

AMPHIBIANS AND REPTILES OF
THE RIO CHUCUNAQUE DRAIN-
AGE, DARIEN, PANAMA, WITH
NOTES ON THEIR LIFE HIS-
TORIES AND HABITS

C. M. BREDER, JR.

BULLETIN
OF THE
AMERICAN MUSEUM OF NATURAL HISTORY
VOLUME 86 : ARTICLE 8 NEW YORK : 1946

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LIFE HISTORIES AND HABITS

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VOLUME 86 : ARTICLE 8

NEW YORK : 1946

BULLETIN OF THE AMERICAN MUSEUM OF NATURAL HISTORY

Volume 86, article 8, pages 375–436, text figures 1–25,
plates 42–60, tables 1–11

Issued August 26, 1946

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INTRODUCTION

UP TO THE TIME OF ENTRY of the Marsh-Darien Expedition in 1924 that portion of the province of Darien in eastern Panama drained by the Rio Chucunaque had never been explored from a zoological standpoint. Herpetological interests were the prime concern of the author, who represented the American Museum of Natural History. Other interests served by the author have already been the subject of publications (Breder, 1925a, 1925b, 1925c, 1925e, 1925f, 1927b; and Gudger and Breder, 1928). General accounts of the expedition have been given by Breder (1925d) and Marsh (1934).

In addition to the accumulation of a representative collection of reptiles and amphibians from this hitherto unknown region, the work included as much study of life histories and habits as the conditions permitted. Naturally, this effort took the major portion of the actual field activities and no doubt militated against the collecting of larger series of preserved material. However, it is still considered that the time so spent was actually of more fundamental value than the simple collecting of large series without other than locational data. The original intent was to work up the material fully and publish jointly with Dr. G. K. Noble, at that time Curator of Herpetology at the American Museum of Natural History. In the meantime Dr. E. R. Dunn has examined the collection taxonomically and identified the entire material. Two forms he named as new species, *Eleutherodactylus brederi* and *Hyla subocularis* Dunn (1934). Other comments published by him are mentioned in connection with the species under consideration.

A map of the region is given in figure 1. A map showing the itinerary of the expedition has already been published by Breder (1927b). The following general description of the region is adapted from this source, amended with modifications to cover the non-aquatic regions which were not discussed in that paper.

The Rio Chucunaque and its tributaries run through unbroken, virgin jungle for nearly their entire lengths. The Negro village

of Yavisa, not far distant from its mouth, is the only settlement that was found on the main river, save for a few scattered huts, the Indians living only on the numerous tributary streams. These villages form the only breaks in the otherwise solid jungle walls flanking either shore. Up to and beyond the mouth of the Rio Membrillo the Chucunaque wanders through a plain, as its extensive meandering indicates. The exact width of this was not determined, on account of the dense growth flanking the stream, although numerous excursions proved that it must be considerable. Above this point the hills begin to close in slowly and the river straightens out very slightly. The Rio Sucubti, up which the expedition branched on the main trip, runs rapidly into the Serrania del Darien, and one is here confronted by a series of difficult rapids over which we spent much time and effort.

In most places the vegetation reaches to the water and overshadows its edges, while in some a fringing beach delimits water from jungle. The almost complete lack of aquatic vegetation of this drainage system was rather unexpected. This might have been anticipated in the lower turbid and tidal portion of the river, but hardly in the clear upper part. Aside from small patches of filamentous algae, nothing was seen except a small amount of *Azzola* just below the mouth of the Rio Membrillo, and from here upwards a small amount of a *Lemna*-like form was occasionally seen mixed with it. This is the total number of aquatic plants seen. None whatever of entirely submerged higher plants was found. On the other hand numerous reed-like forms growing along the banks with just their roots submerged were common. However, much submerged brush was encountered, especially on the upper courses, and this formed excellent cover for fishes which might be expected in weedy places. How the floating aquatic plants are able to withstand the tremendous floodings to which these streams are subject in the rainy season is not clear.

The great Pacific tides have their effect on the Chucunaque about as far inland as the

mouth of the Rio Canglon. This makes a very unpleasant river in its lower reaches, as extensive mud flats flanking both banks are exposed on each receding tide. Just below Yavisa, at the first base camp (Camp Townsend), the rise and fall of tide was carefully studied by Dr. H. L. Fairchild of the University of Rochester, who found the extreme differences in water level, as recorded by him, to amount to 6 feet. The spring tides at Panama City sometimes reach 17 feet. Realizing this, it is not hard to understand the great tidal variation so far inland in this stream that travels for such a distance at practically its base level.

As a result of these tides, the lower reaches are bottomed with soft flocculent mud for the most part, except where some current vagary sweeps clean a sand or gravel bar. The upper reaches, above the effect of tide, are bottomed chiefly by a soft, decomposing, calcareous rock, while on the side streams boulders make their appearance, graduated in size, becoming extremely large as the foothills are approached.

The temperatures of the various waters were taken irregularly and only as more important duties allowed. A general decline in temperature as the river was ascended and also the cooling effect of quantities of rain water entering the streams were noted.

The life zones of the region were found to be in general agreement with those shown on the map of Goldman (1920). Certain minor modifications are indicated in figure 1. A "tongue" of the arid lower tropical zone follows up the Chucunaque to about the mouth of the Rio Membrillo similar to that shown by Goldman to follow up the Rio Tuyra. A very small extension of the humid lower tropical zone extends toward the junction of the Chucunaque and Tuyra, changing conditions markedly on the upper course of two small streams collected in near the Yavisa base camp. A small "tongue" of the arid lower tropical zone follows up each of the

side streams below the Membrillo also, but for a very short distance. At the extreme headwaters of the Rio Sucubti and its tributaries, near the continental divide, a narrow ribbon of the upper tropical zone is again encountered, but, once over the divide, one is immediately plunged again into the humid lower tropical zone. This is in keeping with Goldman's views as to the upper tropical zone's dropping down rather low on the south side of these mountains, dependent on their altitude, and although he does not show it on his map, it seems likely that a slight band of this zone runs for a considerable distance, with few interruptions along this slope of the divide.

Much of the work was done at night, for it was found that only then could one have any reasonable assurance of getting a representative collection of the numerous frogs of the region. As a consequence of this, even after thorough accommodation to field conditions, a rather strenuous day resulted, generally reaching from about 6 A.M. to midnight at least, with little time out. The "siesta" period was usually occupied with writing up notes and caring for specimens.

Incidental to the work of this expedition, various small collections and lesser observations were made in regions not within the Chucunaque drainage. These include sites in and near the Canal Zone and on the Atlantic side of the isthmus in the region of Caledonia Bay. Such material and data are considered along with remarks under the appropriate specific headings.

The field work within the drainage of the Rio Chucunaque commenced when camp was pitched below Yavisa on February 8 and terminated when the continental divide was crossed on foot at Caledonia Pass on May 2, 1924.

The itinerary of the entire trip, indicating the times of field work in reference to the various localities, is indicated in the following list.

ITINERARY OF THE MARSH-DARIEN EXPEDITION OF 1924

	ARRIVAL	DE- PARTURE
CANAL ZONE		
Colon	Jan. 23	Jan. 29
Panama City	Jan. 29	Feb. 5
DARIEN		
Camp Townsend, lower Rio Chucunaque	Feb. 8	Mar. 29
Side trips from Camp Townsend		
Chico village, Rio Chico	Feb. 16	Feb. 21
Rio Tupisa	Feb. 26	Feb. 27
Rio Canglon	Feb. 27	Feb. 28
Rio Tuquesa	Mar. 2	Mar. 5
Rio Tupisa	Mar. 23	Mar. 24
Journey up the Rio Chucunaque		
Rio Canglon (overnight camp below mouth)	Mar. 29	Mar. 30
Rio Sansan (overnight camp above mouth)	Mar. 30	Mar. 31
Rio Metiti (overnight camp below mouth)	Mar. 31	Apr. 1
Rio Membrillo (overnight camp at mouth)	Apr. 1	Apr. 2
Rio Chiati (overnight camp above mouth)	Apr. 2	Apr. 3
Overnight camps between mouth of the Rio Chiati and the mouth of the Rio Sucubti	Apr. 3	Apr. 9 (6 camp sites)
Journey up the Rio Sucubti		
Base camp on lower Rio Sucubti	Apr. 9	Apr. 18
Higher camp (overnight)	Apr. 19	Apr. 20
Still higher camp (overnight; cloudburst)	Apr. 20	Apr. 21
Sucubti village	Apr. 21	May 1
Caledonia village (Atlantic coast)	May 2	May 19
CANAL ZONE		
Colon (hospital)	May 21	June 23
Panama City	June 23	June 25
Colon	June 25	June 29

Observations on the temperature, humidity, and barometric pressure were made at the base camp near Yavisa (Camp Town-

send) by Prof. Herman L. Fairchild for the duration of our stay at that place. In so far as practicable these readings were taken every hour, on the hour. The accumulated data are given in tables 1, 2, and 3, respectively. They give a good measure of the atmospheric conditions at this place for the period covered. Mean and extreme values are presented in table 4 for the three kinds of measurement. From this table it is clear that there was no significant drift in any of these features for the entire period.

The mean values for the entire period of observation and the extremes reached are presented graphically in figures 2, 3, and 4. These show clearly the diurnal variations and indicate the very considerable uniformity of the weather at this place during this period. It will be noted that the daily temperature rise corresponds closely to the drop in relative humidity and the drop in barometric pressure. Reference to table 4 which indicates the number of observations on which each mean is based explains the slight irregularities in the night time readings, when fewer readings were taken. These graphs tend to exaggerate the differences in the measurements, for actually the changes cannot be considered great in any case. The extreme range in temperature was from 35.5° to 20° C., the relative humidity ranged from 100 to 40 per cent and the barometric pressure varied from 29.985 to 29.580 inches of mercury. Temperatures of water and air in other localities were taken when possible and are given in table 5. Data that may be compared with the above are given for Barro Colorado by Park (1938) and Park, Barden, and Williams (1940).

A four-year average of rainfall at Garachiné Point, obtained by Dr. Dunn from the records of the Canal Zone Weather Bureau, is given below by months in inches:

Dec.	3.09	June	7.44
Jan.	2.39	July	6.70
Feb.	0.50	Aug.	6.14
Mar.	0.54	Sept.	5.24
Apr.	1.96	Oct.	10.15
May	10.00	Nov.	11.11

Total 65.26

TABLE 3—Continued

	11	12	13	14	15	16	17	18	19	March 20	21	22	23	24	25	26
Midnight	—	—	.900	—	—	—	—	—	—	—	—	—	—	—	—	—
1	—	—	—	—	—	—	—	—	—	—	—	.860	—	.925	—	—
2	—	—	—	—	—	—	—	—	—	—	.825	—	—	—	—	—
3	—	—	—	—	—	.825	—	—	—	.755	—	—	—	—	—	—
4	—	—	—	.835	.790	—	—	—	—	—	—	—	—	—	.930	—
5	—	—	—	—	—	—	.870	—	—	—	—	—	—	—	—	—
6	—	.895	.940	—	—	—	—	—	.820	—	—	.920	.930	.955	—	.930
7	—	.900	.940	.880	.850	.865	.910	.910	.850	.815	.875	.920	.950	.965	.980	—
8	—	.920	.920	.885	.855	.870	.915	.920	.830	.830	.890	—	.955	.960	.990	—
9	—	.900	.900	.840	—	.850	.910	.900	.820	.830	.870	—	—	—	.950	—
10	.840	.860	.880	.800	.820	.850	.885	.870	.790	.795	—	—	.930	.915	.920	—
11	.770	.835	.840	.770	.795	.805	.850	.840	.795	.755	—	.875	.895	—	.885	—
Noon	.745	.775	.770	.685	.740	.745	.840	.755	.680	.710	.740	.870	.860	.820	.840	—
1	.710	.775	.770	.640	.660	.690	.825	.710	.610	.670	.700	.810	—	.765	.790	—
2	.650	.760	.690	.650	.650	.640	.850	.660	.585	.640	.670	.790	.785	.735	.760	—
3	.645	—	.675	—	—	.640	.850	.660	.580	.640	.675	.790	.775	.750	—	—
4	—	.750	.710	.620	.670	—	.835	.660	.590	.640	.720	.750	.760	.760	.780	—
5	.695	—	—	.650	—	—	.830	.670	.615	.700	.780	.770	—	.810	.810	—
6	.720	.815	—	.680	.750	—	.835	.725	.650	.725	.815	.800	.830	.880	.850	—
7	—	—	—	—	—	—	—	—	—	.840	—	—	—	—	—	—
8	.820	.900	.830	—	.835	.825	.860	.790	—	.800	.850	.860	.875	—	.910	—
9	—	—	—	.785	—	—	—	—	.770	—	—	.880	—	.940	.940	—
10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
11	—	—	.870	—	—	—	—	—	—	—	—	—	—	—	—	—

TABLE 4

TEMPERATURE, HUMIDITY, AND AIR PRESSURE AT CAMP TOWNSEND
(Mean, maximum, and minimum values from tables 1, 2, and 3 by hours, through two months.)

Temperature in Degrees Centigrade												
February					March				Both Months			
H. ^a	N. ^b	Min.	Mean	Max.	N.	Min.	Mean	Max.	N.	Min.	Mean	Max.
M	(4)	21.0	23.0	25.0	(4)	21.0	22.0	23.5	(8)	21.0	22.5	25.0
1	(3)	21.0	21.5	22.0	(6)	21.0	22.5	21.0	(9)	21.0	22.0	23.5
2	(3)	20.5	21.0	21.5	(5)	22.0	23.0	24.0	(8)	20.5	22.0	24.0
3	(3)	21.0	22.0	23.0	(2)	21.0	22.0	23.0	(5)	21.0	22.0	23.0
4	(2)	23.0	22.0	21.0	(7)	20.0	22.0	23.5	(9)	20.0	22.0	23.5
5	—	—	—	—	(3)	22.0	22.5	23.5	(3)	22.0	22.5	23.5
6	(4)	20.0	21.5	23.0	(13)	20.5	22.0	23.5	(17)	20.0	22.0	23.5
7	(19)	20.0	22.0	23.5	(24)	20.5	23.0	24.0	(43)	20.0	22.5	24.0
8	(17)	23.0	24.0	25.5	(25)	22.0	24.5	25.5	(42)	22.0	24.5	25.5
9	(18)	25.0	26.0	28.0	(21)	25.5	26.5	28.5	(39)	25.0	26.0	28.5
10	(18)	26.5	28.0	29.5	(23)	26.0	28.5	30.5	(41)	26.0	28.5	30.5
11	(16)	28.5	30.0	31.5	(23)	29.0	30.0	33.5	(39)	28.5	30.0	33.5
N	(21)	27.5	31.0	33.5	(24)	27.0	31.5	34.0	(45)	27.0	31.5	34.0
1	(15)	26.0	31.5	34.0	(20)	28.5	32.5	34.5	(35)	26.0	32.0	34.5
2	(21)	27.0	32.5	34.5	(25)	28.5	32.0	34.5	(46)	27.0	32.5	34.5
3	(16)	26.5	31.5	33.5	(22)	24.5	32.0	35.5	(38)	24.5	32.0	35.5
4	(20)	26.5	31.0	33.5	(25)	24.5	30.5	32.5	(45)	24.5	30.5	33.5
5	(17)	27.0	29.5	30.5	(21)	25.0	28.5	30.5	(38)	25.0	29.0	30.5
6	(18)	28.5	26.5	21.5	(21)	24.0	27.0	29.0	(39)	24.0	26.5	29.0
7	(4)	25.5	26.0	27.0	(5)	23.5	25.0	25.5	(9)	23.5	25.5	27.0
8	(9)	23.0	24.5	26.0	(13)	23.0	24.0	25.5	(22)	23.0	24.5	26.0
9	(5)	22.0	23.5	24.5	(10)	22.0	24.0	25.5	(15)	22.0	24.0	25.5
10	(1)	—	24.0	—	—	—	—	—	(1)	24.0	24.0	24.0
11	—	—	—	—	(1)	—	21.0	—	(1)	21.0	21.0	21.0

^a H. Hour at which reading was taken.

^b N. Number of observations.

TABLE 4—Continued

Relative Humidity in Per Cent													
H.	N.	February			N.	March			N.	Both Months			
		Min.	Mean	Max.		Min.	Mean	Max.		Min.	Mean	Max.	
M	(4)	95	96	100	(4)	91	93	95	(8)	91	95	100	
1	(3)	90	92	95	(6)	89	91	95	(9)	89	91	95	
2	(3)	95	95	95	(5)	91	93	96	(8)	91	94	96	
3	(3)	99	93	95	(2)	91	93	95	(5)	89	93	95	
4	(2)	91	93	95	(7)	91	93	95	(9)	91	93	95	
5	—	—	—	—	(3)	91	93	95	(3)	91	93	95	
6	(4)	90	94	98	(13)	91	94	95	(17)	90	94	98	
7	(19)	90	94	98	(24)	90	93	99	(43)	90	93	99	
8	(17)	84	88	93	(25)	76	86	92	(42)	76	87	93	
9	(18)	75	79	83	(21)	63	76	89	(39)	63	77	89	
10	(18)	58	72	78	(23)	58	70	91	(41)	58	71	78	
11	(16)	57	68	86	(23)	52	65	77	(39)	52	66	86	
N	(21)	55	63	75	(23)	46	61	74	(44)	46	62	75	
1	(15)	46	58	73	(19)	42	61	74	(34)	42	60	74	
2	(21)	48	59	76	(25)	40	56	77	(46)	40	57	77	
3	(16)	48	62	79	(22)	45	59	96	(38)	45	60	96	
4	(20)	49	62	82	(25)	43	60	91	(45)	43	61	91	
5	(17)	59	70	86	(21)	52	67	94	(38)	52	70	94	
6	(19)	69	79	94	(21)	61	77	91	(40)	61	78	94	
7	(3)	75	80	87	(5)	75	81	91	(8)	75	81	91	
8	(9)	75	84	89	(13)	73	85	96	(22)	73	84	96	
9	(5)	83	88	95	(10)	81	87	91	(15)	81	87	95	
10	(1)	—	91	—	—	—	—	—	(1)	91	91	91	
11	—	—	—	—	(1)	—	90	—	(1)	90	90	90	

Barometric Pressure over 29.000 Inches													
February					March				Both Months				
H.	N.	Min.	Mean	Max.	N.	Min.	Mean	Max.	N.	Min.	Mean	Max.	
M	(2)	.830	.855	.880	(1)	—	.900	—	(3)	.830	.870	.900	
1	—	—	—	—	(2)	.860	.890	.925	(2)	.860	.890	.925	
2	(1)	—	.800	—	(1)	—	.825	—	(2)	.800	.810	.825	
3	(1)	—	.860	—	(2)	.755	.790	.825	(3)	.755	.815	.860	
4	—	—	—	—	(3)	.790	.850	.930	(3)	.790	.850	.930	
5	—	—	—	—	(1)	—	.870	—	(1)	.870	.870	.870	
6	(1)	—	.920	—	(7)	.895	.910	.950	(8)	.895	.915	.950	
7	(15)	.815	.880	.950	(14)	.815	.900	.980	(29)	.815	.890	.980	
8	(14)	.850	.895	.955	(13)	.830	.900	.990	(27)	.830	.900	.990	
9	(13)	.825	.880	.940	(10)	.820	.875	.950	(23)	.820	.880	.950	
10	(16)	.800	.865	.925	(13)	.790	.860	.930	(29)	.790	.860	.930	
11	(11)	.735	.820	.895	(13)	.755	.825	.895	(24)	.735	.825	.895	
N	(19)	.730	.785	.890	(15)	.680	.770	.870	(34)	.680	.775	.890	
1	(12)	.640	.720	.795	(14)	.610	.725	.825	(26)	.610	.720	.825	
2	(17)	.625	.700	.840	(15)	.640	.700	.825	(32)	.625	.700	.840	
3	(12)	.610	.675	.750	(12)	.580	.690	.850	(24)	.580	.680	.850	
4	(17)	.605	.690	.820	(13)	.590	.710	.835	(30)	.590	.700	.835	
5	(12)	.635	.710	.800	(10)	.615	.735	.830	(22)	.615	.720	.830	
6	(14)	.695	.750	.825	(13)	.680	.775	.880	(27)	.680	.765	.880	
7	(4)	.740	.770	.840	(1)	—	.840	—	(5)	.740	.785	.840	
8	(8)	.770	.815	.875	(12)	.790	.845	.910	(20)	.770	.835	.875	
9	(1)	—	.900	—	(5)	.770	.865	.940	(6)	.770	.870	.900	
10	(1)	—	.850	—	—	—	—	—	(1)	.850	.850	.850	
11	—	—	—	—	(1)	—	.870	—	(1)	.870	.870	.870	

TABLE 5
AIR AND WATER TEMPERATURES OF THE RIO CHUCUNAUQUE DRAINAGE
(Read to the nearest full degree Centigrade.)

Date	Hour	Air	Water	Date	Hour	Air	Water
<i>Camp Creek</i>				Mar. 31	8:15 A.M.	27	29
Feb. 11	10:00 A.M.	—	28		12:30 P.M.	34	29
14	2:40 P.M.	27	24	Mouth of Rio Metiti			
22	6:15 P.M.	29	28	31	5:00 P.M.	32	30
Mar. 12	10:00 A.M.	28	26	Above Rio Metiti			
19	9:00 A.M.	26	25	Apr. 1	7:45 A.M.	26	29
<i>Three Falls Creek</i>					12:30 P.M.	27	29
Mar. 17	2:40 P.M.	28	26	Mouth of Rio Membrillo			
<i>Rio Chucunauque at island below Yavisa</i>				Apr. 1	5:00 P.M.	27	29
Feb. 25	3:00 P.M.	—	27		10:00 P.M.	22	28
Mar. 21	3:00 P.M.	—	30		12:00 M	22	28
Small pools		—	34	2	7:30 A.M.	25	28
<i>Rio Chucunauque at Camp Townsend</i>					11:00 A.M.	33	29
Mar. 22	7:00 A.M.	24	30	Above Rio Chioti			
	9:00 A.M.	27	30	2	3:00 P.M.	31	30
<i>Rio Chucunauque to Rio Chico</i>					8:00 P.M.	27	28
Mar. 19	2:30 P.M.			3	8:30 A.M.	24	27
Mouth Rio Chico		—	31		1:30 P.M.	28	29
Rio Chucunauque above				4	7:30 A.M.	24	28
mouth of Rio Chico		—	29		12:00 N	29	29
Juncture		—	30	5	12:30 A.M.	21	27
	2:40 P.M.				3:00 A.M.	21	27
Rio Chico, above mouth		31	30		7:45 A.M.	23	28
Juncture		31	31		11:30 A.M.	31	29
<i>Rio Chucunauque to Rio Tupisa</i>				6	7:30 A.M.	26	27
Feb. 26	3:00 P.M.				2:00 P.M.	30	29
Rio Tupisa		—	31		5:30 P.M.	27	28
Mouth of Rio Tupisa				7	11:30 A.M.	30	28
Mar. 5	2:50 P.M.	35	28		3:00 P.M.	29	28
23	5:00 P.M.	30	29		7:00 P.M.	27	28
<i>Rio Chucunauque; misc. localities</i>				8	4:00 A.M.	25	28
Near Rio Icuana					6:00 A.M.	23	27
Feb. 28	8:30 A.M.	26	27		7:00 P.M.	26	28
Below Rio Icuana					9:30 P.M.	26	28
Mar. 29	2:00 P.M.	37	31	9	9:30 A.M.	27	28
Below Rio Canglon				Mouth of Rio Sucubti			
29	4:30 P.M.	37	30		8:30 P.M.	28	28
Near Rio Canglon mouth				<i>Lower Rio Sucubti at base camp</i>			
29	8:30 P.M.	35	29	Apr. 10	4:00 P.M.	31	29
30	7:00 A.M.	24	29		8:00 P.M.	26	28
Near Rio Tuquesa mouth				11	8:00 A.M.	26	27
30	9:50 A.M.	27	29		4:30 P.M.	31	30
Below Rio Sansan					12:00 M	23	27
30	10:45 A.M.	28	29	12	9:00 A.M.	31	28
Above Rio Sansan					4:30 P.M.	29	29
30	12:45 P.M.	30	30		8:00 P.M.	27	28
	8:30 P.M.	27	28	13	3:00 A.M.	26	28
					6:00 A.M.	26	28
					12:00 N	28	28
					11:30 P.M.	24	27
				14	7:30 A.M.	26	27
					2:30 P.M.	27	27

Date	Hour	Air	Water
15	5:00 P.M.	27	27
	8:00 P.M.	25	27
	12:30 A.M.	24	27
	3:00 A.M.	24	27
	7:30 A.M.	25	26
16	6:30 P.M.	26	27
	8:30 A.M.	27	27
	4:30 P.M.	28	28
17	12:00 M	25	27
	8:00 A.M.	29	28
	1:30 P.M.	30	29
	7:30 P.M.	26	27
18	12:00 M	24	27
	3:00 A.M.	23	27
	6:00 A.M.	24	27
<i>Rio Sucubti, above base camp</i>			
19	10:00 A.M.	30	28
	5:30 P.M.	28	30
	8:15 A.M.	30	28
20	1:30 P.M.	30	29
	After cloudburst		
21	10:00 A.M.	28	25
<i>Indian village on Rio Sucubti</i>			
27	1:00 P.M.	28	26
28	3:00 P.M.	29	26
29	11:30 A.M.	26	24

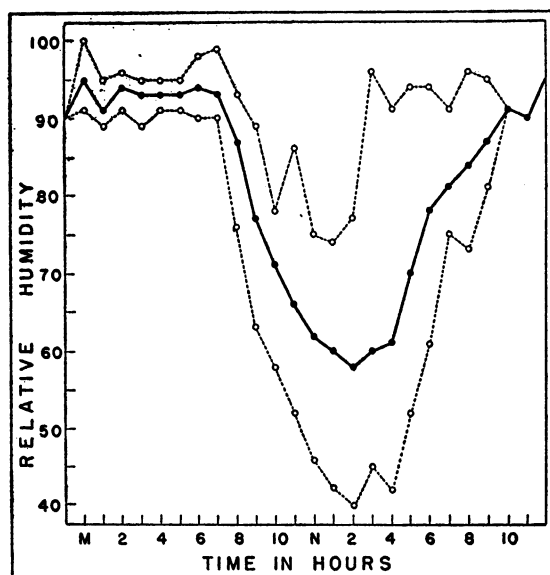


FIG. 3. Hourly relative humidity variations in percentages as measured at Camp Townsend, between February 9 and March 26, 1924. Solid line indicates mean; dotted lines indicate maximum and minimum. Based on the data of tables 2 and 4.

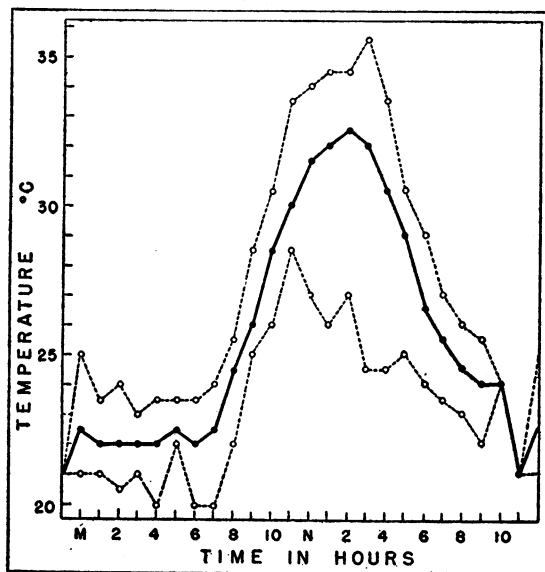


FIG. 2. Hourly temperature variations in degrees Centigrade as measured at Camp Townsend, between February 9 and March 26, 1924. Solid line indicates mean; dotted lines indicate maximum and minimum. Based on the data of tables 1 and 4.

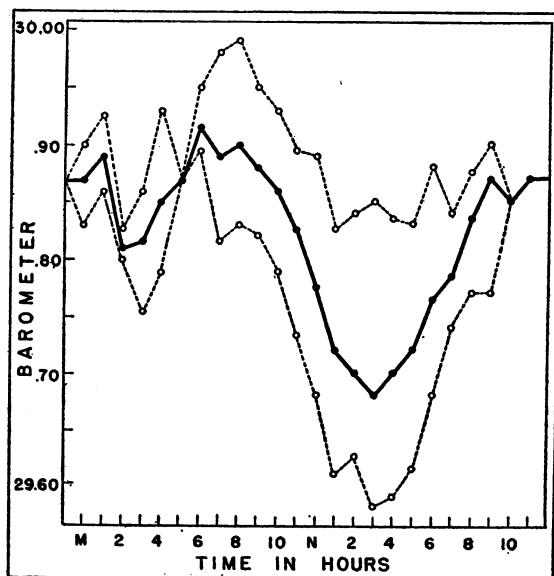


FIG. 4. Hourly air pressure in inches and decimals of mercury as measured at Camp Townsend, between February 9 and March 26, 1924. Solid line indicates mean; dotted lines indicate maximum and minimum. Based on the data of tables 3 and 4.

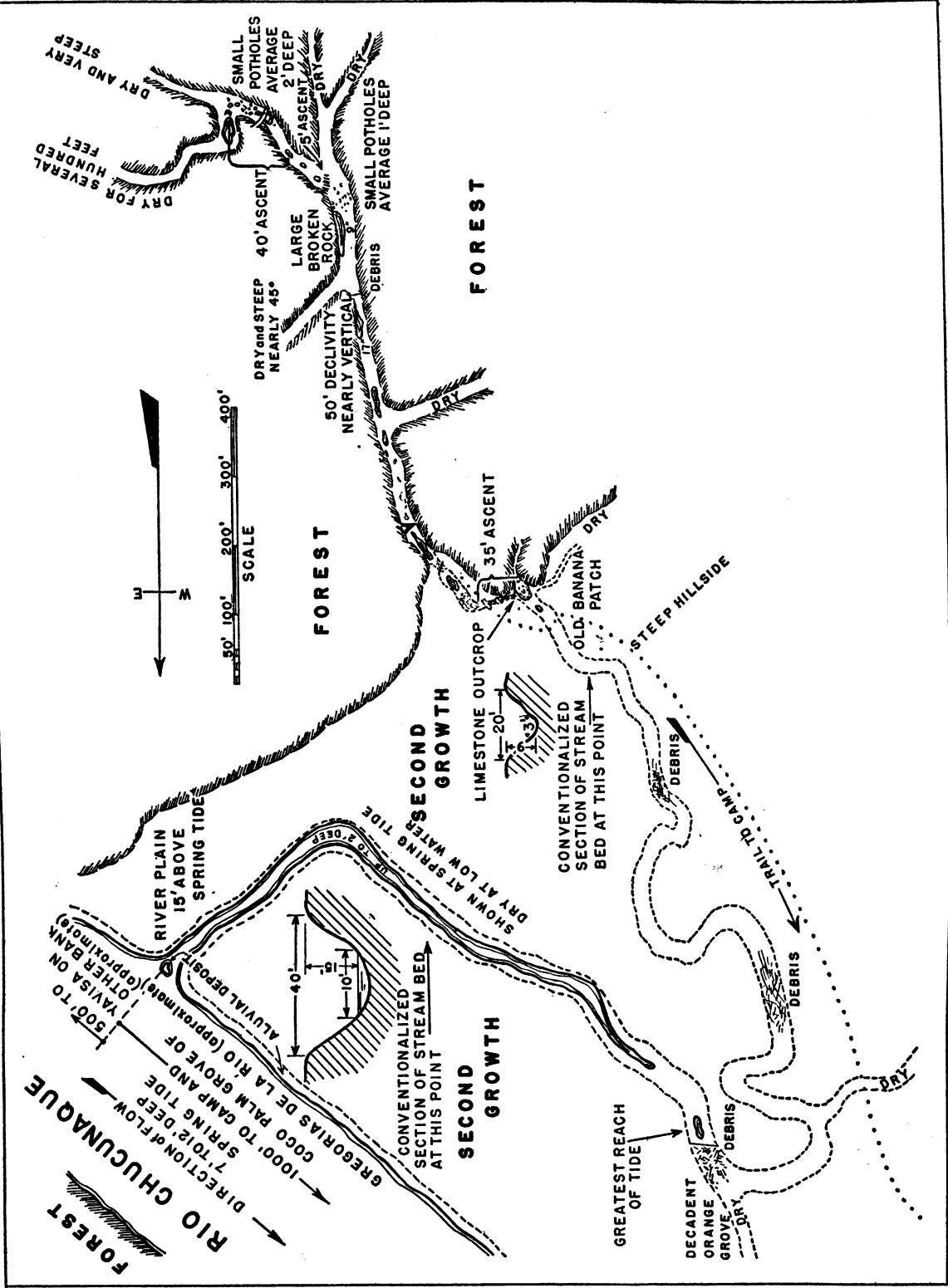


FIG. 5. Map of "Camp Creek," a locality in which many studies herein described were undertaken. For comparison with figures 1, 10, and 16.

This locality is on San Miguel Bay, a distance of some 45 miles west and a little to the south of Yavisa.

The bulk of the field work, other than simple collecting, was undertaken in a small stream bed near the original base camp, Camp Townsend. This stream in its portion within the tongue of the lower humid zone was the site of most of the field work at this place and was dubbed "Camp Creek" in the field notes. As this name has gotten into the literature it is best retained. A map of the area is shown in figure 5. A second stream near but below this camp, in which some study was undertaken, was likewise dubbed "Three Falls Creek" because where it left the lower humid zone there were three attractive falls close together, as compared to a single one in "Camp Creek."

Some time was spent at the Chocoi village on the Rio Chico. As indicated in figure 1, this area is well within the lower arid zone.

Short side expeditions were made to the Rio Canglon, Rio Tupisa, and Rio Tuquesa, all in the lower arid zone.

A period was spent in camps on the lower Sucubti in the lower humid zone and a longer period at the Cuna village on the upper Sucubti in the upper tropical zone. At the latter place the banks of a small nearby stream, noted as Chalichiman's Creek in the field notes, was the site of most of the studies. The name is that of the chief of the village. Like the other two names, above mentioned, this has found its way into the literature. The change in the fauna is evident in the anno-

tated list. Other collecting sites were in the nature of day trips or visited in passing, from overnight camps. These locations are sufficiently evident from the list of stops in the itinerary and the map shown as figure 1.

The various techniques and methods employed will be understood from the context for the most part. Preservation of embryological series of the amphibian material was done with Bless solution, 70 per cent alcohol, 90 parts; glacial acetic acid, 3 parts; 40 per cent formalin, 7 parts. This material was subsequently transferred to 70 per cent alcohol. After 22 years it is still in excellent condition. Adult material was preserved in 3 per cent formalin and later transferred to 70 per cent alcohol. The night time photographs, made before the days of flash bulbs, were taken by means of flash powder in an open flash gun. Dampness and dew made this difficult and somewhat hazardous, the tendency for the powder to cake in small pellets causing it to discharge small glowing balls of magnesium.

The illustrations of developing frogs were all made by Miss M. Sorensen. Mr. C. M. Bogert, Curator of Amphibians and Reptiles at the Museum, was of great aid in locating this long-stored material and also gave much needed advice on various herpetological questions. Dr. E. R. Dunn was good enough to give assistance in a variety of puzzling matters, drawing freely on his great store of field experience in Central American herpetology. Both these gentlemen read and criticized the manuscript.

AMPHIBIA

THE AMPHIBIA OF THE EXPEDITION are nearly all Salientia, other groups being either absent or poorly represented. This is evidently not owing merely to the exigencies of collecting or the collector's predisposition but approximates a real difference in the quantities of the three orders.

APODA

No caecilians were collected. What appeared to be a rather large specimen slithered away in a trash pile of considerable extent, leaving a "tube" of mucus. This was on the upper Sucubti on April 25. Large numbers of *Symbranchus* were either seen or collected in similar situations. Because of the methods employed it is surprising that no caecilians were encountered in these operations which included poisoning areas out of water but covered with wet trash as well as submerged materials.

According to Dunn (1942) the only forms known from Darien are three species of *Caecilia*: *C. tentaculata* Linnaeus and *C. ochrocephala* Cope, both from the Atlantic slope, and *C. elongata* Dunn from Yavisa, making this the only species so far known from this drainage.

CAUDATA

Salamanders were nearly equally absent, only one being taken within the Chucunaque drainage and another near the Canal Zone. As with the caecilians, this seems to represent a real scarcity, since much of the collecting for frogs and fishes included working over brush and debris. Also the habits of *Rivulus* (see Breder, 1927b) demanded the searching of leaves at eye level or thereabouts. In fact it was in just such a place that the single salamander was taken.

Oedipus colonneus Dunn ?

One specimen was found perched eye high on a palm frond about 300 feet from the continental divide, on the Pacific side, May 2. This was in the narrow band of almost typical rain forest with an elevation of about 600 feet, and through Caledonia Pass less than 11 miles from the Atlantic Ocean.

SPECIMENS

A.M.N.H. No.	Locality	Date
41098	Upper Sucubti, near continental divide	May 2

Oedipus complex Dunn

One specimen along the Rio Tapia, near Tapia, taken when a well-baked mud bank was broken away on February 2. Incidentally it was found associated with a *Peripatus* of slightly larger size. See Dunn (1940) on the identity of this specimen.

SPECIMENS

A.M.N.H. No.	Locality	Date
21375	Near Tapia	Feb. 2

SALIENTIA

As already noted, the frogs represented the conspicuous amphibian fauna, in fact comprising nearly 100 per cent of the collection. Frogs were abundant and evident both by sight and sound in a large variety of places. They, in season, contributed to the night voices to a very considerable extent in what is essentially a decidedly noisy nocturnal jungle.

FAMILY BUFONIDAE

Bufo haematiticus Cope

Taken near Yavisa and in the Sucubti drainage. No activity was noted in this species, all individuals seen simply sitting about inactively.

SPECIMENS

A.M.N.H. Nos.	Locality	Date
40561, 40562, 40547, 40548, 41733	Rio Subcuti	Apr. 24-25
39768, 40531, 40880, 40921-40923, 41097	Creek near Indian village on upper Sucubti	Apr. 19-25
51778	Camp Creek	—

Bufo typhonius alatus Thomillot

Although this species was taken in small numbers at virtually all collecting sites as indicated in the specimen list, it, like the preceding species, was evidently not calling or breeding during our stay.

SPECIMENS			A.M.N.H. Nos.	Locality	Date
A.M.N.H. Nos.	Locality	Date			
40857, 40858	Camp Creek	Feb. 18	40620, 40722, 40730-40732		Apr. 1
41038	Upper Camp Creek	Feb. 12		Above Rio Chiati	Apr. 4
41000-41002	Three Falls Creek	Feb. 24	40635, 40653-40683		
41045-41048	Creek above Yavisa	Mar. 14		Below Rio Sucubti	Apr. 6
40949-40953, 41171					
	Rio Chico	Feb. 17			
41694	Rio Icuanti, near mouth	Feb. 28			
41762	Rio Canglon, near mouth	Feb. 27			
41111, 41731	Rio Tuquesa	Mar. 3			
40927, 40651, 40652					
	Rio Chucunaque	Apr. 4-6			
40565-40568	Creek on Rio Sucubti	Apr. 10			
40569-40578	Dry creek on Rio Sucubti	Apr. 14			
39769, 40881	Creek near Indian village on upper Sucubti	Apr. 19-23			

Bufo coniferus Cope

Taken only above Yavisa and only along the Rio Chucunaque. Apparently not in its breeding season during our stay.

SPECIMENS		
A.M.N.H. Nos.	Locality	Date
41042	Above Rio Tupisa	Feb. 27
40549	Mouth of Rio Membrillo	

Bufo marinus (Linnaeus)

Seen at nearly all places within and without the Chucunaque basin except on the San Blas coast at Caledonia. More common in the lowlands than in the higher country and should be considered as typical of the lower tropical arid zone in this country at least. It called at the base camp near Yavisa, on the Rio Chico, and occasionally along the Chucunaque as far up as the mouth of the Tuquesa, March 3 to 5. The call consists of a rapid series of hammer-like notes too fast to count accurately but generally in excess of a dozen. This voice somewhat resembles that of *Bufo americanus* Holbrook but slowed down to such an extent that the separate throbs are distinct. Evidently it calls only at night along the main rivers and small creeks, generally in exposed places, where it sits close to the water's edge or in shallow places.

The following tabulation indicates the time of breeding at the various localities:

DATE	LOCALITY	ACTIVITY AND DEVELOPMENT
January 25-27	Rio Chagres	Larvae with hind legs just appearing
February 2	Rio Abaho	Metamorphosing
February 9	Yavisa	Larvae with hind legs just appearing
March 1	Yavisa	Metamorphosed
March 8-22	Yavisa	Calling
March 10-12	Yavisa	Spawning. Up to March 27 these had not metamorphosed
March 3-5	Rio Tuquesa	Calling. Recently metamorphosed, of two sizes
February 16-20	Rio Chico	Calling. Recently metamorphosed young
February 27	Rio Canglon	Calling
Along Rio Chucunaque		
March 29	Below Rio Canglon	Young. Calling
March 30	Above Rio Sansan	Advanced larvae and young
April 1	Rio Membrillo, mouth	Advanced larvae and young
April 2	Above Rio Chiati	Advanced larvae and young, some without hind legs
April 6-8	Rio Sucubti, mouth	Newly metamorphosed and without hind legs
Along Rio Sucubti		
April 13	Above mouth	New and advanced young
April 16	Farther above mouth	New young
Only a few silent adults from here to the headwaters.		

From this tabulation it would seem that about the Canal Zone spawning takes place in early January and that the young toads leave the water in early February. Near Yavisa the season is about a month later, the young leaving the water in early March. Here

a second spawning takes place in the middle of March, and the young leave in April. Along the Chucunaque and Sucubti the season appears to be about the same but is probably drawn out. By the middle of April all seem to have left the water. However, rain

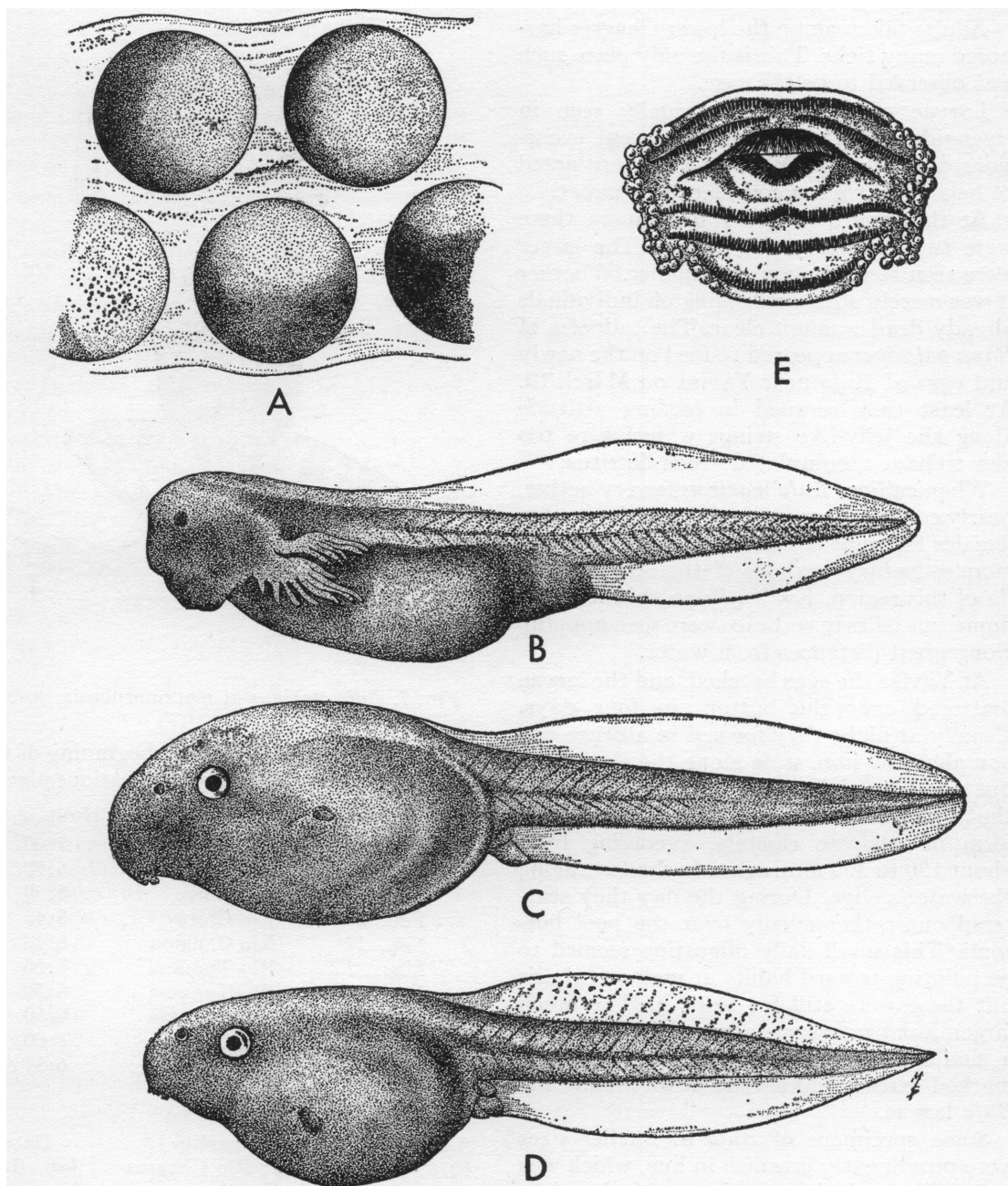


FIG. 6. Development of *Bufo marinus*. A. Portion of egg string; $\times 15$. B. Newly hatched larva; $\times 17$. C. Advanced tadpole; $\times 11.4$. D. Mature tadpole; $\times 5$. E. Mouth of mature tadpole; $\times 17$.

seems to be the chief factor, and probably at all these localities the breeding season is of basically similar duration, local vagaries in rainfall causing the above noted differences. Plate 42 shows an old specimen on the prowl at night as it appeared by flashlight taken near the Rio Canglon on February 27.

Adults taken along the lower Chagres harbored many ticks. This is the only place such was observed to be the case.

Larvae of this species, usually seen in river-side pools, would take frequent excursions out into deeper water and were noted to be able to stem a considerable current.

At the mouth of the Rio Tuquesa there were two sizes of young larvae. The larger were seen to feed upon the smaller. Whether it was merely a case of feeding on individuals already dead was not clear. The tadpoles of *Rana palmipes* appeared to feed on the newly laid eggs of *Bufo* near Yavisa on March 10. At least they scraped in feeding attitude along the jelly-like strings which were too new to have accumulated much detritus.

When calling, *Bufo marinus* is very active, nearly constantly moving about and pursuing females for some distance, in contrast to the more sedentary methods of the other *Salientia* of this region. Evidently on this account, numerous pairs in embrace were seen hopping along great distances from water.

At Yavisa the eggs hatched, and the larvae scattered over the bottom in four days. Usually at night they formed in a dense ribbon about 50 mm. wide along the shore line, but on some nights this was varied so that the accumulations of tadpoles were in the form of separate clusters, averaging from about 150 to 300 mm. across in shallows along the water's edge. During the day they scattered out rather evenly over the pool bottoms. This small daily migration seemed to be pointing toward habits at metamorphosis but these were still far from it. The much larger *Rana palmipes* tadpoles performed in a similar manner, although not to such a marked extent, and settled down among the *Bufo* larvae.

Some specimens of *Bufo* in smaller sizes were prominently greenish in hue, which was especially marked in the interorbital region. The color in the field suggested the possibility

that this was due to an alga rather than to pigmentation, but it was impossible to verify this on the preserved material.

The development of the tadpole and the form of the mature mouth are shown in figure 6. A newly metamorphosed specimen is shown in figure 7.

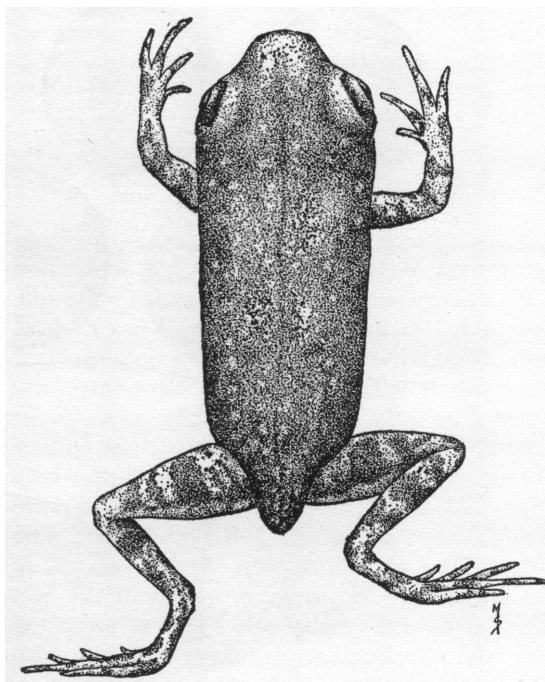


FIG. 7. *Bufo marinus* at metamorphosis; $\times 6.3$.

The following times of the beginning of the evening's calling were noted at various places:

DATE	LOCALITY	HOURL, P.M.
Feb. 17	Rio Chico	7:00
Feb. 18	Rio Chico	6:50
Feb. 19	Rio Chico	6:50
Feb. 20	Rio Chico	6:45
Feb. 27	Rio Canglon	6:15
Mar. 2	Rio Tuquesa	7:10
Mar. 3	Rio Tuquesa	6:50
Mar. 4	Rio Tuquesa	6:50
Mar. 29	Rio Canglon	8:00
	Mean time	6:54 +

SPECIMENS

A.M.N.H. Nos.	Locality	Date
40789-40792	Lower Rio Chagres	Jan. 25
41760, 41761	Rio Canglon, near mouth	Feb. 27

A.M.N.H. Nos.	Locality	Date
41680	Rio Chico	Feb. 19
40619, 40684, 40685, 40721	Rio Chucunaque, above Rio Chiati	Apr. 4
40623, 40624	Rio Sucubti	Apr. 9
51803	Rio Chagres, below dam. Developmental series of eggs and larvae	Jan.
51807	Camp Creek. Developmental series of eggs and larvae	Feb.-Mar.
51816	Identity uncertain. Small specimens	—

Engystomops pustulosus (Cope)

This species was not seen near the base camp near Yavisa before March 8, when five egg clusters were discovered, although one was heard to call on February 15. The first rain occurred on March 9. From then on they were active at that place with some intermissions. The only other place they were found breeding was in a small creek near the Indian village on the upper Sucubti, below the falls (April 23 to 31), and at Caledonia, on the Atlantic coast, within 200 feet of the surf (May 5 to 6). They were not taken along the Chucunaque proper nor seen in the Rio Chico drainage or any other side streams except the Rio Sucubti drainage and in Camp Creek. Evidently they were not of very uniform distribution along the smaller water courses.

The calling of the male is almost invariably done from a floating position, as shown in plate 43. These photographs were taken near the center of activity near Yavisa. See figure 5 for the general conditions in the area. The call was described in the field as a very soft and faint "coo" followed usually by an

contortional effort for these animals to give their faint call. Usually so many call in one small area that a loud and continuous roar is produced. When many are calling together little groups seem to specialize on certain parts of the call. That is, for example, one group may only give the "coo" part while another may give as many as three "clicks" close together, omitting the "coo." One which was counted gave 32 "coo-clicks" per minute, but irregularly spaced. Often while calling loudly, the whole community would suddenly stop, leaving a complete silence for a few minutes for no apparent reason. It frequently happened when the observer was sitting perfectly still, while at other times one could move about among them freely without causing any such cessation. Dunn (1931b) described the call from Barro Colorado as "wheenk" or as "wheu-ak-ak" which looks much more different in print than it sounds. The differences in endings is in agreement with the preceding remarks. Netting (1930) described the call of the closely related *E. trinitatis* Boulenger as "ow-w-w-w-ác" and added that the natives call the voice "coong-la." Calling commenced at dusk and generally ended well before midnight, an item discussed by Park (1938).

The egg clusters, consisting of the ova embedded in a mass of white foam which evidently the spawning pair whip into that consistency at the time of spawning, were usually found at the water's edge and rarely out of contact with it. They generally were completely floating but adhering to any adjacent object and frequently partly or occasionally completely hidden by leaves. See plate 44.

Seventeen normal clusters of regular shape measured as follows, in millimeters:

																	Max.	Mean	Min.
Greatest diameter	76	76	76	76	76	76	76	76	76	76	76	76	50	50	50	63	76	71	50
Least diameter	76	50	50	50	50	50	50	50	50	50	50	50	50	38	38	50	76	50+	38
Greatest depth	57	50	50	13	38	38	50	50	13	50	44	50	50	38	38	50	57	42+	13

equally soft "click" which may be almost inaudible or omitted entirely. The extreme inflation of these toads floats them high, and when the air is in the large throat sac, the head is thrown well back, as seen in the photographs. It appears that it takes great

After exhausting a female of eggs the male would call alongside the newly deposited cluster, as shown in plate 43, and apparently spawn again repeatedly, giving rise to what appeared to be multiple clusters, four of which measured as follows:

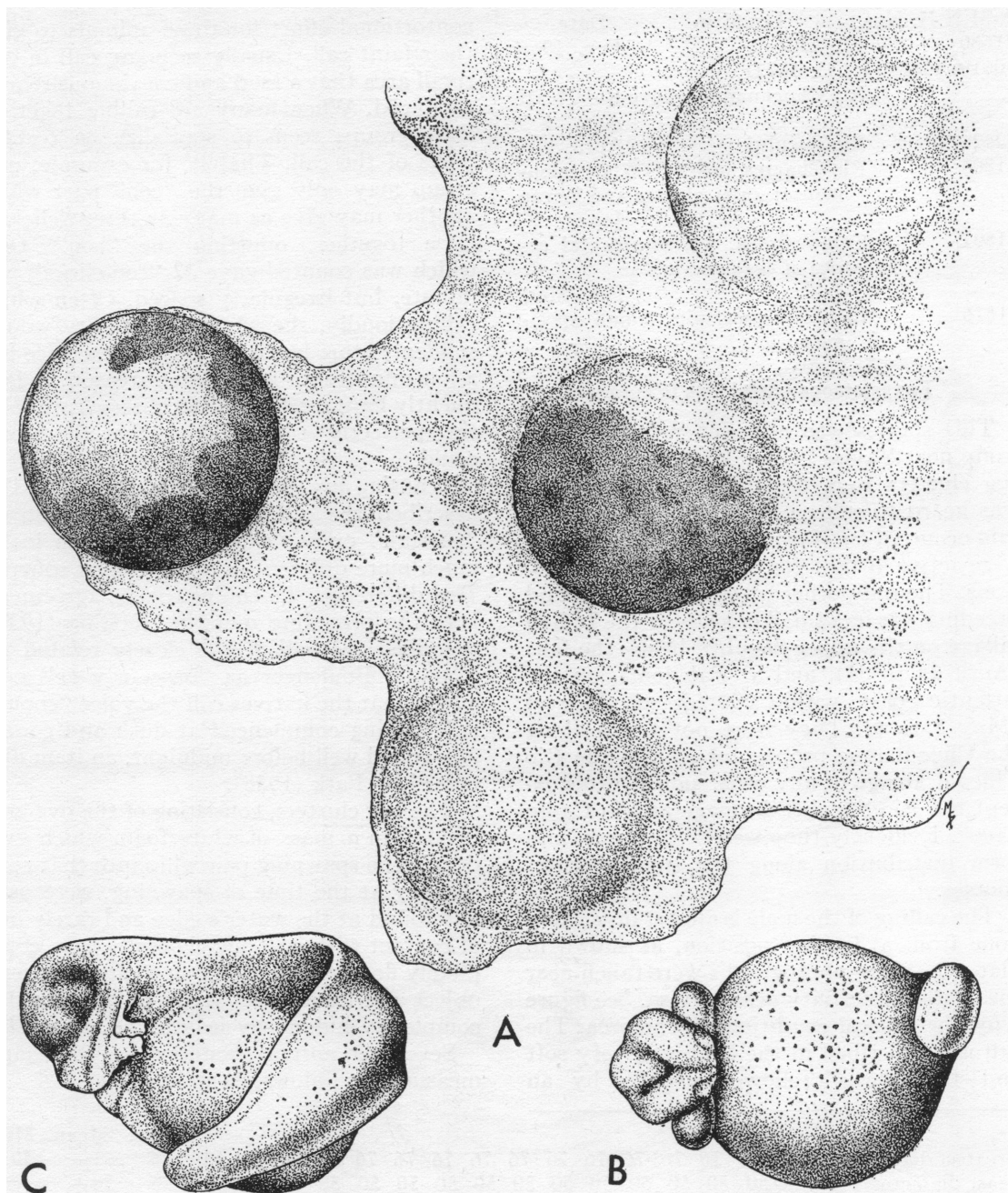


FIG. 8. Development of *Engystomops pustulosus*. A. Eggs as laid in mucous mass; $\times 19$. B. Early encapsulated larva; $\times 19$. Redrawn after Noble (1927). C. Later encapsulated larvae; $\times 19$. Redrawn after Noble (1927).

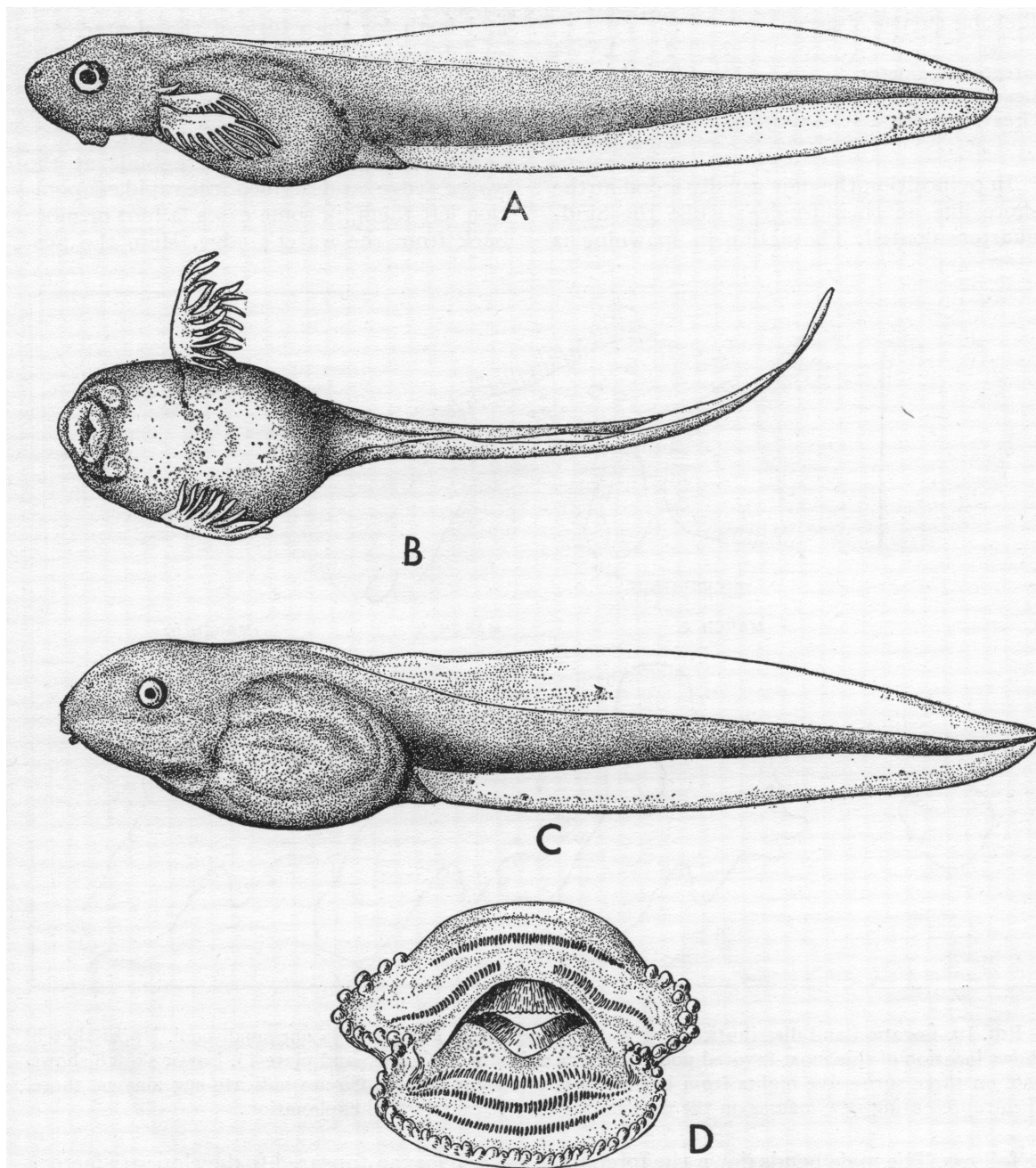


FIG. 9. Development of *Engystomops pustulosus*. A. Newly hatched larva; $\times 29$. B. Ventral view of newly hatched larva; $\times 29$. C. Mature tadpole; $\times 15.3$. D. Mouth of mature tadpole; $\times 55$. All redrawn after Noble (1927).

Probable number of spawn-ings	2	2	3	4
Greatest diameter	115	128	152	245
Least diameter	50	76	101	101
Greatest depth	63	50	50	50

In oviposition the pair usually stood at the shore line on their forelegs while the hind-quarters floated. The action in spawning is

and forth for the width of the cluster, presumably insuring an even distribution. The marked uniformity of size of these clusters as noted in the preceding tabulation is probably accounted for in part by this action.

Although the clusters were built at the water's edge, as described, the rapid evaporation left them, in some cases, a foot or more back from the water's edge. Here the pro-

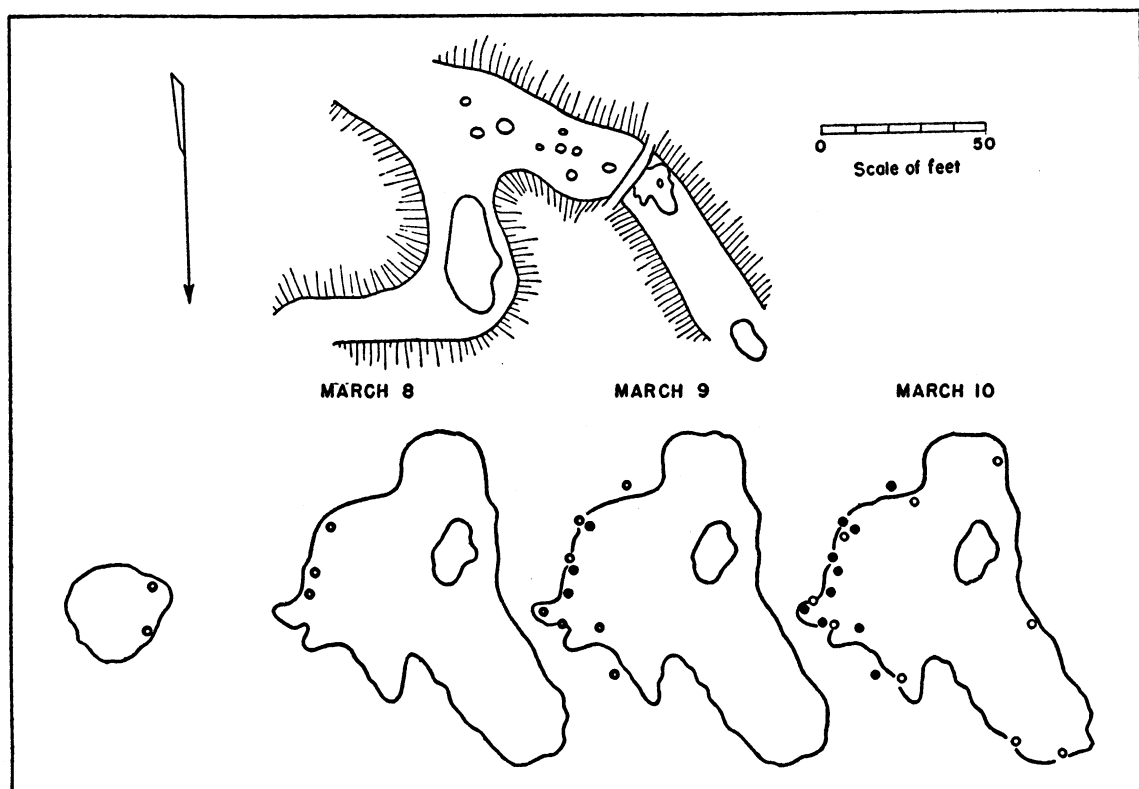


FIG. 10. Location and distribution of nests of *Engystomops pustulosus* in one small pool. Upper sketch shows location of this most-favored pool. For comparison with figure 5 and plate 43. Lower sketch shows pool on three successive nights from beginning of spawning season. Circles indicate egg masses, those open representing new masses on the date indicated. See text for full explanation.

as follows. The male bends down the forepart of the body, arches his back with the hind legs drawn up, then suddenly straightens out and kicks his legs violently for a few seconds, whipping up the froth. Apparently the eggs are distributed by the same action. The female evidently takes no part in whipping the froth, but the fury of the male so obscured her that it was impossible to be entirely certain. While this is going on they weave back

tected larvae appeared to develop satisfactorily, awaiting release by a rainstorm. In the lower photograph of plate 44, the pool has receded, leaving the mass at the right, which is covered by a leaf, remote from the water. This photograph was made immediately after a light rain which has partly filled the pool again and flattened and partly disintegrated the mass. The wet streak leading from the froth mass to the water is a slimy track made

by the dissolving froth and serving as a path for the escaping tadpoles.

The fact that no adults were seen before the breeding season began suggests that they were estivating in some rather inaccessible place.

The eggs are milk white as laid but become pigmented as they develop. Figures 8 and 9 show developmental stages of the larvae and the mature tadpole mouth. Some of these are redrawn from Noble (1925, 1927) who used some of the original notes. It may be noted that there is no evident structure to the mucus in which eggs are embedded, as preserved.

The location and increase in depositions of spawn in one small pool over a period of three days are indicated in figure 10. It is clear from this diagram that one side of the pool was favored and that the calling males stationed themselves not closer together than something over 5 feet.

Noble (1925), referring to these field notes, wrote, "The eggs of *E. pustulosus* are practically identical to those of *P. fuscomaculata*, being only 1.4 mm. in diameter, unpigmented, and laid in large numbers. Development, is however, slower in the former species, and many details, which Budgett tells us are 'blurred and as if hurried over' in *P. fuscomaculata*, are accentuated in *E. pustulosus*. In both species the yolk is small and obviously dense, for the embryo soon curves around it instead of incorporating it at once into the body as in our common frogs and toads." This was said in comparing the findings of Budgett (1899) on *Paludicola* with the present data.

SPECIMENS

A.M.N.H. Nos.	Locality	Date
40742-40755, 40795-40798, 40934, 40935, 41074-41083, 41019-41021, 41768-41772, 51814	Camp Creek	Feb. 26 to Mar. 21
41043	Creek above Yavisa	Mar. 14
41732	Rio Chucunaque	—
40555, 40559, 40560	Rio Sucubti	Apr. 15-24
40579	Dry creek on Rio Sucubti	Apr. 14
40505	Creek near Indian village on upper Sucubti	Apr. 13
51799, 51820, 51801, 51798, 51765	Camp Creek. Developmental series of eggs and larvae	Feb.-Mar.

Leptodactylus bolivianus Boulenger

Heard calling on March 6. It consisted of a faint short grunt of low pitch scarcely audible 10 feet away. Dunn (1933) describes the voice as faint and beginning with a "wh" sound similar to but slightly louder than that of *L. melanotus*. Sometimes it is louder and sounds like "step-up step-up step-up ee." Generally calling is done from under rock ledges.

SPECIMENS

A.M.N.H. Nos.	Locality	Date
39787, 40998, 40999, 41147, 41727	Rio Chico	Feb. 10-20
40585-40587	Mouth of Rio Canglon	Feb. 27
41145, 41027-41031, 41033-41037	Camp Creek	Feb. 9 to Mar. 6
40551-40554	Mouth of Rio Membrillo	Apr. 1
40614, 40615, 41088, 41089, 41121, 41122, 41734	Rio Chucunaque, near camp	Mar. 2 to Apr. 4
40622, 40627, 40643, 40644, 40699, 40713-40715, 40929	Rio Sucubti, near camp	Mar. 4 to Apr. 9
40646, 40647	Camp above Rio Sansan	Mar. 30
40931, 41711	Three Falls Creek	Feb. 24
41068-41070	Old Panama City	Jan. 30
40897	Tapia	Feb. 2
41063		Mar.
41715	Camp Townsend	Feb. 21
40761-40765	Mouth of Rio Tuquesa	Mar. 5
40979-40984	Rio Chico ($\frac{1}{2}$ mile above Indian village)	Feb. 16
41128, 41130, 41131	Camp site below Rio Canglon	Mar. 29

Leptodactylus poecilochilus (Cope)

Taken at only one locality.

SPECIMENS

A.M.N.H. No.	Locality	Date
41022	Camp Creek	Apr. 19

Leptodactylus melanonotus (Hallowell)

Fairly common but apparently not reproducing. Evidently not in voice, which has been described by Dunn (1933) as very low and soft.

SPECIMENS

A.M.N.H. Nos.	Locality	Date
40588-40591	Mouth of Rio Canglon	Feb. 27
40616, 40617, 40640-40642, 40700-40704, 40716-40719, 40720, 40733-40736, 41105, 41106, 41090-41093, 41112-41115, 40930, 41087	Rio Chucunaque	Mar. 3 to Apr. 6
40629-40634	Rio Sucubti, near camp	Apr. 9
40648, 40649	Camp above Rio Sansan	Mar. 30
40690-40698	Mouth of Rio Metiti	Mar. 31
40760, 41123-41126	Mouth of Rio Tuquesa	Mar. 2-5
41697, 41699	Three Falls Creek	Feb. 24
41713		Feb. 14

Leptodactylus pentadactylus (Laurenti)

This large species was common only along the creek near the Yavisa base camp, although seen and heard occasionally along the Rio Chucunaque and Sucubti. It spawned and called prolifically at the first-mentioned locality in the heavy forest. The call con-

quently found in fairly exposed places and because of their size are prominent for a long distance. Less often they are in sheltered nooks, but most frequently near, but not protected by, rocky shelters, evidently used by the makers. See plate 45. Favored locations were the numerous pot-holes. Those selected were of such a size that the masses of froth completely filled them and fully hid the water on which they rested. See plate 46. The great majority are in contact with small bodies of water, less often in dry hollows but never far from water, although never bordering large pools as do those of *Engystomops*. Often there is a depression in the center of these nests. This may be due to the mere weight of material, like a cake falling, or it is possible that the frogs lay the eggs all around themselves by an extension of the weaving motions seen in *Engystomops* and then leap clear of the mass. Because of the timidity of these frogs it was impossible to obtain good observations on the actual oviposition.

The following measurements in millimeters are of 11 regularly formed and normal clusters:

												Max.	Mean	Min.
Greatest diameter	355	305	305	280	256	230	230	230	230	203	152	355	252 +	152
Least diameter	280	305	230	230	230	230	203	177	177	177	152	305	217 +	152
Greatest depth	127	102	127	102	152	127	77	102	102	89	127	152	112 +	77

sisted of a deep and powerful "woorup" or "woop" given every five or 10 seconds with frequent longer pauses. They called usually from near hiding places, such as rock crevices, and not infrequently from their depths. Such calls emanating from underground were hard to locate and frequently difficult to recognize. One male called from a buried position under nearly 2 inches of leaves. A cluster of *Engystomops* eggs was directly over him. Another that was the occasion of some note called at the entrance to its retreat which amounted to a runway, well worn and trampled, smooth and clean. Dunn (1931b) also notes the underground retreats of this species on Barro Colorado Island. Park (1938) noted this species called from dusk to about midnight, which is in agreement with our observation.

Like *Engystomops*, this form produces eggs in a mass of foam, which is proportionately larger. These great masses of froth are fre-

These measurements are of new nests. They have a tendency to flatten and spread, especially after a rain, although it takes a considerable downpour to wash them away. One nest which measured 230 by 280 by 102 mm. was flattened to 343 by 343 by 50 mm. during a two-hour rain. Several were seen to be torn to pieces by torrential rains, the advanced larvae escaping into the rising water. See plate 46. Evidently this is the normal release of the larvae of both these species, the spawning being so synchronized as to fit the weather. We have no data on how long these nests survive in the case of a failure of the rain, but it would seem that there is probably a considerable factor of safety for the imprisoned larvae. The largest egg-cluster handled filled an ordinary tin pail within seven-eighths of its brim when floating on 25 mm. of water. Evidently the larvae liquefy the froth as they move about and are found

in a very slimy fluid. When disturbed they exhibit escape reactions by diving to the bottom of the liquid.

The development of the long slim tadpoles is indicated in figure 11 together with the mouth of the mature tadpole. It may be

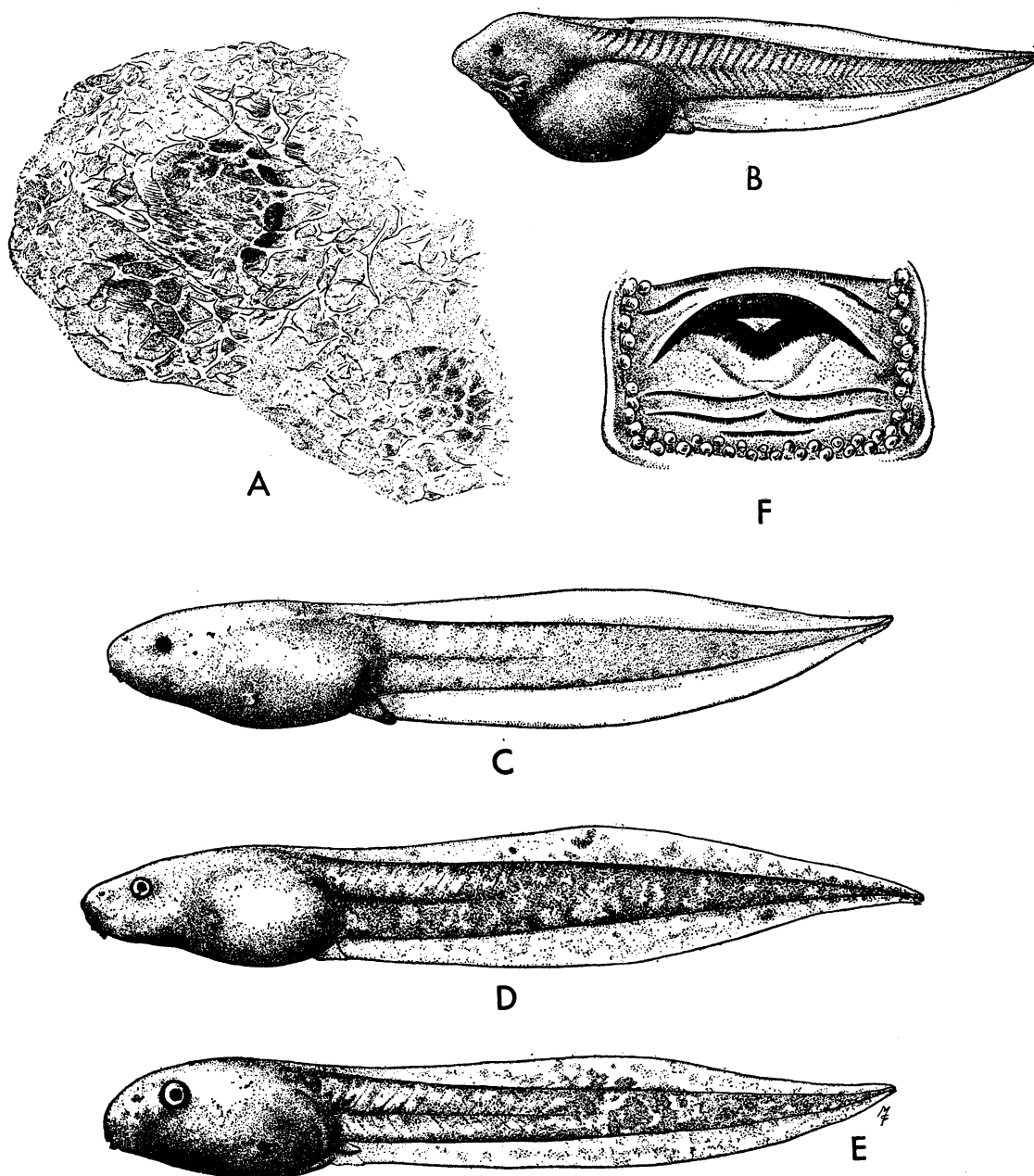


FIG. 11. Development of *Leptodactylus pentadactylus*. A. Eggs as laid in mucous mass; $\times 9.6$. B. Newly hatched larva; $\times 10$. C. Further developed tadpole larva; $\times 10$. D. Nearly mature tadpole; $\times 4.5$. E. Mature tadpole; $\times 3.2$. F. Mouth of mature larva; $\times 21$.

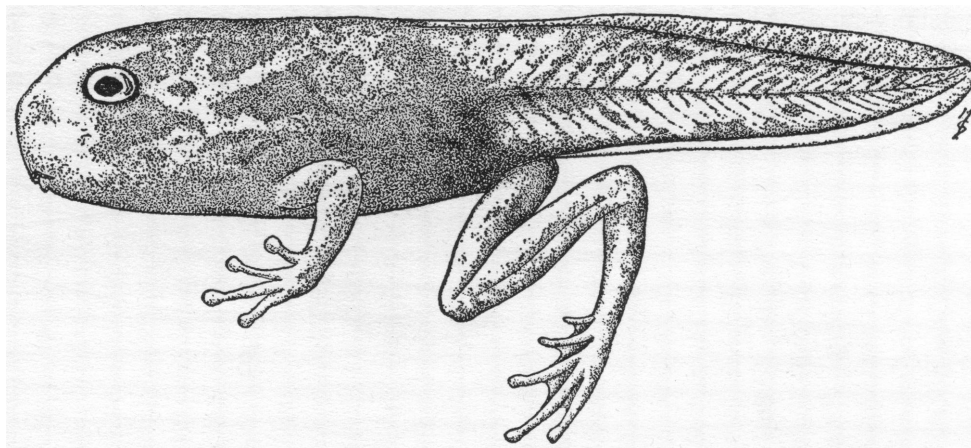


FIG. 12. Metamorphosing specimen believed to be *Leptodactylus pentadactylus*; $\times 5$.

noted that when open this mouth is nearly rectangular. The mucus of this species, unlike that of *Engystomops*, as preserved, shows a strongly vacuolated structure. Figure 12 shows a metamorphosing specimen believed to be this species.

Specimens		
A.M.N.H. Nos.	Locality	Date
41765, 41766, 41061	Rio Chucunaque, near Yavisa	Mar. 17-21
40785-40788, 40793	Camp Creek	Mar. 17-21
40628	Rio Sucubti	Apr. 9
51780, 51804, 51792, 51787, 51789	Camp Creek. Developmental series of eggs and larvae	Feb.-Mar.

***Eleutherodactylus gaigei* (Dunn)**

Not common nor evidently breeding.

SPECIMENS		
A.M.N.H. Nos.	Locality	Date
40507	Chalichiman's Creek	Apr. 23
40926	Upper Camp Creek	Feb. 12

***Eleutherodactylus bufoniformis* (Boulenger)**

Not common nor reproductively active.

SPECIMENS		
A.M.N.H. Nos.	Locality	Date
39765	Creek on upper Rio Sucubti	Apr. 19
40887, 40888, 40501-40504, 41055, 41056	Chalichiman's Creek	Apr. 23-24
51785	Three Falls Creek	—

***Eleutherodactylus fitzingeri* (Schmidt)**

Common throughout the region. Very variable in color and pattern. A few individual eggs on leaves on the forest floor may be of this species. Not heard in voice but Dunn, personal communication, describes it as a birdlike chirping.

SPECIMENS		
A.M.N.H. Nos.	Locality	Date
39785, 39786, 39788, 39789, 40954-40971, 40873, 40985	Rio Chico	Feb. 1-20
41011-41014, 41704, 41705, 41687-41691, 41707-41710	Three Falls Creek	Feb. 24
40925	Upper Camp Creek	Feb. 12
40993-40996, 40989-40991, 40766-40784, 40740, 40741, 41146, 41132-41135, 41032, 41716-41722, 41152, 41153, 41084, 41695, 41696, 41157	Camp Creek	Feb. 11 to Apr. 6
40298	Mouth of Rio Metiti	Mar. 31
40705-40712, 40724-40729, 40637-40639	Rio Chucunaque	Apr. 4-6
40836-40839, 40834, 40827-40829, 40825, 40799-40823, 40842, 40846, 40854, 40564	Rio Sucubti	Apr. 18-24
40856	Above Tupisa about 5 miles	Feb. 27
40513, 40514, 40522, 40530, 40533, 40058	Chalichiman's Creek	Apr. 23-26
40592, 40594-40613	Mouth of the Rio Canglon	Feb. 27
40618	Rio Chucunaque, near camp	Apr. 4
40621, 40625, 40626	Rio Sucubti, near camp	Apr. 9

40645	Camp above Rio Sansan, Rio Chucunaque	Mar. 30
41116, 41119, 41120	First creek above Rio Tuquesa	Mar. 3
41129	Camp below Rio Canglon	Mar. 29
41177-41190	Rio Chico, dry creek, near Indian village	Feb. 17
41682	—	—
41692, 41693	Near mouth of Rio Icuana	Feb. 28
41049-41051	Creek above Yavisa	Mar. 14
41138-41144	Across stream from Yavisa	Feb. 9
40859-40872, 40874-40876	Near Tapia	Feb. 1
51802	Eggs of this species?	—

***Eleutherodactylus brederi* Dunn**

Known only from the Rio Chucunaque basin. Taken on the Rio Subcuti (type locality) and the Rio Chico. The describer considers it the Darien representative of *E. noblei* Dunn of western Panama and Costa Rica (Dunn, 1934). In life this species is a light tan with three inverted V-shaped darker marks on back, which are finely outlined with lighter. There are light bars on sides and legs.

First heard to call on April 24. The voice is a cheerful "bée-up" frequently repeated. The vocal pouch is dilated prominently.

SPECIMENS

A.M.N.H. Nos.	Locality	Date
40523(type)	Chalichiman's Creek	Apr. 26
41052	Chalichiman's Creek	Apr. 24
41176	Rio Chico	Apr. 24
41101	This sp. ?	—

***Eleutherodactylus ockendeni* (Boulenger)**

SPECIMENS

A.M.N.H. Nos.	Locality	Date
41127	Camp below Rio Canglon	Mar. 29
41118	First creek above Rio Tuquesa	Mar. 3
40974, 40975, 41175	Rio Chico, $\frac{1}{2}$ mile above Indian village	Feb. 17

***Eleutherodactylus lutosus molinoi* (Barbour)**

Found only along the upper Sucubti.

SPECIMENS

A.M.N.H. Nos.	Locality	Date
40581	Rio Sucubti, dry creek	Apr. 14
41095	Chalichiman's Creek	Apr. 25

***Eleutherodactylus diastema* (Cope)**

Not common, but calling along the Rio Sucubti. The call, faint and insect-like, is repeated every five to eight seconds as a "peep" or "cheep."

SPECIMENS

A.M.N.H. Nos.	Locality	Date
40580	Dry creek on Rio Sucubti	Apr. 14
40508, 40509, 40542, 40527-40529	Chalichiman's Creek	Apr. 23-26
41681	Rio Chico, below Indian village	Feb. 19
40739, 40737	Rio Chucunaque	Apr. 4
40593	Mouth of Rio Canglon	Feb. 27
40873	Near Tapia	Feb. 1

***Eleutherodactylus latidiscus* (Boulenger)**

Found only on the upper Sucubti.

SPECIMENS

A.M.N.H. Nos.	Locality	Date
40534, 40915	Chalichiman's Creek	April 25

FAMILY BRACHYCEPHALIDAE

***Prostherapis inguinalis* Cope**

Dunn (1940) reported under the name *Hyloxalus fuliginosus* that this species may carry as many as 24 tadpoles on its back.

SPECIMENS

A.M.N.H. Nos.	Locality	Date
40895, 40543, 40540, 40538, 40914, 40916	Chalichiman's Creek	Apr. 26
41100	Atlantic drainage	—

***Phyllobates talamancae* (Cope)**

Common in all stream beds, both wet and dry, and in places along the larger river shores reaching up to the mouth of the Rio Sucubti.

This species is evidently diurnal in all respects and is exceedingly active, moving about constantly in the pursuit of insects. It called during our entire stay in the field. The call consisted of a high-pitched "peep-peep"

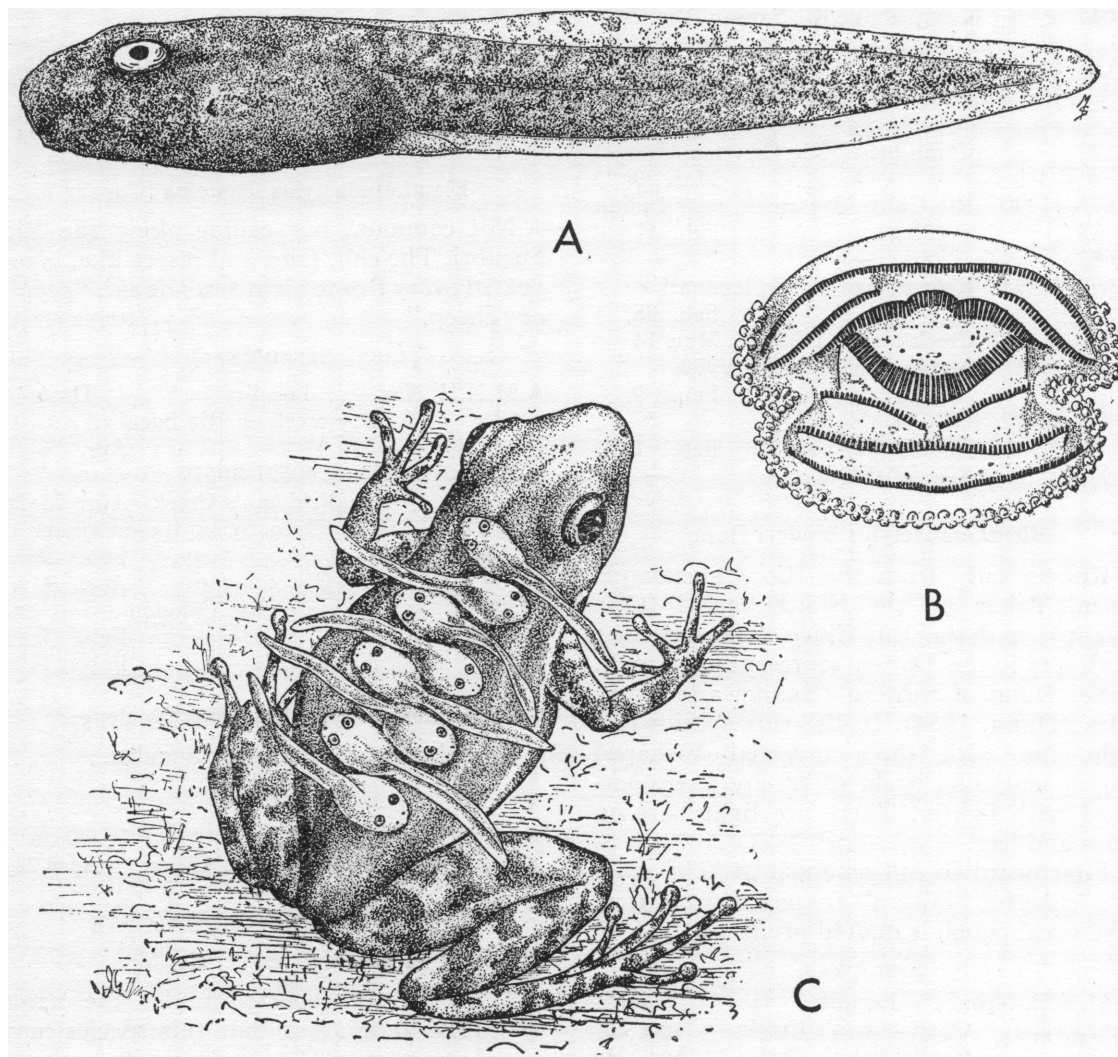


FIG. 13. *Phyllobates talamancae*. A. Mature tadpole; $\times 13.5$. B. Mouth of mature tadpole; $\times 47.5$. C. Adult with tadpoles attached to back; $\times 4$.

somewhat resembling that of a young chick. They usually called from under leaves on the forest floor both along stream beds and at a considerable distance from them. During and after rains they were most fearless. A variable pause, usually rather lengthy, separates each call, and they freely interrupt their calling to pursue food. When in the open they seldom call long from one place, since they are then constantly moving about. The throat is puffed out as a small, nearly globular sac, and the sound is produced as this is vibrated, not deflated. Something over half of the call-

ing frogs were noted to be in the darkest phase this frog shows.

Most of the calling was done in the afternoon, usually reaching its height about 4:00 P.M.

The following times were recorded:

DATE	STARTED CALLING	STOPPED CALLING
February 12	2:30 P.M.	—
February 14	2:40 P.M.	6:10 P.M.
February 24	—	5:00 P.M.

At nightfall they move back into the forest

away from the edge of streams and none were ever found at night along the stream beds, even though at times especial search was made for them.

On March 16 near the base camp at Yavisa an individual was taken with tadpoles being carried on its back. They were arranged across the back facing in alternate directions like sardines in a can. Figure 13 shows this condition, which is based on field sketches and specimens. Dunn (1924b) mentions the tadpole-carrying habit of this species.

SPECIMENS

A.M.N.H. Nos.	Locality	Date
39783, 40932, 41136, 41154, 41155, 51786, 51779, 51797	Camp Creek	Feb. 9 to Mar. 20
41003-41005, 41701	Three Falls Creek	Feb. 24
41164-41169	Dry gully near Camp Creek	Feb. 22
41044, 41107-41110	Creek above Yavisa	Mar. 3-14
41104	Near creek above Yavisa	Mar. 3
41173, 41174, 40972	Rio Chico, $\frac{1}{2}$ mile above village	Feb. 17
41039-41041	Rio Chucunaque, about 5 miles above Rio Tupisa	Feb. 27
40582-40584	Mouth of Rio Canglon	Feb. 27
40738	Rio Chucunaque, below mouth of Rio Sucubti	Apr. 4
40636	First camp on Rio Sucubti	Apr. 16
51800	Camp Creek (adult male and tadpoles)	Mar. 16

Phyllobates pratti Boulenger

Taken only in the upper Rio Sucubti where it evidently replaces *P. talamancae*. Its behavior was much like that of its downstream congener. Dunn (1924a) figures the tadpoles of this species under the name *P. latinasus* and (1940) mentions a male with six tadpoles on its back under the name *H. panamensis* and (1944) discusses the tadpole-carrying habits of the group.

During our stay in the upper Sucubti these called in a manner indistinguishable from the *P. talamancae* near Yavisa. On one occasion it was noted that they began calling every time a small cloud passed over the sun.

While we were watching a large colony of army ants on the march, one of these frogs jumped squarely into the procession and out again, completely unscathed.

SPECIMENS

A.M.N.H. Nos.	Locality	Date
40917, 40919, 40896, 40541	Chalichiman's Creek	Apr. 20-26

Dendrobates auratus (Girard)

Fairly common along moist creek beds. At the base camp near Yavisa they were periodically much more common than usual, but without any evident association with weather conditions. Also, at times they were not uncommon on the forest floor remote from any water, but at all times were noted to be diurnally agile and active. Those at the above locality spent much time in the holes of some small mammal made in the creek banks. At one place an individual was found sitting at the entrance of such a hole which measured 20 mm. by 10 mm., the longest diameter being horizontal. This hole was deep and ramified, and another was found 76 mm. farther in along one of the branches. Another, which was found in the open, dove into a small pool to escape capture but in about five minutes came out and hopped straight up a declivity of about 45° and went into a similar hole. Apparently these are regular resting places for this species.

More common near the Indian village on the Rio Chico. Here the natives stated that these frogs were used to poison the tips of blow gun darts, by first toasting them over a fire.

They were seen irregularly on the trip up the Chucunaque into the headwaters of the Sucubti. The upper Sucubti specimens, taken concurrently with the taking of the first *Atelopus*, appeared to differ in pigmentation to some extent. This was evidently associated with the gradual change of "life zone" which was marked at this place. These seemed to be a trifle plumper and more brilliant, which may be associated with reproduction being in progress. On the Atlantic slope of the San Blas coast, what appeared to be the form seen at Yavisa was taken again, some within a few feet of salt water. A photograph of a Yavisa specimen is shown in plate 47.

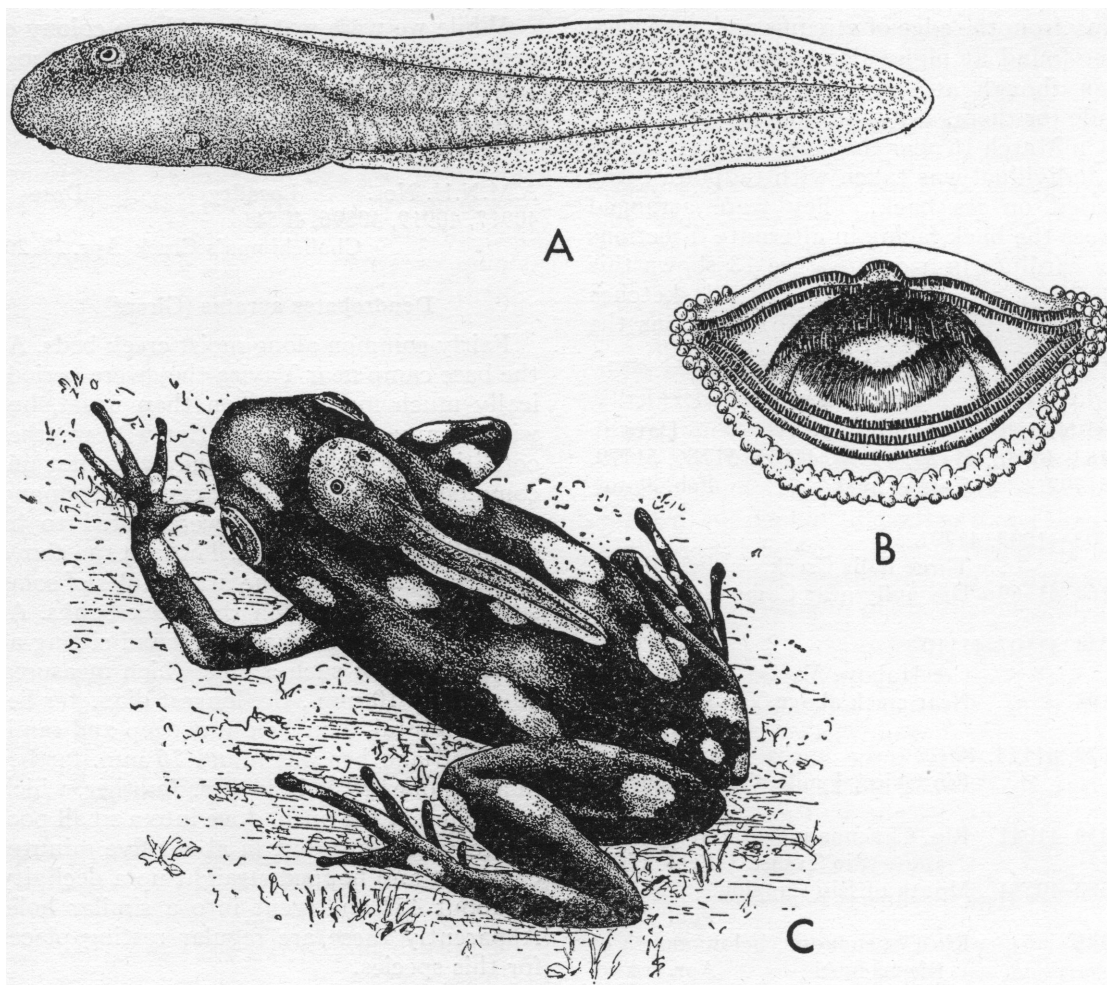


FIG. 14. *Dendrobates auratus*. A. Mature tadpole; $\times 9.5$. B. Mouth of mature tadpole; $\times 28.6$. C. Adult with tadpole attached to back; $\times 4$.

At no place was their voice heard, although Dunn (1941) describes the call as "a low soft buzzing sound." Reproduction was evidently in progress along the upper Sucubti, however, for on April 23 and again on April 27 a specimen was collected each with a single tadpole on its back. The first was preserved. The tadpole was perfectly centered and headed forward, as shown in figure 14, which is based on a field sketch supplemented with the preserved material. This observation was quoted by Noble (1927) and Dunn (1941). Eaton (1941) gives further data on this tadpole-carrying habit. Breder (1927a) mentions seeing as many as two tadpoles on the backs of this frog. Pope (1941) briefly describes the

metamorphosing of an individual specimen. Figure 14 also shows a tadpole in detail and its mouth.

SPECIMENS		
A.M.N.H. Nos.	Locality	Date
39770	Creek on upper Rio Sucubti near Indian village	Apr. 19
40940-40948	Camp Townsend	Feb. 16-24
40976-40978, 41172	Rio Chico, $\frac{1}{2}$ mile above village	Feb. 17
41006-41009, 41170	Three Falls Creek	Feb. 24
40536, 40882-40884, 40524	Chalichiman's Creek	Apr. 23-26
40546	Caledonia	May 6
51805	Camp Creek	Mar. 20

51767 Chalichiman's Creek (tadpoles
from back of adult) Apr. 23, 27

***Atelopus varius glyphus* Dunn**

Seen only on the upper Rio Sucubti after a cloudburst on April 19 to 20. Most abundant above a high falls in a creek near the Indian village. One individual was taken with a cluster of dead eggs adhering to its abdomen. Others kept in aquaria embraced, but no eggs resulted.

The color of the stripes, ordinarily a clear bright yellow, may change to a decidedly greenish yellow at times. Active about stream beds and apparently entirely diurnal.

A call sometimes heard as clouds passed over the sun was thought to be from this species. It consisted of a series of "peeps" not unlike that of *Phyllobates* but more prolonged, generally six in number.

SPECIMENS

A.M.N.H. Nos.	Locality	Date
39762-39764	Creek on upper Rio Sucubti near Indian village	Apr. 19
41094, 40900-40912, 40506, 40898, 40899, 40889-40894, 40535, 40520, 40521	Chalichiman's Creek	Apr. 23-29

FAMILY HYLIDAE

***Hyla rosenbergi* Boulenger**

This large *Hyla*, near to, if separable from, *H. maxima*, was found breeding only near the Yavisa base camp. It was very active in Camp Creek and to a less extent at Three Falls Creek. A few solitary examples were seen along the Rio Chucunaque as far up as the mouth of the Rio Membrillo, although on the Sucubti there was some indication of activity, such as questionable calls in the distance and half-effaced depressions with advanced tadpoles, that may have been of this species.

Breeding is accomplished in the heavy forest along the banks of drying stream beds. Here the male makes a circular depression, typically in the soft earth at the edges of the remaining pools. These fill with water, usually by seepage, and here the male sits and calls. There is considerable variation in these nests, evidently reflecting a considerable amount of adaptability on the part of the nesting males. In the case of nests built in

shallow water, the earthen walls are thrown up higher than the water level. Occasionally a rock crevice is used with merely an earthen dam thrown across its mouth. Examples of the various types of nests are shown in plates 49 to 53 and in figure 15. Sometimes even small pot-holes are used if these be of the right proportions and contain a suitable amount of water. Although during the nest constructing the frogs are very timid, in

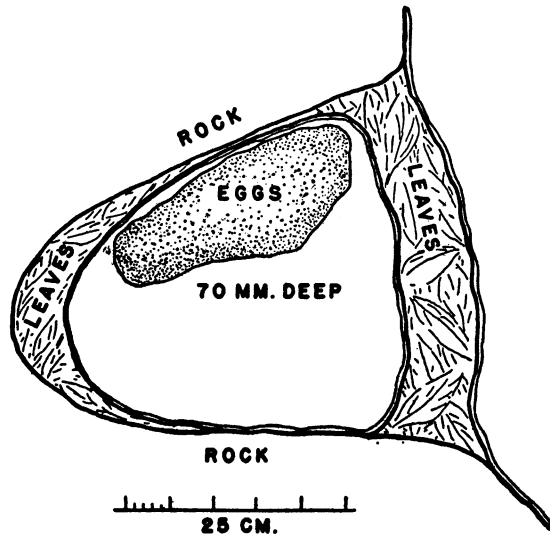


FIG. 15. The largest nest of *Hyla rosenbergi* recorded. As indicated this was made at the edge of a rock hollow with a large dam of leaves and earth. The egg mass was of normal size. This is nest no. 29 of figure 16.

strong contrast to their later behavior, the normal nests are evidently made by the males' pivoting around on their hind end and padding the walls with their front feet. The dimensions of the basins are just the right size for such a procedure to have produced them. The atypical nests, such as those consisting of a dam thrown across a rock crevice as seen in plate 51, would seem to be a purely mechanical response to the hardness and unworkability of the rock, rather than a deliberate attempt to modify the behavior to suit the situation.

The following tabulation gives the sizes in millimeters of 16 regularly shaped and normal nests:

									Max.	Mean	Min.
Greatest diameter	330	305	305	305	305	279	279	279			
	254	254	254	254	254	229	229	203	330	270 —	203
Least diameter	229	229	229	254	254	229	254	178			
	203	203	254	152	203	229	178	178	254	216	152
Depth	82	51	64	51	45	70	51	64			
	13	25	51	64	57	57	13	57	82	51 —	13

After the nest is constructed, the males call repeatedly for several nights, until females are induced to mate with them. The call consists usually of three notes that sound exactly like hammer blows and may be well imitated by rapping a knuckle sharply on a fiber trunk top or similar resonant surface. Sometimes two, four, or five notes are given. The spacing between the sounds is usually about one-half second, although it is generally hurried if more than three are given. There then follows an irregular pause. In making these calls the throat pouch is not greatly dilated. The dilation is about at its greatest as shown in plate 52. As an experiment, a male was placed close to the nest of another which was calling. Immediately the latter moved to the far side of his nest and called from there, facing the other way until the intruder moved off. This may have been more than just a reaction to intrusion as is pointed out subsequently in connection with the mating behavior. Very occasionally a call is given from the bushes a few feet off the ground and under exceptional circumstances from just outside the nest as is discussed later. From this time on the frogs are among the least timid and make excellent experimental material.

An attempt was made to discover if these frogs would take up occupancy in a nest not made by them. To this end three artificial "nests" were constructed near the center of their breeding activity on February 11. These were made to resemble the typical nest as closely as possible and to a human, at least, they were indistinguishable. Although numerous "frog-made" nests were subsequently constructed near these, the artificial "nests" were not used. After these artificial basins had lost semblance to a nest and were mere ill-defined depressions, on March 23, over a month later, one was found to be rebuilt and to contain eggs and the other two were partly reconstructed. This suggests that these frogs

will not bother an already made nest but will begin work on some slight concavity accidentally present. However, the same nests are sometimes used repeatedly as is indicated in table 6 as well as by the fact that sometimes two stages of tadpoles were found in one nest. It is naturally not known whether these were the offspring of a single male or whether one male was willing to forego the labor of nest building. Figure 16 shows in detail the distribution of nests in the area where they were studied intensively, including the "artificial" nests.

Advanced larvae were sometimes found in a solid wriggling mass in a nearly dry nest or buried in the damp leaves at the bottom of a superficially dry one. On March 6 nest no. 26 (see table 6) was in the latter condition. The following day the larvae were all gone although the nest was carefully excavated. It would seem that some small bird or other creature had picked the nest clean, for certainly these larvae have no way of escaping from their basin and no doubt depend on a rain-storm to release them, in a manner similar to those of the froth-forming species of this area. From this later date, however, numerous newly transformed examples were taken from time to time and always only on the leaves of the abundant *Calyptrorhynchus* sp. These young frogs were brownish in various shades with variously distributed small bright green spots on the back. The legs were varied with darker brown and the iris was slightly yellowish, while the face was marked with whitish. The underparts of the limbs were lemon yellow with throat and abdomen whitish. It is not clear how the interval covering the actual metamorphosis was spent, or where.

It is inferred from table 6 that the average time of desiccation of a nest occupied from 10 to 15 days after the eggs had been deposited, if the development was to be suc-

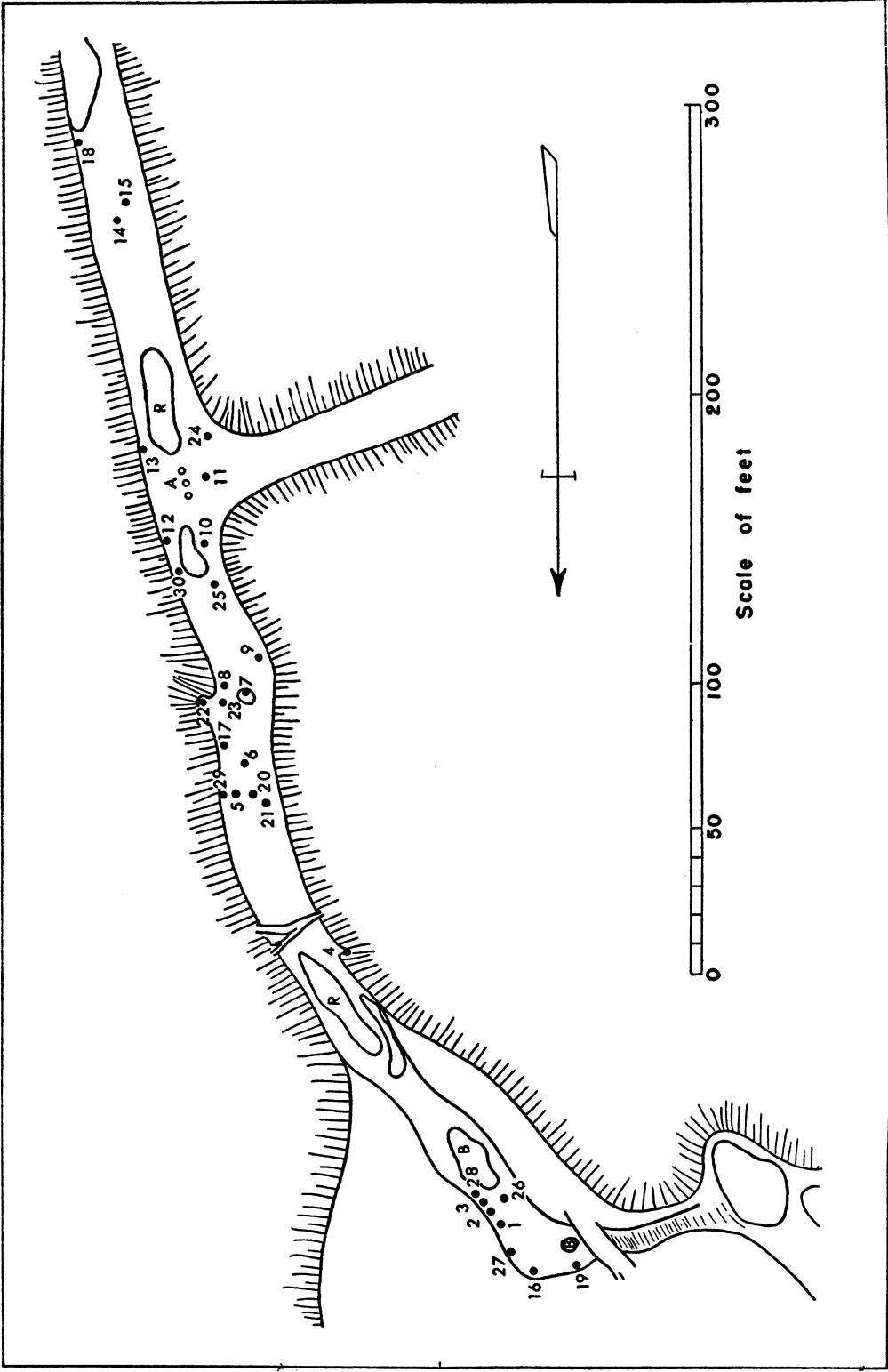


FIG. 16. Location and distribution of nests of *Hyla rosenbergi* on February 11. For comparison with figure 5, table 6, and plates 49, 50, 51, 52, and 53. The dark dots indicate nests and the numbers are those of table 6. "A" indicates artificial nests. "B" indicates *Bufo* tadpoles. "R" indicates *Rana* tadpoles.

TABLE 6
CHRONOLOGY OF THE BREEDING ACTIVITY OF *Hyla rosenbergi*
(See fig. 16 for the location of these nests.)

Nest No. ^a	February 11	February 14	February 21	February 22	March 1
1	Well-advanced larvae	Empty	New batch of larvae	Larvae, external gills	Empty, nearly dry
2	Empty	Empty	Eggs	Newly hatched	Empty, nearly dry
3	Empty, incomplete	Empty	Empty	Empty	Empty, nearly dry
4	Recently hatched larvae	Empty	Empty	Empty	Empty, dry
5	Young larvae	Well-advanced larvae	Further advanced larvae	Further advanced larvae	Empty, nearly dry
6	Empty	Empty	Empty	Empty	Empty, nearly dry
7	Well-advanced larvae	Empty	Empty	Empty and dry	Empty, dry
8	Young larvae	Well-advanced larvae	Further advanced larvae	Further advanced larvae	Empty, nearly dry
9	Empty, incomplete	Empty	Empty	Empty	Empty, nearly dry
10	Young larvae	Well-advanced larvae	Further advanced larvae	Further advanced larvae	Empty, dry
11	Young larvae	Well-advanced larvae	Further advanced larvae	Further advanced larvae	Empty, dry
12	Young larvae	Well-advanced larvae	Empty, embraced pair taken	Empty	Empty, dry
13	Empty, pair taken	Empty	Advanced eggs	Eggs hatching	Empty, dry
14	Empty, pair taken	Empty	Empty	Empty	Empty, dry
15	New eggs	Larvae, external gills	Young larvae	Advanced larvae	Empty, dry
16	—	Empty	Eggs	New larvae	Empty, dry
17	—	New eggs	Young larvae	Advanced larvae	Empty, dry
18	—	New eggs	Young larvae	Advanced larvae	Empty, dry
19	—	—	—	Empty, incomplete	Empty, dry
20	—	—	—	Larvae, external gills	Empty, dry
21	—	—	—	Empty	Empty, dry
22	—	—	—	Larvae, external gills	Empty, dry
23	—	—	—	Empty	Empty, dry
24	—	—	—	New eggs	Advanced larvae, nearly dry
25	—	—	—	Eggs about to hatch	Empty, dry
26	—	—	—	—	Larvae, external gills

^a The nests are numbered in the order in which found. Several still later nests were made in this locality, 27 to 30 inclusive, but it was too near to the time of leaving to keep chronological notes of this sort. See figure 16 for location.

TABLE 7
MOVEMENTS OF MARKED *Hyla rosenbergi*

Tag No.	Date Tagged	First Recovery	Second Recovery	Third Recovery	Fourth Recovery
1	3/15	—	—	—	—
2	3/15	3/16—same place	—	—	—
3	3/15	3/18—to where No. 7 was tagged	3/20—in new nest at site of tagging	3/21—in same nest with 2 others	3/26—in another new nest, nearby
4	3/15	—	—	—	—
5	3/15	3/21—alone, near No. 3's nest	3/22—same place	—	—
6	3/15	—	—	—	—
7	3/15	3/16—same place with No. 11	3/18—embrace with untagged frog at same place	—	—
8	3/15	—	—	—	—
9	3/15	3/16—near same position	—	—	—
10	3/15	3/19—near same position	3/23—500' down stream at edge of full nest	—	—
11	3/16	—	—	—	—
12	3/16	—	—	—	—

cessfully completed, or about from nine to 14 days from the time of hatching. Of the 26 nests thus studied apparently 15 were successful. Of the others desiccation overtook four, and seven were never the receptacles of spawn. In one at least the larvae were found dead and dried in the bottom of the nest.

An attempt was made to determine something of the movements of these frogs. Six specimens were marked by means of small cards tied about their waists on February 14. These were never seen again, but on March 15, 12 were marked by means of small specimen tags tied about their waists in a manner subsequently described and used by Breder, Breder, and Redmond (1927). Of these dozen frogs one-half were seen again in the 11 nights on which observations were made, in the following order of repeats:

No repeats	6
One repeat	2
Two repeats	3
Four repeats	1

The exact data obtained are given in table 7, from which it is evident that there was little movement up or down stream, the greatest being only about 500 feet.

On release these frogs take long leaps and strive to reach the nearest bush or tree, frequently leaping over the surface of a pond rather than swimming. Thus in deep water they leap from a floating position and leap again as soon as striking the surface of the water. Only once did one dive and hide under water.

In order to facilitate continued study of the nesting behavior we marked a considerable number of the nests with small numbered stakes. These appear in some of the photographs and are referable to figure 16 which gives a sketch map of the situation. A number of photographs were taken of these breeding activities, plates 52 and 53 showing a series of behavior items concerning a single male that built and occupied nest no. 2. See also figure 5. Part of this series of photographs has been used by Breder (1925d). The legends with the photographs explain the particular incident. It was the only time in which a male was noted to leave his nest and pursue a female that evidently was not about to enter. It is ev-

ident that the female entered from the back of the nest, that is, at the side to which the male had its back. Other observations indicate that this is the usual order of procedure. It allows the female to jump on the back of the male, which may not be necessary but is usually done. The male at once turns and reverses the positions as shown in the final photograph of that series. As earlier noted the placing of another male near the nest caused the owner to face the other way. It is possible, although it could not be determined in the field, that actually the male is presenting his back to a possible female visitor as part of the courtship procedure.

This region of the stream above a small but nearly vertical fall is not well inhabited by fishes, only a single species being taken there, *Rivulus chucunaque* Breder. This type of nest could hardly be a protection against this fish as it migrates overland freely. Writing of the habits of the fish Breder (1927b) wrote, "The lagoon-like nests of *Hyla rosenbergi* Boulenger were common along stretches of the creeks inhabited by this species and it may be that *Rivulus* is one of the enemies that the construction of these nests is intended to thwart. Once an example was found in a recently constructed nest in company with the male frog that had no doubt made it. The fish seemed not at all concerned by the presence of the frog but the latter was exceedingly nervous and the nest was not laid in although the following day the fish was gone." Other general remarks on this species have been given by Breder (1925d, 1927a). Some of the present data have already been used by Noble (1927, 1931) in abridged form, and it is from him that we obtained the drawing of a larva showing its greatly enlarged external gills, here redrawn as figure 17, D.

Using the original field notes, Noble (1925) in comparing various species of nest-building hylas wrote as follows: "In the case of *H. rosenbergi* the male does all the nest building. This was not determined by direct observation but by the discovery that when the nests are being built only the males are in or near them. The nests are made in the forest along drying pools, close enough to the edge of these rain water or stream filled pools to be filled by seepage from the main body of water. Occa-

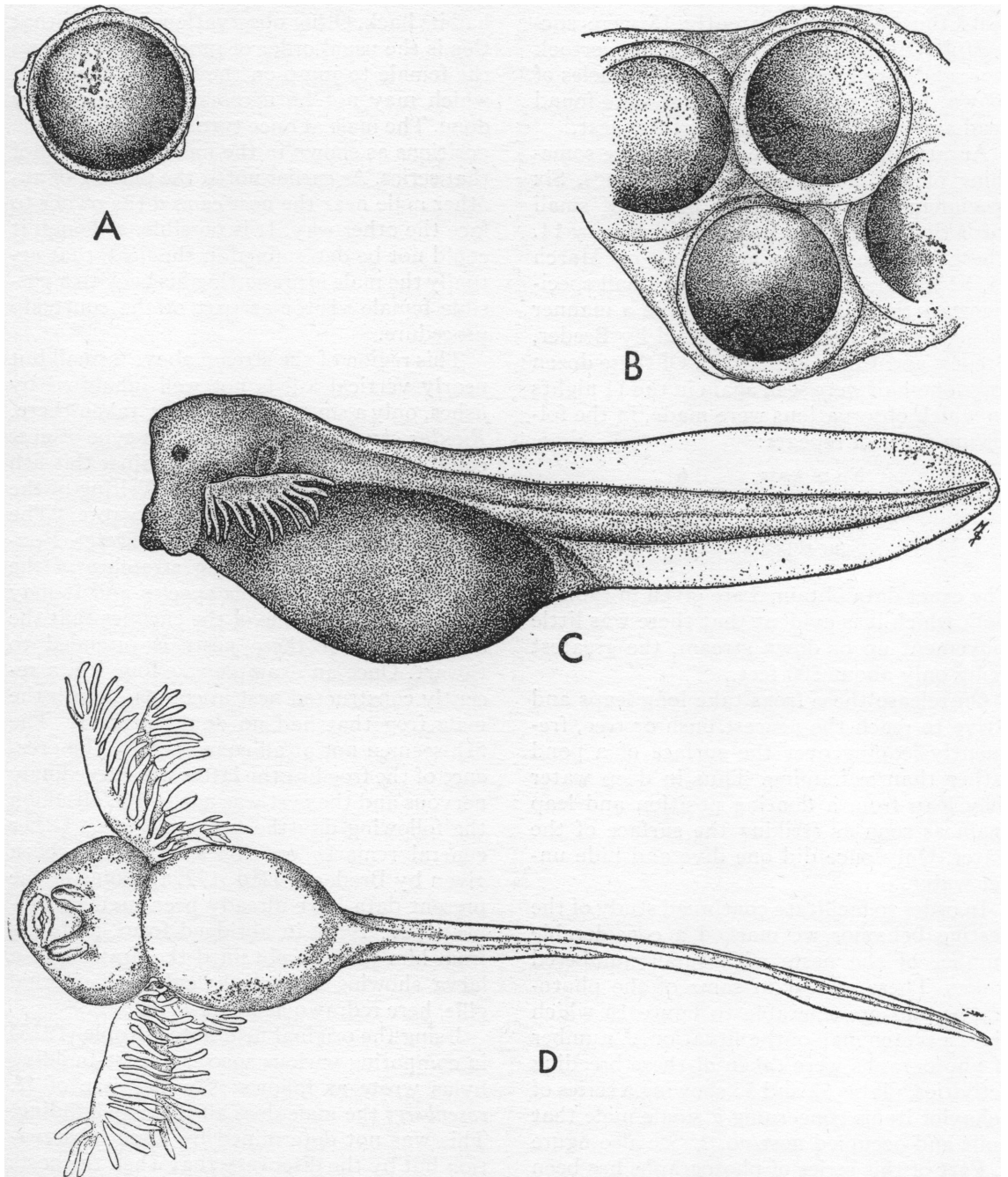


FIG. 17. Development of *Hyla rosenbergi*. A. A single egg as found on February 11; $\times 11$. B. A cluster of eggs from the same nest as found on February 12; $\times 11$. C. Newly hatched larva; $\times 20$. D. Larva with greatest development of gills attained; $\times 15.6$. Redrawn after Noble (1927).

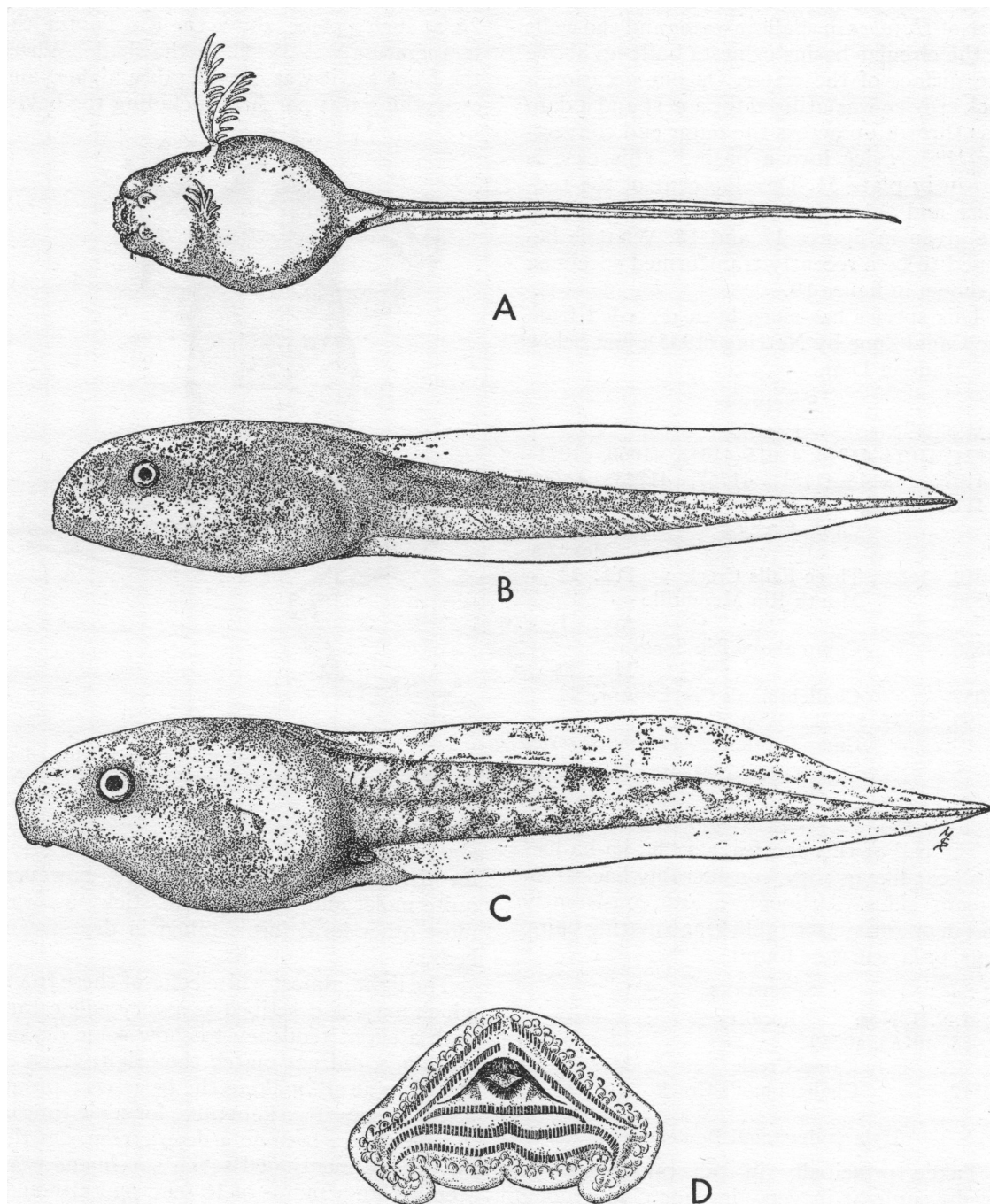


FIG. 18. Development of *Hyla rosenbergi*. A. Specimen reabsorbing gills; $\times 9.6$. B. Advanced tadpole $\times 9.6$. C. Mature tadpole; $\times 4.8$. D. Mouth of mature tadpole; $\times 24.7$.

sionally they are constructed exactly as in the case of *H. faber* in shallow water and the walls of the circular basins or nests built up above the surface of the water. On one occasion a rock crevice was utilized for a nest and a dam was thrown up across the outer end converting the crevice into a basin." This case is shown in plate 51. Development of the tadpoles and the mouth of the mature tadpole are given in figures 17 and 18. What is believed to be a recently transformed specimen is shown in figure 19.

This species has since been recorded from the Canal Zone by Netting (1935), just below the Madden Dam.

SPECIMENS

A.M.N.H. Nos.	Locality	Date
40924, 41024-41026, 41015-41018, 41060, 41071-41073, 41148-41151, 41767, 41723, 41724, 41158-41163	Camp Creek	Feb. 9 to Mar. 20
41010, 41683, 40550	Three Falls Creek Mouth Rio Membrillo	Feb. 24
40650	Camp above Rio Sansan	Apr. 1 Mar. 30
41057, 41790, 51774, 51771, 51796, 51791	Chalichiman's Creek Camp Creek. Developmental series of eggs and larvae	Apr. 24 Feb.-Mar.

Hyla phaeota Cope

The call of this species is a "ha-ha-ha-ha" of a goat-like quality, considerably back from stream sides. Although heard consistently and in quantity (see table 9), no mating pairs, eggs, or larvae were found.

SPECIMENS

A.M.N.H. Nos.	Locality	Date
40988, 40758, 40759	Camp Creek	Mar. 8-10
40512	Chalichiman's Creek	Apr. 23

Hyla underwoodi Boulenger

Taken principally in tall rank grass in bright sunlight in very dry hot places along the river edge. The grass has a saw-like quality and easily cuts through the skin at any false move. In these places the frogs are nearly white in color and were found mostly sitting quietly at the axils of the upper leaves. The upstanding leaves, however, offer little

protection from the blazing sun. On February 26, at such a place, above the Rio Tupisa, the temperature was 37° C. in the shade. Where the frogs sat it was considerably higher, and everything was parched, including the baked

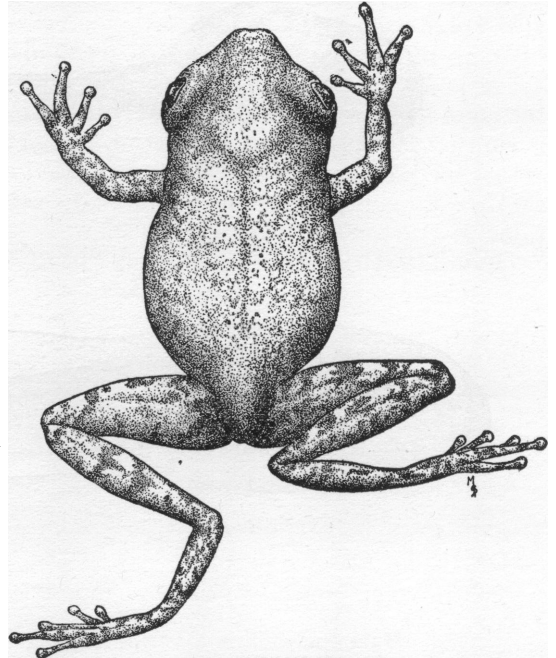


FIG. 19. Metamorphosing specimen believed to be *Hyla rosenbergi*; $\times 3.5$.

and cracked mud that formed the footing for these plants. The frogs were, however, quite moist and slippery, not sticky as were most other local forms taken in dry stream beds.

The light, almost white color of these frogs, which may be described as a very pale cream with a slight tendency to show some darker markings, did not match the bright green of the grass at all, making the frogs very prominent objects. Two kept alive for some time in a cooler place became a deep cream. On the day above mentioned seven specimens were seen within a radius of 10 feet, and although the plants were stripped and examined over a much larger area no more were to be found.

These frogs show an extremely marked tendency to hold a fixed optical position. If allowed to perch on the back of the hand they will sit quietly with a line between the

eye in a horizontal plane. If the hand is twisted so as to incline them one way or another the head holds its position with the interorbital axis horizontal, the body twisting and legs folding or extending accordingly. This will continue perfectly until a certain speed of motion is reached when they invariably hop off. It may be that this particular speed is associated with the speed at which fusion of background takes place. If the hand is rotated far enough, at any speed, through an arc large enough to make it impossible for the frog to compensate by leg or body motions, it also usually leaps away.

Dunn (1931b) gives the voice as "ik lik."

SPECIMENS

A.M.N.H. No.	Locality	Date
51783	Rio Chucunaque, 6 miles above Rio Tupisa	Feb. 26

Hyla leucophyllata (Beireis)

A single specimen taken near Yavisa.

SPECIMENS

A.M.N.H. No.	Locality	Date
40997	Camp Creek	March 8

Hyla subocularis Dunn

Described from a single specimen taken in a dry creek emptying directly into the Rio Chucunaque about a mile above the mouth of the Rio Tuquesa, which is the first stream above that river, and on the same side of the Chucunaque.

SPECIMENS

A.M.N.H. Nos.	Locality	Date
41117 (type)	First creek above mouth of Rio Tuquesa	Mar. 3
51777	Rio Chucunaque	—
51784, 51786	Camp Creek (small, identity not certain)	—

Hyla sordida Peters

Not common nor evidently breeding.

SPECIMENS

A.M.N.H. Nos.	Locality	Date
39784	Rio Chico (near village)	Feb. 20
40936-40939, 40992, 40756, 40757	Camp Creek	Feb.-Mar.
41684, 51788	Three Falls Creek	Feb. 24 to Mar. 12

Agalychnis callidryas (Cope)

This species, not common at any place, was seen and heard in greatest numbers near the Yavisa base camp, in February and March. This, except for a single individual heard and taken at the Indian village on the upper Sucubti, was the only place it called. The calling near Yavisa was all in a very restricted locality. See figure 5. The call consisted of a single liquid "quirt." Dunn (1931b) gives the note as "tlock." Each frog called alone, after which it would be followed by another, two or three minutes later, and so on. Never were more than five heard calling, so that as much as 10 or 15 minutes would sometimes elapse before the first caller gave a second note. This made locating them very tedious and difficult, especially since most called from overhead up to about 15 feet from the ground. Dunn found his frogs calling from 6 to 8 feet in trees which is in essential agreement with these observations. None at this place was seen more than 25 feet from water.

When held in the hand they sometimes gave vent to a rapid series of sharp clicks. They are much given to climbing but little prone to leap although their powers in this direction are considerable. When placed on various shades of green they approximated them very closely in a short time. When sleeping the eyelids were never seen to close completely, a small slit remaining which was covered by a speckled nictitating membrane as shown in plate 54.

Much time was spent in searching for their eggs but absolutely none was to be found. Two held in captivity repeatedly embraced but no spawn resulted. The other localities at which this frog was found follow: Rio Chucunaque, about 5 miles below the mouth of the Rio Canglon on March 10 in daylight in a patch of exposed grass. Rio Sucubti, at the Indian village at least 300 feet from the nearest water in a low palm on April 30. This one was calling.

A number of tadpoles seen only in a single small pond near Tapia may belong to this species in the judgment of Dr. E. R. Dunn. A specimen is shown in figure 20. These were translucent in life and spent most of their time with their mouth pressed against the vertical surfaces of plant stems while the pos-

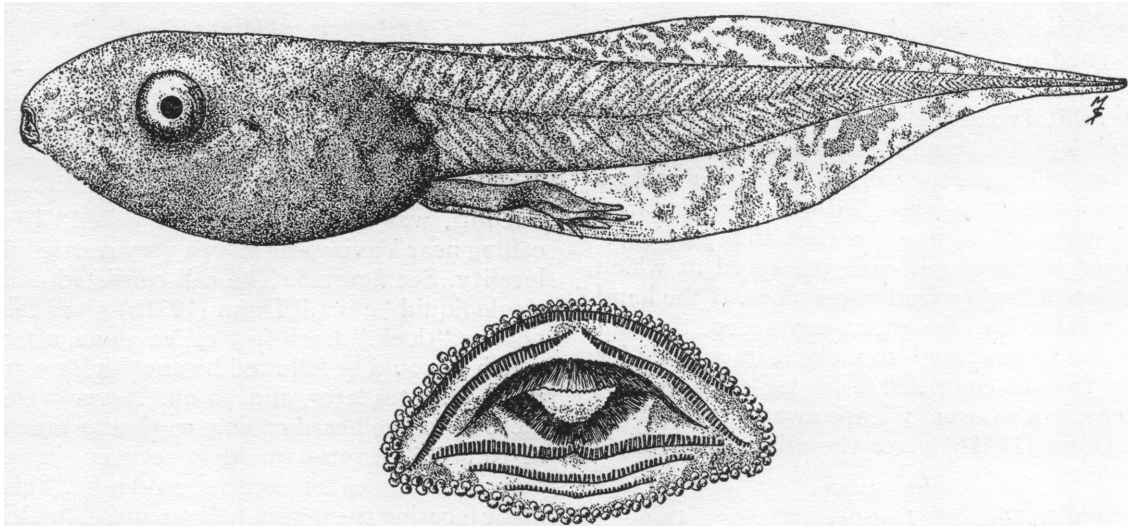


FIG. 20. Unidentified tadpole, possibly *Agalychnis callidryas*; $\times 3.8$; and its mouth; $\times 19$.

terior one-third of the tail was rapidly vibrated. This was clearly not a feeding posture but evidently a resting position.

SPECIMENS

A.M.N.H. Nos.	Locality	Date
39766, 39767	Creek on upper Rio Subcubti near Indian village	Apr. 19
40545	Camp Creek	Apr. 13
51769	Pond near Tapia (tadpoles of this sp.?)	Feb. 2

Centrolene fleishmanni (Boettger)

At Camp Creek this species was found sitting quietly on the leaves of the abundant *Calyptrogyne*. Evidently it is purely nocturnal. They kept their limbs tucked up so carefully that they looked like a simple bump on the leaves. Generally they sat on the top sides of the leaves. None was found close to another, the closest being not less than 100 feet apart. Their distribution at this locality seemed to coincide with that of *Agalychnis*.

Their colors in life were as follows: Iris golden, spotted with darker, pupil horizontal. Dorsal surface light green of varying shades with numerous pigmentless areas on both body and limbs. Colorless below, with internal organs somewhat visible, stomach, intestine, and heart hidden by an argenteous membrane. Alveolar nature of lungs visible, various arteries distinct; tips of toes yellow-

ish from below. The whole effect was of the translucence of colored paraffin.

The heart beats of five examples at 10:30 A.M. at a temperature of 27° C. were at the following counts per minute: 118, 120, 120, 122, 128. The respiration was a flutter too fast to count and not very distinct.

Those on the upper Sucubti were calling and breeding in late April. The call is a single note of considerable intensity and volume: "peerép" at intervals of from five to 10 seconds. The throat pouch distends prominently, but the body inflates little. Most called from the under side of leaves, but a few chose axils and the top sides of leaves. Generally they were in positions overhanging water from about 5 to 20 feet above its surface. They usually sat near the tip of a leaf, which their weight drew into a vertical plane with the frog facing upward. According to Park (1938) this species calls throughout the night, beginning before dusk and not stopping until after dawn, an item we were not able to check.

The eggs of this frog were found in a similar place attached to the under side of leaves, although only two clusters were located. The eggs are large and encased in a generous envelope of clear jelly. The outlines of the cluster follow the eggs, giving the mass a bumpy appearance. One of the clusters is shown in plate 55. It contained nine eggs, and

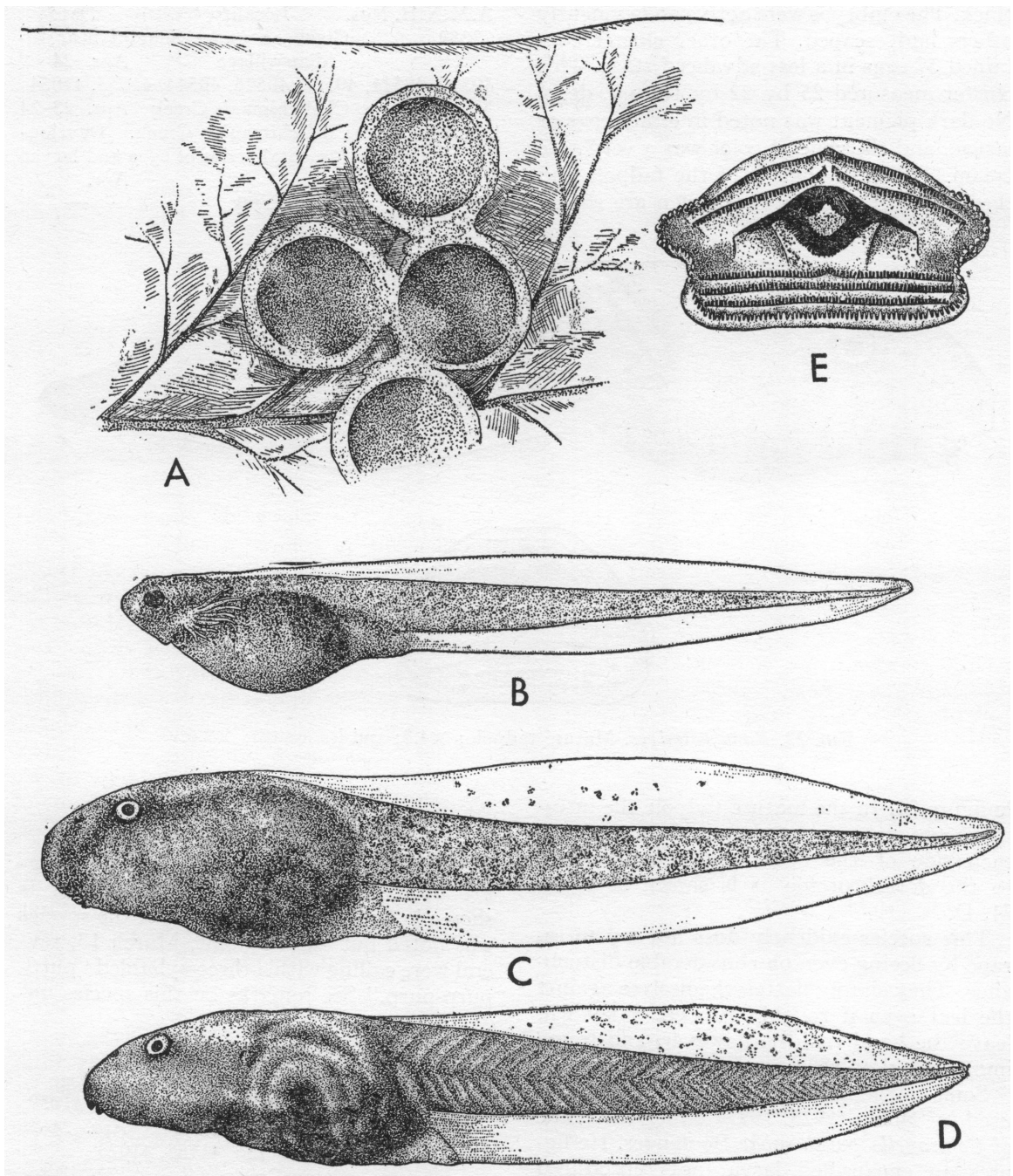


FIG. 21. Development of *Centrolene fleishmanni*. A. Eggs as found attached to leaf; $\times 9.3$. B. Newly hatched larva; $\times 19.5$. C. Advanced tadpole; $\times 16.4$. D. Mature tadpole; $\times 7.8$. E. Mouth of mature tadpole; $\times 25$.

the cluster measured 25 by 19 by 10 mm. thick. The embryos were active and evidently others had escaped. The other cluster contained 37 eggs in a less-advanced stage. This cluster measured 25 by 22 by 10 mm. deep. No dark pigment was noted in either eggs or larvae, and the general color was a very pale cream. The development of the tadpole and the mouth of a mature specimen are shown

SPECIMENS		
A.M.N.H. Nos.	Locality	Date
23389	Creek on upper Sucubti near Indian village	Apr. 24
40510, 40511, 40525, 40526, 40544, 41053, 41054	Chalichiman's Creek	Apr. 23-24
51773	Chalichiman's Creek. Developmental series of eggs and larvae	Apr. —
51775	Camp Creek	—

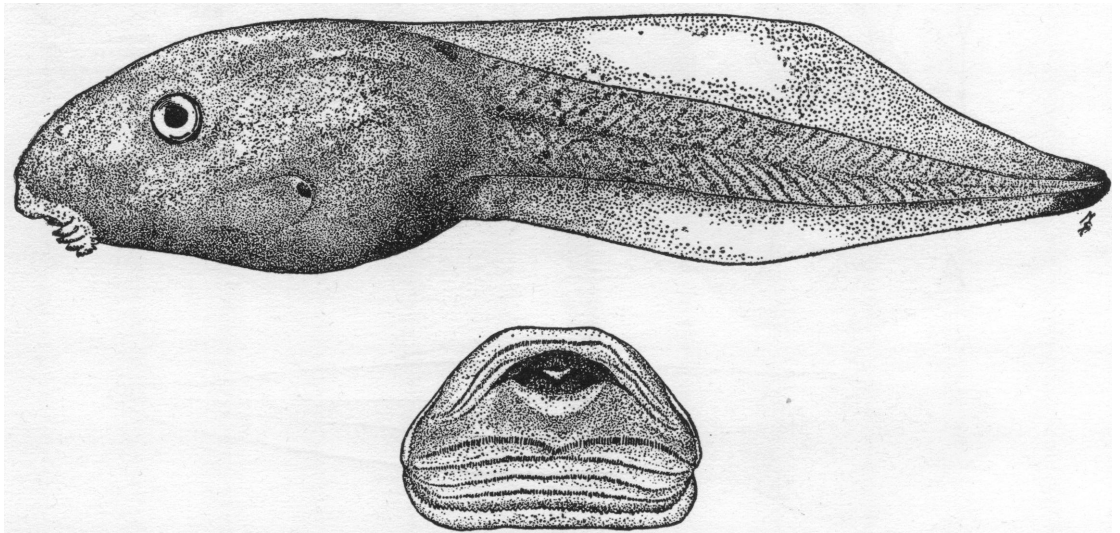


FIG. 22. *Rana palmipes*. Mature tadpole; $\times 4.2$; and its mouth; $\times 9.6$.

in figure 21. In the mature tadpole the intestinal convolutions are deflected upwards on each side of the body and extend nearly to the dorsal profile as is shown in figure 21, D.

This species evidently does not try to escape by fleeing even on considerable disturbance. They simply flatten themselves against the leaf even if roughly rubbed. They will leave the hand rapidly, however, and freeze immediately on the nearest green object.

Some of the above data have already been used by Noble (1925, 1927) under the name of *Centronella parabambae* Boulenger. He figures an encapsulated larva, not reproduced herewith. The name used here follows the usage of Dunn (1931a, 1931b) who also reports confirmatory data on the breeding behavior. His interpretation of the call is "tsee."

FAMILY RANIDAE

Rana palmipes Spix

A tadpole and its mouth are shown in figure 22, and a transforming individual is shown in figure 23. No breeding of the species was noted but on one night, March 13, several were calling with a three-syllabled "purp-purp-purp." See remarks on this species under *Bufo marinus*.

SPECIMENS		
A.M.N.H. Nos.	Locality	Date
40532, 40515-40518, 40537, 40878, 40879, 41059	Chalichiman's Creek	Apr. 24-26
41062, 41728-41730, 41156, 41137, 41023	Camp Creek	Feb. 10 to Mar. 19
40563, 40556-40558, 40824, 40830, 40826, 40832, 40840, 40835, 40843, 40845, 40847, 40852, 40853	Rio Sucubti	Apr. 18 to May 1

41685, 41686, 41706			<i>Rana warschewitschii</i> (Schmidt)		
51766	Three Falls Creek	Feb. 24	Taken only on the upper Sucubti. No tadpoles were found unless they are very similar to those of <i>Rana palmipes</i> and confused with that species. Not heard in voice.		
	Rio Sucubti (tadpoles)	Apr. 18			
51806	Three Falls Creek (tadpoles)	Mar. 12			
51776	Upper Camp Creek (tadpoles)	Feb. 12			
			SPECIMENS		
51768, 51795, 51772, 51794, 51793, 51782, 51770,	Camp Creek (tadpoles)		A.M.N.H. Nos.	Locality	Date
51781		Feb.-Mar.	40918, 40539, 40519	Chalichiman's Creek	April 20-29

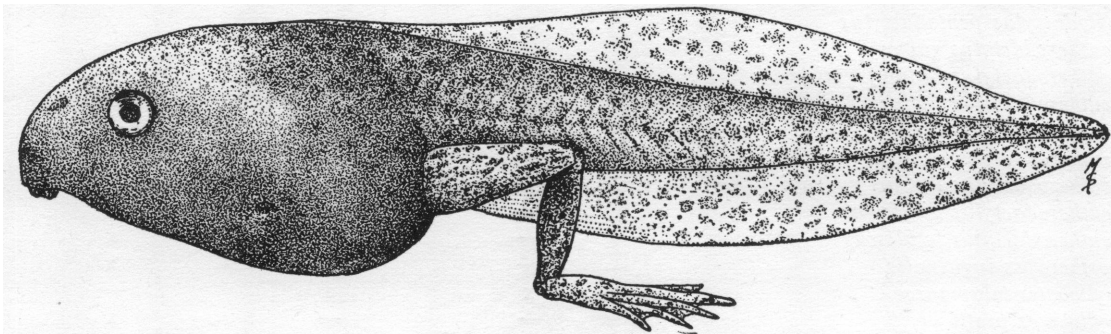


FIG. 23. Metamorphosing specimen of *Rana palmipes*; ×2.4.

DISTRIBUTION OF SALIENTIA IN THE RIO CHUCUNAQUE BASIN

A study of the specimens collected and notes on their appearance in the field have been tabulated according to "life zones" defined by Goldman (1920). These are indicated in table 8. It is not supposed that absences of some of the species from a given zone, in these records, mean more than our failure to find them. It is well known that many have been collected by others in different places external to the Chucunaque basin from the zones in which we found none of a given species (see for example the numerous papers of Dunn on other Panamanian regions). This list does nevertheless give some measure of relative abundance of the various forms, on the statistical basis that in general we were most likely to miss the rarer forms and least likely to miss the most abundant types. Furthermore in some cases true absences may be indicated, for it does not neces-

sarily follow that even if a certain species has invaded a given zone in one drainage it necessarily has done the same in another. At a very minimum this list should be helpful to students who follow into this basin.

The portion of the table expressed in terms of percentages of the total number of species encountered indicates clearly the greater diversity of species encountered in moister regions. Although 50 per cent of the species are actually to be found in the lower dry zone, 19 per cent were found to be confined to the upper zone. Seventy-five per cent of all the species were found in this zone. Thirty per cent of the species are to be found in all three zones, while the two moist zones have 24 per cent species in common, and only 12 per cent are common to the two lower zones. It would seem from this that the relative moisture is the largest single controlling factor.

TABLE 8

DISTRIBUTION OF SALIENTIA IN THE RIO CHUCUNAQUE BASIN IN REFERENCE TO LIFE ZONES

Species	Lower Tropical Zone		Upper Tropical Zone
	Arid	Humid	
<i>Bufo haematiticus</i>	—	x	x
<i>Bufo typhonius</i>	x	x	x
<i>Bufo coniferus</i>	x	x	—
<i>Bufo marinus</i>	x	x	x
<i>Engystomops pustulosus</i>	x	x	x
<i>Leptodactylus bolivianus</i>	x	x	x
<i>Leptodactylus poecilochilus</i>	—	x	—
<i>Leptodactylus melanonotus</i>	x	x	x
<i>Leptodactylus pentadactylus</i>	x	x	x
<i>Eleutherodactylus gaigei</i>	—	x	x
<i>Eleutherodactylus bufoniformis</i>	—	x	x
<i>Eleutherodactylus fitzingeri</i>	x	x	x
<i>Eleutherodactylus brederi</i>	x	—	x
<i>Eleutherodactylus ockendeni</i>	x	—	—
<i>Eleutherodactylus lutosus molinoi</i>	—	—	x
<i>Eleutherodactylus diastema</i>	x	x	x
<i>Eleutherodactylus latidiscus</i>	—	—	x
<i>Prostherapis inguinalis</i>	—	—	x
<i>Phyllobates talamancae</i>	x	x	—
<i>Phyllobates pratti</i>	—	—	x
<i>Dendrobates auratus</i>	x	x	x
<i>Atelopus varius glyphus</i>	—	—	x
<i>Hyla rosenbergi</i>	—	x	x
<i>Hyla phaeota</i>	—	x	x
<i>Hyla underwoodi</i>	x	—	—
<i>Hyla leucophyllata</i>	—	x	—
<i>Hyla subocularis</i>	x	x	—
<i>Hyla sordida</i>	x	x	—
<i>Agalychnis callidryas</i>	—	x	x
<i>Centrolene fleishmanni</i>	—	x	x
<i>Rana palmipes</i>	—	x	x
<i>Rana warschewitschii</i>	—	—	x
Number of species taken	16	23	24
Number of species exclusive to this zone	2	2	6
Number of species found only in one zone		10	
Number of species common to two zones		13	
Number of species common to three zones		9	
Total number of species		32	

DISTRIBUTION OF SPECIES IN PERCENTAGE OF TOTAL NUMBER FOUND

	Present	Unique
Lower tropical zone, arid	50	6
Lower tropical zone, humid	72	6
Upper tropical zone	75	19
Common to lower arid and humid zones		12
Common to lower arid and upper zones		3
Common to lower humid and upper zones		24
Common to all three zones		30

THE VOICES OF CHUCUNAQUE SALIENTIA

In the annotated list, the voices of all frogs heard calling have been described under the appropriate head. As everyone knows, who has tried it, it is extremely difficult to transliterate frog voices, since such calls seem to give very different connotations to different hearers. For this reason, where calls have been described by others, mostly by Dunn, they have been added for comparison.

An attempt has been made to construct a key to the voices of the Salientia of the basin for what use it may be to other students who may enter the region or nearby drainages. This key was made in the field while the calls were being heard. Later have been added to it the transliterations of Dunn and voices he describes from other places which were not heard by us.

The dates on which calls were heard at the Camp Creek station and at Chalichiman's Creek, together with their relative frequency, when such was noted, are given in table 9, to which have been added various incidental records at places where we made short stops. It is hoped that this will be helpful to field students in regard to the location in time and space of such species. A comparison with the climatic data of tables 1 to 4 at Camp Creek should be useful in an ecological study.

Park, Barden, and Williams (1940) studied the nocturnal activity of three species as reflected by their calls on Barro Colorado. These three are *Leptodactylus pentadactylus*, *Eleutherodactylus fitzingeri*, and *Centrolene fleishmanni*.

TABLE 9

CALLING FREQUENCY OF SALIENTIA IN THE RIO CHUCUNAQUE BASIN

The frogs are listed in the order of the frequency of their calls, the first being heard most frequently on any one day. Omission of a name in the following lists of calls means that the species was silent. There was always a general increase in number of callers of any given species as the number of species involved increased.

CAMP CREEK (NOCTURNAL)

- | | | |
|------|----|--|
| Feb. | 10 | <i>Hyla rosenbergi</i> |
| | 11 | <i>Hyla rosenbergi</i> , <i>Leptodactylus bolivianus</i> , <i>Leptodactylus pentadactylus</i> |
| | 13 | <i>Hyla rosenbergi</i> , <i>Agalychnis callidryas</i> , <i>Leptodactylus pentadactylus</i> |
| | 14 | <i>Hyla rosenbergi</i> , <i>Leptodactylus pentadactylus</i> |
| | 15 | <i>Hyla rosenbergi</i> , <i>Leptodactylus pentadactylus</i> , <i>Engystomops pustulosus</i> |
| | 21 | <i>Hyla rosenbergi</i> , <i>Leptodactylus pentadactylus</i> |
| | 22 | <i>Hyla rosenbergi</i> , <i>Leptodactylus pentadactylus</i> |
| Mar. | 1 | <i>Leptodactylus pentadactylus</i> |
| | 7 | <i>Leptodactylus pentadactylus</i> |
| | 8 | <i>Leptodactylus pentadactylus</i> , <i>Engystomops pustulosus</i> |
| | 9 | (First good rain since here)
<i>Bufo marinus</i> , <i>Leptodactylus pentadactylus</i> , <i>Agalychnis callidryas</i> , <i>Hyla rosenbergi</i> , <i>Engystomops pustulosus</i> |
| | 10 | (Second rain, heavy)
<i>Engystomops pustulosus</i> , <i>Bufo marinus</i> , <i>Hyla phaeota</i> , <i>Leptodactylus pentadactylus</i> |
| | 11 | <i>Engystomops pustulosus</i> , <i>Bufo marinus</i> , <i>Leptodactylus pentadactylus</i> |
| | 13 | <i>Leptodactylus pentadactylus</i> , <i>Engystomops pustulosus</i> , <i>Hyla rosenbergi</i> , <i>Bufo marinus</i> , <i>Rana palmipes</i> , <i>Leptodactylus bolivianus</i> |
| | 15 | <i>Leptodactylus pentadactylus</i> , <i>Hyla rosenbergi</i> , <i>Agalychnis callidryas</i> , <i>Engystomops pustulosus</i> |
| | 16 | (Third rain, light)
<i>Leptodactylus pentadactylus</i> , <i>Hyla phaeota</i> , <i>Agalychnis callidryas</i> , <i>Hyla rosenbergi</i> , <i>Engystomops pustulosus</i> |
| | 17 | (Fourth rain, light)
<i>Engystomops pustulosus</i> , <i>Hyla phaeota</i> , <i>Leptodactylus pentadactylus</i> , <i>Hyla rosenbergi</i> , <i>Agalychnis callidryas</i> , <i>Bufo marinus</i> |
| | 18 | <i>Engystomops pustulosus</i> , <i>Leptodactylus pentadactylus</i> , <i>Bufo marinus</i> , <i>Hyla rosenbergi</i> , <i>Agalychnis callidryas</i> |
| | 19 | <i>Hyla rosenbergi</i> , <i>Engystomops pustulosus</i> , <i>Leptodactylus pentadactylus</i> , <i>Bufo marinus</i> , <i>Leptodactylus bolivianus</i> |

Mar. 20 (Fifth rain)

- Hyla phaeota*, *Engystomops pustulosus*,
Leptodactylus pentadactylus, *Hyla*
rosenbergi, *Leptodactylus bolivianus*,
Bufo marinus, *Agalychnis callidryas*
- 21 *Hyla rosenbergi*, *Leptodactylus penta-*
dactylus, *Engystomops pustulosus*,
Leptodactylus bolivianus, *Agalychnis*
callidryas
- 22 *Leptodactylus pentadactylus*, *Hyla rosen-*
bergi, *Engystomops pustulosus*, *Lepto-*
dactylus bolivianus
- 23 *Hyla rosenbergi*, *Engystomops pustulo-*
sus, *Agalychnis callidryas*
- 24 *Leptodactylus pentadactylus*, *Hyla rosen-*
bergi, *Engystomops pustulosus*
- 26 *Leptodactylus pentadactylus*, *Hyla rosen-*
bergi
- 27 *Leptodactylus pentadactylus*, *Hyla rosen-*
bergi

CAMP CREEK (DIURNAL)

Nearly all of the above dates as well as others between first and last noted. Always heard

Phyllobates talamancae

Also a few calls at night on March 9, after the first rain

CHALICHIMAN'S CREEK (NOCTURNAL)

- Apr. 23 *Centrolene fleishmanni*, *Eleutherodactylus diastema*, *Leptodactylus pentadactylus*, *Engystomops pustulosus*
- 24 *Centrolene fleishmanni*, *Eleutherodactylus diastema*, *Engystomops pustulosus*, *Hyla?*^a, *Leptodactylus pentadactylus*, *Eleutherodactylus brederi*
- 25 *Eleutherodactylus diastema*, *Centrolene fleishmanni*, *Engystomops pustulosus*, *Hyla?*^a
- 26 *Eleutherodactylus diastema*, *Centrolene fleishmanni*, *Hyla?*^a

CHALICHIMAN'S CREEK (DIURNAL)

Nearly all of the above dates as well as others between first and last noted. Always heard

Phyllobates pratti

Apr. 25 Also *Atelopus varius glyphus?*

29 Also *Eleutherodactylus diastema*, 1 call
Data treated exactly like that of "Camp Creek."

^a On these three nights were heard single sounds similar to those of *Hyla rosenbergi* but not in series. The specimen could not be located. It may have been another species or an individual not in proper voice.

RIO CHICO AT CHOCOY VILLAGE (NOCTURNAL)

- Feb. 17 *Bufo marinus*
18 *Bufo marinus*
19 *Bufo marinus*, *Leptodactylus bolivianus*
20 *Bufo marinus*

RIO CHICO AT CHOCOY VILLAGE (DIURNAL)

- Feb. 18 *Bufo marinus*. A few still calling at 10:00 a.m.

RIO CANGLON AT MOUTH (NOCTURNAL)

- Feb. 27 *Bufo marinus*
Mar. 29 *Bufo marinus*

RIO TUQUESA AT MOUTH (NOCTURNAL)

- Mar. 2 *Bufo marinus*
3 *Bufo marinus*, *Leptodactylus bolivianus*^b

CAMP ABOVE RIO SANSAN (NOCTURNAL)

- Mar. 30 No frog voices

CAMP BELOW RIO METITI (NOCTURNAL)

- Mar. 31 No frog voices

CAMP AT RIO MEMBRILLO (NOCTURNAL)

- Apr. 1 No frog voices

CAMP ABOVE RIO CHIATI (NOCTURNAL)

- Apr. 2 No frog voices

SERIES OF CAMPS BETWEEN RIO CHIATI AND RIO SUCUBTI (NOCTURNAL)

- Apr. 3 No frog voices
4 No frog voices
5 No frog voices
6 *Hyla phaeota*
7 *Hyla phaeota*
8 *Hyla phaeota*

FIRST CAMP ON RIO SUCUBTI (NOCTURNAL)

- Apr. 9 *Hyla phaeota*, *Leptodactylus pentadactylus*
10 *Hyla phaeota*
11 *Hyla phaeota*
12 *Hyla phaeota*, *Leptodactylus pentadactylus*
13 *Hyla phaeota*, *Leptodactylus pentadactylus*
14 (Heavy rain)
Hyla phaeota, *Leptodactylus pentadactylus*
16 *Hyla phaeota*, *Leptodactylus pentadactylus*

^b It is possible that from here on some of these may be *Leptodactylus melanonotus*.

17 *Hyla phaeota*, *Leptodactylus pentadactylus*

FIRST CAMP ON RIO SUCUBTI (DIURNAL)

Apr. 14 (Heavy rain)

Hyla phaeota, *Leptodactylus pentadactylus*15 *Phyllobates pratti*

SECOND CAMP ON RIO SUCUBTI (NOCTURNAL)

Apr. 18 *Hyla phaeota*, *Leptodactylus pentadactylus*

CAMP ON UPPER SUCUBTI NEAR CONTINENTAL DIVIDE (NOCTURNAL)

May 1 *Centrolene fleishmanni*, *Eleutherodactylus diastema*, *Leptodactylus pentadactylus*

KEY TO THE VOICES OF DARIEN SALIENTIA (FEBRUARY TO APRIL)

- A. Resembles hammer blows
 B. A rapid series, 12 or more before a pause, nearly too fast to count... *Bufo marinus*
 BB. In groups of generally three (occasionally two, four, or five), distinct and readily counted... *Hyla rosenbergi*
 AA. Does not resemble hammer blows
 C. Monosyllabic
 D. Very faint and weak, insect-like
 E. "Cheep" or "peep" every five to eight seconds... *Eleutherodactylus diastema*
 EE. A soft, low, buzzing sound¹... *Dendrobates auratus*
 DD. Not faint or insect-like
 F. A liquid "quirt" or "tlock" every eight to 15 minutes, usually several calling in sequence two to three minutes apart... *Agalychnis callidryas*
 FF. A loud vibrant "woop" or "woorup," every five to 10 seconds with occasional longer pauses... *Leptodactylus pentadactylus*
 CC. Other than monosyllabic
 G. Bisyllabic
 H. Second syllable different from first
 I. A very soft "coo-click" or "whee-ak" with the second scarcely audible, occasionally doubled, or omitted; many usually calling together so as to produce a continuous roar... *Engystomops pustulosus*
 J. A high-pitched "peerép" or "tsee" every five to 15 seconds... *Centrolene fleishmanni*
 JJ. A frequently repeated "bée-up"... *Eleutherodactylus brederi*
 HH. Syllables virtually equal
 K. Short, sharp, and high pitched; produced every three to five minutes; can be imitated by working air about cheeks or sometimes sounds like "step-up"... *Leptodactylus bolivianus*
 KK. A high-pitched "peep-peep," resembling a young chick
 Diurnal... *Phyllobates talmanacae* and *pratti*
 Nocturnal²... *Eleutherodactylus fitzingeri*
 KKK. Resembles "ik lik"³... *Hyla underwoodi*
 GG. Polysyllabic
 L. All syllables similar
 M. Generally four; "ha-ha-ha-ha" ("a" as in hat); generally reminiscent of a goat's voice... *Hyla phaeota*
 MM. Not goat-like
 N. Generally three "purp-purp-purp"... *Rana palmipes*
 NN. Generally six "peeps"... *Atelopus varius glyphus?*

¹ *Dendrobates* not heard by us; this based on Dunn (1941). Where a second transliteration is given, the latter is taken from the works of Dunn; see under the specific headings.

² Not heard by us. Voice described by Dunn (*in litt.*).

³ Not heard by us. Voice described by Dunn (1931b).

REPTILIA

THE REPTILES OF THE EXPEDITION are represented most strongly by the large variety of lizards that abound in the region. Other groups are not nearly so well represented, not being so abundant and conspicuous nor given so much attention by the collector.

SAURIA

As much data on life histories and habits were obtained as time and energy permitted, since the main effort was given over to night work on the Salientia and the daytime was devoted to collecting fishes, which have already been reported.

FAMILY GEKKONIDAE

Gonotodes fuscus (Hallowell)

Common in many places, being taken at Colon, Old Panama, Real de Santa Maria, Yavisa, along the Pinogana trail a few miles from Yavisa, Sucubti Indian village, on the Atlantic coast at Caledonia, and on the islands opposite. This lizard is evidently closely tied to human habitations, the only exception being those taken along the Pinogana trail. They were usually taken either on the inner or outer walls of buildings or on large tree trunks nearby.

Eggs were taken on the grounds of the Hotel Washington at Colon in the latter part of January. These were all found cemented into holes in the trunks of coco palms about 6 feet from the ground. Young specimens were seen climbing about the coconut trunks, but all the adults were taken on the stone work at this place. Later, more eggs were taken at Yavisa. Plate 56 shows the eggs in place at Colon.

Along the Pinogana trail adults were common on the heavily buttressed trees that flanked this trail. Frequently a single male and female appeared to inhabit one trunk exclusively. This condition was noted so often that it appears to be more than accidental.

Evidently this lizard is both diurnal and nocturnal. At Old Panama, where they live amid the ruins, they invariably were found near deep crevices into which they quickly sought shelter when an attempt was made to

capture them. Generally in about five minutes they reappeared and usually took up the exact old position. After such an attempt to capture them they became even more wary. Thus, if not caught on the first attempt, a second attempt, close after, was almost certainly foredoomed to failure.

SPECIMENS

A.M.N.H. Nos.	Locality	Date
42942, 42943, 37417-37419	Old Panama	Jan.
65293	Colon, grounds of Hotel Washington (Developmental series of eggs)	Jan.-Apr.
65479, 49205-49211	Yavisa	—
65298	Caledonia	—
65295	(No locality)	—
50500	Sasardi Island	May 13

Lepidoblepharis sanctaemartae fugax Ruthven

SPECIMENS

A.M.N.H. Nos.	Locality	Date
65297	Near Yavisa	—
65294	Rio Chagres below Gatun Dam. Developmental series of probably this species	—
Preserved periodically from Jan.-Apr.		

Lepidoblepharis peraccae Boulenger

A single specimen taken at the edge of a small spring under a damp twig in an otherwise hot dry area. The lizard acted much like a salamander.

SPECIMENS

A.M.N.H. No.	Locality	Date
65296	Rio Chagres below Gatun Dam	Jan. 25

Sphaerodactylus lineolatus Lichtenstein and Martens

Taken only on the upper Sucubti.

SPECIMENS

A.M.N.H. Nos.	Locality	Date
37904	Upper Rio Sucubti	Apr. 24
65299	Caledonia	—

***Thecadactylus rapicaudus* (Houttuyn)**

These entirely nocturnal lizards were seen only at Old Panama, near the Yavisa base camp, and a little below the mouth of the Sucubti. Specimen about half grown was seen at Old Panama on June 24.

SPECIMENS		
A.M.N.H. Nos.	Locality	Date
37414-37416	Old Panama	Jan. 30
37570, 65480	Near Yavisa	—

FAMILY IGUANIDAE***Anolis lemurinus* (Cope)**

Found only in the upper Chucunaque.

SPECIMENS		
A.M.N.H. Nos.	Locality	Date
42927	Mouth of Rio Sucubti	Apr. 9
42928	First creek above the Rio Tucasa	Mar. 3

***Anolis poecilopus* (Cope)**

Taken only on the upper Sucubti.

SPECIMENS		
A.M.N.H. Nos.	Locality	Date
42902, 42903, 42915	Chalichiman's Creek	—
42906, 42907	Creek near the Indian village on upper Sucubti	Apr. 25

***Anolis limifrons* (Cope)**

Common along small creeks throughout the Rio Chucunaque drainage.

SPECIMENS		
A.M.N.H. Nos.	Locality	Date
42909-42914	Along Rio Sucubti	Apr. 13
42916-42918	Creek near Indian village on upper Rio Sucubti	Apr. 24
49204	Rio Sucubti	—
57703	Rio Chico near Indian village	Feb. 20
37902, 37903	Rio Chucunaque	Apr.

***Anolis capito* Peters**

Taken only on the upper Sucubti.

SPECIMENS		
A.M.N.H. No.	Locality	Date
42908	Rio Sucubti	Apr. 13

***Anolis frenatus* Cope**

Taken only below Yavisa.

SPECIMENS

A.M.N.H. Nos.	Locality	Date
37871	Three Falls Creek	Feb. 13

***Anolis tropidogaster* Hallowell**

Taken only on the lower Chucunaque.

SPECIMENS		
A.M.N.H. Nos.	Locality	Date
42920, 42921, 42923-42925	Camp Creek	—
42922	Below Rio Tupisa on Chucunaque	—

***Norops auratus* (Daudin)**

Taken only at Colon.

SPECIMENS		
A.M.N.H. Nos.	Locality	Date
42933-42941	Colon, Panama	Jan. 24

***Polychrus marmoratus* (Linnaeus)**

A single specimen was found, at the junction of the Rio Chucunaque and the Rio Tuquesa. It was discovered at night sleeping as it clung to a vertical twig, head up. At this time it was pale green and matched the background of leaves. On capture it took on a brown phase and would constantly menace with wide open jaws.

The following day when removed from the collecting bag its coloration was as follows: Generally bright pea green, including the underparts. Tail light tan encircled with Vandyke brown bands, a stripe of tan continuing up the back to the nape. From the insertion of the hind legs this is interrupted by four dark bands similar to those on the tail. The dew-lap is nearly white and bears a dark, nearly black spot, in the area covered with minute scales. The large scales of this region are bright green. Dark vertical and horizontal lines run respectively down and back from the eye, and these are present irrespective of color changes elsewhere.

At times the general coloration and pattern change so that the dark bands on the back reach down over the flanks. These extensions are largely obscured by the small scales of the sides which are light green, almost white, the effect being as of a semi-obscuring screen laid over the barred pattern. The tail evidently takes no part in these changes. The overlying "screen" may fade almost com-

pletely, allowing the brown barring to show through more plainly.

When on the defensive this lizard shows a tendency to flatten the ventral surface so that the body is roughly triangular in section. At such times the ribs show plainly. It could swim rapidly and well.

The specimen has apparently been lost.

***Basiliscus basiliscus* (Linnaeus)**

Common throughout the region. The adults generally seen along the larger streams, and the young found back into the smallest wooded tributaries. The behavior checked closely with that given by Barden (1943).

SPECIMENS

A.M.N.H. Nos.	Locality	Date
37405, 38073	Base camp near Yavisa	—
37406	Rio Sucubti	—
37407	Rio Chico	—
37545-37547	Lower Chagres	Jan. 25

***Enyalioides heterolepis* (Bocourt)**

Taken only on the upper Sucubti.

SPECIMENS

A.M.N.H. Nos.	Locality	Date
37569	Creek on upper Sucubti near Indian village	—

***Iguana iguana iguana* (Linnaeus)**

Common throughout the region and much used for food by both the Negroes and Indians of Darien.

SPECIMENS

A.M.N.H. Nos.	Locality	Date
37857, 37858	Rio Sucubti	May 9

FAMILY SCINCIDAE

***Mabuya mabouya mabouya* (Lacépède)**

Found only in the upper Chucunaque and reaching over to the Atlantic drainage.

SPECIMENS

A.M.N.H. Nos.	Locality	Date
37855	Lower Rio Sucubti	Apr. 22
37901	Rio Chucunaque	Apr. 7
37856	Caledonia	May 16

FAMILY TEIIDAE

***Echinosaura palmeri* Boulenger**

Taken usually buried in dampish trash, in places similar to those where one might ex-

pect to find salamanders in North America. The following quotation from Dunn (1944) is in complete agreement with our findings. "I have observed these ground lizards at three localities in western Panama. They remain hidden under debris during the day, but wander about at night. Their extraordinary resemblance to an irregular piece of dead wood is enhanced by their slow movements and their trick of becoming absolutely rigid when handled, either at night or when uncovered in the day."

SPECIMENS

A.M.N.H. Nos.	Locality	Date
42946-42950	Three Falls Creek	Feb. 24
49185	Camp Townsend	—
49200, 49201, 49186-49188, 49212, 49213, 49189, 49199	Chalichiman's Creek	—

***Ameiva festiva* (Lichtenstein)**

Fairly common along the lower Chucunaque.

SPECIMENS

A.M.N.H. Nos.	Locality	Date
37127, 37128, 37130-37134	Camp Creek	Feb. 25 to Mar. 24
37135-37138	Three Falls Creek	—
37255	Base camp near Yavisa	Mar. 24
37265, 37266	Pinogana trail near base camp	—
37445	Base camp, below falls	Feb. 9

***Ameiva leptophrys* (Cope)**

Found only below Yavisa.

SPECIMENS

A.M.N.H. Nos.	Locality	Date
37870	Three Falls Creek	—

***Ameiva ameiva praesignis* (Baird and Girard)**

Taken in the Canal Zone and the lower Chucunaque.

SPECIMENS

A.M.N.H. Nos.	Locality	Date
37072-37077	Lower Rio Chagres	Jan. 27
37870	Three Falls Creek	Feb. 13

***Cnemidophorus lemniscatus lemniscatus* (Linnaeus)**

Common along the lower reaches in open fields.

SPECIMENS

A.M.N.H. Nos.	Locality	Date
37152-37165	Rio Chico, $\frac{1}{2}$ mile above Indian village	—
37247-37251	Base camp near Yavisa	Mar. 7
37256-37259, 37262	Near the base camp at Yavisa	Mar. 24

FAMILY ANGUIDAE

Diploglossus monotropis (Kuhl)

A single specimen on the deep jungle floor during a rainstorm was found to be rather sluggish. Life colors were noted as follows.

The entire ventral surface a brilliant vermilion with a slight orange tint. The sides mottled with this, olive, and occasional dabs of lemon yellow. Undoubtedly the gaudiest lizard seen on the entire trip. Barbour (1923) similarly described a specimen, but differences in his color notes indicate a considerable range of variation.

SPECIMENS

A.M.N.H. No.	Locality	Date
37560	Rio Sucubti	Apr. 30

SERPENTES

Snakes were not encountered in any numbers. As so often noted by travelers in the tropics, they were found to be much more scarce than in many of the more temperate regions.

All species collected have been listed by Dunn and Bailey (1939) as occurring in Darien on the basis of other material.

FAMILY COLUBRIDAE

Pliocercus euryzonus euryzonus (Cope)

SPECIMENS

A.M.N.H. Nos.	Locality	Date
36178	Rio Chucunaque	—

Leimadophis epinephelus epinephelus (Cope)

SPECIMENS

A.M.N.H. Nos.	Locality	Date
36205	Darien	—
65300	Three Falls Creek	Mar. 12

Xenodon rabdocephalus (Günther)

SPECIMENS

A.M.N.H. Nos.	Locality	Date
36188	Rio Sucubti	—

Drymobius rhombifera (Günther)

SPECIMENS

A.M.N.H. Nos.	Locality	Date
36192, 36196	Darien	—

Spilotes pullatus pullatus (Linnaeus)

SPECIMENS

A.M.N.H. Nos.	Locality	Date
36201	Darien	—

Chironius carinatus (Linnaeus)

SPECIMENS

A.M.N.H. Nos.	Locality	Date
36206, 36207	Darien	—

Leptodeira annulata annulata (Linnaeus)

SPECIMENS

A.M.N.H. Nos.	Locality	Date
36191, 36193-36195, 36197, 36198, 36202, 36204	Darien	—

Imantodes cenchoa (Linnaeus)

SPECIMENS

A.M.N.H. Nos.	Locality	Date
36199	Darien	—

Dipsas viguieri (Bocourt)

SPECIMENS

A.M.N.H. Nos.	Locality	Date
36200	Darien	—

FAMILY ELAPIDAE

Micrurus mipartitus (Duméril and Bibron)

SPECIMENS

A.M.N.H. Nos.	Locality	Date
36186, 36187	Rio Sucubti	—

FAMILY CROTALIDAE

Bothrops atrox (Linnaeus)

SPECIMENS

A.M.N.H. Nos.	Locality	Date
36209	Rio Sucubti	—

CROCODILIA

Crocodilians were common along the larger rivers, but only two species are known from this river system.

Crocodylus acutus Cuvier

Abundant along the lower and middle Chucunaque and working up into surpris-

ingly small streams sometimes scarcely wider than the animal itself. Some specimens of extremely large size, on a careful estimate appearing to be between 18 and 20 feet in length.

They were nesting in clear sandy places along with river turtles. Plate 58 shows such a nest and the eggs removed from it. See under *Pseudemys ornata* for a detailed description of the locality. This nest contained 46 eggs which were buried to a depth of about 45 cm.

Later in April young crocodiles were sometimes found in groups, usually in some

noted that there is some slight tendency for the two axes to bear an inverse ratio to each other. Considerable variation in the texture of the shells, from very smooth to nearly rugose, was noted.

Various members of the party would at times attempt to shoot a large specimen. These, on being hit, would invariably slip into the water and disappear, where they would evidently die at the bottom of the large muddy lower Chucunaque. The evidence of this is that a few days later a dead, bloated, floating specimen would drift past the camp. To this carcass the vultures would

TABLE 10
DIMENSIONS OF THE EGGS OF *Crocodylus acutus*
(Measurements to nearest 0.05 cm.)

Long Diameter	5.00	5.05	5.10	5.15	5.20	5.25	Total
7.50	—	—	—	—	1	—	1
7.55	—	—	—	—	—	—	—
7.60	—	—	—	—	—	—	—
7.65	—	—	—	—	—	—	—
7.70	—	—	—	1	—	—	1
7.75	—	—	—	—	—	1	1
7.80	—	—	—	—	2	—	2
7.85	1	—	—	—	—	—	1
7.90	—	—	—	—	1	—	1
7.95	—	—	—	1	1	1	3
8.00	—	—	—	—	—	1	1
8.05	—	—	—	—	—	—	—
8.10	—	—	—	1	—	—	1
8.15	—	—	1	—	—	—	1
8.20	—	—	—	—	—	—	—
8.25	—	—	—	—	—	—	—
8.30	—	—	—	—	1	—	1
Total	1	—	1	3	6	3	14
	Long Diameter			Short Diameter			
Maximum	8.30			5.25			
Mean	7.90+			5.20—			
Minimum	7.50			5.00			

sheltered cove and still with the umbilicus prominent. One such group, April 8, contained eight which were all floating in a very deep hole along the river bank. A half-grown specimen is shown in plates 57 and 59.

The measurements of 14 of the nearly perfectly ellipsoidal eggs from the above-noted nest are given in table 10, in which it may be

give considerable attention, frequently riding down stream on it and trying to find or make an opening through the tough hide. Such a pair are shown in plate 59, as they drifted past camp. When too many lighted, the carcass would submerge and the vultures would fly off. In one case the birds were seen to effect an entrance in some manner or else internal

pressure burst the carcass, for it emitted putrefying matter explosively, spattering the vultures, and then of course it sank as the gas escaped.

SPECIMENS

A.M.N.H. Nos.	Locality	Date
45102-45104	Rio Chucunaque (newly hatched)	Apr. 8
45116	Rio Sucubti	Apr. 22
65287-65290	Developmental series of eggs from Rio Tuquesa. Preserved periodically from Mar. 3 to Apr. 8	Mar. 3

Caiman fuscus (Cope)

The generally smaller caiman was less common and more frequently encountered in the side streams. Here they were inclined to make "slides," frequently from rather high banks. A photograph of one is shown in plate 60. This is not in an earthen bank but in the soft fossiliferous limestone of the region. At one time this may have been part of the water course of this stream, but the water now takes an entirely different route and at least much of the groove has certainly been the work of the caiman. Evidence for the idea that it was once a water course is the pot-hole in which is growing a small *Calyptrogyne*. This slide was near the waterfall in the locality called Camp Creek shown in figure 5 near the edge of the forest. The animal was frequently seen perched at the top and would usually coast down the slope before a near approach could be made, although at night it was once accidentally stepped on, a rather frightening experience. Evidently they use these upper resting places for other than mere sunning spots.

TESTUDINATA

Turtles were relatively scarce in this region.

Geomyda annulata (Gray)

SPECIMENS

A.M.N.H. Nos.	Locality	Date
45063	Rio Sucubti	Apr. 16

Geomyda punctularia melanosterna (Gray)

SPECIMENS

A.M.N.H. Nos.	Locality	Date
45064	Rio Chucunaque	Mar.

Pseudemys ornata (Gray)

Although relatively few adults were seen or collected, the nests of this species were studied in some detail. Nesting occurs in sandy places along the river where for various reasons small areas have been denuded of vegetation. Such spots are evidently formed by the collapse of banks during the previous rainy seasons, aided by a leveling effect of the torrential rains. Much of the shore line is grown up in dense stands of coarse grasses and similar rank growths amid the roots of which it would be exceedingly difficult or impossible for turtles to make an excavation. All the nesting sites located were either on the Rio Tuquesa or near it on the Chucunaque. Such a place is shown in plate 58 with the excavated eggs in a pile near the nest from which they have been removed as well as a similar pile of much larger eggs from a nearby crocodile nest. This place was found on the Rio Tuquesa a short distance above its mouth. The turtle eggs as found are shown comparatively with an indication of their measurements in plate 59. There were four nests here, not shown in the photograph, and contained 15, 16, 16, 17 eggs apiece.

Another such nesting area, studied in great detail, was located on the Rio Chucunaque a short distance above the mouth of the Tuquesa. A sketch map of this nesting site is shown in figure 24. Here eight nests were found, all of one species, located in a bare sandy area limited by a rank growth of grass and weeds. It is evident that all the nests were more than 20 feet from the water's edge but none was farther than 35 feet away, although a somewhat greater distance could have been reached before the matted vegetation is encountered. Where the nests were located on level ground they were dug vertically, but when on a slope, dug at an angle, indicating that the makers excavated the nest at right angles to the plane on which they rested and not in response to gravity, presumably a purely mechanical circumstance. Those nests that were made on a slope are indicated in figure 24 by small arrows, the direction of which indicates the facing of the mouth of the nest. It is evident that this direction has nothing to do with the direction of water from the nest but is conditioned only by the slope of the ground.

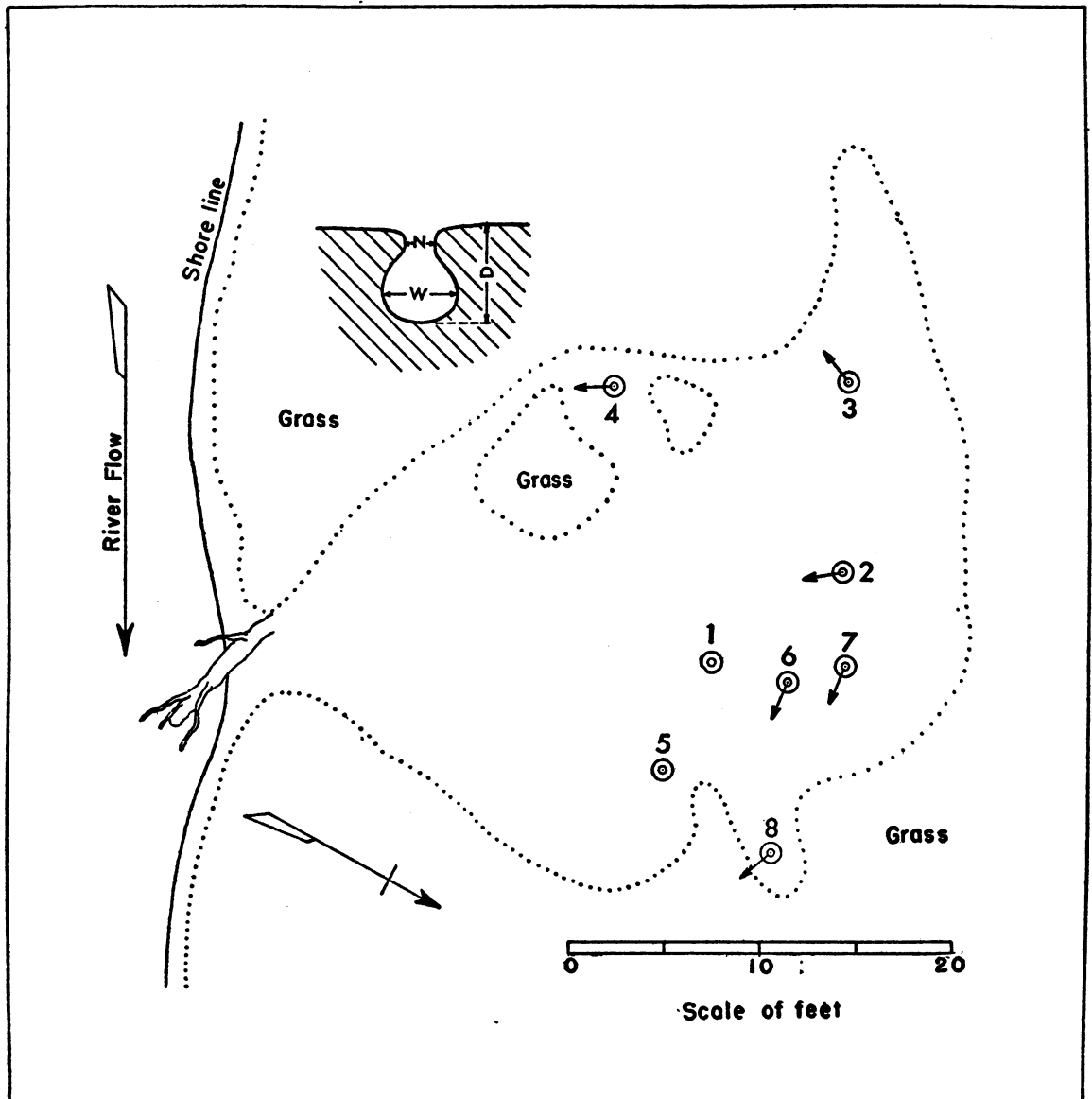


FIG. 24. Diagram of nesting area of *Pseudemys ornata*. The contents and dimensions of these nests are given in table 11. The direction of opening of the nests is indicated by short arrows. Vertical nests are without arrows. The inset indicates the nature of the dimensions given in table 11.

There was no evidence of the nests on the surface. They were located by prodding the ground with small sticks, that replaced by the turtles being much softer and easily penetrated than the untouched ground. It is believed that all the nests in this area were located, as the entire clear space was gone over most carefully by four persons.

The general shape of the nest is indicated by the cross section shown as an insert in figure 24. The location of dimensions on it refers to table 11 which gives the details of the size of each nest and its contents. As indicated therein, each nest contained both empty shells and incubating eggs. It does not follow that the empty ones had hatched, and

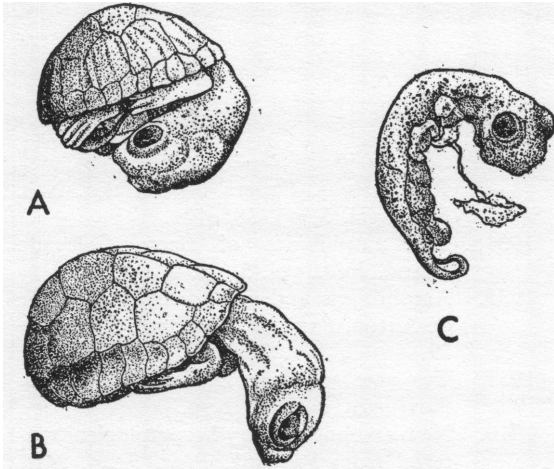


FIG. 25. Embryos of *Pseudemys ornata*. A and B. Advanced embryos nearly ready to hatch; $\times 1.75$. C. Early embryo with yolk removed; $\times 2.9$.

these were certainly not multiple nests as could be told from their firm walls and regular shape. Just what became of the contents of the empty shells is far from clear, for if they had hatched the escaping young turtles

would have disturbed the surface as would have any predator that might have come upon them. The incubating eggs, furthermore, while in various states of development were all far from hatching. All of the 109 eggs from eight nests lay on their side, with not a single one tipped on end.

SPECIMENS

A.M.N.H. Nos.	Locality	Date
46485, 65291, 65292	Rio Chucunaque about Rio Tuquesa. (Hatching eggs from nests of table 9.) Periodically preserved from Mar. 14 to Mar. 24	Mar. 14
65286	Rio Chucunaque (Eggs from another locality brought in by boy)	Mar. 4

Testudo tabulata Walbaum

Seen only on the San Blas coast where they were common about and in the Indian village of Caledonia. Living specimens were brought back, see Townsend (1925) and Breder (1925a).

TABLE 11

DIMENSIONS AND CONTENTS OF THE NESTS OF *Pseudemys ornata*

(The nests tabulated below are shown and numbered in fig. 24 as is an explanation of the dimensions indicated. Dimensions in cm.)

Nest No.	Depth	Nest Dimensions		Number of Eggs Found in Nest		
		Diameter	Neck	No. Empty	No. Incubating	Total No.
1	25.5	30.5	5.0	7	7	14 ^a
2	23.0	20.5	7.5	9	5	14 ^b
3	25.5	25.5	7.5	5	11	16
4	25.5	25.5	7.5	6	8	14
5	18.0	23.0	7.5	13	2	15
6	30.5	23.0	7.5	9	4	13
7	30.5	20.5	9.0	5	3	8
8	30.5	25.5	10.0	6	9	15
Max.	30.5	30.5	10.0	13	11	16
Mean	26.1 +	28.2 +	8.2 +	7 +	6 +	14 +
Min.	18.0	20.5	5.0	5	3	8

^a Only peripheral eggs intact.

^b 13 cm. of soil to first egg.

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PLATES 42-60



Bufo marinus (Linnaeus). An old specimen active at night in the pursuit of food. Taken by flashlight near the mouth of the Rio Canglon



Engystomops pustulosus (Cope). *Two upper photographs.* Males in typical calling postures. The pictures were made at the moment of the greatest distention of the vocal pouch. *Middle left.* The spawning in progress. The frothy mass is already well formed and the pair is nearly buried in it, visible in the lower part. The kicking hind legs of the male are distinguishable extending into the froth. *Middle right.* Same location a little later. The female has left and the male has renewed his calling. His head appears between the rock and the froth, while the left side of the vocal pouch has buried itself in the froth. *Lower.* The center of the nesting activity. The white spots at the far side of the pool represent these small frothy masses. See location in figures 5 and 10



Egg masses of *Engystomops pustulosus* (Cope). *Upper*. A typical egg mass, floating on the surface of a small pool and anchored to a twig. *Middle*. An egg mass deposited as above but half hidden under twigs and leaves and anchored from above. *Lower*. An egg mass in the process of disintegration, after a light rain. The wet streak from what is left of the mass to the water edge is broken-down froth down which the escaping tadpoles make their way to the pool



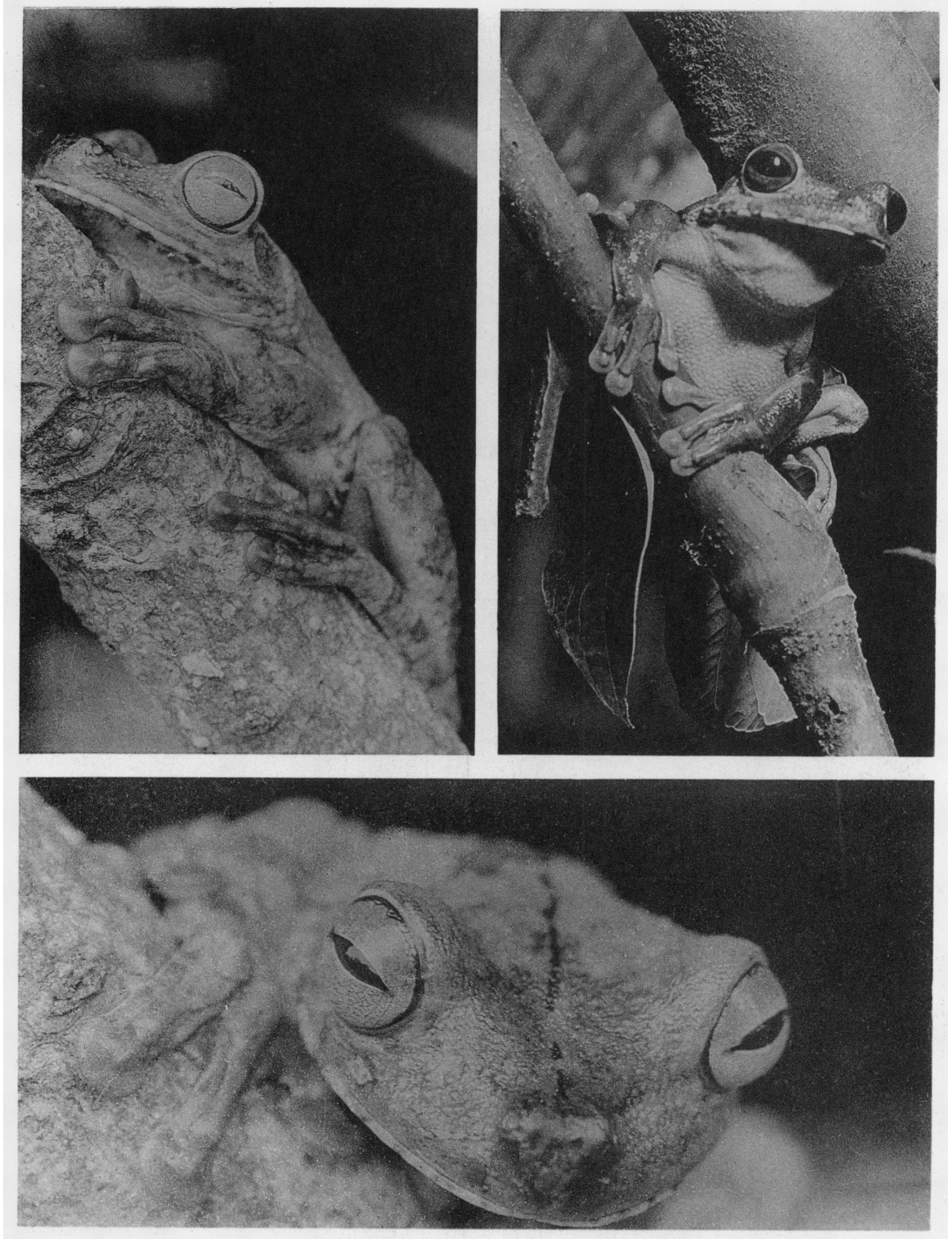
Egg masses of *Leptodactylus pentadactylus* (Linnaeus). *Upper*. A large typical mass on the forest floor in a very slight depression. *Lower*. An unusually well hidden mass under loose boulders. Only a small extent of the mass is visible



Egg masses of *Leptodactylus pentadactylus* (Linnaeus). A mass in a large, nearly dry pot-hole. More frequently the mass would completely fill the pot-hole and hide all the forest debris, which in this one is of unusually large amount. *Lower*. A well-disintegrated mass just after a heavy shower. The water has risen nearly to the edge of the mass itself, and most of the tadpoles have escaped



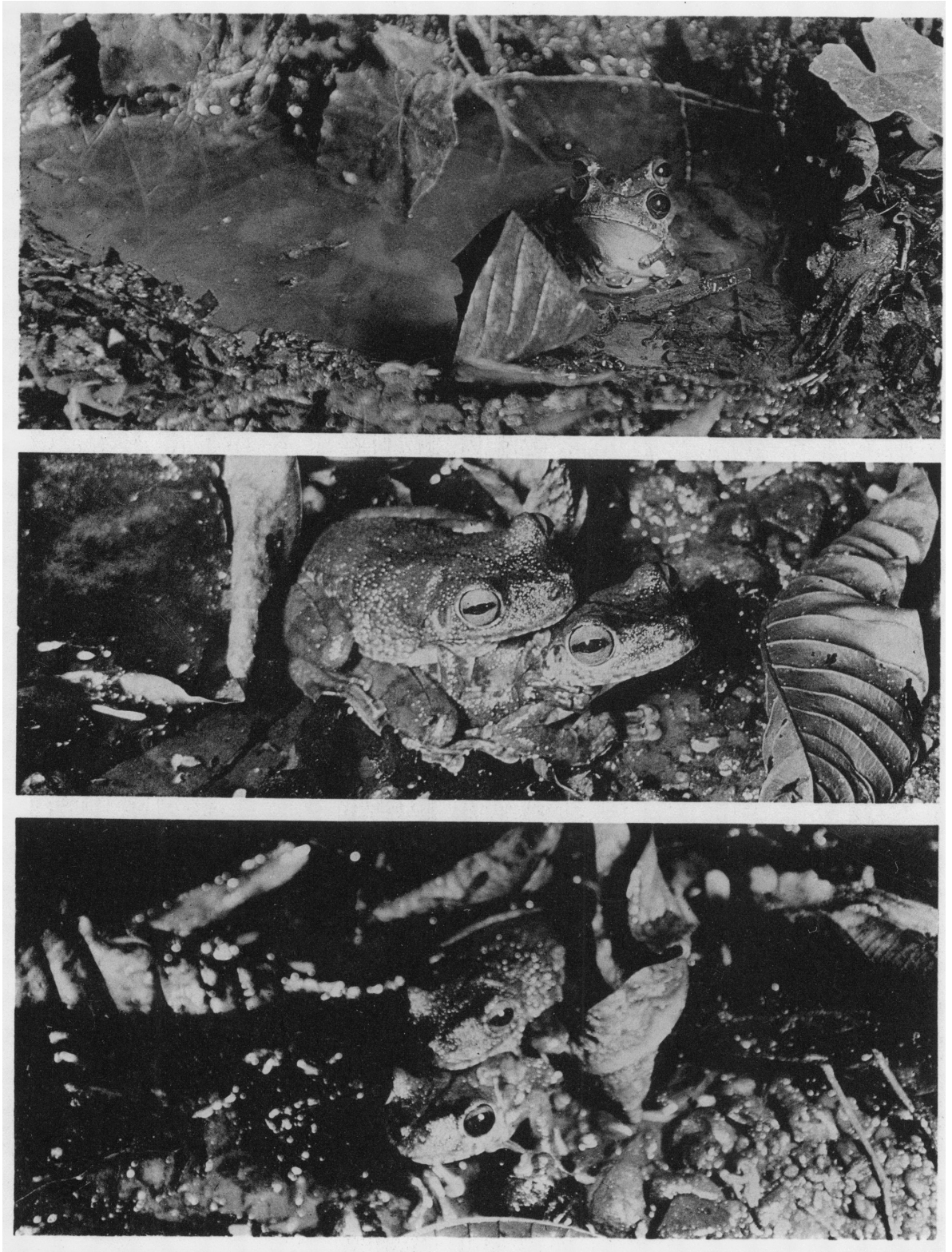
Dendrobates auratus (Girard). From a living specimen in a characteristic pose taken near Yavisa



Hyla rosenbergi Boulenger. *Upper left.* Daylight photograph showing the maximum contraction of the horizontal pupil. *Upper right.* Night photograph just after dusk of a specimen descending from its arboreal roost to the spawning grounds. *Lower.* Daylight photograph showing the full face view



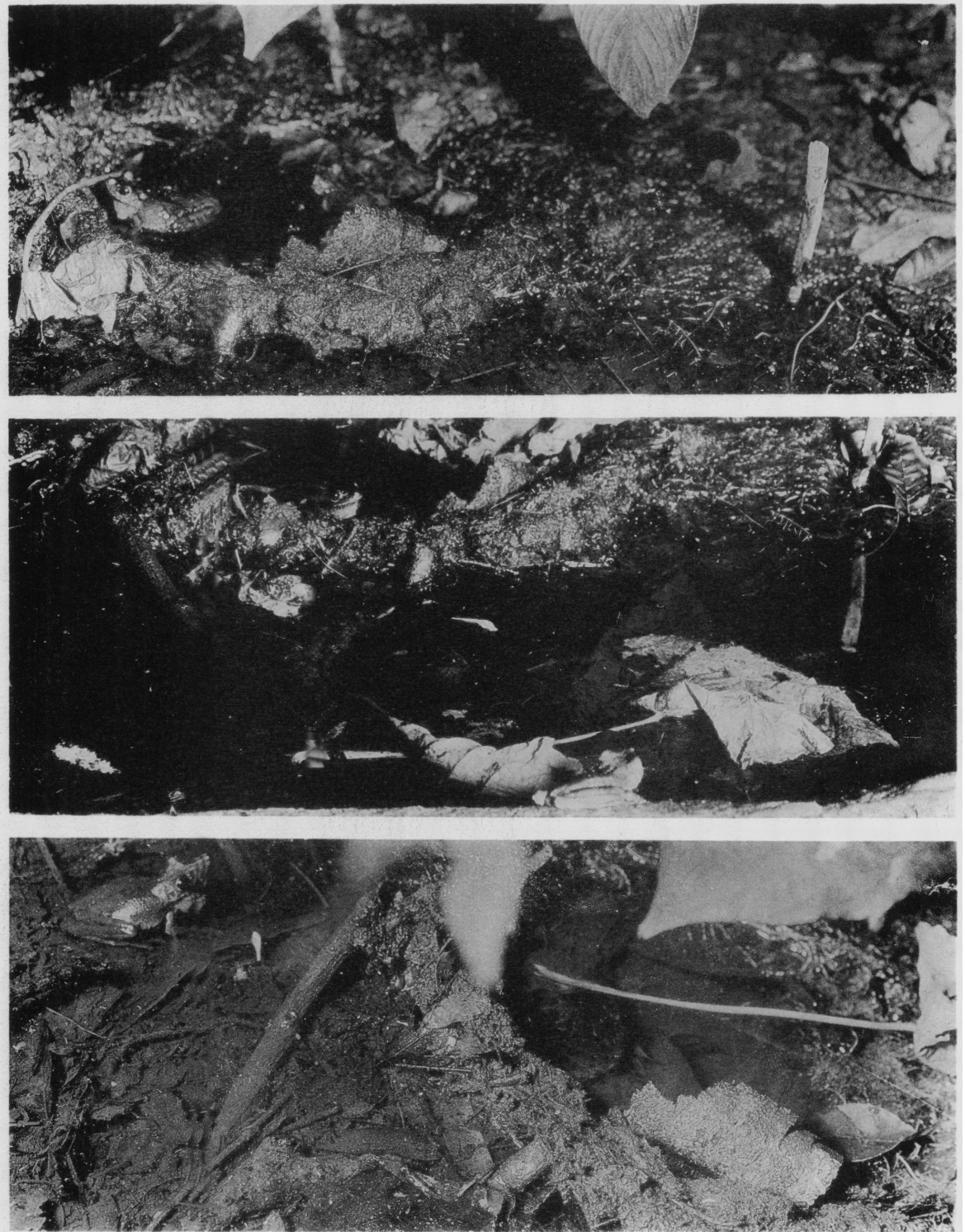
The nests of *Hyla rosenbergi* Boulenger. *Upper.* View taken close to the forest floor of a typical nest. Nest no. 3 of figure 16. This well illustrates how the soft earth is rolled back to form the rim of the nest. Such a basin fills entirely by seepage. *Lower.* A more nearly vertical view of another typical nest. Nest no. 6 of figure 16. The nearly perfect circle that these nests commonly describe is indicated, as well as the nearby water from which seepage has taken place



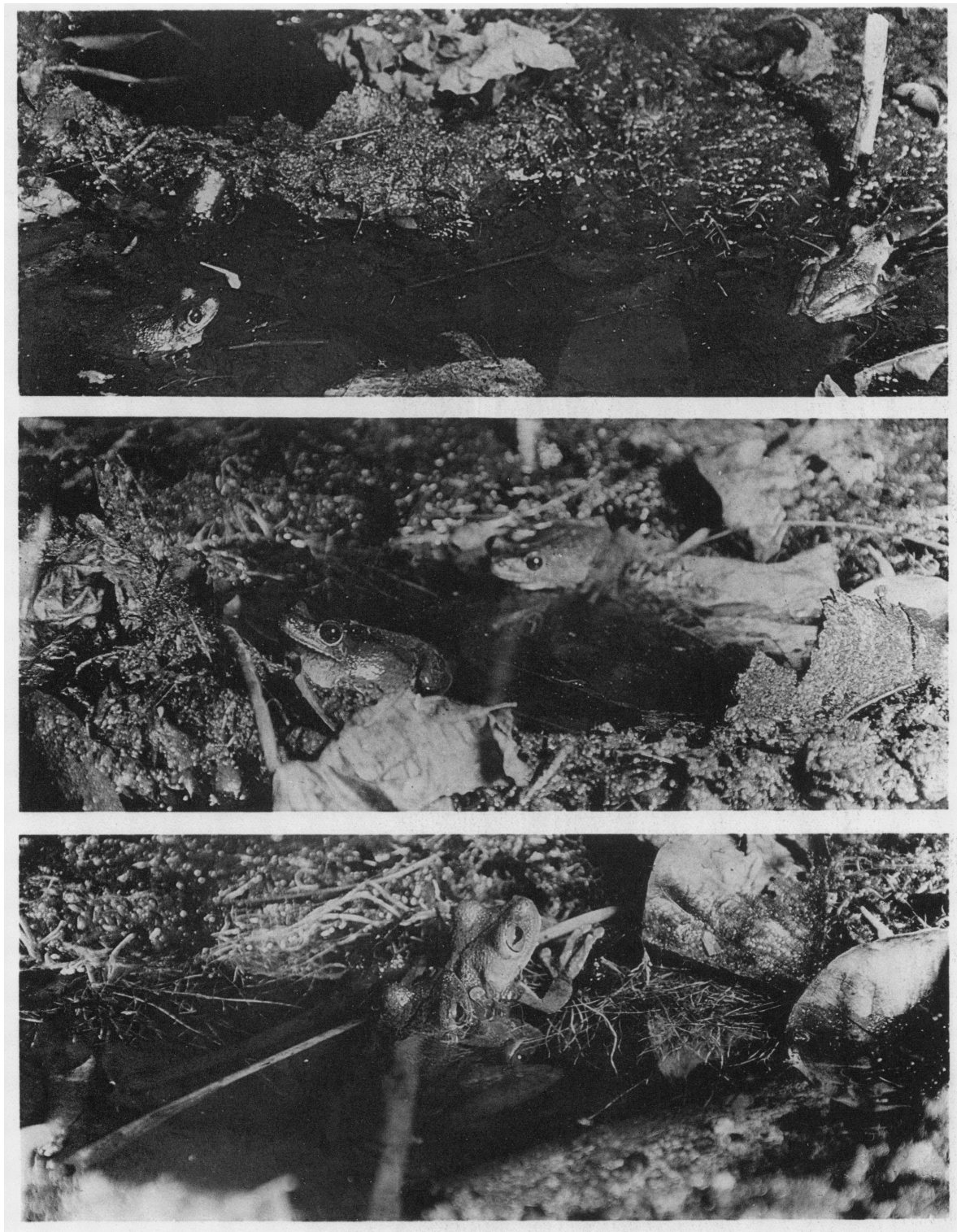
Amplexus in *Hyla rosenbergi* Boulenger. *Upper*. Typical amplexus with both individuals well immersed in the water of the nest. Nest no. 13 of figure 16. *Middle and lower*. Less frequently the pair may be poised on the edge of the nest nearly or entirely out of water. Nest no. 14 of figure 16



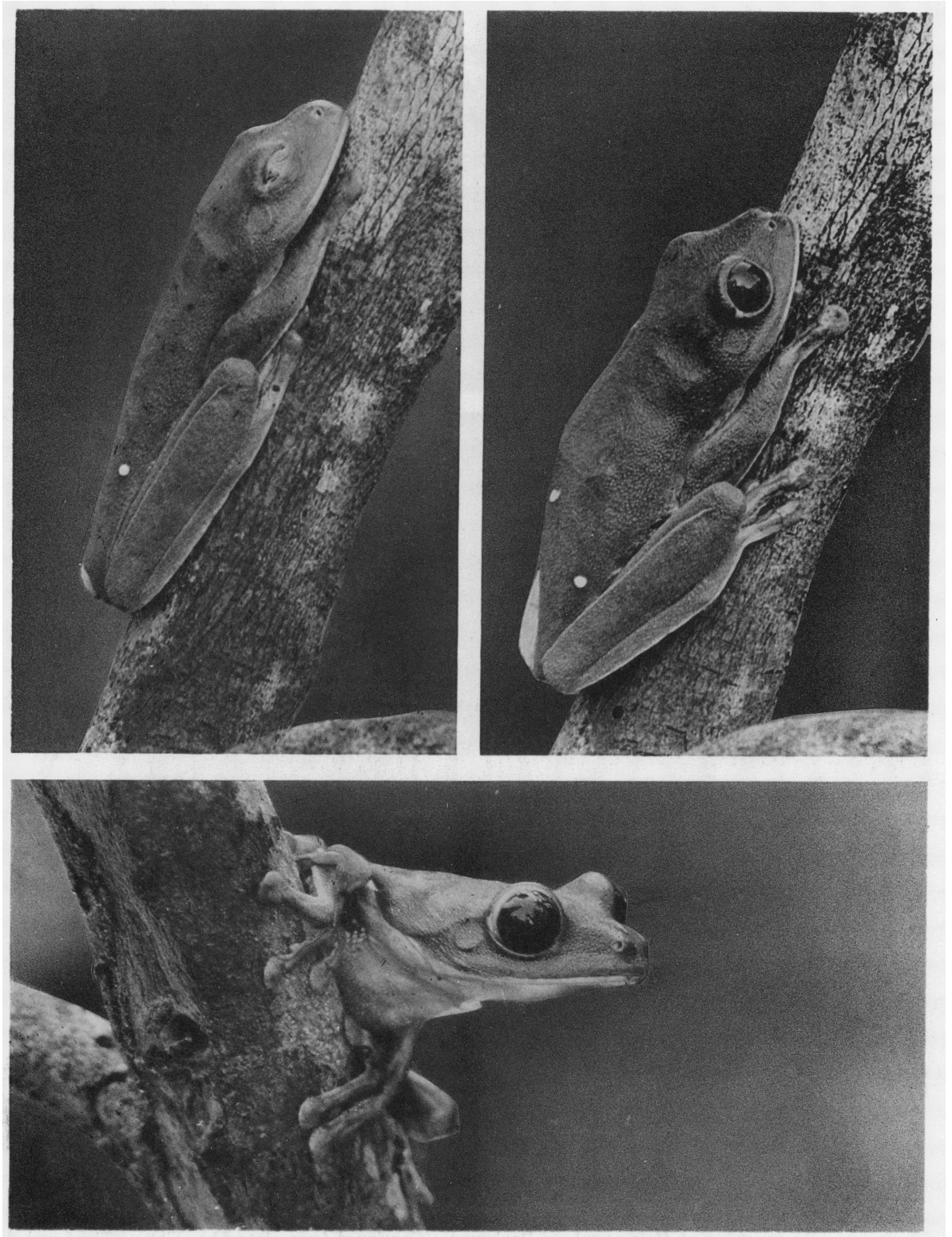
A nest of *Hyla rosenbergi* Boulenger made in a rock crevice. Here the simple dam closing the entrance to the outside water of the pool proper is clearly seen to reach neatly from one rocky shore to the other. Nest no. 4 of figure 16



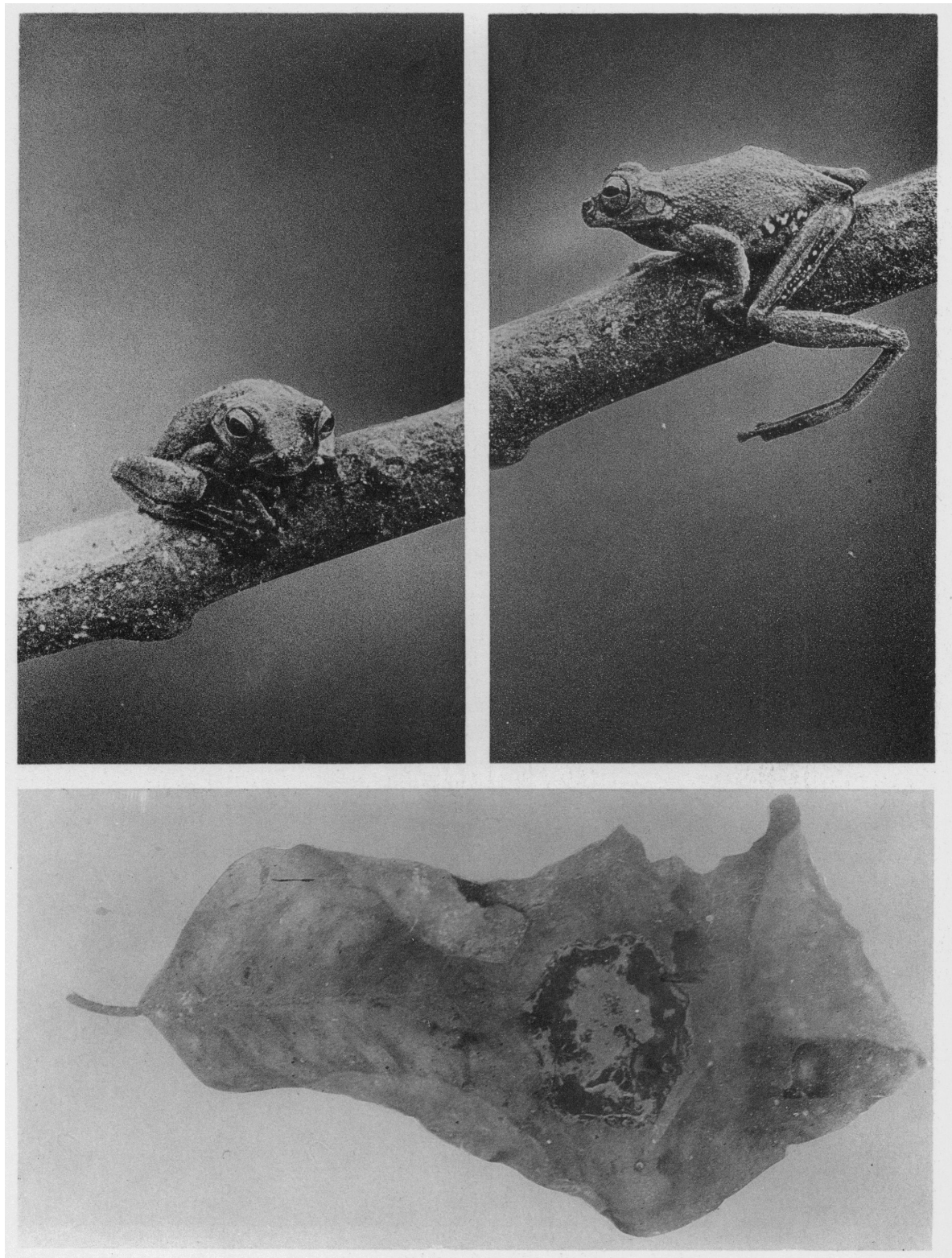
A study in the courtship of *Hyla rosenbergi* Boulenger. *Upper*. A male calling in nest no. 2. This represents about the maximum of the relatively slight extension of the throat pouch. A female, not in the photograph, is approaching from the left, and the male is facing in her direction. *Middle*. The approaching female passes between the photographer and the calling male. He has turned to face her and she sits on a log in the extreme foreground and turns her head to face him. Incidentally this shows the extreme mobility of the neck region of this species. *Lower*. The female passes on and the male jumps to the other side of his nest and continues to call. Nest no. 2 of figure 16. The marker for nest no. 3 may be seen at the extreme right. (Continued on plate 53)



A study in the courtship of *Hyla rosenbergi* Boulenger. (Continued from plate 52.) *Upper*. The female moves on toward nest no. 3 in which there is also a calling male, just out of the picture to the right. The male from nest no. 2 has given up calling from the other side of his nest and is following the female. *Middle*. This unusually aggressive action is evidently successful for when male of nest no. 2 reenters his nest the female passes between the two nests and enters from the rear. *Lower*. The female touches the male, on which he immediately turns and reverses the position so that amplexus occurs with the pair facing in the opposite direction.



Agalychnis callidryas (Cope). *Upper left.* The sleeping posture. Here the incomplete closure of the eyelids may be seen, which is typical. *Upper right.* Awakened. This is a typical pose, as usually found. *Lower.* Poised for a leap. The large eyes are a brilliant ruby red



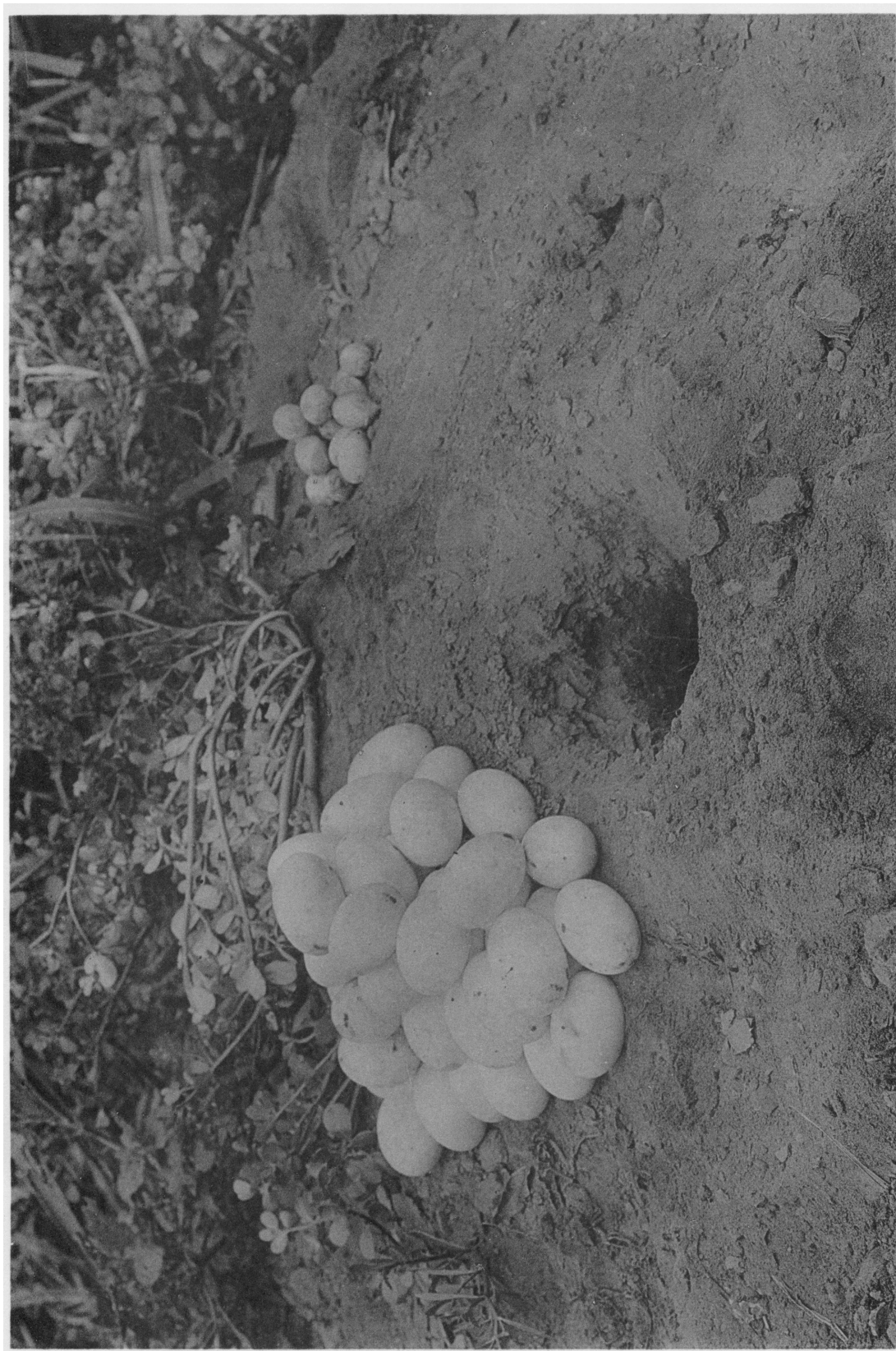
Upper two photographs. *Hyla phaeota* Cope, the right showing the markings on the legs and flank which are completely hidden at rest. Lower. The eggs of *Centrolene fleishmanni* Boulenger



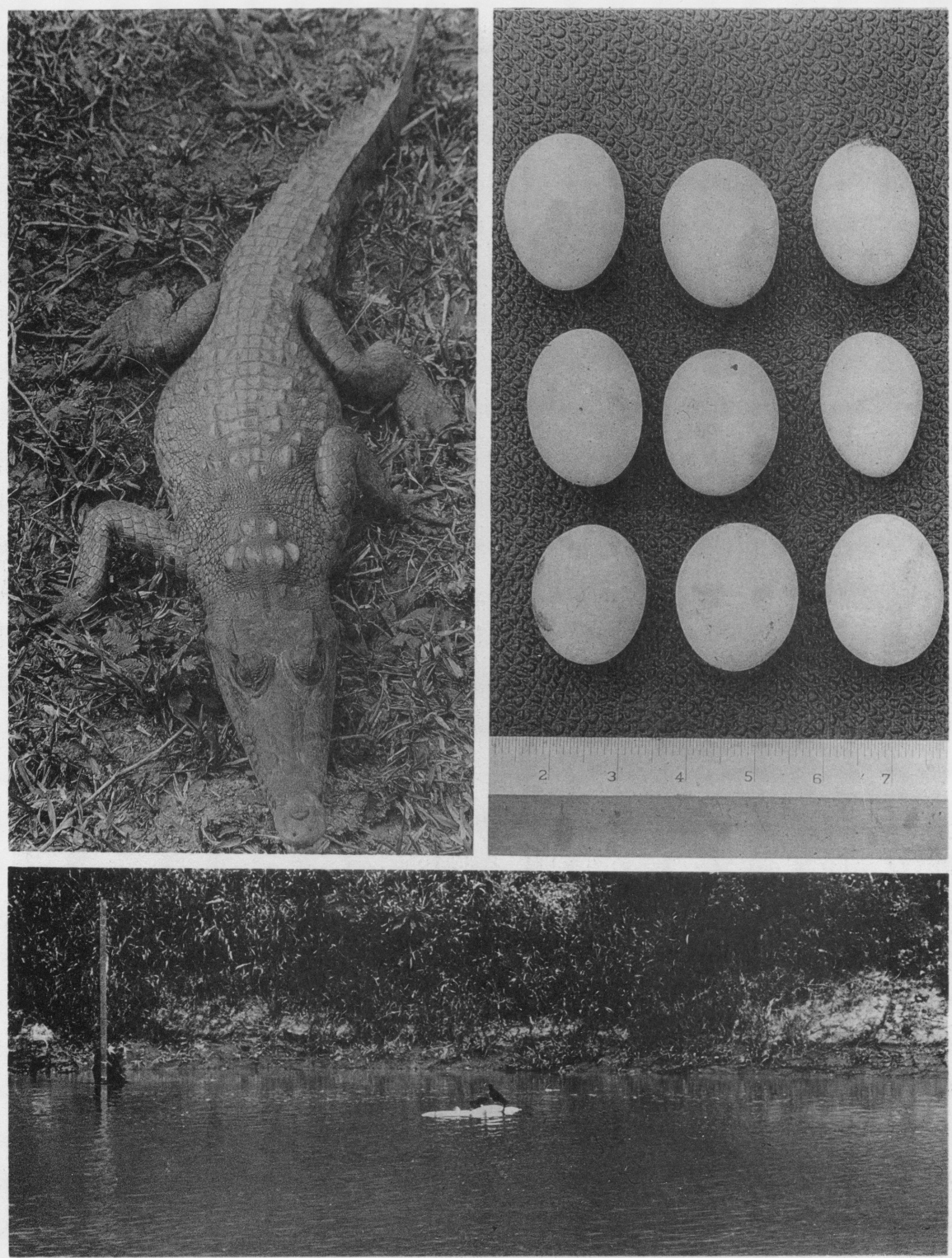
The eggs of *Gonotodes fuscus* (Hallowell) as found in a crevice of the trunk of a coco palm



The head of an immature specimen of *Crocodylus acutus* Cuvier



The eggs of *Crocodylus acutus* Cuvier and *Pseudemys ornata* as removed from their respective nests



Upper left. An immature *Crocodylus acutus* Cuvier. Upper right. The eggs of *Pseudemys ornata*. Lower. A dead *Crocodylus* drifting downstream with two vultures as riders. See text for explanation



A "slide" of *Caiman fuscus* (Cope). This one was made in the soft limestone of the region

