Bull. Inst. Zool., Academia Sinica **4**: 19-27 (1965)

THE TAXONOMIC STATUS OF THE WHITE-STOMACH SNAKE, *NATRIX PERCARINATA SURIKI* MAKI, ON TAIWAN[1]

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ABSTRACT

Study of the morphological characteristics, embryos, and habits and habitat of the Taiwan population of the white-stomach snake, *Natrix percarinata*, shows it to be subspecifically distinct from the mainland form, and the name *Natrix percarinata suriki* Maki should be applied to it.

The type locality of *suriki* is Makazayzaya, southern Taiwan; the type locality of *percarinata* is Kuatun, Fukien. Presumably the mainland form occupied Taiwan when the island was still connected to the mainland. The long geographic isolation, since about 6200 B. P. and the peculiar environmental conditions to which it has been subjected, probably are important factors in the differentiation of *Natrix percarinata suriki* Maki.

Although *suriki* and typical *percarinata* closely resemble each other, they differ in the following characteristics:

1. Ventrals 135+++-150+, mean 144.5 in *suriki*, 138-143, mean 140.5 in *percarinata;* thus *suriki* has a little higher average ventral count. In *suriki*, the postoculars are 3, occasionally 4, very rarely 2; anterior temporals 2, very rarely 1 (fused). In *percarinata*, the postoculars are 4, occasionally 3 or 5, and the anterior temporals 3, occasionally 2 or 4.
2. Generally, the dorsal color pattern in *suriki* is dark gray or gray with poorly defined black reticulations, in *percarinata*, the dorsum is slaty gray, bluish brown, purplish brown, or olive brown with a series of black-edged patches which are lighter in the center. The vertical black bars in *suriki* are never edged with light color as in *percarinata*.
3. The hemipenis of *percarinata* bears a few large spines cranial to the three basal hooks, which the hemipenis of *suriki* does not have.
4. The point of insertion of the *M. retractor penis magnus* in *suriki* is 23.5 subcaudal, in *percarinata* the 20th.

The White-stomach snake, *Natrix percarinata suriki* Maki, 1931, is a very common nonpoisonous snake on Taiwan, but its exact taxonomic status has never been clearly defined. It is a member of the Asiatic group that includes *Natrix aequifasciata, annularis, bellula, triangu-ligera* and *percarinata* (1, 2), but is not in Malnate's list of recognized species. Presumably he either synonymized it with, or considered it a subspecies of *percarinata*. Maki (3) described it as a new

1 This study was supported partly by the Institute of Zoology, Academia Sinica and the China Medical Board of New York, Inc.

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species, *Natrix suriki*. Pope (4), basing his conclusion on Maki's data that Taiwan specimens have higher ventral counts than those of mainland *Natrix percainata*, suggested that *suriki* may be a subspecies of *percarinata*. Smith (1) included Taiwan in the range of *percarinata*. Later, Wang and Wang (5) adopted Maki's classification. In the same year, Chen (6) recognized the Taiwan white-stomach snake as *percarinata*. More recently, Kuntz (7) employed Maki's nomenclature.

In view of these varying opinions, I decided to make an extensive study of the Taiwan white-stomach snake.

MATERIALS

I accumulated 119 (48♂ and 71♀) specimens from June 1960 to November 1964. Two were obtained from Neihu (northern Taiwan); 1 from I-Lan-Hsien (northeastern Taiwan); 1 from Tao Yuan Hsien (western Taiwan); 84 from Puli, Nan Tou Hsien (central Taiwan); 15 from Ping Tung Hsien (southern Taiwan); 16 from Chishan, Kao Hsiung Hsien (southern Taiwan). In addition, 14 fully developed embryos, measuring* 10.7 (1), 13.5 (2), 13.70 (1), 13.75 (1), 13.8 (1), 13.9 (3), 14.0 (1), 14.05 (1), 14.3 (2) and 14.4 cm (1) in total length, were obtaine from newly laid eggs. Each embryo bears an egg tooth.

* The figures in parentheses indicating the number of embryos.

For comparison, six specimens of the mainland *N. percarinata* were borrowed from the United States, 1 from the American Museum of Natural History, New York (AMNH 33674, ♂), 5 from the Chicago Natural History Museum, Chicago (CNHM 18724, ♀; 18750, ♀; 18751, ♀; 18753, ♀; and 18756, ♀).

SCALE CHARACTERISTICS AND MEASUREMENTS

The scale characteristics of the present series agree well with Maki's description, but are somewhat different from those of Pope (4, 8). Rostral twice as broad as high, just visible from above; nasals divided below the nostrils; very rarely completely divided; nostrils dorso-lateral; internasals narrowed anteriorly; upper labials 9, rarely 8, very rarely 10, usually the 4th and 5th border the eye, rarely the 4th only, very rarely the 3rd and 4th, 5th and 6th, or 3rd, 4th and 5th; 5 anterior lower labials contact the anterior chin-shields, which are considerably shorter than the posterior pair; preocular 1, rarely 2 or partly divided anteriorly; postoculars 3, occasionally 4, very rarely 2 or 1 (fused); anterior temporals 2, very rarely 1 (fused); posterior temporals 3, occasionally 2, very rarely 4; one of the temporals may be divided transversely; dorsal scales with apical pits (very faint) on the neck only, in 19–19–17 rows, strongly keeled, the outer rows weakly keeled, sometimes smooth. Other details are shown in TABLE I.

TABLE I

Ventral and subcaudal counts and measurements of Taiwan white-stomach snakes

	Sex	No. of specimens	Range	Mean
Ventrals	♂	48	143-150+*	147
	♀	71	135+++-148	143
Subcaudals	♂	38	68-77	72.5
	♀	62	64-74+	69.5
Total length**	♂	37	49.9-74.8cm	62.4cm
	♀	58	52.1-103.3cm	77.7cm
Tail / Tatal length	♂	38	0.25-0.31	0.28
	♀	62	0.23-0.29	0.26

* + means half ventrals, but regarded as a complete one.

** Five young specimens (1♂, 4♀) are not included.

The three largest females of the series measure 103.3, 93.0, and 88.5 cm (total length), and the three largest males 74.8, 74.7 and 72.5 cm. The tubercles present on the anterior lower labials and chin-shields are considered adult male characteristics (*Fig. 4*); they cannot be found in young males nor fully developed embryos. TABLE I clearly shows that males have higher average ventral and subcaudal counts than do females.

COLOR PATTERN

The dorsal color is generally dark gray, occasionally lighter gray, with ill-defined black reticulations or a series of narrow, irregular black cross-bands; adjacent cross-bands may unite on the back or on both sides. Lateral, vertical black bars are often present but, in my series, are never edged in front and behind with light color as in the mainlad *percarinata*. Chin, throat and the anterior portion of the the belly are uniformly yellowish gray, the rest of the belly light gray to dusky gray, occasionally with a yellowish, rarely a pinkish, cast. The ventrum of most specimens shows black bars, about 1 or 2ventrals wide and 1 or 2 ventrals apart, set alternately, on both sides of the belly. Two such black bars often are opposite each other forming black cross-bands (*Fig. 3A*). Such cross-bands are not found in all specimens (*Fig. 3B*). In the series studied, the 1st cross-band is never found before the 30th ventral plate. The coloration and configuration of the black bars and cross-bands are occasionally not well developed or may be very faint (*Figs. 3C* and *D*). In such cases, the number of cross-bands cannot be counted accurately; where readily counted, however, the greatest number of cross-bands was found to be 17. Occasionally, between the two lateral series of black bars, a number of irregular black spots may be present, forming, more or less, a belly pattern of three series of black spots as portrayed by Maki (3) and as shown in *Figs. 3E* and *3F*.

Each fully developed embryo examined shows a dorsal series of dark rhombic patches with light centers (*Fig. 5A*). The patches are generally connected sequentially, resulting in a more or less zigzag form. Each patch turns downward on the sides, forming a vertical dark bar. The ventral pattern, is as that of the adults, black bars and cross-bands, or three series of irregular black spots (*Fig. 5B*).

THE HEMIPENIS

The hemipenis usually extends to the posterior edge of 7th subcaudal plate, occasionally to the 8th, very rarely to the 9th. In the study of the hemipenial structures, the procedure and terminology of Dowling and Savage (9) were followed, and Clark's (10) average level of origin of the *M. retractor penis magnus* as a systematic character in snakes was adopted.

Shape—The hemipenis is subcylindrical and slightly bilobed at its tip.

Sulcus spermaticus—This structure is simple and terminates distally in the right lobe (*Fig. 1C*); its lips are spinous and somewhat raised.

Ornamentation—The hemipenis is covered by spines of various sizes. If viewed medially, on the right side of the basal portion there are three enlarged basal hooks in a compact, longitudinal row; the remaining basal portion is covered by numerous minute spines. At the proximal end of the distal portion, a relatively small area is occupied by large spines. Distally, the hemipenis is entirely covered by minute spines placed in more or less oblique rows (*Fig. 1A*). In size and distributions the spines on the lateral surface are like those on the medial one (*Fig. 1B*). The tip of the hemipenis is free of spines, the spineless area being clearly demarked (*Fig. 1C*).

Musculature—The average level of origin of the *M. retractor penis magnus* is the middle of the 23rd subcaudal plate; the range of its origin is from the 21st to the 26th subcaudal plates.

OTHER CHARACTERISTICS

An examination of the dentition and hypapophyses of four skeletonized specimens (Nos. 531♂, 596♀, 597♀, 613♀) shows: maxillary teeth 26–31, gradually becoming larger posteriorly in the series ((4) gives counts of 29 to 32 for four Fukien *percarinata*)); palatine teeth 13–17, subequal; pterygoid teeth 22–26, gradually decreasing in size posteriorly; dentary teeth 27–30, those at both ends smaller, the others being subequal in size. Hypapophyses are present on all dorsal vertebrae. Eye large, the diameter, measured forward from the anterior rim of the orbit, reaching the anterior edge of the loreal (minimum), or the anterior edge of the posterior half of the nasal (maximum).

HABITS AND HABITAT

The white-stomach snake occurs in rapidly flowing mountain streams. The streams at Puli, about 460 meters above sea level, which swarm with these snakes are open and not shaded by forests; the stream at Chishan is about 560 meters above sea level. Other specimens in my collection were taken in the mountains at altitudes as low as 100–300 meters. In summer, the snakes are often seen in shallows which are not overgrown with vegetation.

A snake catcher told me that he once saw a snake holding a fish in its mouth. Ten specimens were examined for stomach contents; only one was found to contain food remains, a piece of the opercular of a fish. In one specimen (No. 610, ♀), three trematodes, clustered together with mucous, were found near the cardiac region.

Thirty four eggs with white, soft, thin shells were taken from the sanke cage on September 17, 18, and 28, 1962; they were measured 2.8–3.4×1.9–2.8 cm. The embryos were removed for examination from fourteen.

DISTRIBUTION

Data from literature and from the present collections show that the white-stomach snake occurs in the northern, central, western and northeastern parts of Taiwan. No occurrence has been reported from eastern Taiwan (Hualien Hsien and Tai-tung Hsien).

Maki (3) obtained the holotype of *suriki* (adult male, No. a, in Mus. of Coll. Kyoto, collector Maki, July 24, 1928) at Makazayazaya (in Ping-tung Hsien), southern Taiwan.

DISCUSSION

The scale characters of the island form agree with those of the mainland form except for the following: the postoculars are 3, occasionally 4, very rarely 2; anterior temporals 2, very rarely 1 (fused). According to Pope (4), the postoculars of the mainland form are 4, occasionally 3 or 5; and and the anterior temporals 3, occasionally 2 or 4.

The males of the island form have slightly higher average ventral and subcaudal counts than the females, indicating sexual dimorphism. In the mainland form females and males have the same average ventral counts, but the males have a slightly higher average subcaudal count. In the present series, the total length of the smallest male (No. 546) showing the tubercles is 49.9 cm. No gravid female was found after dissection, therefore, the smallest adult female size could not be determined.

The island and mainland forms have the following characteristics in common: hemipenis slightly bilobed at the tip, with simple sulcus spermaticus; maxillary teeth becoming gradually larger posteriorly in the series; internasals narrowed anteriorly, nostrils dorso-lateral; dorsal scales with apical pits (very faint) on neck only; all dorsal vertebrae with well developed hypapophyses; eye large, diameter measured forward from the anterior edge of the orbit, reaching to the anterior edge of the loreal (minimum) or anterior edge of the posterior half of the nasal (maximum).

The dorsal color pattern of Taiwan specimens is generally dark gray or lighter

gray with ill-defined black reticulations or a series of narrow irregular black cross-bands. None are known to have dark, black-rimmed, rhombic patches with lighter centers (purplish gray olive), alternating on either side of the mid-dorsal line as Fan (11) depicted. The vertical bars on both sides in the island form are never edged in front and behind with light color as in the mainland form. On the lower surface in Taiwan specimens, excepting the normal black bar and cross-band pattern, the irregular black spots, set more or less in three series, are occasionally seen either in adults and in the fully developed embryos. Anteriorly the first cross-band in my series is never found before the 30th ventral plate; Pope (4) pointed out that in the mainland form cross-band can not be found on the first few dozen ventral plates.

The rhombic dark pattern with light center of the fully developed embryos is comparable to that of the juvenile color pattern of the mainland form described by Schmidt (12). It may be assumed that the two forms are very similar in their ontogenetic development.

The hemipenial structure of the island form is similar to that of the mainland form; the hemipenis of the mainland form, however, possesses a few additional large spines just cranial to the three basal hooks. The additional spines are more or less covered by fleshy ridges on the organ *in situ* and are easily overlooked (*Fig. 2*). The average level of origin of the *M. retractor penis magnus* in the island form is the 23.5 subcaudal, in the mainland form, the 20th. Thus, the two forms are distinguishable by the more posterior origin of *M. retractor penis magnus* in the insular form.

TABLE II

The different characters between ***percarinata*** *and* ***suriki***

	percarinata	*suriki*
Postoculars	4, occasionally 3 or 5**	3, occasionally 4
Anterior temporals	3, occasionally 2 or 4**	2, very rarely 1 (fused)
Ventrals	♂ (9)* 139–143, mean 140** ♀ (9)* 138–142, mean 140**	♂ (48)* 143–150+, mean 147 ♀ (71)* 135+++–148, mean 143
Subcaudals	♂ (8)* 70–79, mean 74** ♀ (6)* 67–73, mean 70**	♂ (38)* 68–77, mean 72.5 ♀ (62)* 64–74+, mean 69.5
Hemipenis	with a few additional large spines cranial to the 3 basal hooks.	without any additional large spines cranial to the 3 basal hooks.
Dorsal color pattern	***purplish olive gray, slaty gray, bluish gray, purplish brown, olive brown to olive gray bearing dark, black-rimmed, rhombic patches with light centers, alternating on either side of mid-dorsal line. Lateral vertical black bars edged with light color in front and behind.	dark gray or lighter gray with ill-defined black reticulations or a series of narrow irregular black cross-bands. Lateral vertical black bars never edged in front and behind with light color.
Average level of origin of *M. retractor p. magnus*	20th subcaudal plate.	23.5th subcaudal plate.

* The figures in parentheses indicate the number of specimens.

** The figures cited are from Pope (8).

*** The dorsal color pattorn of *percarinata* cited is from Fan (11).

The type locality of the mainland form, cited from Pope (4), is Kuatun (in Chungan Hsien), northern Fukien (near Kiangsi). Pope (4) records the mainland form as ranging southeastward to the coastal region of northern Fukien. The separation of Taiwan from Fukien occurred about 6,200 B. P. (before present) (13). It is difficult to interpret how the geographic isolation and the insular environmental conditions affect the males of the island form to develop a higher average ventral count.

The embryos of the island form bearing dark patches with light center on the back resemble those of the mainland form, but in adults the patches become ill-defined black reticulation. Did this change take place for adaptation to the peculiar environmental conditions? More field data are necessary to answer this question.

The differences between the mainland and insular forms may be tabulated in TABLE II.

Because of the differences, shown above, between the two populations, the Taiwan population is believed to warrant recognition as a subspecies of the mainland forms. Accordingly, Maki's name, *suriki* (3), is revived for the Taiwan snakes as *Natrix percarinata suriki*.

Acknowledgements I am very grateful to Dr. R. G. Zweifel, Associate Curator, the American Museum of Natural History, N. Y., Lt. Col. H. L. Keegan, Chief of the Department of Entomology, U. S. Army 406 Medical Laboratory, Japan, Dr. R. F. Inger, Curator of Reptiles and Miss. S. Andris, the Chicago Natural History Museum, Chicago, and Mr. J. D. Romer, M. I. Biol., C. M. Z. S., Hong Kong, for their helps in providing valuable reference materials or the loan of specimens. I wish, also, to thank Dr. R. F. Inger for his help in examining the additional hemipenis and the *M. retractor penis magnus* of *N. percarinata percarinata*. Special thanks are given to Dr. C. H. Pope, a herpetologist of world wide fame and experience, Dr, W. W. Tanner, Professor of Zoology, Brigham Young University, Provo, Utah and Editor of Herpetologica and Mr. E. D. Malnate, an expert of water snake, the Academy of Natural Science of Philadelphia for their suggestions and comments on the manuscript.

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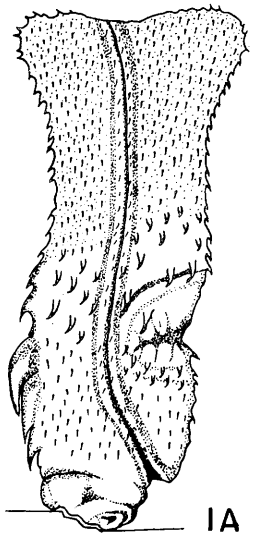
Fig. 1—The right hemipenis of *N. percarinata suriki* (No. 583):
A medial view. ×6.2
B lateral view. ×6.2
C top view. ×6.2

Fig. 2—The right hemipenis of *N. percarinata percarinata* (AMNH. 33674, collector Pope, 1929), medial view; ×8 (not completely everted).

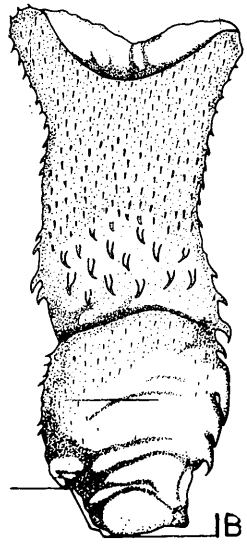
Fig. 3—Ventral surfaces of *N. percarinata suriki:*
A black bars and cross-bands present.
B black cross-bands absent.
C black bars and cross-bands not well developed
D color pattern very faint.
E and *F* black bars and spots more or less in three series; *E* with comparatively less black bars and spots.

Fig. 4—Ventral view of the head of *N. percarinata suriki* (No. 570 ♂) showing tubercles on anterior labials and chin-shields.

Fig. 5—*A* Dorsal surface and, *B* ventral surface of the fully developed embryos of *N. percarinata suriki.*



1A



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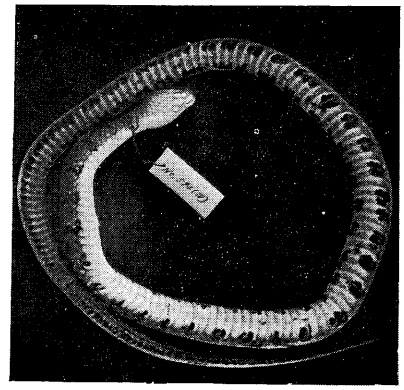

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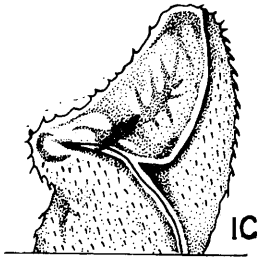

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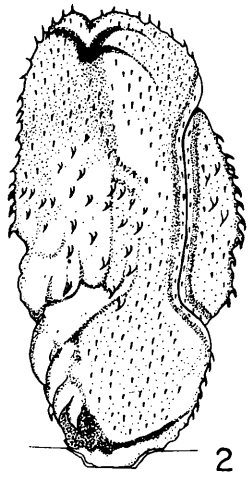

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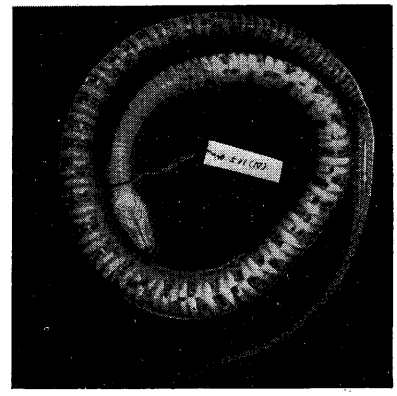

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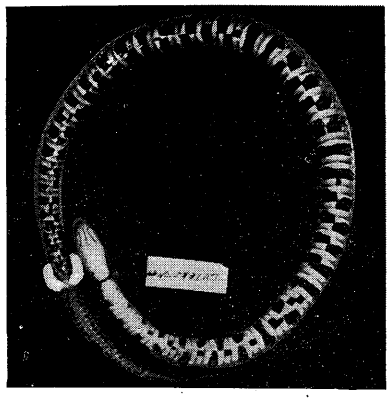

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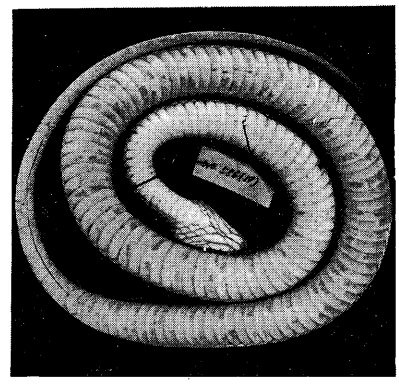
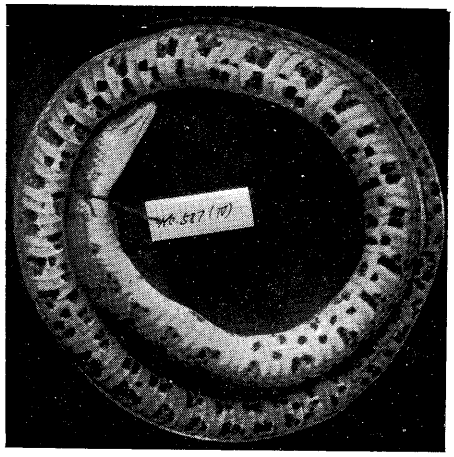


3D



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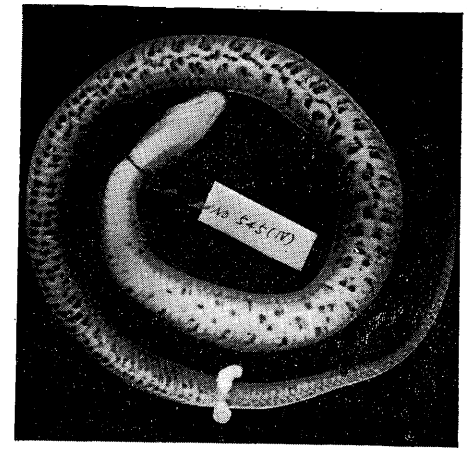

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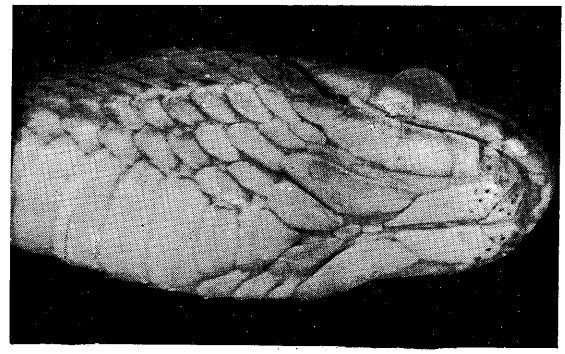

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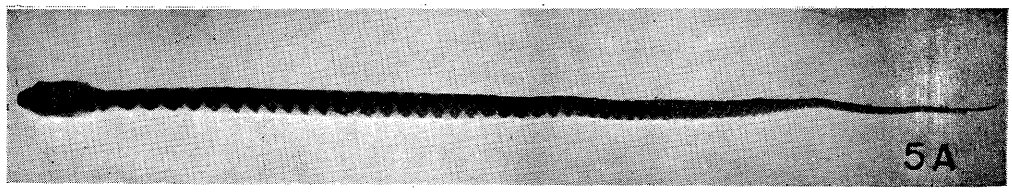

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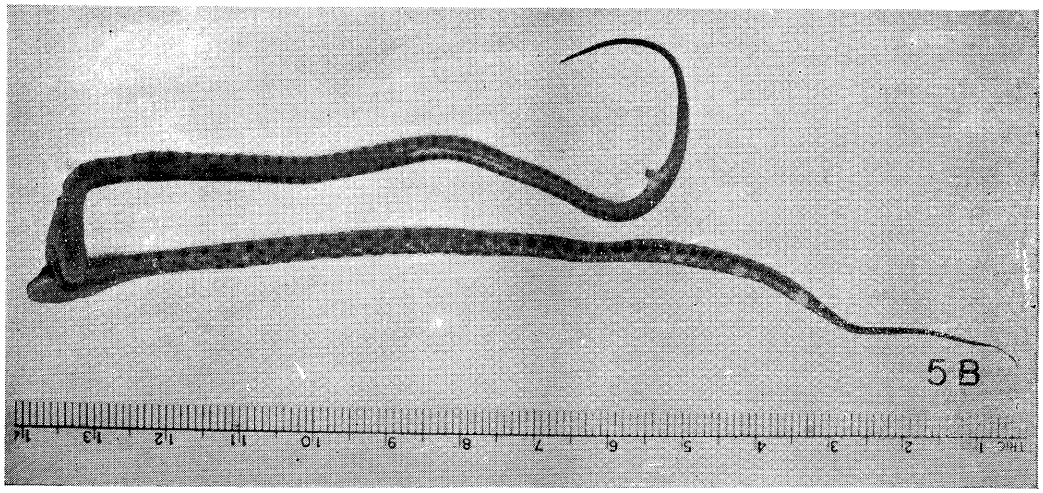

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