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NOTES ON THE HERPETOFAUNA OF SURINAM III.— A NEW SPECIES OF DENDROBATES (AMPHIBIA SALIENTIA, DENDROBATIDAE) FROM SURINAM

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With 3 text-figures and 3 plates

INTRODUCTION

During a recent collecting trip, financed by grant W 956-2 from WOTRO (Netherlands Foundation for the Advancement of Tropical Research), I spent 47 days (22 August-7 October 1968) on the Sipaliwini savannah in southern Surinam. The Sipaliwini savannah is part of an extensive savannah that covers the watershed between the Sipaliwini River in Surinam and the Paroe River in Brazil. Though the watershed is very low, the waters of Sipaliwini and Paroe Rivers never seem to make contact, as is the case with other rivers on the Rupununi savannah and in southern French Guiana. About one tenth of this savannah is situated in Surinam, the remainder in Brazil (see inset fig. 3). G. Mann (in Fittkau et al., 1968) calls this a tropical wet savannah and describes the ecology of this habitat extensively.

The soil of the Sipaliwini savannah is classified by Beek & Bramao (in Fittkau et al., 1968: 92) as belonging to Soil Region B 1-Guiana Uplands, and is composed of Latosols and Red-Yellow Podzolic soils. This difference in soil composition with the coastal savannahs (with a sandy soil) is evident in the vegetation, while also there are differences in physiography. In the coastal savannahs the ground is covered with a sparse cover of grasses, but there are also many shrubs, up to two metres in height. The Sipaliwini savannah is nearly completely covered with grasses, only in the wet valleys *Mauritia* palms and on the hills a few widely spaced, low, crooked trees, never forming a closed canopy, are present. Shrubs are absent. In some places extensive bare rockslates are exposed and the top and slopes of quite a few hills are covered with large rocks. In contrast with the flat coastal

savannahs the Sipaliwini savannah is very hilly, the highest point on Surinam territory being the summit of the Vier Gebroeders Mountain, 554 m above sea level, that is, about 300 m above the surrounding area.

The area around the Vier Gebroeders Mountain differs from the area west and south of it by the presence of a number of forest-islands (residues of the original vegetation) (pl. 3 fig. 3). More to the north their frequency increases, being highest just north of Moro Grande Mountain. In some of these forest-islands a peculiar blue frog of the genus *Dendrobates* was found, which turned out to belong to a new species.

Dendrobatus azureus nov. spec.

(pl. 1 figs. 1, 2; pl. 2 figs. 1-6; table 1)

Material

Holotype. — RMNH 13837a, Sipaliwini, forest-island on western slope Vier Gebroeders Mountain, 2°N 55°58'W, Surinam, 11 September 1968, leg. M. S. Hoogmoed.

Paratypes. — RMNH 13837, same data as holotype, 10 ex.; RMNH 13838, Sipaliwini, forest-island on western slope Vier Gebroeders Mountain, 2°N 55°58'W, Surinam, 10 September 1968, leg. M. S. Hoogmoed, 1 ex.; RMNH 13839, Sipaliwini, forest-island 1.5 km northeast of Vier Gebroeders Mountain, 2°1'N 55°57'30"W, Surinam, 19 September 1968, leg. M. S. Hoogmoed, 5 ex.; RMNH 13840, Sipaliwini, forest-island 2 km north of Vier Gebroeders Mountain, 2°1'N 55°58'W, Surinam, 23 September 1968, leg. M. S. Hoogmoed, 6 ex.; RMNH 13841, Sipaliwini, forest-island on northeastern slope of Vier Gebroeders Mountain, 2°N 55°57'30"W, Surinam, 27 September 1968, leg. M. S. Hoogmoed, 3 ex.; RMNH 13842, Sipaliwini, forest-island on western slope Vier Gebroeders Mountain, 2°N 55°58'W, Surinam, 30 September 1968, leg. M. S. Hoogmoed, 1 ex. + 2 tadpoles; RMNH 13843, Sipaliwini, forest-island on western slope Vier Gebroeders Mountain, 2°N 55°58'W, Surinam, 1 October 1968, leg. M. S. Hoogmoed, 10 ex.

Description of holotype

Snout truncate, projecting; loreal slightly convex, sloping inwards from canthus rostralis to upper lip; canthus rostralis rounded; eye diameter equal to distance from eye to nostril. Nostril an oval oblique slit, slightly swollen; swellings visible from above; nearer tip of snout than to eye. Interorbital space flat, $1\,1/2$ times width upper eyelid. Tympanum indistinct, oval, deeper than wide; vertical diameter $2/3$ horizontal eye diameter; horizontal diameter $2/5$ horizontal eye diameter; posterior margin hidden by a flat indistinct fold from posterior corner of the eye to base of forelimb.

No maxillary or vomerine teeth; tongue oblong, narrow, attached with its foremost part. Choanae small, round; situated in the dorsolateral part of the palate.

A large central metacarpal tubercle; subarticular tubercles distinct. Fingertips expanded into large discs, of first finger smallest (1.3 mm), of third finger largest (2.0 mm), of second and fourth fingers equal and intermediate

(1.8 mm wide). Fingers without a trace of webbing between them, first shorter than second.

An inner and an outer metatarsal tubercle; subarticular tubercles indistinct. Tips of toes expanded in small triangular discs, scarcely wider than the digits, distinctly smaller than discs of fingers; toes free of webbing. A tarsal fold is present. Ankles touching when hindlimbs are placed at a right angle to the body. Tibio-tarsal articulation reaching eye when hindlimb is passed forward along the body.

Skin smooth above and below, free from the skull.

Measurements. — see table 1.

Colour in life. — Above and below bright blue with black spots (pl. 1 figs. 1, 2). Limbs, belly and posterior part of the back dark blue; discs of fingers and toes lighter. Across the belly and sides a light-blue area is present which, in the middle of the belly, is divided by a narrow longitudinal stripe of darker blue. The black spots are rounded, of different sizes. A few big spots on the back are surrounded by smaller ones, no regular pattern is evident. On the belly only small spots and on the throat spots of intermediate size are present. Because of the dark blue colour of the thighs, the black spots there are scarcely discernable. Iris dark red-brown.

Colour in preservative. — After six months in preservative the bright blue colour has disappeared and the ground colour now is dark greyish-blue.

Attitude. — In life this species has a strongly hunched back. When in a resting position the anterior part of the back is nearly horizontal; at the point where sacral vertebrae and ilium come together there is a sharp drop and the posterior part of the back is nearly vertical (plate 1 fig. 2). Its belly is bulging because of this peculiar condition of the back, which is unique among the frogs of the genus *Dendrobates* from this area. Both *D. tinctorius* (Schneider) and *D. trivittatus* (Spix) have nearly straight backs (pl. 1 figs. 3, 4).

The paratypes agree with the holotype in most respects. In four specimens the skin on the lower surface of the thighs is wrinkled, in the remainder it is smooth as in the holotype. In five specimens the skin on top of the head shows numerous small, shallow pits and is attached to the skull. In three other specimens the pits are widely spaced and few, and the skin is free from the skull. No correlation with age exists, because the frogs with attached skin range in snout-vent length from 31-43 mm, that is from half-grown to adult.

In the degree of spotting there is much variation. There are specimens with numerous small black spots on the back, specimens with a few large

spots, and in others only a few intermediate spots are present. In some specimens the belly and throat are completely free of spots (pl. 2 fig. 3). The light band across the belly is present in all specimens.

Some specimens show aberrations, for instance RMNH 13839a has the second finger of the left hand very much thicker than the others, its top is blunt, without an expanded disc. RMNH 13837b has a short lateral growth on the third finger of its left hand (pl. 2 figs. 3, 4).

Description of the tadpoles

One adult specimen (RMNH 13842), a male, was carrying two tadpoles on its back when collected. The tadpoles were situated on the posterior part of the back, with their tails curled around their bodies (fig.1), symmetrically

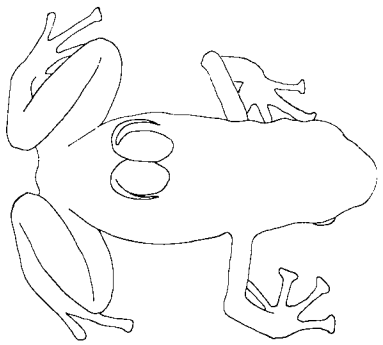

Fig. 1. Dorsal view of ♂ *Dendrobates azureus* nov. spec. (RMNH 13842), carrying two tadpoles.

regarding the parental longitudinal axis. This may indicate that two is the normal number of tadpoles carried around by this species.

Larvae small, 4 mm snout-vent length, tail length about 6 mm. Spiraculum on the left side, on the border between flank and belly. The anus seems to be median, but because of bad preservation this is not clear. Body ovoid, flat-

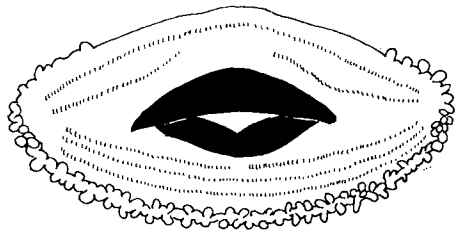

Fig. 2. Oral disc of tadpole of *Dendrobates azureus* nov. spec. (RMNH 13842).

tened dorso-ventrally. Eyes on top of the head, small, invisible from below. Oral disc oval, not indented laterally. Denticle formula: $\frac{1}{1+1}\,\frac{}{}\,\frac{1}{1+1}\,\frac{}{}\,2$

The interruption in the upper inner denticle row is wide, about as wide as each part of the denticle row. The lower inner denticle row is just narrowly interrupted (fig. 2). The tadpoles are in stage 26 of Limbaugh & Volpe (1957), which is comparable with stage 19 of Kopsch (1952) and with stages 49/50 of Nieuwkoop & Faber (1956).

Distribution

D. azureus seems to be restricted to some of the forest-islands in the Sipaliwini savannah (fig. 3). Despite extensive collecting in the forest adjoining the western border of the savannah, no *D. azureus* could be collected there; instead *D. trivittatus* (Spix) was present. Thus, *D. azureus* seems to be a relict that survived in the forest-islands, after the forest that formerly covered the area, gave way to the savannah. The forest-islands are separated completely, both from each other and from the forest bordering on the savannah, by savannah-area's which appear to be impassable for *D. azureus*. Because of this, it is not probable that the species originated by isolation in one of the forest-islands and afterwards invaded other forest-islands. Col-

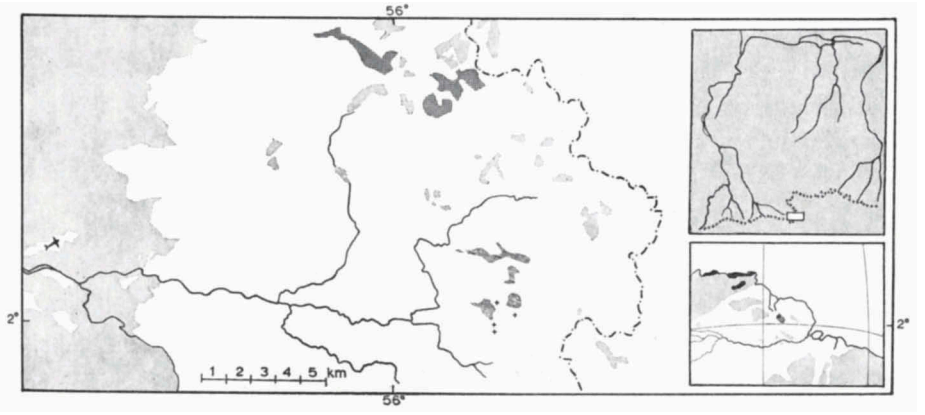

Fig. 3. Map of Sipaliwini savannah north of the Vier Gebroeders Creek. The grey area represents forest. *Dendrobates azureus* nov. spec. was collected in the hatched areas, in the checkered areas it was seen by Dr. J. P. Schulz of the Surinam Forest Service. The inset in the upper right corner shows the location of the area in Surinam. The inset in the lower right corner shows the location of the Sipaliwini-Paroe savannah (hatched area) in South-America.

lecting in the forest north and east of the savannah in the right spots (see under Ecology) may eventually reveal the presence of the newly described species there.

Ecology

The physiognomy of the forest-islands inhabited by *D. azureus* is similar to that of the vast area of forest covering most of Surinam. No influence of the surrounding savannah was evident, though the numbers and kinds of species of trees and shrubs may differ slightly. Most of the forest-islands inhabited by *D. azureus* are situated on slopes of hills. All of them are stretched out along a creek descending the slope. These creeks run smoothly across the forest floor for short stretches and then form falls or just disappear into the ground between enormous boulders, sometimes coming to the surface again about fifteen metres lower down the slope. Between these rounded boulders there are large cavities Most boulders are covered by mosses and ferns that thrive in the humid atmosphere (pl. 3 figs. 1, 2). The boulders seem to represent a very important condition in the habitat of the frogs, because in forest islands in which they are absent, *D. azureus* is absent too. In all forest-islands where *D. azureus* occurred it was only present among and near the boulders. All frogs were taken in the immediate vicinity of the creeks, never more than 20 metres from water. The water in the creeks is very clear and has a temperature of about 25° C. The air temperature in the forest-islands is about 27° C in daytime and drops to about 20° C during the night. *D. azureus* was collected at elevations between 315 and 430 metres above sea level.

The frogs are active in daytime from 8 a.m. till 6 p.m. During this active period they leapt around very lively, catching very small insects (the nature of which could not be established, the creatures being hardly visible to the naked eye). They did not shrink back from our encampment area, which was very open and sunny in comparison with the surrounding forest. Very agile, they climbed the big boulders that frequently obstruct the creek's course; in the same way they moved on level ground, with short, fast jumps. During these jumps the hunched back does not disappear, the head of the animal is elevated relatively high from the ground by the stretched forelimbs, the hindlimbs are completely folded when the animal lands.

Relationships

Two other species of *Dendrobates* are present in Surinam, viz., *D. trivittatus* (Spix), which occurs throughout Surinam from near the coast to the Brazilian border, and *D. tinctorius* (Schneider), which seems to be restricted

to the western and more mountainous part of the country and does not venture north of the coastal savannahs. *D. azureum* is closely related to *D. tinctorius* (Schneider) from which it differs in the size of the fingerdiscs, the shape of the tympanum, the possession of an extremely hunched back, and in pattern and colour. Another related species, *D. machadoi* Bokermann is known from southern Guyana and from the Serra do Navio, Territorio Federal de Amapá in Brazil. However, this species may very well turn out to be identical with *D. tinctorius* (Schneider) as far as I can judge by the single specimen from Guyana available to me (American Museum of Natural History reg. no. 79874), and by Bokermann's (1958) description and figures. However, I did not see the types, so synonymising better be postponed until the types of *D. tinctorius* (Schneider) and *D. machadoi* Bokermann have been compared.

As there has been some confusion about the application of the name *D. tinctorius* (Schneider) to Surinam specimens it seems useful to state that I completely agree with Boulenger's (1913: 1026-7) concept of the species. Confusion probably arose from the extraordinary variability of *D. tinctorius* (Schneider), both in pattern and in size of discs. I hope to be able to communicate more extensively on this matter in a future paper.

Key to the Surinam species of Dendrobates [1])

1. Dorsal skin glandular, first finger longer than or equal to the second 3
   Dorsal skin smooth, first finger shorter than second 2
2. Back with dots on a greyish-blue (in preservative) or bright blue (in life) groundcolour, no longitudinal light lines. Tympanum indistinct, oval, in most specimens larger than disc of 3rd finger . . . . . *D. azureus* spec. nov.
   Back in principle with two dorsolateral white lines, fusing in the coccygeal region, and a white horseshoe-shaped spot on the head, groundcolour black. Tympanum distinct, nearly round, in most specimens smaller than disc of 3rd finger . . . . . *D. tinctorius* (Schneider)
3. First finger longer than second, no yellow spots in groins and on the posterior surface of the tibiae; adult males reaching 40 mm . . . . . *D. trivittatus* (Spix)
   First finger equal to second, yellow spots in groins and on the posterior surface of the tibiae; size small, adult males reaching 20 mm . . . . *D. pictus* (Tschudi)

Acknowledgements

The trip to the Sipaliwini savannah was made in close cooperation with the Surinam Forest Service (Dienst 's Landsbosbeheer), which was most help-

1) While the present paper was in press, Mr. P. A. Silverstone from Los Angeles drew my attention to the fact that among the unidentified material collected by me in 1968, 6 specimens of *Dendrobates pictus* (Tschudi) are present. This species has hitherto not been reported from Surinam. The key to the Surinam species of *Dendrobates* has been adapted to include *D. pictus*, although this species is not mentioned in the text.

ful in supplying labourers and equipment. The map was drawn by Mr. W. C. G. Gertenaar, the photographs of pl. 2 were made by Mr. Chr. Hoorn, both from the Leiden Museum.

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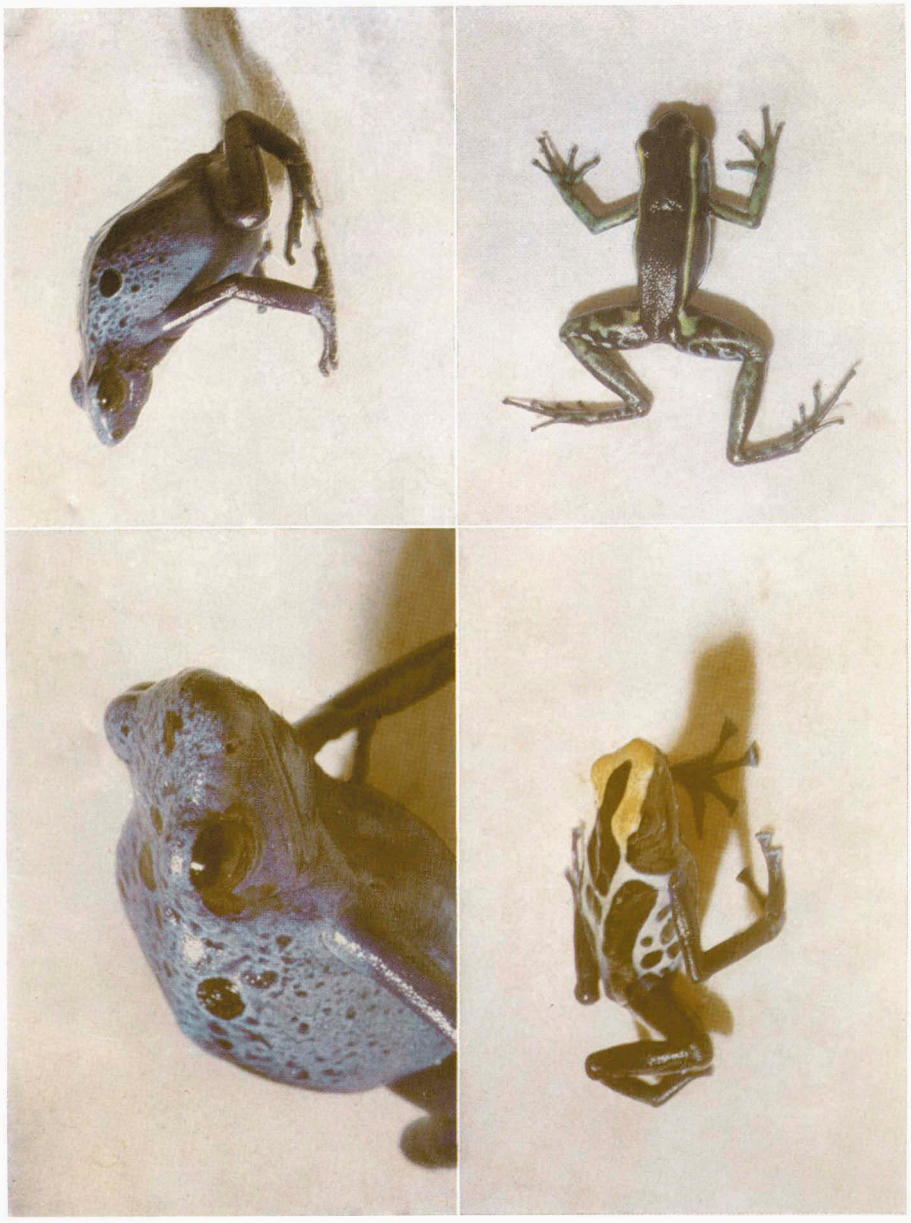
Explanation of Table 1

A, snout-vent length; B, head width at tympanum level; C, horizontal eye-diameter; D, distance between eye and nostril; E, vertical diameter of tympanum; F, horizontal diameter of tympanum; G, largest diameter of disc on third finger of right hand; H, distance between the nostrils; I, interorbital width; J, width of upper eyelid. All measurements are in mm.

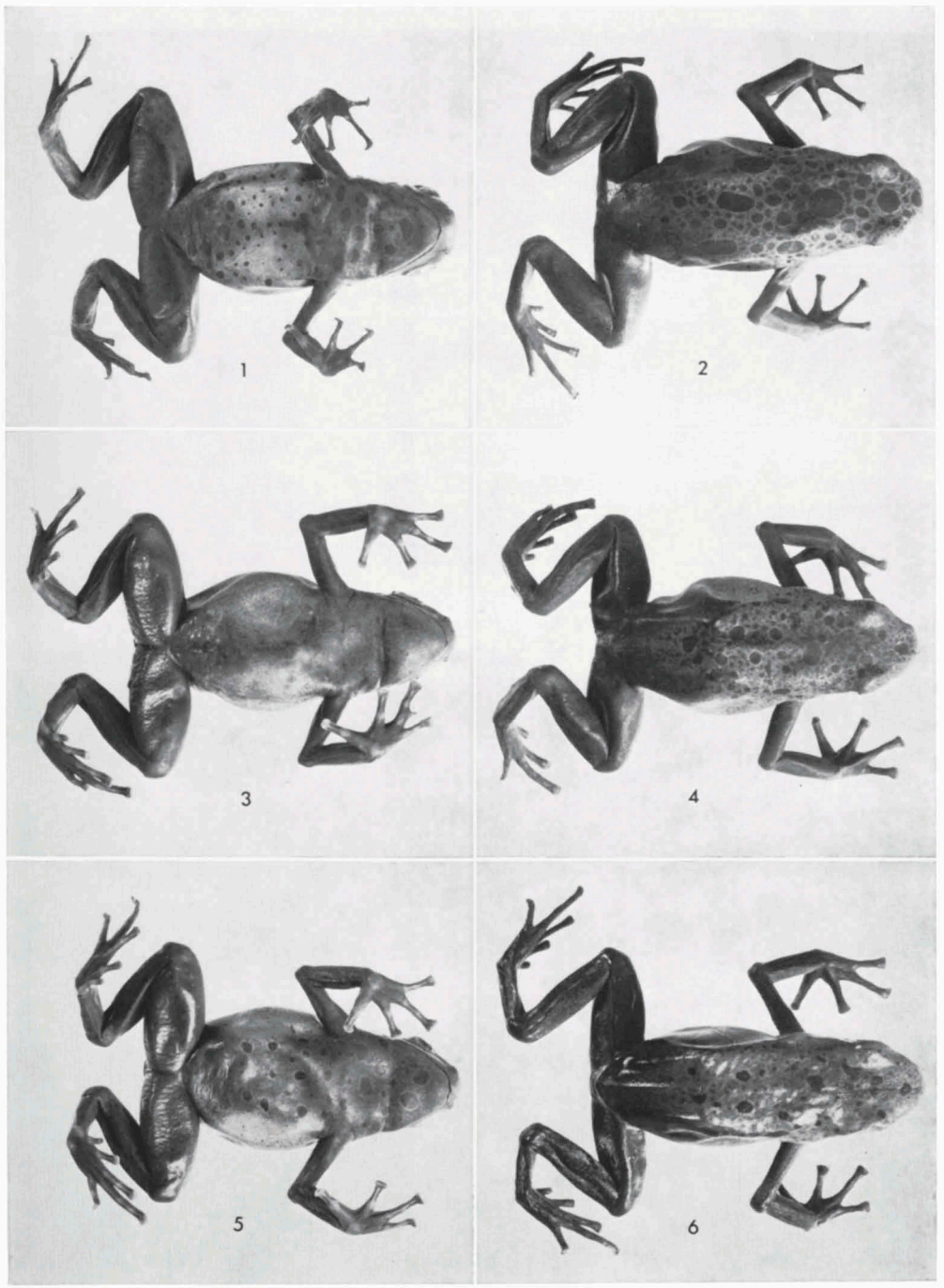
(A) = A/B; (C) = C/D; (E) = E/F; (I) = I/J.

Table 1. Measurements of *Dendrobates azureus* nov. spec.

Reg. no.	A	B (A)	C	D (C)	E	F (E)	G	H	I	J (I)
13837 a	42	11.9 (3.53)	4.0	3.5 (1.14)	3.1	2.1 (1.47)	2.0	4.8	5.0	3.2 (1.56)
b	41	11.4 (3.59)	3.8	3.5 (1.08)	2.6	1.8 (1.49)	2.1	5.1	4.7	3.4 (1.38)
c	42	11.6 (3.62)	4.0	3.5 (1.14)	2.5	1.9 (1.32)	2.0	5.1	4.5	3.6 (1.25)
d	41	11.8 (3.47)	4.1	3.7 (1.11)	2.4	1.8 (1.33)	2.3	5.1	4.2	3.7 (1.14)
e	42	11.5 (3.65)	4.4	3.7 (1.19)	2.4	1.7 (1.41)	1.7	5.2	4.4	3.5 (1.26)
f	39	11.2 (3.48)	4.2	3.3 (1.27)	2.5	1.7 (1.47)	2.4	4.8	5.2	3.0 (1.40)
g	42	11.2 (3.75)	3.8	3.3 (1.15)	2.7	1.7 (1.59)	2.1	5.2	4.7	3.6 (1.31)
h	45	11.4 (3.94)	4.4	3.7 (1.19)	2.9	2.4 (1.21)	1.9	5.3	4.6	3.5 (1.31)
i	43	11.4 (3.77)	4.4	3.9 (1.13)	2.6	2.0 (1.30)	2.0	5.0	4.8	3.8 (1.26)
j	39	10.5 (3.71)	4.1	3.4 (1.20)	2.8	1.8 (1.56)	2.2	4.7	4.2	3.2 (1.31)
k	29	8.4 (3.45)	3.2	2.5 (1.28)	1.9	1.3 (1.45)	1.4	3.8	4.2	2.3 (1.83)
13838	42	11.8 (3.56)	3.6	3.5 (1.02)	2.3	1.8 (1.28)	2.1	5.2	4.9	3.2 (1.53)
13839 a	44	11.3 (3.89)	4.3	3.8 (1.13)	2.7	2.2 (1.23)	1.9	5.3	4.7	3.2 (1.47)
b	41	11.4 (3.59)	4.4	3.8 (1.16)	2.6	1.9 (1.37)	1.9	5.0	4.6	3.4 (1.35)
c	39	10.5 (3.71)	4.1	3.3 (1.24)	2.2	1.6 (1.38)	2.3	4.5	4.8	3.5 (1.37)
d	39	10.8 (3.61)	3.9	3.6 (1.08)	2.4	2.0 (1.20)	2.6	5.0	5.0	3.2 (1.56)
e	31	9.0 (3.44)	2.9	3.0 (0.99)	2.1	1.5 (1.40)	1.6	3.9	3.8	2.4 (1.58)
13840 a	20	6.0 (3.33)	2.4	1.9 (1.26)	1.5	1.2 (1.25)	0.8	2.5	2.6	1.9 (1.37)
b	24	7.2 (3.33)	3.0	2.6 (1.15)	1.4	1.1 (1.27)	1.2	3.4	2.9	2.4 (1.21)
c	43	11.1 (3.88)	3.9	3.7 (1.05)	2.3	1.9 (1.21)	2.1	4.9	4.3	3.1 (1.39)
d	43	11.6 (3.70)	4.5	3.6 (1.25)	2.6	1.8 (1.44)	1.9	5.2	5.0	3.1 (1.94)
e	39	10.1 (3.86)	3.9	3.3 (1.18)	2.4	1.8 (1.33)	2.1	4.6	4.1	2.7 (1.52)
f	43	11.2 (3.83)	4.2	3.4 (1.23)	2.6	1.9 (1.37)	1.8	5.0	4.5	3.1 (1.45)
13841 a	39	10.8 (3.61)	4.1	3.2 (1.28)	2.2	1.8 (1.22)	2.9	4.8	4.8	3.2 (1.50)
b	43	11.5 (3.73)	4.1	3.8 (1.08)	2.6	2.1 (1.24)	2.0	5.6	5.2	3.3 (1.58)
c	43	11.6 (3.70)	3.9	3.6 (1.08)	3.0	1.9 (1.58)	2.2	5.7	4.8	2.9 (1.66)
13842	40	10.6 (3.77)	3.9	3.9 (1.00)	2.1	1.7 (1.24)	2.8	4.8	4.3	3.3 (1.30)
13843 a	43	12.1 (3.55)	4.2	3.8 (1.11)	2.3	1.4 (1.64)	1.8	5.3	5.3	3.8 (1.39)
b	39	11.0 (3.54)	3.8	3.2 (1.19)	2.3	1.6 (1.44)	2.4	4.6	4.4	3.4 (1.29)
c	43	11.3 (3.82)	4.3	3.7 (1.16)	2.5	1.9 (1.32)	2.0	4.8	4.5	3.3 (1.36)
d	43	11.1 (3.88)	4.2	3.5 (1.20)	2.6	2.3 (1.13)	1.6	5.2	4.2	3.2 (1.31)
e	44	11.3 (3.89)	4.1	3.3 (1.24)	2.5	1.8 (1.39)	1.8	5.1	4.7	3.6 (1.31)
f	41	11.3 (3.62)	4.2	3.4 (1.23)	2.2	1.5 (1.47)	1.8	5.2	4.3	3.3 (1.30)
g	39	10.8 (3.61)	4.3	3.4 (1.26)	2.4	1.5 (1.60)	2.1	4.8	4.1	3.2 (1.28)
h	38	11.2 (3.39)	4.0	3.5 (1.14)	1.9	1.4 (1.36)	2.1	4.8	4.6	3.4 (1.35)
i	39	10.5 (3.71)	4.3	3.3 (1.30)	2.3	1.7 (1.35)	2.4	4.9	4.2	3.3 (1.24)
j	31	8.5 (3.64)	3.6	2.9 (1.24)	1.8	— (—)	1.4	3.7	3.5	2.6 (1.35)
Range of ratios:		3.33-3.94		0.99-1.30		1.13-1.64				1.14-1.94
Average of ratios:		3.65		1.17		1.37				1.40



Figs. 1, 2. *Dendrobates azureus* nov. spec.; fig. 3. *D. tinctorius* (Schneider); fig. 4. *D. trivittatus* (Spix).



Figs. 1, 2. *Dendrobates azureus* nov. spec.; holotype (RMNH 13837a), in ventral and dorsal view; figs. 3, 4. *D. azureus* nov. spec., paratype (RMNH 13837b), in ventral and dorsal view; fig. 5. *D. azureus* nov. spec., paratype (RMNH 13837d), in ventral view; fig. 6. *D. azureus* nov. spec., paratype (RMNH 13837c), in dorsal view.

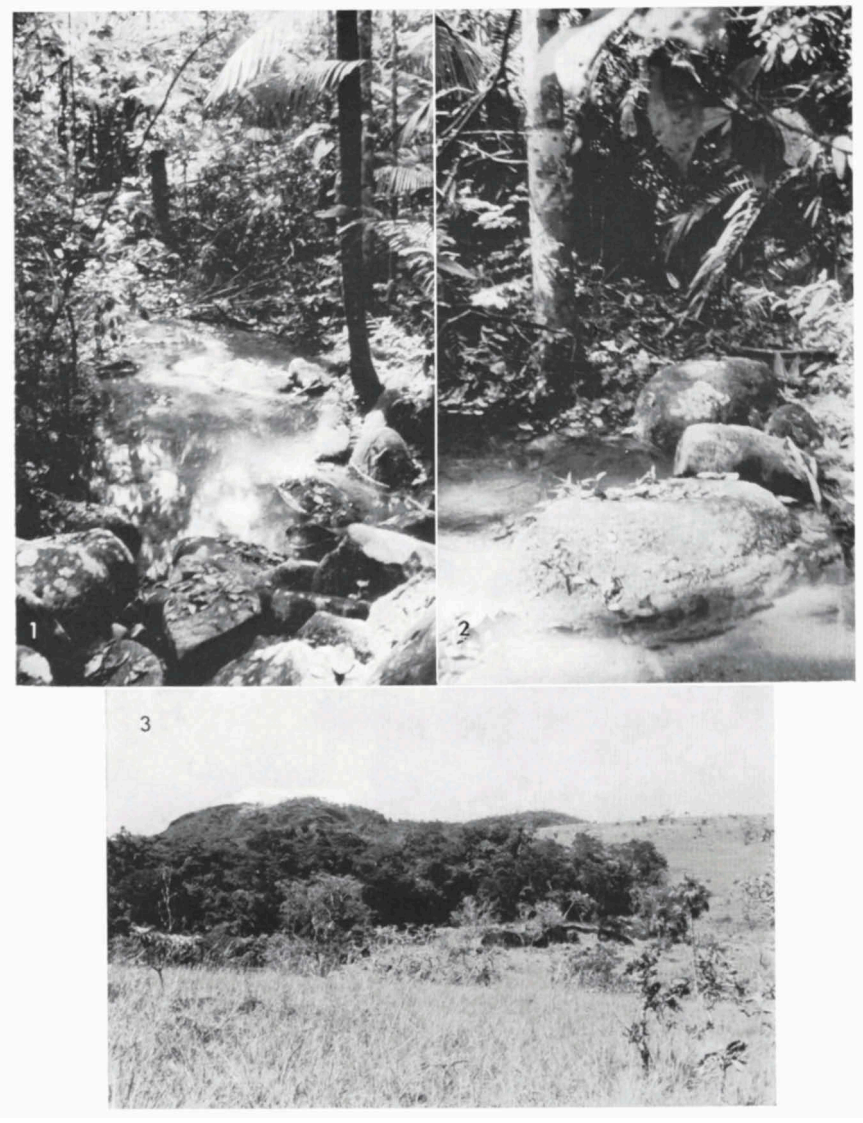


Fig. 1. Interior of forest-island in Sipaliwini savannah, with pile of boulders in front obstructing the creek's course; fig. 2. Detail view of creek bank; fig. 3. Forest island in Sipaliwini savannah, north of Vier Gebroeders Mountain, which is partly visible in the background.