernible pattern on the dorsum and limbs. It is necessary to examine the specimen biometrically, and compare the data obtained with the norms and variations known for series of the two species to determine its identity.

In the following tables, digests of the mensural and proportional data of 91 sexually mature male *"avivoca"* and 50 sexually mature male *versicolor* are given. The former are largely from the type locality (Mandeville, Louisiana) of *avivoca* and immediately adjacent areas, although specimens representing nearly every known general locality where the species occurs have been included. The *versicolor* series is a homogeneous sample of 40 specimens taken from a single chorus at Indianapolis; the remaining specimens have come from the Mississippi Valley in Illinois, Kentucky, Missouri and Tennessee.

It is immediately obvious from these data that the types of Cope's *phaeocrypta* and Viosca's *avivoca* (which is also a sexually mature male) are very similar, and both fall easily within the variational limits found for the *avivoca* series. In all discrete data, the *avivoca* form is manifestly a smaller animal than *versicolor*. Proportionately, it is characterized by a longer hind limb, greater interocular and internasal spaces, a smaller tympanum, and a larger eye. Certain other trends seem indicated, but my data are not extensive enough to confirm them. Unfortunately, while these mensural and proportional data are useful for defining populations, the overlap in most instances is so great as to strongly restrict their usefulness in the identification of individual specimens save where the standard deviations and d/σ (in connection with the areas and ordinates of the normal curve) are employed as well. An exception to this is the ratio of the diameter of the tympanum to the diameter of the eye, in which no overlap appears. Tympanic measurements are taken across the greatest diameter of this organ on the rim of the tiny ridge it bears, while the diameter of the eye is measured horizontally from the angles formed by the lids; measurements were taken with a vernier-scale caliper under low magnification, and such accuracy is essential.

TABLE I

	avivoca			*versicolor*			type *phaeocrypta*	type *avivoca*
snout-anus length	29.0–	*33.9* (2.2)	–40.0	40.0–	*44.8* (2.4)	–50.0	30.7	32.0
head length	9.0–	*10.7* (.74)	–13.0	12.0–	*13.5* (.76)	–15.0	9.1	9.2
head width	11.0–	*12.5* (.79)	–14.0	14.0–	*16.3* (1.0)	–18.5	11.2	12.0
intertympanic width	9.0–	*10.5* (.62)	–12.0	12.0–	*13.3* (.73)	–15.5	9.0	9.5
diameter eye	3.0–	*3.8* (.29)	–4.5	4.0–	*4.1* (.26)	–5.0	3.7	4.0
diameter tympanum	1.25–	*1.60* (.16)	–2.00	2.0–	*2.5* (.25)	–3.0	1.5	1.6
internasal space	2.5–	*2.9* (.28)	–3.5	2.7–	*3.4* (.31)	–4.0	2.6	3.0
interocular space	3.0–	*3.5* (.37)	–4.5	3.5–	*4.0* (.33)	–5.0	3.0	3.2
hind limb length	43.0–	*51.0* (3.7)	–61.0	55.0–	*62.0* (3.5)	–70.0	46.0	49.0
4th toe length	12.0–	*15.1* (1.5)	–18.0	17.5–	*19.8* (1.2)	–23.0	14.0	15.5
3rd finger length	8.0–	*10.4* (.89)	–12.5	12.0–	*14.3* (.85)	–16.0	10.0	10.0

Measurements of 91 sexually mature male *Hyla avivoca*, 50 sexually mature male *Hyla v. versicolor*, the type of *Hyla versicolor phaeocrypta*, and the type of *Hyla avivoca*. Italicized figures are means, parenthetical figures are the standard deviations.

TABLE II

	avivoca			*versicolor*			type *phaeocrypta*	type *avivoca*
snout-anus/hind limb minus 4th toe	86.0–	*97.0* (6.54)	–120.0	94.0–	*107.0* (5.46)	–120.0	96.0	96.0
4th toe/snout-anus	39.0–	*44.0* (2.21)	–50.0	41.0–	*44.0* (1.83)	–48.0	45.5	48.5
4th toe/hind limb	25.0–	*31.0* (1.57)	–33.0	28.0–	*32.0* (1.27)	–35.0	30.4	31.6
snout-anus/hind limb	62.0–	*68.0* (2.84)	–74.0	66.0–	*71.7* (3.00)	–78.0	66.7	65.2
tympanum/eye	33.0–	*43.0* (2.90)	–47.5	50.0–	*60.0* (5.80)	–71.0	40.0	40.0
interocular/snout-anus	8.0–	*10.3* (.94)	–13.3	7.7–	*8.9* (.70)	–10.7	9.7	10.1
internasal/snout-anus	7.1–	*8.5* (.75)	–10.0	6.4–	*7.9* (.58)	–8.9	8.4	9.3
tympanum/snout-anus	3.7–	*4.7* (.41)	–5.7	4.7–	*5.6* (.44)	–6.6	4.8	5.0
eye/snout-anus	9.3–	*11.1* (.72)	–12.7	8.0–	*9.3* (.68)	–11.3	12.0	12.5
head length/snout-anus	26.7–	*31.8* (1.73)	–35.0	28.1–	*30.1* (1.09)	–32.6	29.6	28.7
head width/snout-anus	29.4–	*36.3* (1.83)	–39.4	30.5–	*35.7* (1.67)	–39.1	36.5	37.5
head length/head width	74.0–	*87.5* (4.02)	–96.0	78.5–	*84.7* (3.68)	–96.5	81.2	76.5
head length/intertympanic	91.2–	*102.9* (4.06)	–115.0	93.5–	*101.5* (3.06)	–108.2	101.0	96.8

Proportions of 91 sexually mature male *Hyla avivoca*, 50 sexually mature male *Hyla v. versicolor*, the type of *Hyla v. phaeocrypta*, and the type of *Hyla avivoca*. Italicized figures are means, parenthetical figures are standard deviations.

The pattern of the type of *phaeocrypta* is in no way unique, and is duplicated by many of the Louisiana specimens; mensurally and proportionately the *phaeocrypta* type is in accord with the known variations of undoubted *avivoca;* it seems clear then, that Cope's *phaeocrypta* and Viosca's *avivoca* represent the same species, which must be known as *Hyla phaeocrypta* Cope.

Hyla phaeocrypta occurs from southern Illinois (Jackson, Richland, Alexander, and Wabash counties) through the Mississippi Valley to Louisiana (excluding the swamps of the valley and the coastal plain lying to the west), thence east to Florida (Jackson, Liberty counties) and north to Georgia. In addition, I have heard the call of this species in the gum trees of the mud flats along the Wabash River on the outskirts of Terre Haute, Indiana. Harper (1933: 230) tentatively includes Burt's record (1928: 630) of *Hyla phaerocrypta* [*sic*] from Riley County, Kansas, within the range of the species; I am inclined to disregard it as a record for this form, and consider the specimen as probably referable to *versicolor.*

Of specimens extant, I have seen but three females of *phaeocrypta,* representing 2.85% of the total number studied. Carr (1940: 58), reporting on Floridian specimens, says that he has never seen a female. Females of this species must be highly secretive or else there is a significant deviation from the general sex ratio of most animal populations, for collections have been made throughout the spring and summer months when they would presumably be abroad.

Harper (*loc. cit.*), in reporting the occurrence of *avivoca* (= *phaeocrypta*) in the Ogeechee River swamp, near Louisville, Jefferson Co., Georgia, includes in his data notes on a female specimen with a snout-anus length of 49 mm., supposedly of this species. I have had only a few specimens from peripheral points in the range of *phaeocrypta* available to me; these in no discernible way differed from other material. Comparing Harper's measurement with the *avivoca* (*phaeocrypta*) snout-anus data shows that *P* equals considerably less than 0.006 ($d/\sigma = 5+$), or, that the chances of a specimen of these proportions occurring in the populations sampled are less than .06 times in 1000. In practice, these chances are about nil. Conversely, comparison with the *versicolor* data shows that *P* equals 16 ($d/\sigma = 1.4+$), or that the chances of such a specimen occurring in the *versicolor* populations are about 16 in 100, and in practice, quite good. These considerations are admittedly theoretical; if Harper's specimen is truly referable to *phaeocrypta* it probably indicates a significant size trend in Atlantic coastal populations. It seems much more likely that it is simply a *versicolor.*

Complete series of *phaeocrypta* from the larval and early post-larval stages through the subsequent years to fullest maturity are not now available; indeed, much of the life history and ecology of this animal are chiefly surmisal from fragmentary data at hand. Available specimens indicate that 29 mm. is the lower limit of size of sexually mature males; an extreme limit of 41 mm. is known for males, and 42 or 43 mm. for females. Neither the eggs nor the tadpoles have been described; quite possibly they may reflect some affinity with *versicolor,* as Wright has found to be true in the case of *Hyla femoralis* (1932: 285, 289).

Wright and Wright (1933: 229) suggest that the bird-voiced hyla breeds

from June to mid-August. Available evidence indicates an earlier season. Harper (*loc. cit.*) reports clasping on April 25, near Louisville, Georgia; Carr (*loc. cit.*) says that breeding in Florida has been observed from April 11 to July 12; Cagle (1942: 180) has found the species abroad in southern Illinois as early as March; Endsley (1937: 70, and private communication) has taken males and females together in early May in Chester County, Tennessee; I have heard the species calling in mid-April near Terre Haute, Indiana. Finally, I have examined two females taken by Viosca on April 11 (St. Tammany Parish, La.), one of which is spent, the other with the oviducts packed with ripe ova. A third female, taken in St. Tammany Parish, but on June 12, is also gravid and greatly distended with ova. These data point to a breeding season extending from early April to the middle of July, depending on local conditions.

Fig. 1. Left to right, type, *Hyla phaeocrypta,* USNM 12074, Mt. Carmel, Wabash Co., Ill., actual length snout to anus, 30.7 mm; juvenile *Hyla v. versicolor,* USNM 17360, Great Falls of the Potomac, Montgomery Co., Md., actual length snout to anus, 22 mm; type, *Hyla avivoca,* USNM 75017, Mandeville, St. Tammany Parish, La., actual length snout to anus, 32 mm.

The highly distinctive voice of *phaeocrypta* need be confused with no other North American hylid save possibly *Hyla crucifer.* It does not take a particularly keen ear to distinguish the voices of these two species. The call of *phaeocrypta* is lower-pitched, and is usually composed of a short trill, followed by several piping, or whistling notes. The call of *crucifer* usually consists of a number of whistles, all of about equal length. The difference between these calls can be shown thus: —..... (*phaeocrypta*); — — — — — — — — — — (*crucifer*). The similar-appearing *versicolor* has a call quite unlike that of *phaeocrypta,* for it is a coarse, toad-like trill, relatively low-pitched. The call of *Hyla femoralis,* which in appearance at least, is similar to *phaeocrypta,* is a coarse, grating, staccato

croaking repeated in rapid succession several times a minute, described by Harper (in Wright, 1932: 278) as *kek-kek,* and ending with a *krak-krak.*

The texture of the skin is difficult to describe but *phaeocrypta* is a much smoother-appearing animal than *versicolor.* Where the latter is dorsally warty or pebbled, the former is but finely granular, or in preserved material quite smooth. The smallest *versicolor* is usually much coarser-skinned than the largest *phaeocrypta* (see cut).

There is little difference in the color and pattern of *phaeocrypta* and *versicolor.* The markings are possibly slightly less massive dorsally and tend to be somewhat more posteriorly situated in the former. In living and freshly preserved specimens of *phaeocrypta* the most outstanding point of difference is the bright green color of the axillary and inguinal areas and the postfemoral surfaces. In *versicolor,* this hue is replaced by a golden or orange wash. Unfortunately, these pigments seem quite soluble and are not discernible in most preserved specimens.

The ecological differences between *phaeocrypta* and *versicolor* are not understood. While the mechanical barrier of size probably aids in preventing interbreeding, other factors must surely be operative. Wherever *phaeocrypta* has been taken, *versicolor* has also been found. They apparently breed at the same time, in the same waters, and share the same general ecological niche. The barriers that separate these sympatric forms are, by elimination, probably physiological. The two species are remarkably similar, yet surely genetically distinct. A field study of the relationships of *phaeocrypta* and *versicolor,* of *versicolor* and *femoralis,* and where they occur in the same general region, of *femoralis* and *phaeocrypta,* might solve some of the problems involved.

The more obvious characteristics of *phaeocrypta* and *versicolor* may be summarized as follows:

phaeocrypta

1. Call a piping, bird-like whistle.
2. Dorsal skin finely granular, or quite smooth.
3. Inguinal and postfemoral areas with a bright green wash.
4. Minimum male breeding size 29 mm., maximum size 41 (♂) or 43 (♀) mm.
5. Hind limb proportionately longer: ratio snout-anus/hind limb averages 68% (range 62.0–74.0%).
6. Interocular space proportionately greater: ratio interocular/snout-anus averages 11.4% (range 8.0–13.3%).
7. Internasal space proportionately greater: ratio internasal/snout-anus averages 8.5% (range 7.1–10.0%).
8. Tympanum proportionately smaller, eye proportionately larger: ratio of tympanum/eye averages 43.0% (range 33.0–47.5%).

versicolor

1. Call a toad-like trill.
2. Dorsal skin warty or heavily pustulose.
3. Inguinal and postfemoral areas suffused with orange or golden.
4. Minimum male breeding size 40 mm., maximum size 51 (♂) to 60 (♀) mm.
5. Hind limb proportionately shorter: ratio snout-anus/hind limb averages 74% (range 66.0–78.0%).
6. Interocular space proportionately smaller: ratio interocular/snout-anus averages 8.9% (range 7.7–10.7%).
7. Internasal space proportionately smaller: ratio internasal/snout-anus averages 7.9% (range 6.4–8.9%).
8. Tympanum proportionately larger, eye proportionately smaller: ratio of tympanum/eye averages 60% (range 50.0–71.0%).

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470 PELHAM ROAD, NEW ROCHELLE, NEW YORK.

Water Goggling: A New Method for the Study of Turtles [1]

By LEWIS J. MARCHAND

THE large, crystal-clear, spring runs of Florida hold great promise for the student of natural history. These interesting streams, clear to depths up to a hundred feet and more, with an abundant fauna and flora, and constant year-round temperature, offer almost unparalled opportunities for the study of the life-histories of many animals. In my own studies of turtles I have long felt that the natural history resources of these streams warranted a search for something better than the routine methods of trapping, seining, and the use of baited lines.

Water goggles were first extensively introduced upon the market in 1936, and were at this time of the two eyepiece type. These were not entirely satisfactory, since the diverging eyepieces do not permit the focussing of both

[1] A contribution from the Department of Biology, University of Florida.