

SNAKES OF THE UPANO VALLEY OF AMAZONIAN ECUADOR

CHARLES M. FUGLER AND A. BRAD WALLS

University of North Carolina at Wilmington
Wilmington, North Carolina 28403

ABSTRACT

Sixteen genera and twenty species of snakes from the Upano valley of eastern Ecuador are discussed. Extensions of geographic and altitudinal ranges are cited. Intraspecific and infrasubspecific variations are noted. Populational variation for certain populations is noted.

INTRODUCTION

The valley of Río Upano is approximately mid-distant between two areas adjacent to the Andean escarpment having received recent attention from investigators: the drainage basins of Rios Napo and Pastaza in Amazonian Ecuador and the tropical lowlands of northeastern Perú. The herpetofauna of the intervening Andean foothills and tropical lowlands, primarily the Provinces of Morona Santiago and Zamora Chinchipe, remains inadequately described.

Paralleling the Andean escarpment, the Upano valley is isolated from the tropical lowlands by the Vieja Cordillera de Cutucú (Fig. 1). Immediately south of the confluence of Rios Upano and Paute the valley is narrowly contiguous with the Amazonian lowlands. Within the valley, base elevations decrease from 1,000 meters near Macas to 914 meters at Mendez. In its greatest length the valley is 80 kilometers with a maximum width of 20 kilometers.

The lower slopes of the foothills and the western flanks of the Vieja Cordillera de Cutucú are characterized by Tropical Evergreen Rainforest (Rumney, 1968). Scattered remnants of the indigenous vegetation are extant on the valley floor. Extensive agriculture and cattle husbandry have drastically altered the floristic aspect.

Peters (1955, 1960) and Peters and Orejas-Miranda (1970) list 18 genera and 28 infrageneric taxa from the Upano valley, of which 16 genera and 21 species and subspecies are noted hereinafter. Intensive field studies in 1974-75 failed to obtain representatives of *Atractus* and *Helicops*.

Peters (1956) and Fugler and Walls (*in manuscript*) noted that the Upano populations of *Dipsas catesbyi* and *Leptodactylus wagneri* are differentiated from conspecific populations of the drainage basins of Rios Napo and Pastaza. Additional infrataxonomic divergence is discussed herein.

The documentation of the snakes of the Upano valley is of multifold significance: (1) elimination of a bio-

geographic hiatus in Amazonian Ecuador; (2) establishment of a basis for studies of faunistic changes in an highly disturbed area; (3) comparison of variation within geographically isolated populations and lowland conspecifics.

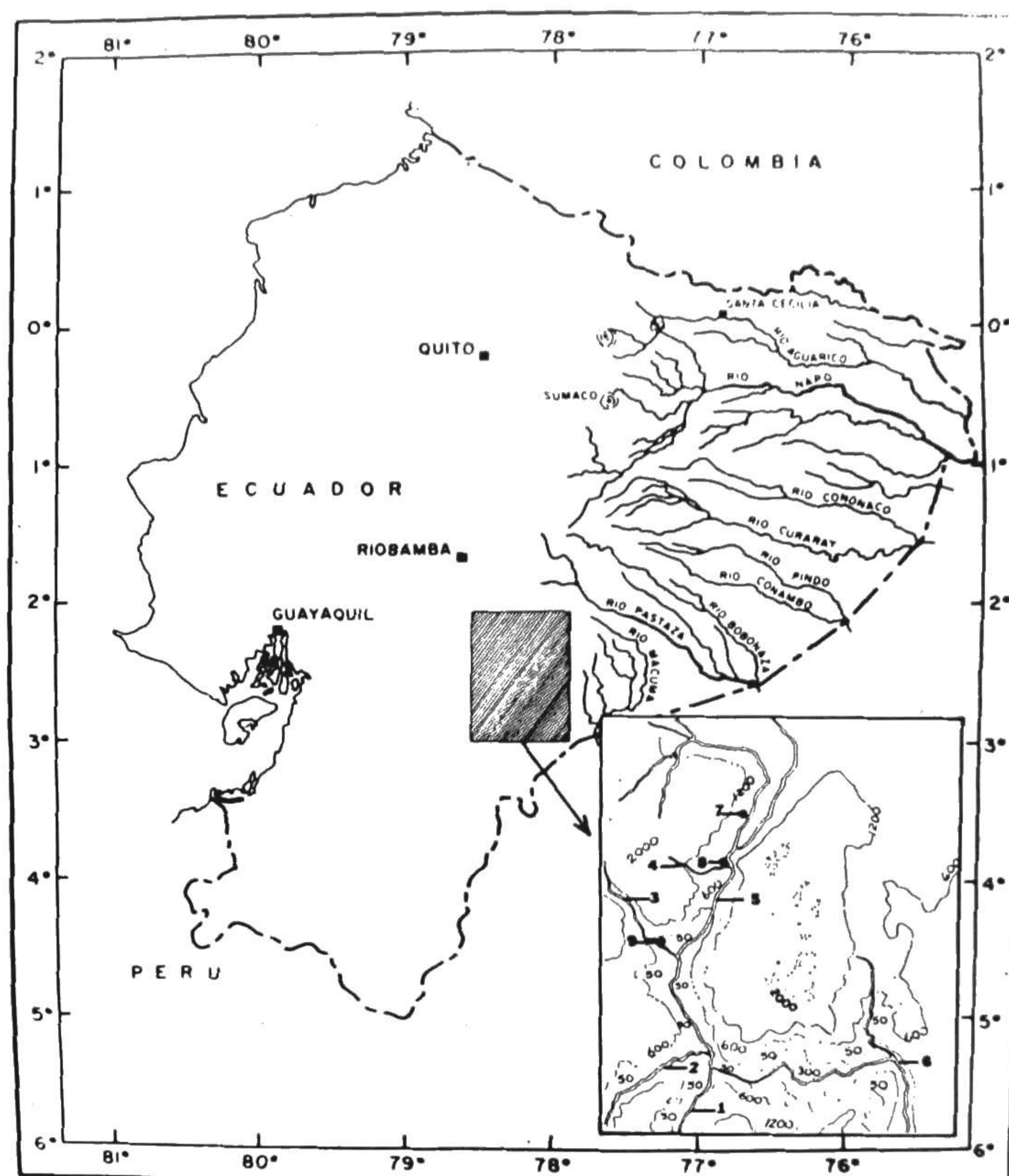


FIG. 1: Map of Ecuador and the valley of Río Upano (inset). Key to numbered localities: 1—Río Coangos 2—Río Zamora 3—Río Paute 4—Río Tutanangoza 5—Río Upano 6—Río Santiago 7—Macas 8—Sucúa 9—Méndez. Localities cited in text but not included on map: Sevilla Don Bosco (E bank of Río Upano opposite Macas); San José (E kms SW of Sucúa).

ACCOUNTS OF SPECIES

The taxonomic allocations, except where noted, follow Peters and Orejas-Miranda (1970). The arrangement of the species is alphabetic.

The abbreviations refer to the following institutions or collections:

USNM—United States National Museum
JAP—James A. Peters (USNM)
GOV—Gustavo Orcés V. (USNM)
UIMNH—University of Illinois Museum of Natural History
EPN—Escuela Politécnica Nacional (USNM)

SMNH—Swedish Museum of Natural History
MCZ—Museum of Comparative Zoology
UMMZ—University of Michigan Museum of Zoology
UNC-W—University of North Carolina at Wilmington
AMNH—American Museum of Natural History

Bothrops atrox (Linnaeus)

1758. *Coluber atrox* Linnaeus, Systema Naturae, Ed. 10:222.
1970. *Bothrops atrox* (Linnaeus)—Peters and Orejas-Miranda, Cat. Neotrop. Squamata, Pt. 1:44.
Province of Morona Santiago. Sucua. UNC-W 295, male; dorsal scale rows, 25-25-18; ventrals, 200; caudals, 70, in double row; supralabials, 7-7; infralabials, 8-8; anal, single; scales between supraoculars, 8. UNC-W 281, male; dorsal scale rows, 28-25-20; ventrals, 206; caudals, 57, in double row; supralabials, 7-7; infralabials, 9-8; anal, single; scales between supraoculars, 8.
The conformation of the snout is normal. The supracephalic scales are carinate. The internasals are in contact. The supraocular scales are large. The second supralabial enters the pit. The carinae of the dorsal scales are shorter than the scale.
The ground color of the dorsum is gray-green, the venter, white with heavy mottling, and the caudals, heavily mottled.

B. atrox is recorded from few localities south of the drainage of Río Pastaza. In that the species is reported from higher elevations (Río Pastaza, Abitagua, 1200 m, UMMZ 89047) its occurrence in the Upano valley is anticipated.

The species is known from numerous localities in eastern Ecuador. Selected locality data are:
Province of Napo. Río Napo, San Francisco, 200 m, UMMZ 92066; Río Llunchi, 250 m, UMMZ 92967; Río Alpayacu, 300 m, UMMZ 91545; Río Cotapino, 400 m, UMMZ 91547; Río Payamino, 400 m, UMMZ 91546. Province of Pastaza. Río Pastaza, 500 m, UMMZ 89046-47, 89049-51, 89033-35; Sarayacu, 500 m, UMMZ 89039-42. Province of "Santiago Zamora", 300 m, UMMZ 83053-57.

Bothrops castelnaudi Duméril, Bibron, and Duméril
1854. *Bothrops Castelnaudi* Duméril, Bibron, and Duméril, Erp. Gén., 7:154.

Province of Morona Santiago. Mendez. UNC-W 277, female; dorsal scale rows, 28-25-19; ventrals, 237; caudals, 82, in single row; supralabials, 7-7; infralabials, 10-10; scales between supraoculars, 5.

The snout is normal in conformation. The second supralabial forms the anterior border of the pit. The internasals are in contact. The supracephalic and dorsal scales are carinate, the carinae not extending to the edge of the scale.

Distinctive dark-brown blotches are present on the dorsum. The interspaces, in preservative, are characteristically pink to reddish-pink. The ventral coloration varies from cream, slightly mottled anteriorly and on the caudals to dark-brown with minute spots medially. The first dorsal scale row and the lateral edges of the ventrals are white-spotted, forming short, interrupted, dorsoventral stripes on the body and tail. The supracephalic region is pinkish-red. Black spots occur on the supraoculars and on the interorbital, parietal, and internal areas.

In eastern Ecuador *B. castelnaudi* has not been reported previously from elevations similar to those of the Upano valley. It has not been reported, in Ecuador, south of two localities in the north of the Province of Morona Santiago.

B. castelnaudi, a relatively common species in eastern Ecuador, is recorded from the following localities:
Province of Napo. Headwaters of Río Arajuno, USNM 165281-82. Province of Pastaza. Río Bufe, tributary of Río Bobonaza, USNM 165288; headwaters of Río Bobonaza, USNM 165289; Río Liquino, tributary of Río Curaray, USNM 165290; headwaters of Río Bobonaza between

Puyo and Canelos, USNM 165291; Copataza, USNM 165292; Canelos, Río Bobonaza, USNM 165293; Río Corrientes, USNM 165295; region of upper Río Curaray, USNM 165294; Río Pastaza, 500 m, UMMZ 89055. Province of Morona Santiago. Taisha, USNM 165283; Chiguaza, USNM 165284.

Chironius fuscus (Linnaeus)

1758. *Coluber fuscus* Linnaeus, Systema Naturae, Ed. 10:222.
1929. *Chironius fuscus* (Linnaeus)—Amaral Mem. Inst. Butantan, 4:161.
Province of Morona Santiago. Sucua. UNC-W 297, female; dorsal scale rows, 10-10-10; ventrals, 145; caudals, 130; loreals, 1-1; preoculars, 1-1; postoculars, 2-2; supralabials, 9-9; infralabials, 10-10; temporals, 1+1, 1+1; anal, single; apical pits not detectable; dorsal scale rows acarinate. UNC-W 291, male; dorsal scale rows, 10-10-2; ventrals, 152; caudals, 72; loreals, 1-1; preoculars, 1-1; postoculars, 2-2; supralabials, 9-9; infralabials, 9-9; temporals, 1+1, 1+1; anal, single; apical pits not detectable; dorsal scale rows acarinate.

In preservative the dorsal ground color is slate-blue, the venter white anteriorly and slate-blue posteriorly. Ill-defined interrupted white stripes are present on the lateral aspect of the posterior ventrals.

The allocation of these specimens to *C. fuscus* is tentative pending generic revision. Characters of scutellation and color are in concurrence with those cited by Peters and Orejas-Miranda (1970).

The species has not been reported from Ecuadorian localities south of the drainage system of Río Pastaza nor from elevations of similar magnitude within the Upano valley.

Specific localities in eastern Ecuador are as follows:
Province of Napo. Río Napo, San Francisco, 200 m, UMMZ 84759; Río Cotapino, 400 m, UMMZ 92014-15, 118603, 132635. Province of Pastaza. Río Pastaza, 500 m, UMMZ 88939-40; Sarayacu, 500 m, UMMZ 88941; Canelos, MCZ 36959.

Chironius schlueteri (Werner)

1899. *Herpetodryas schlueteri* Werner, Zool. Anz., 22:115.
1960. *Chironius schlueteri*—Peters, Bull. Mus. Comp. Zool., 122:512.
Province of Morona Santiago. Santa Teresa. UNC-W 293, female; dorsal scale rows, 12-11-8; ventrals, 138; caudals, 125; supralabials, 9-8; infralabials, 8-9; loreals, 1-1; preoculars, 1-1; postoculars, 2-2; temporals, 1+2, 1+2; anal, single; apical pits not detectable on paravertebrals; paravertebrals carinate.

The dorsal ground color, dark-brown in preservative, extends onto the supracephalic scutes. The ventral scutes are white. The median edges of the darker paired caudals are edged in black.

The referral of this individual to *C. schlueteri* is tentative pending the revision of the genus. It concurs with the current specific diagnosis (Peters and Orejas-Miranda, 1970) except for the greater number of dorsal scale rows.

C. schlueteri is known only from the Amazonian slopes of Ecuador (Peters and Orejas-Miranda, 1970).

Apparently an infrequently encountered species, it has not been reported previously from elevations similar to those of the Upano valley.

Province of Napo. Above Dureno, UIMNH 61204. Limón Cocha, UIMNH 54676, 61206, 61270, 79904. Province of Morona Santiago. Macuma, UIMNH 62866, 62870, 62872.

Dipsas catesbyi (Santzen)

1796. *Coluber catesbyi* Santzen (typographical error), Meyer's Zool. Arch., 2:66.
1956. *Dipsas catesbyi* (Santzen)—Peters, Am. Mus. Nat. Hist. Novitates, 1783:2.

Province of Morona Santiago. Sucua. UNC-W 35, female; ventrals, 170; caudals, 80; loreals, 1-1; supralabials, 8-8; infralabials, 8-8; preoculars, 1-2; postoculars, 1-2; temporals, 1+1+2; UNC-W 36, female; ventrals, 176; caudals, 89; loreals, 1-1; supralabials, 8-8; infralabials, 8-10; preoculars, 3-2; postoculars, 2-1; temporals, 1+1+2, 1+1+2.

The fourth and fifth supralabials enter the orbit. The loreal does not enter the orbit. Lepidosis is in agreement with the

previously recorded variation (Peters, 1956, 1960; Peters and Orejas-Miranda, 1970).

The dorsal body blotches (21 in each specimen), brownish-black, edged in white, attain the greatest width laterally. The dorsal ground color is tawny-brown. The ventrals and caudals are heavily stippled.

Peters (1956), in a definitive study of geographic variation in *D. catesbyi*, determined that the population of eastern Perú is morphologically closer to those of Ríos Napo and Pastaza than are either to the Upano population. The latter population, however, is intermediate between the northeastern Ecuadorian and eastern Peruvian populations.

D. catesbyi, a frequently encountered species in eastern tropical Ecuador, is recorded from the following localities:

Province of Napo. Río Cotapino, 450 m, UMMZ 92016; Limón Cocha, UIMNH 54654, 61208-10, 61212, 61265. Río Napo watershed, UMMZ 88975; Tena, UIMNH 61213. Province of Pastaza. Canelos, AMNH 35875-76; Río Pastaza, UMMZ 88971-74; Montalvo, EPN 76. Province of Morona Santiago. Arapicos, EPN 82; Chiguaza, EPN 702-03, 721-24; Gualaquiza, AMNH 25179-92; Macas, EPN 729-30, AMNH 28826, 28836, 28856-57, 35810, 35812, 35829, 35842-43, 35857-58; Macuma, EPN 707; Riobamba, AMNH 15211, 15216, 23282, 35902-05, 35907-09, 35918.

Dipsas pavonina Schlegel

1837. *Dipsas pavonina* Schlegel, Essai Physion. Serpens, 2:280.
1960. *Dipsas pavonina*—Peters, Misc. Publ. Mus. Zool. Univ. Michigan, 114:61.

Province of Morona Santiago. Sucua. UNC-W 292, female; dorsal scale rows, 13-13-12; ventrals, 186; caudals, 92; loreals, 1-1, entering orbit; supralabials, 8-8; infralabials, 9-10, first pair in contact medially; postoculars, 1-2; temporals, 1+2, pair 2 pairs of chinshields, 5-6 infralabials in contact with chinshields.

The supracephalic scutes are uniformly pigmented. The dorsal body saddles, brownish-black, are wider at the vertebral row than laterally. The dorsal ground color is tawny-brown.

The individual, although divergent from the specific diagnosis (Peters, 1960a), is provisionally referred to *D. pavonina*. The number of ventrals, caudals, and pairs of chinshields are less than previously recorded (Peters, *op. cit.*).

The species is known from Macas (Peters, 1960a). Additional locality records from eastern tropical Ecuador are: Province of Napo. Limón Cocha, UIMNH 61211, 92324; Loreto, JAP 8880-81. Province of Pastaza. Sarayacu, JAP 8882; Río Bobonaza, GOV 6241-42; Río Bufe, tributary of Río Bobonaza, GOV 6587; Dos Ríos, JAP 7925.

Drepanoides anomalus (Jan)

1863. *Cloelia anomala* Jan, Elenco Sist. Ofidi, 1863:92.
1896. *Drepanoides anomalus*—Peracca, Bol. Mus. Zool. Anat. Comp. Univ. Torino, 11(231):3.

Province of Morona Santiago. Sucua. UNC-W 273, female; dorsal scale rows, 15-15-15; ventrals, 161; caudals, 22; supralabials, 6-6; infralabials, 6-6; preoculars, 1-1; postoculars, 1-1; temporals, 1+2, 1+2; anal, single. UNC-W 286, male; dorsal scale rows, 15-15-15; ventrals, 147; caudals, 33; supralabials, 6-6; infralabials, 6-6; preoculars, 1-1; postoculars, 1-2; temporals, 1+2, 1+2; anal, single. UNC-W 287, female; dorsal scale rows, 15-15-15; ventrals, 142; caudals, 32; supralabials, 6-6; infralabials, 6-6; preoculars(1-1); postoculars, 1-1; temporals, 1+2, 1+2; anal, single. UNC-W 288, female; dorsal scale rows, 15-15-15; ventrals, 161; caudals, 22; supralabials, 6-6; infralabials, 6-6; preoculars, 1-1; postoculars, 1-1; temporals, 1+2, 1+2; anal, single.

Transverse dorsal black bands, delimited by narrow, ill-defined white bands, are continuous ventrally. The supracephalic scutes are black, the extent and density of pigmentation varying.

D. anomalus is recorded from Macuma, Province of Morona Santiago (GOV 8372-73, 8375; JAP 8653-54). It has not been reported previously from the Upano valley nor from localities of similar elevations.

In eastern Ecuador the species is known from the following localities:

Province of Napo. Headwaters of Río Arajuno, GOV 8310; Limón Cocha, UIMNH 92349. Province of Pastaza. Río Conambo, JAP 9147; Río Linguino, GOV 8377; Montalvo, Río Bobonaza, GOV 8304; Río Pastaza (Rendahl and Vestergren, 1941).

Drymoluber dichrous (Peters)

1863. *Herpetodryas dichroa* Peters, Monats. Akad. Wiss. Berlin, 1863:284.

1930. *Drymoluber dichrous* (Peters)—Amaral, Mem. Inst. Butantan, 4:82.

Province of Morona Santiago. Sucua. UNC-W 140, female; dorsal scale rows, 15-15-15; ventrals, 176; caudals, 57; supralabials, 8-8; infralabials, 9-9; preoculars, 1-1; postoculars, 2-2; loreals, 1-1; temporals, 1+2, 1+2; anal, single; 2 pairs of genials, anterior pair shorter than posterior; posterior genials in medial contact anteriorly; posterior maxillary teeth not grooved; mental groove absent; apical pits present.

The dorsum is late-gray in preservative. The dorsal color encroaches upon the distal aspect of the ventrals. The supracephalic scutes are slate-gray.

D. dichrous is known from Limón, Province of Morona Santiago (JAP 6896), a locality of greater elevation than the Upano valley. It is also recorded from Macas (USNM 65475).

Additional localities from eastern Ecuador are:
Province of Napo. Loreto, GOV 7893; headwaters of Río Arajuno, GOV 8303; Limón Cocha, UIMNH 54671, 82314; Tena, UIMNH 61274; Río Cotapino, 400 m, UMMZ 92044. Province of Pastaza. Río Linguino, JAP 8510; headwaters of Río Bobonaza, GOV 6193; Río Bufe, tributary of lower Río Bobonaza, GOV 6579; Río Conambo, near mouth of Río Romarizo, GOV 7404; Río Conambo, GOV 7892; Paracachi, Río Curaray, GOV 7467; Río Pastaza, MCZ 36965. Province of Morona Santiago. Chiguaza and Macuma, GOV 7602; Río Llushín, N of Arapicos, GOV 7891. Province of Imbabura. Pimampiro, UMMZ 83708.

Epicrates cenchría cenchría Linnaeus

1758. *Boa cenchría* Linnaeus, Systema Naturae, Ed. 10:215.
1830. [*Epicrates*] *Cenchría* Wagler, Nat. Syst. Amphib.:168.
1929. *Epicrates cenchría cenchría*—Amaral, Mem. Institut. Butantan, 4:77.

Province of Morona Santiago. Sucua. UNC-W 38, male; dorsal scale rows, 34-42-24; ventrals, 253; caudals, 56; supralabials, 13; infralabials, 15; loreals, 2-2; anal, single. UNC-W 41, male; dorsal scale rows, 33-43-25; ventrals, 264; caudals, 59; supralabials, 12; infralabials, 15; loreals, 2-2; anal, single.

All meristic and non-meristic characters agree with the known subspecific variation (Peters and Orejas-Miranda, 1970).

E. c. cenchría is known from the Upano valley (Mendez, JAP 7900; 1 mi. N Mendez, JAP 6692).

Additional locality records for the subspecies in eastern Ecuador include:

Province of Napo. Limón Cocha, UIMNH 61245; Shushufinde, Río Aguatico, GOV 7905. Province of Pastaza. Río Llushín, N Arapicos, GOV 7879; Canelos, Río Bobonaza, GOV 7880; Río Conambo, GOV 7882. Province of Morona Santiago. Macuma, GOV 7881, UIMNH 62857; Río Llushín, EPN S-909.

Erythrolamprus guentheri Garman

1883. *Erythrolamprus guentheri* Garman, Mem. Mus. Comp. Zool., 8(3):154.

Province of Morona Santiago. Sucua. UNC-W 33, female; dorsal scale rows, 15-15-15; ventrals, 193; caudals, 44; loreals, 1-1; supralabials, 7-7; infralabials, 8-8; preoculars, 1-1; postoculars, 2-2; temporals, 1+2, 1+2; anal, divided; black annuli on body, 31; black and white annuli of approximately equal width. Macas-Mendez. USNM 8393, male; dorsal scale rows, 15-15-15; ventrals, 193; caudals, 43; loreals, 1-1; supralabials, 7-7; infralabials, 8-8; preoculars, 1-1; postoculars, 2-2; temporals, 1+2, 1+2; anal, divided; black annuli on body, 30; black and white annuli of approximately equal width.

The Upano specimens are non-divergent from other individuals from eastern tropical Ecuador. The following variation

obtains in the available Ecuadorian sample: dorsal scale rows, 15—15—15; ventrals, 190—193 (male), 176—195 (female); caudals, 37—43 (male), 37—43 (female); black annuli, 18—30 (male), 18—35 (female); supralabials, 7—7; infralabials, 8—8, 9—9 (2); preoculars, 1—1; postoculars, 1—1; loreals, 1—1; temporals, 1+2, 1+2; black and white annuli of approximately equal width.

The male from the Upano valley, USNM 8393, exhibits a striking pattern deviancy. The scales of the central area of the white annuli are heavily pigmented, presenting the aspect of an ill-defined band. In other specimens the distal edge of all scales, rather than one-half to three-fourths, are pigmented.

E. guentheri is known only from the Amazonian slopes of Ecuador to elevations of 950 meters (Peters and Orejas-Miranda, 1970). A juvenile female (UNC-W 443), conspecific with the lowland series, bears the questionable provenance of Cuenca, Province of Azuay.

Specimens Examined. Province of Napo. Loreto, GOV 8392. Province of Pastaza. Río Conambo, near mouth of Río Romarizo, GOV 7406; upper Río Curaray, GOV 8391; Río Liguino, Río Bobonaza, GOV 7435; Río Pindo, GOV 8380; Sarayacu, GOV 8378; Shell Mera, JAP 8931. Province of Morona Santiago. Macuma, GOV 8390.

Imantodes cenchoa cenchoa Linnaeus

1758. *Coluber cenchoa* Linnaeus, SYST. NATURAE, Ed. 10:226. 1949. [*Imantodes cenchoa*] *cenchoa*—Smith, Proc. U. S. Nat. Mus., 92:384.

Province of Morona Santiago. Sucua. UNC-W 31, male; dorsal scale rows, 17—17—17; ventrals, 258; caudals, 97; loreals, 1—1; supralabials, 8—8; infralabials, 9—10; preoculars, 1—1; postoculars, 2—2; temporals, 2+3, 2+3; anal, divided. UNC-W 33, female; dorsal scale rows, 17—17—17; ventrals, 248; caudals, 157; loreals, 1—1; supralabials, 8—8; infralabials, 10—12; preoculars, 1—1; postoculars, 2—2; temporals, 2+3, 2+3; anal, divided.

Distinct dorsal body bands, not broken posteriorly, number 39. A V-shaped light mark, bifurcating on the posterior aspect of the parietal, terminates at the posteromedial border of the orbit. The venter, light in color, possesses characteristic dark spots. The vertebral scale row is twice as large as the adjacent paravertebral scales.

The Upano specimens are referable to the nominative race on the basis of the number of ventral scutes and the pigmentation of the latter (Smith, 1942; Peters and Orejas-Miranda, 1970).

The species has not been reported previously from the Upano valley nor from specific localities south of Río Pastaza drainage. It is recorded from elevations greater than those of the Upano valley.

I. c. cenchoa is recorded from numerous localities in eastern Ecuador among which are the following:

Province of Napo. Alpayacu, 300 m, UMMZ 91556; Abitagua, 400 m, UMMZ 91555; Río Cotapino, 400 m, UMMZ 92010; Limón Cocha, UIMNH 92259-60; Llunchi, Río Napo, UMMZ 84757; Río Mapoto, 1300 m, UMMZ 84100; Santa Cecilia, UMMZ 129348, MCZ 96673. Province of Pastaza. Canelos, 500 m, UMMZ 88904; Río Pastaza, 500 m, UMMZ 88901-02; Río Pastaza, between Mera and Abitagua, 1100 m, UMMZ 92011. Province of "Santiago Zamora." UMMZ 82877-78.

Imantodes lentiferus (Cope)

1894. *Himantodes lentiferus* Cope, Am. Nat., 28:613.

1929. *Imantodes lentiferus*—Amaral, Mem. Inst. Butantan, 4:203.

Province of Morona Santiago. 10 km W Sucua. UNC-W 52, female; dorsal scale rows, 15—15—15; ventrals, 218; caudals, 46; loreals, 1—1; supralabials, 8—8; infralabials, 9—10; preoculars, 1—1; postoculars, 2—2; temporals, 1+2+2, 1+2+2; anal, divided.

The lower dorsal-scale-row count immediately differentiates *I. lentiferus* from sympatric species in eastern tropical Ecuador.

The species is known from elevations significantly higher than those of the Upano valley. South of the drainage basin of Río Pastaza *I. lentiferus* is reported from the Province of "Santiago Zamora" (UMMZ 82876) and from "Taisha, Macas",

Province of Morona Santiago (USNM 162486). The latter localities are widely separated altitudinally and spatially.

Other localities in the eastern Ecuadorian lowlands include the following:

Province of Napo. Abitagua, 1100 m, UMMZ 91557-63; Río Cotapino, 400 m, UMMZ 90821; Limón Cocha, UIMNH 54656, 54674, 61190-92, 92263-64, 92319; Río Napo, UMMZ 88898; Puerto Napo, UIMNH 55927; San José Viejo de Sumaco, USNM 162485. Province of Pastaza. Immediate environs of Arajuno, JAP 7780; upper Río Bobonaza, USNM 162492; headwaters of Río Bobonaza, USNM 162493; Río Bufe, tributary of lower Río Bobonaza, USNM 162488; Chichirota, USNM 162487; region of upper Río Curaray, USNM 162490; Río Pastaza, 500 m, UMMZ 88899-900; Río Pindo, near town of Río Tigre, USNM 162489; Sarayacu, Río Bobonaza, USNM 162491; Río Sarayacu, USNM 167247; Río Shilcayacu, below Puyo, USNM 162494, 167246; near Río Topo, 1200 m, UMMZ 92009; Río Villano, USNM 167245. Province of Chimborazo. Riobamba, MCZ 29292.

Leimadophis typhlus forsteri (Wagler)

1824. *Natrix G. Forsteri* Wagler, in Spix, Sp. Nov. Serp. Bras.:16.

1964. *Leimadophis typhlus forsteri*—Hoge, Mem. Inst. Butantan, 30(1960-62):59.

Province of Morona Santiago. Sucua. UNC-W 272, male; dorsal scale rows, 19—19—16; ventrals, 162; caudals, 40 (tail incomplete); loreals, 1—1; preoculars, 1—1; postoculars, 2—2; supralabials, 9—9; infralabials, 10—10; temporals, 1+1(+2), 1+1(+2); anal, divided.

The dorsal ground color is uniformly slate-blue in preservative. The venter is off-white except for the encroachment of the dorsal ground color laterally.

The specimen agrees with the specific and subspecific diagnostic characters except for the anomalously divided temporals.

The subspecies is known from Macas (USNM 65477-78). Other localities in eastern Ecuador from which *L. t. forsteri* is recorded include the following:

Province of Pastaza. Río Pastaza, 500 m, UMMZ 89020-22. Province of "Santiago Zamora". UMMZ 82889-90. Peters and Orejas-Miranda (1970) noted that the subspecific distribution is uncertain.

Leptodeira annulata annulata (Linnaeus)

1789. *Coluber albofuscus* Lacépède, Hist. Nat. Serp., 2:312.

1958. *Leptodeira annulata annulata*—Duellman, Bull. Amer. Mus. Nat. Hist., 114:47.

Province of Morona Santiago. Sucua. UNC-W 39, male; dorsal scale rows, 18—19—15; ventrals, 182; caudals, 86; supralabials, 8—8; infralabials, 11—11; preoculars, 1—1; temporals, 1+2, 1+2. UNC-W 278, female; dorsal scale rows, 18—19—13; ventrals, 184; caudals, 98; supralabials, 8—8; infralabials, 11—11; temporals, 1+2, 1+2.

The genus *Leptodeira* has received monographic attention, consequently no additional comment is merited.

In eastern Ecuador, Perú, and Bolivia *L. a. annulata* attains elevations slightly in excess of 1000 meters. The subspecies is known from Macas (AMNH 28822, 35837, 35851, 35856; USNM 65486) and Macuma (EPN 768-773).

The subspecies, not uncommon in the eastern tropical lowlands, is known from numerous localities (Duellman, 1958).

Liophis purpurans (Duméril, Bibron, and Duméril)

1854. *Ablaps purpurans* Duméril, Bibron, and Duméril, Erp. Gén., 7:312.

1872. *Liophis purpurans* (Duméril, Bibron, and Duméril)—Gunther, Ann. Mag. Nat. Hist., (4)9:19.

Province of Morona Santiago. Sucua. UNC-W 274, male; dorsal scale rows, 17—17—15; ventrals, 135; caudals, 63; loreals, 1—1; supralabials, 8—8; infralabials, 8—8; preoculars, 1—1; postoculars, 2—2; temporals, 1+2, 1+2; anal, divided; apical pits absent; prefrontals, paired; 2 supralabials enter orbit; black laterocaudal stripe present.

L. purpurans has not been reported previously from the Upano valley nor from localities of similar elevations. It has not been reported from localities south of Río Pastaza drain-

age although Cope (1868) reported the species from "Río Napo or the upper Río Marañón."

Localities in eastern Ecuador from which the species is known include the following:

Province of Pastaza. Río Pastaza, 500 m, UMMZ 88970. Province of Napo. Limón Cocha, UIMNH 61248-256, 63524.

Micrurus langsdorffi ornatissimus (Jan)

1858. *Elaps ornatissimus* Jan, Rev. Mag. Zool., (2)10:521.

1967. *Michirus langsdorffi ornatissimus* (Jan)—Rozé, Am. Mus. Nat. Hist. Novitates, 2287:310.

Province of Morona Santiago. Mendez, UNC-W 48, female; ventrals, 225; caudals, 30; black annuli on body, 41. Sucua, UNC-W 51, male; ventrals, 208; caudals, 48; black annuli on body, 48. Province of Pastaza. Río Pastaza, UMMZ 88917, female; ventrals, 230; caudals, 36; black annuli on body, 60; UMMZ 88918, male; ventrals, 209; caudals, 48; black annuli on body, 40.

UNC-W 48, a juvenile female, possesses well-defined narrow white bands delimiting the black annuli, characteristic of *M. steindachneri*. In the Upano male the white bands are reduced to rows of white spots in agreement with the diagnosis of *M. langsdorffi*. White spots are present on the supracephalic scutes of the male (diagnostic of *M. steindachneri*). The number of black annuli on the male is within the recorded variation of

FIG. 2.: Geographic variation in selected meristic characters in the *Micrurus lemniscatus* complex.

Character	<i>diutius</i>	<i>lemniscatus</i>	<i>carvalhoi</i>	<i>helleri</i>
ventrals male	222.4±2.9±0.7	228.4±4.6±1.3	232.5±6.0±2.1	228.5±5.0±1.1
ventrals female	230.8±2.2±0.7	240.9±5.3±1.6	246.7±2.7±0.9	234.2±5.9±0.5
caudals male	35.9±1.0±0.3	37.1±2.1±0.6	35.2±2.7±0.7	37.0±2.3±0.5
caudals female	34.3±2.7±0.9	32.9±4.3±1.1	37.5±3.6±1.3	37.1±3.9±1.1
body triads	9.9±1.2±0.3	11.2±2.5±0.5	11.1±1.8±0.3	9.6±1.0±0.2

M. langsdorffi. The specimen, therefore, is allocable to either species (Peters and Orejas-Miranda, 1970).

Rozé (1967), without comment, separated the population along the eastern slope of the Andes in Ecuador and Perú under the trinomial *M. l. ornatissimus*. *M. l. ornatissimus* is distinguishable from the nominative race solely on the mean number of black annuli.

The subspecies are apparently altitudinally separated (Peters and Orejas-Miranda, 1970). As the geographic ranges are currently defined, *M. l. ornatissimus* is restricted to the Amazonian slopes of eastern Ecuador and northern Perú, and the nominative race to the upper Amazonian region from southern Colombia to northern Perú.

Rendahl and Vestergren (1941) briefly noted two specimens (SMNH 3163) from Río Pastaza, Province of Pastaza. The number of black annuli and scutellation are typical of *M. l. ornatissimus*: ventrals, 213, 231; caudals, 51, 38; black annuli on body, 49, 55; sexes not stated.

Machado (1945) noted the meristic variation in *M. langsdorffi* (Wagler) of the upper Brazilian Amazon (= *M. l. langsdorffi* (Jan) as currently defined): ventrals, 204-225, caudals, 37-54. The Brazilian and Ecuadorian populations are apparently not differentiated.

Micrurus lemniscatus helleri Schmidt and Schmidt

1925. *Micrurus helleri* Schmidt and Schmidt, Zool. Ser., Field Mus. Nat. Hist., 12:29.

1967. *Micrurus lemniscatus helleri* Schmidt and Schmidt—Rozé, Am. Mus. Nat. Hist. Novitates, 2287:35.

Province of Morona Santiago. San José. UNC-W 49, male; ventrals, 244; caudals, 37; body triads, 9. Sucua. UNC-W 50, male; ventrals, 244 caudals, 37; body triads, 9. Province of Napo. Limón Cocha. UIMNH 61039, female; ventrals, 256, caudals, 40; body triads, 10; UIMNH 61040, male; ventrals, 235; caudals, 38; body triads, 11. Puyo. MSU 1411, male; ventrals, 236; caudals, 38; body triads, 11.

These specimens are tentatively referred to *M. l. helleri* as the

subspecies is currently diagnosed. Subspecific variation is inadequately known.

Published localities for the subspecies are limited to the type locality (Pozuzo, Department of Huanuco, Perú) although eastern Ecuador is included within the subspecific range. Burger (1955) remarked that the population of *M. lemniscatus* of the eastern lowlands adjacent to the Andean cordillera is differentiated from other populations. Rozé (1967), recognizing the population of eastern Brazil (*M. l. carvalhoi*), reduced *helleri* to subspecific status without comment. Peters and Orejas-Miranda (1970), *vide* Rozé (*op. cit.*), retained the subspecific status of *helleri*.

Analysis of Burger's data and those obtained from other specimens indicate that *M. l. helleri* is poorly differentiated (Fig. 2). No meristic or chromatic character or combination of characters distinguish *M. l. helleri* from other geographic races.

Rendahl and Vestergren (1941) reported *M. lemniscatus* from Río Pastaza, Province of Pastaza (SMNH 3164). The ventrals (258) and caudals (32) are greater and lesser, respectively, than previously recorded counts for *M. l. helleri* (sex not given). According to Machado (1945) the ventral and caudal counts of Brazilian *M. lemniscatus* vary from 241 to 262 and 30 to 39. The variations in the ventrals are closer to *carvalhoi* while the caudal variation might conform to all described subspecies.

Oxyrhopus petola digitalis (Reuss)

1834. *Coluber digitalis* Reuss, Mitgl. Senckenb. Naturforsch. Ges., 1:148.

1970. *Oxyrhopus petola digitalis* (Reuss), new combination—Peters and Orejas-Miranda, Bull. U. S. Nat. Mus., 297(1):233.

Province of Morona Santiago. Sucua. UNC-W 34, female; dorsal scale rows, 19—19—17; ventrals, 211; caudals, 108; loreals, 1—1; supralabials, 8—8; infralabials, 9—9, 6 in contact with chinshields; preoculars, 1—1; postoculars, 9—9; temporals, 2+3, 2+3; anal, single. 10 kms. W Sucua. UNC-W 289, female; dorsal scale rows, 19—19—17; ventrals, 212; caudals, —; loreals, 1—1; supralabials, 9—8; infralabials, 9—9, 4 (left) and 5 (right) in contact with chinshields; preoculars, 1—1; postoculars, 2—2; temporals, 2+3, 2+3; anal, single. Sucua. UNC-W 290, male; dorsal scale rows, 19—19—15; ventrals, 183; caudals, 84; loreals, 1—1; supralabials, 8—8; infralabials, 9—8, 5 in contact with chinshields; temporals, 2+2, 2+2; anal, single.

The preoculars, narrowly contacting the frontals in two individuals, are separated in the third. The supracephalic scales, densely pigmented in two specimens, are lightly pigmented in the third. A distinct white nape stripe is present in one individual.

In older individuals, ontogenetic changes are indicated by the expansion of the black dorsal bands and the subsequent reduction of the intervening white bands. Individual variation is also evidenced in the arrangement of the supracephalic scutes.

O. p. digitalis is known from the Upano valley (Macas, USNM 65476) and from elevations greater than those of the Upano valley.

Other localities in eastern Ecuador from which the subspecies has been recorded are:

Province of Pastaza. Abitagua, Río Pastaza, 1000 m, UMMZ 91578, 91580-83, 91587; near Río Topo, upper Río Pastaza, 1200 m, UMMZ 91579; Pastaza valley between

Mera and Abitagua, 500 m, UMMZ 92064. Province of Zamora Chinchipe. 60 kms NE Zamora, UMMZ 123272.

Pseudoboa coronata Schneider

1801. *Pseudoboa coronata* Schneider, Hist. Amphib., 2:286. Province of Morona Santiago. Mendez. UNC-W, female; dorsal scale rows, 17-17-17; ventrals, 173; caudals, 28; loreals, 1-1 (greatest height anteriorly); supralabials, 7-7; infralabials, 7-7; prefrontals, 2-2; postoculars, 2-2; anal, single.

The dorsal ground color, in preservative, is dark brown with narrow cream-colored bands frequently incomplete dorsally. Black reticulation occurs on the cream-colored venter.

P. coronata is recorded from localities of elevations similar to those in the Upano valley. It has been reported also from the Province of Morona Santiago (Macuma, JAP 8646; Chiguaza, GOV 8376) but not from the Upano valley.

The species is known from relatively few localities in eastern tropical Ecuador:

Province of Pastaza. Puyo, 3300 ft., JAP 7901; Río Villano, GOV 8365; Río Liguino, tributary of Río Villano, upper Curaray, GOV 8368.

Pseustes sulphureus sulphureus (Wagler)

1837. *Dipsas Dieperinkii* Schlegel, Essai Physion. Serpens, 2:282.

1937. *Pseustes sulphureus sulphureus*—Brongersma, Zool. Meded., 20:6.

Province of Morona Santiago. Sucua. UNC-W 296, male; dorsal scale rows, 18-18-18; ventrals, 210; caudals, 136, in double row; loreals, 1-1; supralabials, 8-8; infralabials, 10-2; preoculars, 1-1; postoculars, 3-3; anterior pair of chinshields shorter than posterior pair; suboculars absent; anal, single.

The first two dorsal scale rows are acarinate. At midbody and posteriorly the first row only is acarinate. In preservative the dorsal ground color is green-gray with indistinct black saddles.

P. s. sulphureus is recorded from an elevation (UMMZ 88946, 1800 m, Banos, Province of Tungurahua) significantly higher than the Upano valley. The species has not been reported previously from the Upano valley or from localities south of the drainage of Río Pastaza.

Xenodon severus (Linnaeus)

1758. *Coluber severus* Linnaeus, Systema Naturae, Ed. 10:219.
1826. *X. [enodon] severus*—Fitzinger, Neue Classification der Reptilien: 57.

Province of Morona Santiago. Sevilla Don Bosco. UNC-W 276, male; dorsal scale rows, 21-21-16; ventrals, 140; caudals, 36; loreals, 1-1; supralabials, 8-8; infralabials, 11-11, first pair in contact medially; preoculars, 1-1; postoculars, 2-3; maxillary teeth, 8; 2 pairs of chinshields, 5 pairs of infralabials in contact with the first pair of chinshields; anal, divided.

The dorsal ground color, in preservative, is slate-gray. The venter is white anteriorly and mottled blue-gray posteriorly. The caudals are mottled blue-gray.

Except for the lesser number of maxillary teeth the specimen agrees with the specific diagnosis (Peters and Orejas-Miranda, 1970).

X. severus is known from Macas (USNM 65472). It has been recorded from localities whose altitudes are equal to or greater than those of the Upano valley.

Additional locality records in eastern Ecuador are: Province of Napo. Loreto, GOV 8976, USNM 165405-06, 165384, 165386; Río Misahuallí, GOV 8977, USNM 165385. Province of Pastaza. Headwaters of Río Bobonaza, Río Solís, USNM 165404; Río Bufe, tributary of Río Curaray, GOV 6580-81; Canelos, USNM 165383; headwaters of Río Capahuari, GOV 8978; Río Conambo, JAP 3759, USNM 165402-03; Río Corrientes, near "la pica" del Conambo, Río Huiyayacu, upper Río Corrientes, USNM 165399; Río Corrientes, tributary of Río Tigre, USNM 165381-82; Río Cotapino, UMMZ 90825; Don Tomás, 5 kms S Montalvo, USNM 165404; general region of upper Río Pastaza drainage, JAP 7946; Río Pastaza, UMMZ 36974, 88951; Río Pindo, near town of Río Pueblo, JAP 3731; Río Pindo, GOV 8979; Río Pindo, near town of Río Tigre, USNM 165376; Río Pucayacu, USNM 165380; Río Villano, GOV 7979.

DISCUSSION

Nine taxa occurring in the Upano valley, excluding species of *Atractus* and *Helicops*, are reported from altitudes in excess of 1000 meters. These taxa are known from the upper Río Pastaza and its tributaries: *Bothrops atrox*, *Drymoluber dichrous*, *Imantodes c. cenchoa*, *Imantodes lentiferus*, *Micrurus lemniscatus helleri*, *Oxyrhopus petola digitalis*, *Pseudoboa coronata*, *Pseustes s. sulphureus*, and *Xenodon severus*. The Tropical Evergreen Forest, characteristic of the lower Andean slopes, extends to the upper limit of the Tropical Zone or beyond in optimal valleys. It is improbable that the populations in the Upano valley penetrate the tributaries of the Río Upano. The transition from mesic to xeric vegetation is abrupt at the maximum altitude of the Tropical Zone immediately west of the Upano valley.

Nine species were reported previously from the Upano valley or from localities of approximately equal elevations. The taxa are *Dipsas catesbyi*, *Dipsas pavonina*, *Drepanoides anomalus*, *Epicrates c. cenchria*, *Erythrolamprus guentheri*, *Leimadophis typhlus forsteri*, *Leptodeira a. annulata*, and *Micrurus langsdorffi ornaticissimus*. These taxa probably range into higher altitudes in the upper Pastaza valley. Their presence at elevations greater than the Upano valley in its tributaries is problematical.

The altitudinal range of four species, previously known only from the tropical lowlands, is extended: *Bothrops castelnaudi*, *Chironius fuscus*, *Chironius schlueteri*, and *Liophis purpurans*. Their occurrence at higher elevations in the Pastaza valley is anticipated.

Certain populations inhabiting the Upano valley are infrataxonometrically differentiated (Peters, 1956; Fugler & Walls, in manuscript). Further analysis of the Upano populations may indicate heretofore unrecognized divergence. Geographic isolation of the Upano populations from those of the tropical lowlands, although partial, is significantly greater than the Pastaza valley from the adjacent lowlands.

Peters (1960) described three distributional patterns involving the snakes of eastern Ecuador: (1) the Amazonian Basin from the Atlantic coast to the Andean foothills (2) from southern Colombia to Bolivia along the eastern Andean escarpment (3) southeastern Ecuador and northeastern Perú. The Upano species are predominately of patterns (2) and (3).

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DISTRIBUTION OF CHROMIUM IN VEGETATION AND SMALL MAMMALS ADJACENT TO COOLING TOWERS

FRED G. TAYLOR, JR. AND PATRICIA D. PARR

Oak Ridge National Laboratory
Oak Ridge, Tennessee 37830

ABSTRACT

Surface contamination of vegetation by aerosol pollutants and subsequent ingestion by grazing vertebrates is a pathway for incorporation of toxic elements into food chains. Small mammals (herbivores) were live-trapped in a fescue-dominated field adjacent to large, mechanical draft cooling towers comparable to those utilized by power generation facilities. Cooling waters of the towers contain a chromate, zinc-phosphate compound to inhibit corrosion and fouling within the cooling system. A fraction of the cooling water becomes entrained within the exit air flow and is deposited as drift on the landscape. Resident mammals are subjected to increased chromium exposures both through ingestion and through inhalation pathways. Concentrations in vegetation ranged from 342 to 15 ppm at 15 and 130 meters downwind. Chromium distribution in mammals adjacent to the cooling towers was compared by organ analyses to corresponding organs and tissues of mammals collected remote from drift. Concentrations of chromium in pelt, hair, and bone of animals trapped near the cooling towers were significantly higher ($P < 0.01$) than concentrations in tissues from control animals. Air concentrations of chromium had previously been determined to be relatively constant at 50 ng/m³ within 200m of the tower (Alkezeeny et al., 1975), and thus provided a potential pathway for increased chromium levels through inhalation. The fate of ingested chromium-contami-

nated vegetation and possible incorporation by body tissues was determined from a feeding experiment using radiolabelled chromium.

INTRODUCTION

Chromium, an essential trace element found in almost every living organism, has been reviewed in detail as a potential environmental pollutant (National Academy of Sciences, 1974). As with many other trace elements or compounds, increased quantities often produce deleterious effects. Trace levels are considered essential to some mammalian species and irreversible metabolic damage may result from a long-term chromium deficiency. Chromium is a complex element occurring in several oxidation states. Hexavalent chromium (+6) is more toxic than the trivalent form (+3) because of its oxidizing potential and ease in penetrating biological membranes. Interaction of chromium oxide, dichromate or chromate compounds with organic matter can result in reduction to the inert trivalent form. Unreliable or non-reproducible analytical techniques have resulted in erroneous conclusions concerning the ambient or natural occurrence of the element and its effects on biota (National Academy of Sciences, 1974). Elevated levels of chromium have generally paralleled advances in technological and industrial uses of the element or compounds containing chromium. Such increased burdens in the environment may be derived from uses in plating and foundry applications, chemical manufacturing, and corrosion inhibition.