ON ELEVEN ASIAN ELAPID SNAKES WITH SPECIFIC REFERENCE TO THEIR OCCURRENCE IN THAILAND

by

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I. INTRODUCTION

In Thailand the family of snakes designated Elapidae is composed of eleven forms, five species and six subspecies. As all of these are or may prove to be potentially dangerous to man a basic understanding of them as a family and as individuals is desirable. To date no publication has satisfied this need.

The present paper provides a concise description and discussion of each type of elapid snake presently considered a member of the fauna of Thailand. These are:

1. *Bungarus flaviceps flaviceps*
2. *B. candidus*
3. *B. fasciatus*
4. *Naja kaouthia kaouthia*
5. *Ophiophagus hannah*
6. *Maticora bivirgata flaviceps*
7. *M. intestinalis intestinalis*
8. *Calliophis macclellandii macclellandii*
9. *C. gracilis*
10. *C. maculiceps maculiceps*
11. *C. maculiceps malcolmi*

A discussion of the family Elapidae in general follows.

Family ELAPIDAE Boie

(Terrestrial Proteroglyphids)

Elapidae Boie, Isis, 1827, p. 510.

A. The Family: The snakes of this family resemble those of the family Colubridae in most anatomical respects but differ in the more highly developed condition of certain salivary glands of the head (the venom

glands) and in the grooved condition of the anteriormost maxillary teeth which allows the flow of the secretions from these glands. The grooved condition and the position of these teeth is the only readily evident diagnostic and identifying characteristic of the members of this family. While the serpents of the family Hydrophiidae (sea snakes) also have proteroglyphous venom-conducting teeth they are readily distinguishable from those of the present family in that they are partially or wholly marine; the tail of a member of the Hydrophiidae is vertically compressed to facilitate marine locomotion whilst in all Elapidae the tail is subcylindrical or cylindrical.

B. Identifying Characteristics : Loreal scale absent; maxillary bone with a grooved fang attached at its anterior end; a pair of head glands capable of producing a toxic secretion which is voided by way of maxillary fangs; maxillary teeth present or not present behind fangs; hypapophyses more or less developed throughout vertebral column; tail subcylindrical or cylindrical.

In all Thai Elapidae the third supralabial usually touches the orbit and the nasal scale. In only one nonvenomous Thai snake does this scale touch the nasal, *viz.*, *Xenopeltis unicolor*, but in this the third supralabial fails to touch the orbit.

C. Physical Description :

1. ***Dimensions :*** From less than 300 mm to over five and one-half metres long. In many species the female reaches a greater maximum length than the male, while in the male the tail attains a greater length relative to the body length.

2. ***Physical Characteristics :*** Head not or only slightly wider than neck; mental groove present; facial bones moveable; prefrontal bone not in contact with nasal bone; mandible comprised of several bones without a coronoid bone; a pair of venom glands present; temporal glands probably absent; a grooved venom-conducting fang semirigidly attached to anterior end of each maxillary bone (the fang not fixed to the venom duct and if lost prematurely replaced by a new fang within a period of days.

However, both fangs are periodically shed); this fang often followed by a diastema and additional maxillary teeth which may also be grooved; body form generally resembles that of colubrid snakes, although in both families there is considerable variation; hypapophyses present throughout vertebral uolumn, usually well developed (also present in all Hydrophiidae and Viperidae, and best developed in the latter family); tail subcylindrical or cylindrical.

3. *Coloration :* Extremely variable. With respect to the forms dealt with in this paper it is interesting to note that two are similarly banded alternately light and dark *(Bungarus fasciatus* and *B. candidus*), two *(Bungarus flaviceps flaviceps* and *Maticora bivirgata flaviceps)* are black with red heads and tails, and the ventral colour schemes of two *(Maticora intestinalis intestinalis* and *Calliophis gracilis)* are almost identical to one another. Three forms *(Calliophis hughi, C. maculiceps maculiceps*, and *C. maculiceps malcolmi)* are light-coloured and have dark heads and two crossbands on the tail.

4. *Lepidosis :* Head covered with large symmetrical scales; loreal absent; costals more or less smooth; females in many species possess somewhat more ventrals and fewer subcaudals than do males.

5. *Hemipenis :* Extremely variable.

D. Observations : All the forms included in the genera dealt with herein are terrestrial, and many are crepuscular or nocturnal and ophiophagous. Many of the larger forms are known to practice primitive parental care.

E. Distribution : Representatives of this family inhabit both hemispheres, but are absent from all countries having overly cold climates. With respect to any single country's ophidian fauna, Australia has the largest percentage of elapid species. Twelve forms are known to occur in Thailand.

F. Significance to Man : This family is probably more important to the people of Thailand than any other family of snakes. This, however, is not only due to the fact that all of its members possess dangerous venoms,

but also because several of these members possess large quantities of venom and are commonly met with near human habitations. Further, these are often large enough to inflict a lethal wound in man and are easily irritated. These factors figure in accounting for a large uumber of deaths in humans annually; GHARPUREY (1962, p. vii) wrote that every year 20,000 to 23,000 people die from snake-bite in India alone, many from the bites of elapid snakes.

The members of the family Elapidae have religious, commercial, and economic significance to the people in the areas wherein they are found. In Asia the image of the cobra is often used as a decoration in temples and is of significance in Buddhism. The cobra and other elapids are used as food and medicine and their skins are tanned and used in the production of belts, handbags, neckties, etc. Economically the Asian elapids play a major part in the control of vermin, which in turn helps check the spread of disease.

G. A Key to the Genera of Elapid Snakes Presently Known to Occur in Thailand:

1. Vertebral scales:
   - enlarged; maxillary bone not extending forward beyond palatine bone . . . . . ***Bungarus***
   - not enlarged; maxillary bone extending forward beyond palatine bone 2
2. Large occipital scales:
   - two present, which are in contact with each other; nuchal ribs elongate; subcaudals monoserial and biserial . . . . . ***Ophiophagus***
   - none present 3
3. Nuchal ribs:
   - elongate . . . . . ***Naja***
   - not elongate 4
4. Venom glands:
   - extending into body cavity; anal scale single . . . . . ***Maticora***
   - not extending into body cavity; anal scale divided . . . . . ***Calliophis***

II. GENUS *BUNGARUS* DAUDIN, 1803 (Kraits)

Bungarus Daudin, Mag. Encycl., vol. 5, year 8 (1803), p. 434 (based on Russell's Indian Serp., vol. 1, 1796, p. 3, pl. 3).

DIAGNOSIS: Head subovate, not or only slightly wider than neck; eye large to small; pupil circular or vertically subelliptic; scales smooth; nasal sutured; loreal absent (although BOULENGER, 1896, p. 365, writes: "Mr. W.L. Sclater records a specimen of *B. bungaroides* with a well-marked loreal shield on either side"); maxillary bone extending as far as but not beyond palatine bone; 1-4 maxillary teeth which are small and feebly grooved in addition to a large venom-conducting fang which is distinctly grooved anteriorly; anterior mandibular teeth longest and feebly grooved. Body subcylindrical or slightly compressed; costals smooth, pitless; vertebrals much enlarged (except in *lividus*); costals 13-19; anal single; dorsal vertebrae usually with strong lateral expansions connected with prezygapophyses and postzygapophyses. Tail length moderate or short, tail ending bluntly or in a point; subcaudals monoserial or biserial or both.

SMITH (1943, pp. 407-408) gives a description of a hemipenis which is more or less applicable to most members of this genus. It reads:

> "The hemipenis extends to the 6th-9th caudal plate; the distal one-third or half is calyculate, the remainder spinose. The calyces are smallest near the tip of the organ and increase in size as they approach the spinose area. Each cup is stiffened by spine-like structures which, like the ribs of an umbrella, hold the membrane and project beyond its margin. The transition from the calyculate to the spinose area is fairly abrupt; the largest spines are those nearest the calyces; they are thick and papilla-like in form, and bear a small, sharp spine at the tip. The bifurcation of the sulcus is at about the middle of the calyculate area or the junction of the calyculate and spinose areas, and the lips of the sulcus are beset with small spines throughout."

OBSERVATIONS: The generic name "Bungarus" is latinized version of the Telugu vernacular word "bungarum" which means gold, in reference to the yellow colour of *B. fasciatus*.

The diagnostic combination of the vertebral scales enlarged and the undivided anal and some or all of the subcaudals single is to be found in only one nonvenomous Thai snake, *viz.*, *Aplopeltura boa*. However, in the latter there is no mental groove, and this characteristic readily destinguishes it from all Thai Elapidae. In other aspects of their lepidosis the *Bungarus* are similar to numerous nonvenomous or mildly venomous forms; snakes of the genera *Pareas*, *Ahaetulla*, and *Boiga*, as well as *Elachistodon westermanni* and *Xenelaphis hexagonotus*, possess enlarged vertebrals. Certain snakes of the genus *Trimeresurus* may possess subcaudals which are arranged both monoserially and biserially. In the eye of a living *Bungarus* the iris is black, rendering the pupil difficult or impossible to discern; this, however, is also true of most if not all snakes of the genus *Lycodon*.

The species of *Bungarus* are terrestrial and oviparous, and are predominantly crepuscular or nocturnal and inoffensive. Many are ophiophagous. PITMAN (1912, p. 636), with reference to *Bungarus sindanus*, warned that kraits are invariably found in pairs, and unless both were killed "one is asking for trouble". Pairs of kraits are no doubt often found together, especially during the breeding season, but it is almost certainly a fallacy to believe that the death of a krait will cause its mate to avenge its death.

Three interesting reports of *Bungarus* envenomation in man warrant inclusion herein. BANERJI (1956, pp. 85-86) records a young woman bitten on a finger by a *Bungarus;* she felt no symptoms until four days later, at which time she began to feel pain. After some constitutional disturbances she duly recovered. The same author (Ibid., pp. 86-87) writes of a man who was bitten on the throat by a *Bungarus* and survived. SMITH (1923, pp. 56-57) writes:

> "... there is the remarkable story recorded by Sir Joseph Fayrer of four men who allowed themselves to be bitten by an Indian Krait in the belief that it would do them no harm. They were bitten at night and the snake was goaded on to do so by hitting it with a stick. The man who was first bitten died before the night was out, the second and third in the course of the next morning, while, the last man to be bitten, after being seriously ill, recovered."

Three forms of the genus *Bungarus* are known to occur in Thailand, viz., *f. flaviceps*, *candidus*, and *fasciatus*. These may be identified by the following key:

A Key to the Forms of *Bungarus* Presently Known to Occur in Thailand

1. Alternate light and dark bands on body:
   none present; head and tail red or orange, body black . . . . . ***f. flaviceps***
   present 2
2. Body annulate black and yellow, each band joining itself on venter; tail normally blunt . . . . . ***fasciatus***
   Body white with black blotches; venter immaculate white; tail normally pointed at tip . . . . . ***candidus***

A. *Bungarus flaviceps flaviceps* Reinhardt, 1843 (Red-headed Krait)

Bungarus flaviceps Reinhardt, Vidensk. Selsk. Skrift., vol. 10, 1843, p. 267, pl. 3, fig. 4, (type-locality, Java). Plate XXVIII.

1. Identifying Characteristics

Head red or orange; body black; tail red or orange; subcaudals partly single and partly biserial; venom glands confined to head.

2. Physical Description

a. ***Dimensions:*** A relatively long but not necessarily thick snake. The greatest recorded total length for this subspecies known to the author is that of TWEEDIE (1954, p. 115) of a Malayan specimen that measured 2010 mm long. The following measurements of a specimen listed by CANTOR (1847, p. 112) should serve to give an idea of the relationships between various dimensions (in mm):

Total length	511
Length of head	16
Length of boby	419
Length of tail	76
Circ. of neck	25
Circ. of boby	32
Circ. of tail base	16

TAYLOR (1965, p. 939) describes a very young specimen measuring 398 mm in total length.

b. ***Physical Characteristics :*** Head subovate and rather more blunt anteriorly than that of either *candidus* or *fasciatus*. A distinct dorsal ridge formed by spinous processes of vertebrae runs the length of body and tail; abdomen broad and slightly arched, so that body in cross section appears broadly triangular.

c. ***Coloration :***

Juvenile : Head red (fading to yellow in preservative); a pointed elongate black mark extending out of back of nape along interparietal suture to frontal; lips and throat yellow to red. Iris and tongue black.

Body iridescent black or blue-black, posteriorly graduating to a shade varying from red to orange (fading in preservative), sooner ventrally than dorsally; light parts of hindbody sometimes with a few small black spots; a vertebral dotted line formed by anterior part of each vertebral having a short, longitudinal, white, light blue, red, or orange streak (this line gradually widening posteriorly to fuse with coloration of tail); a distinct white or light blue serrate stripe covering upper half of lowest costal row and lower half of adjacent row, each scale with a small black spot, and lower half of lowest row black; belly black, posterior edge of each ventral grey.

Tail red (fading in preservative), sometimes with a few small black spots.

Adult : Head as in juveniles but with elongate black mark usually absent, nape sometimes red; throat white.

Body dark iridescent brown or blue-black; pale pink or orange-yellow of the interstitial skin sometimes extending onto scales so as to form longitudinal stripes, particularly on two lowest costal rows; vertebral dotted line partially or completely absent (if present, it is red); yellow lateral stripe present or absent ventrals brown, orange, pink, yellow, ivory-white, or white, immaculate or with distant ends clouded black or brown; posterior half of body and tail may be lighter than anterior half. Interstitial skin pale pink or orange-yellow.

Tail as in juvenile but lightest subcaudally.

The chief coloration changes that occur in the transition from juvenile to adult consist of the partial or complete disappearance of the vertebral dotted line, most of the light colour on the lowest costals, and the black marks on the head, posterior part of the body, and tail. The ventrals, which are black in juvenile specimens, are whitish or of some other light shade in the adults. Both young and old specimens possess the same resplendent head and tail, although in the adult the hindbody may be a darker shade of red than the tail.

d. *Lepidosis :*

Head : Rostral wider than high, visible from above, its posterior border convex; supralabials 7, third and fourth touching orbit; oculars 1+2 (sometimes 3); temporals 1+2+3 or 2+2+3; internasals much shorter than prefrontals; frontal hexagonal (sides being practically parallel), as long as or slightly longer than wide, as long as or longer than its distance from tip of snout, equal to length of parietal suture, but shorter than parietals; supraoculars each about half as wide as frontal; mental triangular; infralabials 6, first in contact with its mate behind mental, 3 or 4 in contact with anterior genials; genials equal to each other in length.

Body : Vertebrals strongly enlarged, as wide as or wider than long at midbody; costals 15-19 (occiput), 13 (body), smooth, imbricate, rhomboidal, pitless; ventrals 193-237, (males 220-237, females 193-217): anal single.

Tail : Subcaudals 42-54, (males 47-53, females 42-54), partly single and partly biserial (usually single following anal and usually no distinct line of demarcation between either condition).

e. *Hemipenis :* According to SMITH (1943, p. 411) the hemipenis of this subspecies differs from those of the other members of the genus in that the lips of the sulcus within the spinose area are quite smooth.

3. **Biosis**

a. *General Habits :* Apparent rarity is very likely the reason why so relatively little is known concerning many aspects of the biosis of this large and conspicuously marked form.

A large specimen taken in Rat Buri province, Thailand, contained a recently eaten and "exceedingly large *Trimeresurus gramineus*" *(vide*, COCHRAN, 1930, p. 36: It should be remembered that inasmuch as the form *gramineus* has undergone a considerable amount of revision since 1930 the specimen to which Cochran was referring may actually have been what is presently considered *albolabris*, *erythrurus*, etc.; the form *gramineus* as presently recognized has not been recorded from Thailand). The fact that this particular individual had eaten a Crotalid snake is of interest in that this is in contrast to the gastronomic indulgences of the closely related *Ophiophagus hannah*, which, although ophiophagous, seems to intentionally avoid all Crotalidae and Viperidae.

b. ***Reproduction:*** Unknown.

c. ***Habitat:*** This subspecies is generally regarded as being submontane in habitat (specimens having been taken in foot hills and mountains at elevations of up to 914 metres). That it is not always so is shown by the fact that several specimens have been taken at considerably lower elevations. For example, TWEEDIE (1950, p. 198) records two young Malayan individuals taken at sea level and within a short distance of the shore. LIM (1955, p. 125) records a specimen from a forest area, and a second specimen from a scrub-brush area.

d. ***Observations:*** An elapid which very much resembles the present one is the closely related *Maticora bivirgata flaviceps* (dealt with in full detail in a later section of this paper). However, as TWEEDIE points out (1961, p. 96) the resemblance in the dorsal coloration between the two "is most remarkable and difficult to account for on any of the accepted theories of adaptive coloration unless it is regarded as a case of Mullerian mimicry." Mullerian mimicry as used here is the case when two dangerous animals come to resemble one another and by doing so become better known and thus avoided. These two forms are easily differentiated from each other by an examination of their ventral colour schemes; in the present form it is dark while in the *Maticora* it is reddish.

Other snakes besides the present form possess subcaudals which are arranged both monoserially and biserially. Some of the elapids that do so are *Bungarus bungaroides*, *Ophiophagus hannah*, the Egyptian *Walterinnesia*

aegyptia, and members of the Australian genus *Pseudechis*, to name a few. As an aberrational character biserial subcaudals have been reported in a number of Asian Elapids whose subcaudals are normally single, *viz.*, *Bungarus fasciatus*, *B. candidus*, etc.

4. **Distribution in Thailand**

Apparently only two specimens of this subspecies have been recorded from Thailand, these being from the provinces of Nakhon Si Thammarat and Rat Buri respectively. The occurrence of these two specimens in these two provinces might suggest that the form has a basically peninsular-centred distribution (it is not rare in Malaya) but extends north into the Central Plain of Thailand. This theory is supported by the fact that specimens have been reported from both Burma and South Viet Nam, both of which are as far or farther north than Rat Buri province. Further, the fact that this subspecies is essentially submontane or predominately so, would leave no reason for its not having extended its range up the peninsula from Malaya and along the Bilauktaung mountain range.

Bungarus f. flaviceps may be distributed in Thailand more widely than it is presently recognlized to be. The high mountains of Northern Thailand would be conducive to its occurring in that part of the country. Further, the author has heard stories of large, black, red-headed snakes being seen in Chiang Mai province. While these need verification as to which form of snake was actually seen, it would seem probable that the individuals were examples of *B. f. flaviceps*.

5. **Significance to Man**

No casualities in man have been recorded. However, evidently no experiments have been conducted to determine the character or strength of the venom of this form.

6. **Conclusions**

a. It would appear that this subspecies is free from any major taxonomic problems inasmuch as it is distinct from all other elapids, including the only other recognized subspecies of *flaviceps*, *viz.*, *baluensis* Loveridge.

b. This is one of the larger members of the genus *Bungarus*.

c. There are marked differences in the coloration of juvenile and adult specimens.

d. Sexual dimorphism is evidenced in ventral scale counts.

e. This is one of two Thai Elapids, excluding aberrant individuals, in which the subcaudals ars both single and biserial, the other being *Ophiophagus hannah*.

f. The hemipenis differs from that typical of *Bungarus*, in that the lips of the sulcus within the spinose area are smooth, as opposed to being beset with small spines.

g. It is terrestrial, probably oviparous, and probably predominantly ophiophagous and nocturnal (it may be significant that the specimen of "*gramineus*" mentioned to have been eaten by the Rat Ruri specimen represents a nocturnal form as well).

h. It is for the most part submontane in habitat.

i. The closely related *Maticora bivirgata flaviceps* has a colour scheme which, being very similar to that of the present form, may suggest a mimetic relationship.

j. It is apparently rare in Thailand.

k. Nothing is known of the effects of its venom in man.

B. ***Bungarus candidus*** (Linnaeus), 1754 (White-banded Krait)

Coluber candidus Linnaeus, Museum S.R.M. Adolphi Friderici Regis Svecorum . . . 1754, pp. 32-33, pl. 7, fig. 1. Plate XXIX.

1. **Identifying Characteristics**

Body and tail crossbanded with black blotches; venter immaculate white or yellowish; body not semitriangular in cross section; tail pointed at tip.

2. **Physical Description**

a. ***Dimensions:*** A medium-sized serpent. The greatest recorded length for this species available to the author is that of TAYLOR and ELBEL (1958, p. 1162) of a specimen from Nakhon Ratchasima province, Thailand, which measured 1442 mm in total length.

The varions measurements of body and tail lengths given by respective writers (ranging from 850 and 100 to 1442 and 140 mm for body and tail respectively) would suggest sexual dimorphism in boody-tail length ratios. It would appear that males possess relatively longer tails than do females.

The following measurements of a specimen listed by CANTOR (1847, p. 113) should serve to give an idea of the relationships between various dimensions (in mm):

Total length	848
Length of head	25
Length of body	705
Length of tail	117
Circ. of neck	32
Circ. of body	51
Circ. of tail base	26

A very young Malayan specimen lent to the author for examination through the courtesy to Mr. K.J. Frogner of the Bishop Museum measured about 300 mm total length.

The growth rate of a Malayan specimen (mentioned by LIM, *et. al.*, 1960, p. 186) might be indicated by the fact that it took from 14-18 days to complete the sloughing of its skin, and that the interval between subsequent sloughings varied from 56-75 days.

b. ***Physical Characteristics*** : Head subovate and broadly rounded; snout protruding slightly over mandible anteriorly. Body elongate, tapering posteriorly. Tail gradually tapering to a point. (The skull of a specimen of *candidus* is figured by BOULENGER, 1896, p. 365, fig. 26.)

c. ***Coloration*** :

Juvenile : Chiefly like adult except that there is a marked absence of blending between dark and light shades in juveniles, especially on nape. Also, juveniles differ from adults in having a marked reduction in density and number of dark marks on the light interspaces of the body and tail; these dark marks are sometimes altogether absent.

Adult : Head black or grayish black above, this colour continuous with first black mark on nape or faintly distintc from it so that an

indistinct V-shaped mark is present; lips, chin, and throat very faint or pale yellow or white, immaculate; all or greater part of supralabials cream or white. Iris black and tongue white.

Body white with from 21-35 iridescent black, purplish black, or dark brown oval blotches which are widest on vertebral line; these blotches narrow laterally but usually reach tips of ventrals, and are wider than their interspaces posteriorly; vertebrals usually with two dark marks each; light interspaces between dark blotches are white, gray-white, yellow, or ivory, each constituent scale with a small dark median mark; these marks more intense anteriorly but sometimes absent on vertebrals and lower scale rows (also varying considerably from individual to individual); belly pale yellow, ivory, or white, immaculate, usually somewhet fainter along edges of ventrals. Interstitial skin white.

Tail white above with from 8-11 dark blotches which are equal to or slightly wider than light interspaces; subcaudals purplish brown to immaculate white or white with irregular pale yellow crossbars and gray mottlings.

KOPSTEIN (1938, p, 364, pl. 4) figured two specimens of *candidus* from Java, both apparently aberrant individuals with respect to coloration. In the first (fig. 3) the black bands are present anteriorly—but towards the middle of the body they fade away completely and give way to the white, in which each scale has the typical dark mark on it. In the second specimen (fig. 4), apparently a melanistic individual, there are only faint suggestions of light bands here and there.

The former specimen figured by KOPSTEIN brings to mind WALL'S statement (1906, p. 65) that it is characteristic of *candidus*, "at least the common Indian variety, that the white bars are most distinct posteriorly, and fade away anteriorly—in fact, the anterior one-third of the body is frequently without marks in adults." (N.B.: It is open to question whether the "variety" WALL was referring to was what is presently considered to be *candidus*,)

d. ***Lepidosis:***

Head: Rostral wider than high, visible from above; supralabials 7, third and fourth touching orbit, fifth and sixth largest; nasals 2; oculars 1+2; temporals 1+2 or 1+1, anteriorly they are invariably much longer

than wide; internasals shorter than but about half area of prefrontals; supraoculars only slightly smaller than frontal; parietals narrow, elongate, longer than wide; infralabials 7, 3 (rarely 4) touching anterior genials, which are equal to or somewhat longer and wider than posterior genials.

Body: Vertebrals at midbody and posteriorly wider than long, i.e., much enlarged; costals 19-21 (occiput), 15, rarely 17 (most of body); ventrals 194-237; anal single.

Tail: Subcaudals 37-56 (40-53 in specimens from mainland Asia), single, but occasionally an aberrant individual will have several biserial.

e. ***Hemipenis:*** Judging from SMITH's treatment of the hemipenis of this from (1943, p. 417) it evidently does not vary from the norm of the genus as set down by him (*Ibid.*, pp. 407-408).

3. **Biosis**

a. ***General Habits:*** This largely or exclusively nocturnal species is by nature quiet and inoffensive when in the presence of human beings. It has generally earned for itself the reputation of being timid and shy, and that this is sometimes its temperament is shown by FLOWER (1899, p. 690). The latter reported that having mistaken a young specimen for the harmless *Lycodon subcinctus*, "I carried it in my hand upstairs to keep in my room, but fortunately noticed it was a Krait and killed it before it had bitten anyone."

While some individuals are quite unwilling to bite, others are easily irritated even by relatively slight disturbances and thrash about snapping at their tormentors. One which was being photographed at Mr. Y. Siah's Bangkok Reptile Grove in Bangkok, Thailand, became very irritated with the photographer and several times lunged out and snapped at him with obvious intent. It is interesting to note that this individual showed none of the awkwardness or uncertainty of movement that is seen in a *B. fasciatus* under similar conditions. Instead, its movements were marked with agility and deliberation.

A relatively large amount of information is available on the feeding habits of this species. Although its diet is said to include small mamals, it no doubt feeds predominantly upon cold-blooded vertebrates, primarily snakes. Species of snake recorded to have been eaten by it include

Typhlops braminus, *Cylindrophis rufus*, *Xenopeltis unicolor*, *Gonyosoma oxycephalum*, *Ptyas korros*, *Ptyas mucosus*, *Lycodon aulicus*, and *Boiga gokool*. It has also been reported to have eaten specimens of the genera *Ahaetulla*, *Natrix*, and *Dryophis*. LIM, *et. al.* (1960, p. 186) write that one specimen consumed a young Crotalid snake.

B. candidus also feeds upon lizards, and included in the forms known to have been eaten by it are *Hemidactylus frenatus*, *Platyurus platyurus*, *Draco melanopogon*, and *Mabuya multifasciata*. A specimen presently living in Mr. Y. Siah's Bangkok Reptile Grove has thrived for over a year on a diet of specimens of the two first-named forms.

This species is known to eat toads and very likely will be shown occasionally to take frogs. As a note of interest, a specimen recorded by PRATER (1924, p. 487) was found to have eaten some cooked meat! The fact that it was killed near a kitchen, however, probably explains this.

LIM, *et. al.* (1960, p. 186) record some interesting information concerning the behaviour of one Malayan individual. They write:

> "It would attack its prey by striking at the middle of the body and while the victim was struggling the Krait would work its teeth along the body until it reached the victim's head, when it would be swallowed head-first. Skinks, lizards, and harmless snakes showed no particular reaction when put into the cage, and the Krait would attack them at once. When a young Cobra, some 480 mm long was put into the cage, however, the Krait showed signs of alarm and attempted to get away from the Cobra which was approaching with neck upright and hood expanded. After about two hours the snakes calmed down and each retreated to its own corner of the cage. The young Cobra was found dead four days later, the cause of death being unknown."

The above information is of interest in view of the fact that the closely related *Ophiophagus hannah* is known to devour other Elapids but to shy away from crotalids and viperids.

b. ***Reproduction:*** This species is oviparous, laying from six to ten eggs. These are reputedly deposited in holes in the ground. Judging from what has been observed in other species of this genus it would not be unreasonable to assume that the female, perhaps with the male in attendance, remains with her eggs until they hatch.

It is a fairly well-established fact that among in certain species of snakes a specific behaviour pattern often occurs among the males during the breeding season, but it is only recently that such behaviour has been observed in *candidus*. TAYLOR (1965, pp. 942-943) described an instance involving two males. These were in a pool below a small waterfall on a solid rock floor which was shallowly covered by water. The time was 9.45 p.m. TAYLOR writes:

> "Their tails and perhaps half of their bodies were closely entwined, the anterior half to their bodies erect and being thrust, rapidly, now on one side and now on the other side of their adversaries head. Each snake seemingly went through the same motions, all the while being propelled through the water by the undulatory movement of the entwined portions of their bodies, back and forth, around and across the pool. They seemingly had no intention of leaving the pool and were wholly unaware of the light or of our presence."

Various authors have hypothesized that such behaviour in snakes, generally referred as a "combat dance", occurs when one male, unable to locate a female with which to mate, attempts to court another male. Whatever the true reason, it is fairly well established that this phenomenon is associated with the reproductory cycle.

c. ***Habitat:*** While specimens of this form have been taken at elevations of up to 1525 metres they have also been collected at considerably lower elevations. They are said to be found near human dwelling places in certain localities due to their fondness for the rodents which are initially attracted to these areas. Indeed, the first recorded Thai specimen was reported to have been found in a bungalow (*vide*, SMITH, 1914, p. 123).

LIM (1955, p. 125) lists specimens taken in scrub areas, the vicinity of towns, and on motor roads. Mr. G. Dietrich reported to the present author that he captured one specimen in Khon Kaen province, Thailand, in a locality which consisted of small hills, dense and scrub jungle, and sandy-rocky soil.

d. *Observations :* This species is one of the few elapids used by man for purposes other than the production of antivenin serums to be used against its own bite. The author observed two dead and dried specimens in the possession of a merchant in Bangkok, Thailand. These were supposed to possess certain medicinal properties. *B. candidus* is said to be used by snake charmers in Bengal and on the Coromandel Coast.

This species probably has more nonvenomous species of snake which are often mistaken for it than does any other Thai elapid. Some of these are : *Lycodon subcinctus*, *L. striatus*, *L. jara*, the Indian form of *L. aulicus*, *Dryocalamus nympha*, *D. gracilis*, and *D. davisonii*. Juvenile specimens of *candidus* especially resemble juveniles of the first-named form in shape and colour. This resemblance is further heightened by the dentition of the *Lycodon*, in which the fifth maxillary tooth is somewhat removed from the fourth and thus resembles the proteroglyphous arrangement of the maxillary teeth of an elapid snake. However, in *Lycodon* the light bands are half or less than half the length of the dark ones, while in the *Bungarus* they are relatively much longer.

It should be pointed out the enlarged vertebral scales of *Bungarus candidus* should readily distinguish it from any non-elapid snake in Thailand with which it might be confused on the basis of colour, size, or shape.

4. Distribution in Thailand

In Thailand this species has been found in the provinces of Chon Buri, Khon Kaen, Nakhon Ratchasima, Lop Buri, Pattani, and Trang. It is therefore evidently widespread in Thailand. Its distribution is seemingly not correlated with any particular geographical or biological zones, although it is as a rule not found in large cities.

5. Significance to Man

The venom of *candidus*, said to be very virulent, is supposedly the cause of many deaths in humans annually. BOULENGER reported in 1912 (pp. 199-200) that more deaths are caused by it in India than by any other snake. It is supposed to be far more deadly than *B. fasciatus* and has been estimated to possess venom which is approximately four times more toxic than that of *Naja naja*.

Of the action of the venom of this species BOULENGER *(l.c.)* wrote: It "is similar to that of the Cobra, acting chiefly on the central nervous system, death resulting from failure of the respiratory mechanism, probably owing to a direct action of the venom on the respiratory centre in the *medulla oblongata.*" Only a comparatively small quantity of venom is injected in one bite.

There are authenticated records of humans dying as a result of being bitten by *candidus*. WALL wrote (1906, p. 67):

> ". . . Fayrer ('Thanatophidia', p. 54) records another case where a chowkidar was bitten in the forefinger. He suffered burning pain in the finger, later on in the hand, and then over the whole body; he became weak, could hardly articulate, and then got drowsy. He vomited after some native medicine, then lost the power of swallowing, and died in 6 hours. Again Fayrer (*l.c.* p. 60) records the case of a man bitten in the finger who experienced great pain in the wound, and the hand swelled up to the wrist. His breathing became short and hurried, he complained of constriction round the chest, became drowsy, and then insensible. He died in 3 hours, frothy mucus oozing from the mouth and nostrils. Elliot (Trans. Brit. Med. Association, S. Ind Br., 1895, p. 31) records a case where a sepoy was bitten on the inner side of his ankle, and death supervened in 31 hours."

PRATER (1924, p. 487) records an additional case where an Indian man, awakening from sleep, was bitten on the hand. Beyond a swelling pain in the hand below the wrist the man complained of no ill effects and recovered. This fortunate outcome might be explained if it is theorized that the snake had just expended its supply of venom, for example on a recent meal. Indeed, the snake had recently fed. On the other hand, the whole account becomes even more puzzling when the nature of its meal is stated: the snake was found to have recently fed on some scraps of cooked meat, a meal for which it needed no venom to subdue!

6. Conclusions

a. No subspecies of this form are presently recognized.

b. It seems to be very closely allied to *B. caeruleus* with respect to hemipenial characters, and is very similar to both *B. multicinctus* and *B. sindanus* in other aspects of its physical description.

c. It is medium-sized serpent.

d. There is not too much difference in the colour schemes of juveniles and adults. In the former the distinctness between the light and the dark areas is considerably more pronounced.

e. It is subject to considerable variation in colour from individual to individual.

f. It is nocturnal, terrestrial, ophiophagous, and oviparous.

g. Whilst generally considered timid and inoffensive it is capable of being irritated to the point of viciously defending itself.

h. A stereotyped "combat dance" takes place among the males of at least some Thai populations.

i. It is widely distributed in Thailand without apparent regard to geographical or biological zones.

j. Numerous nonvenomous species of snake are often mistaken for it; it is distinguished from all of these by its enlarged vertebrals.

k. It is capable of inflicting a fatal bite in man.

C. ***Bungarus fasciatus*** (Schneider), 1801 (Ngu saam liem; Yellow-banded Krait)

Pseudoboa fasciata Schneider, Historiae amphibiorum naturalis et literariae, fasc., 2, 1801, pp. 283-284 (based on Russell's Indian Serp., vol. 1, 1796, p. 3, pl. 3, (type-locality, Bengal). Plate XXX.

1. **Identifying Characteristics**

Body and tail with black and yellow or cream, each band joining itself on venter; body semi-triangular in cross-section; tail naturally blunt at tip.

2. **Physical Description**

a. ***Dimensions :*** A medium-sized to large snake, one of the largest members of its genus and the largest member to occur in Thailand. The average length of adults is said to be 1800 mm. but the largest specimen on record measured much in excess of this. It taped 2134 mm long and was killed in Koderma (India ?) (*vide*, SMITH, 1914, pp. 58-59).

A 2020 mm long specimen was recorded by SMITH (ibid.) as having been killed at the Bangkok Nursing Home, Bangkok, Thailand, in 1913.[2]

The following measurements were compiled by the author after an examination of C.T.N.R.C.[3] No. 523-809, collected in Chiang Mai province, Thailand by Mr. O. Gordon Young. They should serve to show the relationships between various dimensions (in mm):

Total length	1138
Length of head	28
Length of body	1000
Length of tail	110
Width of neck	16
Width of midbody	18
Width of tail base	10

Known hatchlings of *fasciatus* have measured from 320-349 mm in total length.

b. ***Physical Characteristics:*** Head subovate; diameter of eye equal to its distance from front of nostril; pupil circular; larynx not attached to tongue sheath, its anterior portion projecting into mouth like a small tube instead of adhering to upper part of tongue sheath.

The body in cross-section appears more or less triangular, mainly due to a prominant ridge along the back and tail which is formed by an elongation of the neural spines of the vertebrae. Indeed, the Thai name for this serpent, "Ngu saam liem" refers to the triangularity of its body. The elongation of the neural spines results in the skin of the back being very strongly adherent to the vertebrae and thus very difficult to remove from the body.

The tail in adults is blunt and more or less swollen at its tip to the extent of appearing to have had its last few inches amputated. In juveniles, however, the tail is not so blunt and appreciably tapers toward

2) There is some inconsistancy in Smith's various recordings of the length of this specimen. In 1914 (pp. 58-59) he wrote that it was 2020 mm long, but in 1923 (p. 60) he recorded the same specimen as having measured 2900 mm. Inasmuch as (1) the latter measurement is much in excess of the maximum known length of the species, and (2) the same author later (1943, pp. 412-413) reported "One recorded by me from Siam measured 2020 mm in total length . . ." it seems best to consider the 2900 mm measurement an error.

3) = Centre for Thai National Reference Collections, A.S.R.C.T.

its tip, suggesting that this tail-bluntness is a normal characteristic developing with age. There is some property in the recently-sloughed skin of this species that attracts ants and other insects, that feed on the skin.

c. *Coloration:*

Juvenile: As adult, except much paler, all lighter shades being more white than yellow.

Adult: Head brown with yellow mottlings and with a large, somewhat triangular black mark, which is continuous with first crossband of nape, extending forward onto head to supraocular region where it merges with other dark colouring; this mark usually bordered on lateral margins by yellow or cream; lips and throat dark to pale yellow, cream, or tan, sutures of scales of lips often black; chin often immaculate. Iris black; pupillary edge thinly margined with gold (in most other *Bungarus* the pupil is usually not discernible against the black iris); tongue red anteriorly, fading to grey towards base, or entirely flesh-coloured.

Body iridescent throughout, dark to very pale yellow, cream, or buff, with from 16 (or 17) to 32 (or 33) black, purplish black, or dark, greyish crossbands which usually entirely circumscribe body; these bands more or less equal to their light interspaces and usually narrowing somewhat laterally; light interspaces sometimes with black spots or flecks; belly usually paler than dorsum, both shades meeting with a distinct line of demarcation at ventrocostal junction line.

Tail as body but with from 3-5 black or purplish black crossbands.

d. *Lepidosis:*

Head: Rostral much wider than high, visible from above; supralabials 7, third and fourth touching orbit, second decidedly narrower than third, sixth largest; nasal sutured, anterior portion largest; oculars 1+2; temporals 1+2, anterior scarcely longer than wide, as long or longer than its distance from tip of snout, as long as or a little shorter than parietals; neither supraocular as wide as frontal; infralabials 7; genials short, more or less equal in length, or anterior pair distinctly larger than posterior pair, three infralabials in contact with anterior pair.

Body : Vertebrals much enlarged, wider than long at least at mid-body; costals 17-21 (neck), 15, rarely 17 (body); ventrals 200-234; anal single.

Tail : Subcaudals 23-41, single (or a few rarely double as an aberrant character).

e. ***Hemipenis*** : POPE's (1935, p. 333) description of the hemipenis of this species, based on a specimen from Canton, China, is as follows:

> "The hemipenis extends to the seventh subcaudal plate and is spinose proximally, calyculate distally, the two areas thus characterized being about equal in extent. The spines are at first small but gradually increase in size until, finally, those adjacent to the calyces become suddenly enlarged. The line of demarcation between the spines and calyces is abrupt, the first calyces being raised as a flounce or ridge. The remaining ones are smaller and relatively uniform. The organ is barely forked at the tip. About five indistinct, longitudinal ridges are present in the calyculate region. The lips of the sulcus are prominent througout, set with small, uniform spines in the spinous area, and calyces in the calyculate region."

3. **Biosis**

a. ***General Habits :*** *B. fasciatus* is predominantly a nocturnal form but is said to be occasionally met with feeding by day. It evidently does not much like the direct sunlight but has been reported to have been attracted to lights at night. The captive specimens in the Queen Saovabha Memorial Institute in Bangkok, Thailand, are hardly ever seen outside of their concrete "houses" during daylight hours. The author has been told that this species is to be found especially active in certain localities on rainy nights.

The diet of this Elapid has been shown to include a wide variety of vertebrates, including mammals (mice, etc.), birds, lizards, snakes (*Natrix piscator*, *Enhydris enhydris*, etc.), snake eggs, amphibia, and fish.

Probably the best known habit of this species is its "spasmodic" movements when under provocation. When angered, aroused, or molested, it shams aggressiveness by hissing and flinching convulsively and by

hiding its head in its coils. It does not attempt to defend itself or escape, but evidently relies upon its awkward movements to confuse and turn away would-be attackers. If further provoked it flinches several times more and then once again hides its head beneath some part of its body. Meanwhile, its body becomes rigid and somewhat depressed, so that the flinching is invariably in a more or less sideways or lateral direction, i.e., from side to side. If provoked and then left undisturbed a specimen will usually remain in its rigid defensive posture for a long time, but if continually provoked it may attempt to escape.

The unaggressive nature of this species is further attested to by the fact that the attendents at the Queen Saovabha Memorial Institute in Bangkok daily carry armloads of these snakes about from place to place without fear of being bitten. WALL (1926, p. 564) records the interesting account of one that wrapped itself around a person's leg yet did not bite him; the snake was hurriedly and unceremoniously kicked away. A young and inexperienced friend of the author, being interested in snakes, obtained an adult *fasciatus* and for some weeks kept the creature as a pet. During this time he did not realize the true identity of the snake and several times took it out to handle it, wrapping it about his hands and draping it across his shoulders. The snake was always calm and inoffensive, never attempting to bite.

While more or less ungainly when annoyed or disturbed, a calm specimen of *fasciatus* can be very fast and determined in striking at and grabbing food; for all practical purposes all live specimens should be considered dangerous to man.

b. ***Reproduction:*** The species is oviparous. From 8-12 eggs, measuring from 45-64 × 22-38 mm, are laid in a hole in the ground or under stacks of vegetable debris or other objects which are on the ground. Although the female remains with her eggs she evidently shows no form of parental concern or protective instincts for them; there is no evidence to suggest that the male takes any interest in the eggs whatsoever.

Hatchlings measure from 320-340 mm long. They are rarely seen, as is the case with eggs or gravid females, at least in many parts of Thailand—a phenomenon which does not, however, mean these are scarce. EVANS (1905, p. 519 : cited by POPE, 1935, p. 334) writes that a female with eight eggs and four young was discovered on 16 May.

c. *Habitat :* This is primarily a lowland form but has been taken at elevations of up to 2300 metres. It is found in both open country and in jungle, but is said to prefer the former. It is also met with in or near human habitations, to which it ventures in search of food; No. 2417-035760 (Chulalongkorn Univ. Coll.) was collected in a house in Nakhon Si Thammarat province, Thailand. This species is said to be often found in or near water, in flooded fields, pools, or swamps, and has been observed to enter tidal waters near the sea. However, it is also found commonly in dry localities.

d. *Observations :* This species, being as large and conspicuously marked as it is, must have a high mortality rate because of its want of initiative to defend itself when under attack. It should be pointed out, however, that it is not known whether *fasciatus* defends itself when under attack by animals—the fact that it does not do so with man does not mean that it acts this way as a rule. WALL (1909 : cited by SMITH, 1943, p. 413) reports that a bullock bitten by a specimen it had trodden on, died "about 20 minutes or so later".

It has been observed that the eyes of all *Bungaras*, including *fasciatus*, are not so well developed as are those of some other snakes. This knowledge might lead one to suspect that one of the other sensory organs of the bungarids is relied upon when these snakes hunt for food. For example, the Jacobson's Organ in the *Bungarus* may be more highly sensitive than it is in other snakes. One specimen of *fasciatus* kept by Mr. Y. Siah in Bangkok was completely blind as a result of an accident. Nevertheless, it could always locate and capture snakes put into its cage as food.

B. fasciatus is sometimes popularly confused with several harmless snakes, among them *Boiga dendrophila melanota* and *Lycodon fasciatus*. BOULENGER (1912, p. 199) writes that the Malay people of Biserat call *B. dendrophila* and *B. fasciatus* by the same name, and FAYRER (1874, p. 7) records the fact that the people of certain districts of India recognize a black and yellow banded variety of cobra which is sometimes confused with *fasciatus*.

4. Distribution in Thailand

This species will probably be found to occur throughout the whole of Thailand. It has been found to the north of Thailand in China, to the east in Cambodia, to the west in Burma and India, and to the south in Malaya. In Thailand itself it has actually been recorded from the following thirteen provinces: Ang Thong, Ayutthaya, Chiang Mai, Lop Buri, Nakhon Pathom, Nakhon Si Thammarat, Nonthaburi, Pattani, Phra Nakhon, Samut Prakan, Saraburi, Sing Buri, and Thon Buri. One of the largest known specimens was killed in the compound of the Bangkok Nursing Home in Bangkok, Thailand.

This species would seem to be essentially a lowland form in Thailand, being found more often in the plains than in the hills and mountains. Its distribution is without apparent regard to geological or biological zones, and it does not refrain from contact with human habitations and the largest of Thai cities.

5. Significance to Man

Because of the disinclination of this species to bite, even in self-defense, there are relatively few case reports of bites from it in man. Yet such reports do exist. WALL (1913, p. 99) wrote:

> "Fayrer records a case of a woman bitten in the foot at Tavoy. She suffered from tingling and swelling locally but exhibited no constitutional effects. It certainly seems from the local condition that some poison had been injected into the wounds."

There are also reports of domesticated fowl, dogs, and cattle dying as a result of bites from *fasciatus*.

The venom of *fasciatus* is said to be less toxic than cobra venom, and is said to have a concentration of neurotoxins as well as an absence of respiratory or heart stimulants. The symptoms of it in humans resemble those resulting from an injection of combined cobra and *Vipera russelii* venoms. KELLAWAY (1929, p. 97) writes that when injected intravenously into animals in moderate doses it fails to kill by causing intravascular thrombosis, but may kill if the dose is much increased.

This species is of some small significance to man in that it is used commercially and medicinally. Specimens are sometimes dried and used by medicinal practitioners or are cooked to be eaten in restaurants. It is also said to be used by snake charmers in ports of India.

6. **Conclusions**

a. Largely because of the fact that it does not vary to any great extent throughout its entire range this species presents no major taxonomic problems. No subspecies of it are recognized.

b. It is one of the largest members of its genus and is the largest member known to occur in Thailand. It is also of the largest elapids known to occur in Thailand.

c. The bluntness of its tail is evidently a characteristic normally obtained through age; young specimens do not have blunt tails but old ones do.

d. Its conspicuous markings should serve to distinguish it from all other Asian serpents.

e. The only colour differences between adults and juveniles is that the latter are usually paler throughout and their markings more distinct than are those of the adult.

f. There is not much variation in lepidosis.

g. It is terrestrial, mainly, nocturnal, and oviparous. It does not show any strong dietetic preferences. It does not attempt to defend itself when attacked by humans.

h. The female remains with her eggs, evidently until they hatch, but does not show any particular concern for their well-being or for the hatchlings.

i. It does not show any strong habitat preferences, but is probably found in Thailand most often in the lowlands.

j. It will probably be found to occur througout the whole of Thailand. It is common in some Thai localities.

k. It is a potential menace to human life and there are case reports of humans being bitten by it. However, it is not an aggressive serpent.

III. GENUS *NAJA* LAURENTI, 1768 (Cobras)

Naja Laurenti, Specimen medicum, exhibens synopsin reptilium emendatum, 1768, p. 90, (type of genus, *Coluber naja* Linnaeus).

DIAGNOSIS: Head subovate, not or only slightly wider than neck; eye size moderate to large; pupil circular; scales smooth; nasal large, sutured; loreal absent; maxillary bone extending beyond palatine bone; maxillary

teeth O-3, small and faintly grooved, in addition to a large venom-conducting fang which is distinctly grooved anteriorly; mandibular teeth: anterior longest; body cylindrical; costals smooth, pitless, in 13-25 diagonal transverse rows on body (often more on neck); nuchal ribs elongate and capable of expanding neck into a lateral hood; tail length moderate; subcaudals biseral or some single.

OBSERVATIONS: The generic term "Naja" probably originated from the Indian vernacular term "Nag", which means "snake". It is interesting to note, however, that in many different and widely separated localities a term sounding similar to "Naja" is locally employed to designate various types of *Naja*. Some of these are: Naya, Naia, and Nageya (used by the Sinhalese people of the Indian subcontinent), Nala pambu (the Tamil people of the Indian subcontinent), tedong naga (the people of Kuching, Sarawak), Nagara havoo (Mysore State in India), Nagoo (the Coromandel Coast), and Ular tedong naga (the Iban people of Borneo).

The only form *of Naja* dealt with in this study is *kaouthia kaouthia*. The term "kaouthia" is believed to have been taken from the vernacular term "keautiah" which in Bengal is used to designate cobras possessing the monocellate type of hood marking.

The snakes of the genus *Naja* are well known for their ability to spread "hoods" (although they are not the only group of snakes that can do so). The hood of a cobra is formed when the elongate ribs of the nuchal region are pulled upwards to fill out the loose skin of the neck in a lateral direction. In at least some of the Asian forms the ribs of the first 30 vertebrae of the neck (exclusive of the first three) are involved in the formation of the hood. These are much less bowed and are much longer than those of the remainder of the body, the ninth or tenth on each side being the longest and the ones preceeding and succeeding these gradually diminishing in length. The ribs involved in the production of the hood are set at an angle of from 40° to 45° to the long axis of the spine, and the head is bent at right angles to the body at the atlas or first vertebrae.

It should be remembered that the hood of a *Naja* is formed voluntarily by the snake and only during certain types of emotional stress.

When the snake is excited, angered, irritated, or frightened, it usually forms its hood, but when calm and unannoyed it does not.

The forming of a hood by a *Naja* is a typical example of "aposematic behaviour" (when a dangerous or distasteful animal proclaims its unagreeable nature by indulging in a warning display designed to discourage potential enemies).

The *Naja* are terrestrial (however, closely related forms, notably the African *Boulengerina annulata*, are very much aquatic), and diurnal, crepuscular, or nocturnal. Their diets are not confined to any single animal form but include virtually all small vertebrates capable of being overpowered and swallowed. In habits they vary from form to form, although most are naturally unaggressive and inoffensive. Adults of the African *Hemachates haemachates* (closely related to *Naja*) "play 'possum", that is to say, assume the semblance of a corpse in the hopes of discouraging potential enemies.

The snakes of the genus *Naja* probably form one of the most dangerous groups of snakes in the world. They are responsible for a large number of deaths in humans annually.

Of this genus only the species *k. kaouthia* is recognized by the present author as occurring in Thailand, although other authors may recognize various other forms as occurring therein as species.

A. ***Naja kaouthia kaouthia*** Lesson *in* Férussac, 1831 (Ngu hao; Monocellate Cobra)

Naja kaouthia Lesson *in* Férussac, Bull. Sci. Nat., 1831, vol. 25, p. 122. Plate XXXI.

1. **Identifying Characteristics**

Provisions for a nuchal hood present; at least one cuneate scale usually present between fourth and fifth infralabial scales[4]; subcaudals biserial.

4) The cuneate, when present, is disgnostic of *N. k kaouthia* in Thailand, being found in no other form of land snake in Thailand except as an aberration. However, it should be remembered that this scale may be present in certain members of the family Hydrophiidae.

2. Physical Description

a. *Dimensions:* A medium-sized to large snake. The maximum recorded length for this subspecies is evidently that of 1970 mm (vide, WALL, 1921, p. 476). SMITH (1923, p. 59) writes that 1500 mm is about average length for adult specimens. A typical male specimen of *N. k. kaouthia* from Central Thailand was measured by the present author just after it had died. Its measurements, which follow, should serve to give an idea of the relationships between various dimensions (in mm):

Total length	836
Length of head	39
Length of body	635
Length of tail	162
Width of neck	20
Width of midbody	23
Width of tail base	10

The growth rate of juveniles seems to be rapid, becoming slower as the individual matures. In the closely related *Naja naja* full growth is reached at the end of a given individual's fourth or fifth year.

b. *Physical Characteristics:* Eye small, its diameter a little more than half its distance to oral border; nostril large, vertically elliptic; a single, small, solid tooth following venom-conducting fang (which may be up to 7 mm long and when decalcified resembles the fang of a typical opistoglyphid or rear-fanged snake); right side of hood usually somewhat larger than left side.

When in the field the author finds that the following two characteristics will readily distinguish *N. k. kaouthia* from any harmless species with which it might be confused, and vice versa; (1) the eye is relatively small and the supraocular scale shaped so as to give the eye a look of intense scrutiny, and (2) the tail is relatively short and stout.

The ability to spread a hood is not diagnostic of *N. k. kaouthia* inasmuch as certain other forms of snake, in addition to other forms of *Naja*, can also form nuchal hoods. Notable among these are certain of the natricine snakes. Further, *N. k. kaouthia* spreads its hood only when in certain emotional states.

It is of interest to note that the recently sloughed skin of a *N. k. kaouthia* often retains some of its original pigment and contains some property that renders it attractive to ants and other insects, that eat it.

c. *Coloration:*

Juvenile: Head and anterior portion of body yellow, cream, or orange below, usually with a monocellate marking on hood dorsally; this marking may be well defined (in which case it is outlined in black), almost entirely absent, or confined to interstitial skin; sometimes a pale chevron or oval mark or plain bar on nape just behind hood and sometimes one to two similar marks further down on body; lips light or dirty white; throat very ligtht (white to yellow) with black marks at ends of eleventh and twelfth ventrals (which appear as spots on spread hood); these marks followed by one to three broad blackish to dark brown crossbars. Tongue reddish posteriorly, purple near tips.

Body highly iridescent, olivaceous to brown or nearly black above, dorsolateral scales dark-edged; body sometimes with indistinct pale rings or fine white transverse lines which are primarily on interstitial skin; venter usually a lighther shade of dorsal colour; transverse markings of back and sides may be continued on venter as yellowish bars. Interstitial skin light or dark with dark or light marks.

Subcaudal region usually lighter than venter, sometimes with each subcaudal edged with gray or brown on posterior edges and thus made very distinct.

Adult: Head as in juvenile; lips usually a shade very similar to body colour.

Body and tail cream, yellowish, tan, brown, dark or light grey, or blackish; venter and subcaudal region lighter than dorsolateral areas.

The chief colour changes that occur in the transformation from juvenile to adult consist of the markings becoming indistinct or obliterated and the whole body becoming more pale. Adults are not as highly iridescent as juveniles.

There is evidence to support the belief that the coloration of various cobra populations is related to their geological environment (e.g., those found near sandstone being reddish, etc.). Also, the coloration of Thai

k. kaouthia seems to vary considerably from locality to locality. Greenish or bluish cobras have been observed in North Thailand and Burma by various herpetologists. These, not now available for examination, were presumably examples of *k. kaouthia*.

d. ***Lepidosis:***

Head: Rostral wider than high, partly visible from above; supralabials 7 (rarely 6), third and fourth (or rarely only third) touching orbit, last elongate; nasal sutured, its parts subequal; oculars 1+3 or 2+3; temporals 2-3 primary +3-4 secondary or either $\frac{1}{1+1}$ or $\frac{1}{1+2}$; internasals large, shorter than prefrontals, in contact with nasals and preocular (in only one nonvenomous Thai snake does the preocular touch the internasal; *viz.*, *Pareas monticola*, but in this the third supralabial fails to touch the nasal; in forms of *Maticora*, *Calliophis*, and *Ophiophagus* the third supralabial touches both orbit and nasal); prefrontals shorter and narrower than internasals; frontal small, as long as or shorter than its distance to rostral, as large as or larger than prefrontals; supraocular longer than frontal; parietals longer than frontal; mental much smaller than rostral; infralabials 8 (rarely 7), 4 bordering primary genials; O-2 cuneates present between fourth and fifth infralabials (sometimes excluding fifth infralabial from oral margin); genials subequal or primary pair larger than secondary pair.

Body: Costals 25-32 (neck), 19-22 (body), 15, rarely 17 (before vent); costals disposed in oblique transverse rows; ventrals 161-196, angularly bent; anal single.

Tail: Subcaudals 21-59, biserial (or several sometimes aberrantly single).

e. ***Hemipenis:*** The form *atra* is considered by DERANIYAGALA (1960, pp. 41-63 and 1961, pp. 205-232) to be a subspecies of *kaouthia*. The following description is based on a Chinese specimen of *atra* described by POPE (1935, pp. 351-352):

> "The hemipenis extends to the tenth subcaudal plate and is forked opposite the seventh. Its proximal third is beset with numerous spines. These spines are abruptly superseded by a region of large ones which in turn is interrupted opposite the

point of forking of the sulcus by a narrow, transverse, smooth area. This area does not, however, intercept the sulcus or its two adjacent, longitudinal ridges and is followed by more spines only slightly smaller than those that precede it. These last spines soon arrange themselves in more or less evident rows, and this arrangement becomes increasingly conspicuous as the spines decrease in size and gradually become connected basally until the approximate distal fifth of the organ is calyculate, the calyces being poorly developed and having spinous edges. Two well-developed ridges lie immediately adjacent to the sulcus throughout its length. They are spinous save in the distal, calyculate region where they are calyculate."

3. **Biosis**

a. *General Habits:* *N. k. kaouthia* is both diurnal and nocturnal, being active as well as dormant during both night and day. Three specimens taken by the author in Songkhla province, Thailand, illustrate this. They were all taken in the course of a single morning; one was discovered under a large stone, the second was found in a hollow log, and the last was surprised as it made its way through some underbrush. While active during the day this form is probably more so at night, and the fact that it strikes more accurately and bites more often in the night than in the day is well known.

While many Thai elapids are predominantly ophiophagous, *k. kaouthia* will readily eat both warm-blooded and cold-blooded vertebrates. Animals known to have been eaten by it include mammals (mice and rats), birds (mainly the smaller finchlike forms), other reptiles (lizards and snakes: it is sometimes cannibalistic), and amphibians (*Rana erythraea*, *R. limnocharis limnocharis*, *R. tigerina pantherina*, and *Bufo melanostictus*).

It would be of interest to mention here some of the more remarkable reports of what the closely related *Naja naja* of India has been known to eat. One specimen was reported to eat 32 mice in a single month—a little over one a day! There are records of fowls' eggs being recovered from cobras' stomachs and subsequently hatched! One cobra ate a small mouse--and with it a part of the rodent's nest, which included a lump of cotton and a 432 × 356 mm piece of cloth! Several cobras have

been reported at sea, though probably carried there by flooding rivers. WALL (1921, p. 556) reported that new-born Indian cobras eat the residual yolk in their eggs before vacating the latter to provide for a possible dearth of food in their early lives.

How do cobras subdue their prey? Do they always utilize their venom in doing so? Several times the author observed captive specimens of *k. kaouthia* to glide up to a frog and try to swallow it outright The frog would of course hop away, when the cobra would glide after it for a second go and the whole procedure would be repeated. Invariably the snake had to give up these tactics and as a last resort would use a quick strike to secure the amphibian. SMITH (1943, p. 435) recorded similar observations on cobras trying to eat toads. The present author's brother, David R. Soderberg, suggested that perhaps the snake uses its venom only when in certain emotional attitudes, i.e., anger, fear, self-defense, irritation, frustration, etc. Hence, repeated failure to capture its prey would anger or irritate a cobra and so invoke the use of its venom apparatus.

N. k. kaouthia is not an aggressive snake. Although individuals vary in temperament almost all specimens will usually strive to avoid an encounter with a human being. If such an encounter is unavoidable they will almost invariably seek to escape through rapid flight.

The cobra is capable of putting on an effective defensive display. Raising up the anterior third or more of its body and spreading a hood, it sways back and forth, opening its mouth and hissing during both inhalation and exhalation. If overly excited or angered this hissing becomes more of a snorting.

The hood of the cobra is formed when the elongated ribs of the neck are pulled upward and outward to fill out the loose lateral skin of the neck. As stated by the author (1965, p. 19) the hood is seen only when the snake intentionally spreads it, and is usually not seen in a resting or dead specimen.

An angry cobra is relatively slow and only fairly accurate in striking because its movements are impeded by the lateral expansion of its neck. One which is calm and unexcited, however, is much faster and surer in striking at an object. When a cobra strikes its mouth is

open at an angle of about 45°, and in the course of a strike the cobra usually utters a loud, explosive hiss. If the strike lands true the cobra immediately proceeds to inject its venom, this being aided by a mastication of the part. Very young cobras are not as dangerous as older ones because of the minuteness of their fangs.

Some populations of Thai *kaouthia* not only react to provocation by spreading hoods but also spit their venom more than a metre through the air at their source of annoyance. This is evidently accomplished when the cobra suddenly contracts its temporal muscles to cause the venom glands to be contracted, with the result that the venom is forced out of the venom duct at a high velocity. The venom is voided in the form of a fine spray or as recognizable droplets. If it enters the eyes of a human or animal it may cause temporary or permanent blindness, and upon entering an open wound may cause symptoms similar to those resulting from an intravenous injection.

LIM, *et. al.* (1960, p. 186) report that a Malayan cobra, when offered live food, would spit upon it and then follow this with a quick bite. The animal was then allowed to die, after which it would be swallowed. They further record: "On one occasion a white mouse was spat upon but not bitten and it died within two minutes".

b. ***Reproduction:*** The fact that in this form and the closely related *Naja naja* the breeding pair remain together some time is fairly well-established. They evidently remain thus for a period of time before the actual construction of the nest as well as after its construction and until the eggs are finally hatched. DUCKETT (1964, pp. 210-211) reported that he personally witnessed at least five instances in which a tractor in the act of ploughing unearthed two cobras, which he assumed to be male and female, and a clutch of eggs. SMITH (1937, pp. 62-63) wrote about a pair of captive Indian cobras that exhibited tendencies to remain together during their breeding season. Though cobras remain with their eggs they do not actually guard them.

The nest of an Asiatic *Naja* may be in an already existing hole in the earth or it may be of the snake's own construction. SMITH (*ibid.*) wrote of one nesting pair of captive Indian cobras:

> "When they were moved into the new cage they were provided with a large mound of earth with sods of grass on the top, the whole pile being some 15 inches high. Into this mound they burrowed, digging their way into it at different places with their noses and finally meeting in the middle where they formed a cavity large enough to contain them both. The cavity was some eight inches below the surface and had several holes leading to it which were used indiscriminately for entrance and exit."

In *N. k. kaouthia* sexual maturity is probably reached when the snake is two to three years old. Mr. Y. Siah related to the author that mating in it occurs during January and February. While the actual act of copulation has evidently not been recorded for the present subspecies, it has been for the Inpian *Naja naja;* WALL (1921, p. 473) writes:

> ". . . coitus lasted inter-mittently for three days. He (one Mr. Hampton) observed that the pair nodded their heads continually, and their bodies quivered. They did not take the slightest notice of anybody in front of their cage. They did not expand their hoods, neither did they wrap themselves around one another. Each turned the vent upwards and sideways to effect engagement."

Recorded "gestation" periods of *N. naja* vary from 51 to about 150 days, and hatching periods of the eggs from 47 to 84 days after being laid. In *N. k. kaouthia* these periods are very likely similarly long.

N. k. kaouthia lays up to 28 eggs. These are deposited usually in or around March. During that month in 1962 the author observed large numbers of these snakes' eggs in the pits at the Pasteur Institute (Queen Saovabha Memorial Institute) in Bangkok, Thailand. Further, on 9 March 1965 a one and one-half metre long female specimen in the collection of Mr. Y. Siah (Bangkok) laid 28 eggs, three of which were infertile. Such eggs are yellowish white upon being laid but are white if the embryo is removed, i.e., the shell is noticeably thin.

The behaviour of the female *N. k. kaouthia* after she has laid her eggs could not be labeled "guarding them". Mr. Siah's above-mentioned specimen coiled about and on top of her eggs after laying them, but in another hour moved off them and thereafter showed no interest in them.

WALL (1921, p. 554) observed that during various stages of their development the embryos of a clutch of *N. naja* eggs could move their bodies and protrude their tongues. One which he removed from its shell, several days before it would have hatched normally, hissed at him. He observed that in the male embryo the genitalia are extruded up to about four days before exovation. Exovation is accomplished with the aid of an egg-tooth.

During the more than two years spent in collecting information prior to the writing of this study the author found no conclusive evidence to support the belief that if a cobra is killed its mate will avenge its death. There are, however, several records that would suggest that among Asiatic *Naja* there is sometimes a decided tendency towards social life apart from sexual impulses. As mentioned above, the fact that breeding pairs remain together for at least short periods of time is fairly well-established.

c. ***Habitat:*** The habitat of *N. k. kaouthia* might be correctly defined as "any place where there is a suitable supply of food". Indeed, specimens of this form are found in Thailand to be equally common in jungles, rice-fields, human habitations (cities), on the plains, or in the hills at elevations of up to 1000 metres. Wherever there is an abundance of the cobra's natural foodstuffs there may also be cobras.

In the same sense, the microhabitat of *N. k. kaouthia* might be stated to be "any situation that offers shelter". Although habitat preferences vary from individual to individual almost all specimens are found in close proximity to water. In some localities the cobra populations are semiaquatic.

In Thailand *N. k. kaouthia* is probably one of the few elapids commonly found in or near human habitations. It was once commonly met with in Bangkok, and is still occasionally reported as occurring there (the author recently received a juvenile specimen taken on Soi 63, Sukhumvit Road, Bangkok, from Mr. and Mrs. Raymond A. Matheny), but no doubt the numbers of *N. k. kaouthia* in Bangkok have decreased in direct proportion to the growth of the city. However, *kaouthia* is still commonly met with in many of the smaller Thai cities.

d. ***Observations:*** Several large nonvenomous snakes, notably those of the genus *Ptyas*, are popularly mistaken to be *N. k. kaouthia*. Various Natricine snakes (including *Pseudoxenodon macrops*, *Macropisthodon rhodomelas*, *M. flaviceps*, *Natrix piscator piscator*, *N. flavipunctata*, and *Rhabdophis subminiatus subminiatus)* are capable of forming nuchal hoods similar to that of *N. k. kaouthia*. However, excluding *Ophiophagus hannah* there is no Thai snake which can spread a nuchal hood to the width of that of *kaouthia*. This does not apply to other countries, as in Australia *Notechis scutatus* and its allies can also spread hoods of appreciable size.

The mongoose (*Herpestes* spp.) is a known enemy of *N. k. kaouthia*. However, these mammals do not intentionally seek out cobras to destroy them: they will attack and eat almost any palatable animal they encounter and are capable of overcoming. Although the mongoose does have a somewhat higher resistance to certain snake venoms than do some other mammals, in overcoming a cobra it almost certainly relies most heavily upon its speed and agility.

The cobra has many potential enemies. Among them are domestic cats, dogs, pigs, buffalo, and fowl, as well as predatory birds, monitor lizards (*Varanus* spp.), and ophiophagous snakes (notably *Ophiophagus hannah*). Both endoparasites and ectoparasites affect it, and man not only kills it on sight but also destroys its supplies of food and encroaches upon its natural habitats.

4. Distribution in Thailand

N. k. kaouthia is ubiquitous in Thailand. It can be found from the peninsula north to the Laotian border and from the Burmese border across the Central Plain to the Thai-Cambodian border. It has been reported from thirty-eight Thai provinces and will almost certainly be found to occur in the remaining thirty-three. The ones from which it has been recorded are: Ang Thong, Ayutthaya, Chachoengsao, Chainat, Chiang Mai, Chon Buri, Kanchanaburi, Khon Kaen, Lampang, Lamphun, Lop Buri, Nakhon Nayok, Nakhon Pathom, Nakhon Ratchasima, Nakhon Sawan, Nakhon Si Thammarat, Nan, Narathiwat, Nonthaburi, Pathum Thani, Pattani, Phet Buri, Phetchabun, Phitsanulok, Phra Nakhon, Phichit,

Prachin Buri, Prachuap Khiri Khan, Rat Buri, Samut Prakan, Samut Sakhon, Samut Songkhram, Saraburi, Singburi, Songkhla, Suphan Buri, Thon Buri, and Uthai Thani.

According to PURANANANDA (1957, p. 3), *N. k. kaouthia* is most plentiful in the provinces of Lop Buri, Samut Prakan, and Saraburi.

5. Significance to Man

In Thailand, *N. k. kaouthia* is probably the most dangerous snake to man. This is primarily because a good percentage of its bites in man prove fatal, but is also for the reason that it bites often. Commercially its skin is used in the production of shoes, belts, pocketbooks, neckties, and wallets. Its flesh and certain of its internal organs are eaten by some people or are incorporated in the preparation of medicinal soups and tonics. Its skeleton is sometimes dried and ground into powder and used by medicinal practitioners.

As pointed out above, this form is most significant to man because of its ability to take human life; every year a number of people in Thailand die as a result of being bitten by a cobra.

The local symptoms of a *N. k. kaouthia* bite in man are a slight swelling, a little pain and numbness at the site of the wound, and these are accompanied by general difficulty in breathing, in keeping the eyelids open, and in speaking. In addition to this, the tongue feels swollen and there may be hiccoughing and vomitting. Involuntary emission of urine and faeces are later symptoms. Death, if such is to be the result, may occur anywhere from within a few hours to many days after the infliction of the bite. It should be pointed out that not all bites prove fatal.

6. Conclusions

a. There is presently much difference of opinion among herpetologists as to what the status of the form *kaouthia* should be. Whatever its status, the distinctions between it and other Asiatic *Naja* are vague at the present time.

Asiatic cobras tend to vary from population to population and from individual to individual regarding physical characteristics. Differences among specimens from different localities—or even the same locality—are to be found in lepidosis, coloration, hemipenial characters,

measurements, etc. These differences have given rise to problems regarding status, and the question is whether to consider the forms of *Naja* of Asia as races, subspecies, or species.

Attempts have been made to clarify the status of these serpents. Some have incorporated geographical distribution, others have relied heavily upon lepidosis, and many have been based upon coloration. Yet for the most part these evaluations have been unsatisfactory primarily for the reason that they cannot be broadly applied, that is to say, be applied to all cobra populations found in Asia. Before this extremely complex problem can be solved, distribution, lepidosis, colour, dentition, hemipenial characters, and other characteristics must all be taken into equal consideration.

In this paper the author had tentatively followed DERANIYAGALA'S (1960, pp. 41-63, and 1961, pp. 205-232) division of the Asiatic cobras, as this is probably the most comprehensive evaluation of the problem as a whole to date.

DERANIYAGALA (*ibid.*) considers *N. naja* a full species which possesses several subspecies, but also recognizes *kaouthia* as a full species which possesses six subspecies. His reasons for these steps include: (1) there are marked differences between the hemipenial characters of the forms *naja* and *kaouthia*; (2) both forms are sympatric in Bengal; (3) there are obvious differences in dentition between the two; (4) there are differences between the two forms in coloration in both juveniles and adults; (5) hybridization sometimes occurs between the two forms (the present author realizes that this fact does not evidence specific distinction, as the more distinct two species are the less likely they are to hybridize); (6) in *naja* the scales of the distended hood are widely separated from one another by the interstitial skin whilst in *kaouthia* they are generally in contact with one another or nearly so; (7) the venoms of the two forms apparently differ from each other in composition.

In the present study the form *kaouthia* has been hesitantly considered a distinct species, the form of it commonly found in Thailand being the forma typica. Further, the author recognizes only the forma typica as occurring in Thailand.

b. This is a medium-sized to large snake.

c. It is readily distinguished from any nonvenomous Thai snake through the relatively small size of its eye and the shortness of its tail.

d. There is much variation in colour among individuals of this form, but generally juveniles tend to be darker than adults.

e. There is a relatively large amount of variation in the number and arrangement of the scales of the head and body, especially the temporals.

f. It will eat almost any animal which it can overcome and swallow.

g. It is not aggressive and seeks to avoid encounters with humans: however, it is capable of putting on a convincing defensive display.

h. Some individuals habitually spit their venom at any source of annoyance.

i. It is oviparous, terrestrial, and probably more nocturnal than diurnal.

j. It may be looked for and found in any sort of habitat that offers it a suitable supply of food and adequate shelter.

k. It has been found in more than half of the Thai provinces, and will very likely be found in the remaining ones.

l. It is of some significance to man medicinally and commercially.

IV. GENUS *OPHIOPHAGUS* GÜNTHER, 1864 (Cobras)

Hamadryas (not of Hubner, 1806) Cantor, Asiatic Research, vol. 19, 1836, p. 87, (type of genus, *hannah*).

DIAGNOSIS: Head subovate, slightly wider than neck; snout blunt; eye size moderate to large; pupil circular; scales smooth; nasal large, sutured; loreal absent; two large occipitals in contact with each other and with parietals; maxillary bone extending forward beyond palatine bone; maxillary teeth 3 in addition to a short but large venom-conducting fang; pterygoid teeth 10-12. Body not stout but heavy, subcylindrical; costals smooth, pitless, number on posterior third of body at least two less than number on anterior third of body; posterior dorsal vertebrae with hypapophyses. Tail length long to short, tail tapering to a point; subcaudals both single and biserial.

OBSERVATIONS: This is a monotypic genus. Its species, *O. hannah*, known to some as the hamadryad, is the longest species of venomous snake known to the world at present. This is not to say that it is the largest in girth, for certain other forms of venomous snakes exceed it in this dimension, notably the American *Crotalus adamanteus*, the African *Bitis gabonica*, etc.

Like the snakes of the previous genus, *O. hannah* possesses the ability to raise voluntarily a nuchal hood. This it does only when in certain emotional states; its hood is not raised continually. This form is terrestrial and largely diurnal and almost entirely ophiophagous.

Because of the great size of this species, its relatively high level of intelligence, and potent venom, *O. hannah* is considered to be one of the most potentially dangerous creatures of the jungle, but its apparent general rarity and unaggressiveness prevents it from taking a high toll of human life.

A. *Ophiophagus hannah* (Günther), 1864 (Ngu chong arng; Hamadryad)

Hamadryas hannah Cantor, Asiatic Research, vol. 19, 1836, pls. 10-12, (type-locality, Sandarbans, near Calcutta, India). Plate XXXII.

1. **Identifying Characteristics**

Provisions for a nuchal hood present; no cuneate scale present; two large occipital scales in contact with each other present behind parietals; subcaudals both single and biserial.

2. **Physical Description**

a. ***Dimensions:*** An extremely large serpent when full-grown, the longest venomous serpent known to man. The maximum total length recorded for it appears to be 5588 mm, recorded for a specimen from Nakhon Si Thammarat province, Thailand, by AAGAARD (1924, p. 315). This, however, is far in excess of the average length of adults, which is from 3962 to 4572 mm. Hatchlings measure from 500 to 535 mm long.

The tail of *hannah*, which is relatively longer in males than in females, occupies from about 1/4 to 1/6 of the total length of a given specimen. The diameter of the body is relatively small in comparison to the total length of the body, being less than 63 mm for a specimen measuring 4267 mm long (*vide*, SHEBBEARE, 1947, p. 31).

The following list of measurements was compiled by the author after an examination of C.T.N.R.C. No. 523-462, and should serve to illustrate the relationships between various dimensions (in mm):

Total length	2745
Length of head	65
Length of body	2033
Length of tail	647
Width of neck	34
Width of midbody	40
Width of tail base	24

b. ***Physical Characteristics:*** Head subovate and depressed, barely wider than neck; snout rounded; temples swollen, nostrils large; eye moderately large, its diameter about equal to its distance to nostril or from 2/5 to 1/2 the length of the snout in adults; venom-conducting fangs canaliculate but grooved on anterior surfaces where walls have coalesced, from 10 to 12 mm long in adults; each venom-conducting fang followed after a diastema by three small subequal maxillary teeth which are grooved on their outer surfaces; palatine teeth subequal, 7-9, grooved on their inner surfaces, anododont; pterygoid teeth 9-14, ridged on their inner and outer surfaces, anododont, decreasing in length posteriorly; mandibular teeth 14-18, grooved on their outer surfaces, anododont, decreasing in length posteriorly.

Body slim, round, gradually tapering towards tail from about midbody; expanded hood relatively long and narrow. Tail relatively long and tapering.

The hood of *O. hannah*, which is neither curved nor very wide, is rather long, and thus quite different from that of *Naja k. kaouthia*. The difference between the shapes of the hoods of these two forms is sufficient to distinguish immediately one from the other in the field, although size alone may be used in this. This, however, is not true outside of Thailand, for the *Naja* found in the northwest parts of the Indian subcontinent possess hoods which are long and narrow, and the same is true of various African elapids (*viz.*, *Naja nivea*, *N. nigricollis*, *N. haje*, *Boulengerina annulata*, *Hemachatus haemachates*, etc.).

BURTON (1950, p. 562) records a 4750 mm long specimen that weighed 12 kg., while DITMARS (1960, p. 88) recorded one about 4572 mm long weighing about 7.3 kg.

The present author has observed that the freshly sloughed skin of *hannah* emits a strong odour which much resembles that of a raw cucumber *(Cucumis sativus)*, and that within several days of being sloughed the skin may decompose in a way similar to that in which other organic tissue decomposes.

c. ***Coloration :***

Juvenile : Head black, dark brown, or olivaceous above, with four white, cream, or yellow bars, *viz.*, (1) on top of snout (sometimes indistinct), (2) in front of eyes, (3) in back of eyes, (4) traversing hinder part of parietals and temporals; of these numbers (3) and (4) are usually composed of a series of spots which are separated from each other by sutures of scales which are involved; underside of head immaculate, white, cream, or yellowish.

Body black, dark brown, olive-brown, or violaceous brown above, with 32-54 narrow, white, buff, or pale or rich yellow chevrons, transverse bars, or rows of spots, each averaging 1-2 costal rows wide and separated by from 5-7 costal rows (but those on nape usually broader than the rest); these marks usually more or less chevron-shaped and directed towards head, but sometimes more or less transverse posteriorly (dark colour of hindbody sometimes completely supplanting light marks); all light marks expand laterally: venter black, plumbeous, yellowish, or whitish, with narrow black or brown (white in cases of individuals having black venter) crossbars which are confined to edges of ventrals and which correspond in position with dark colour of dorsolateral areas.

Tail black, dark brown, olive-brown, or violaceous brown above, with 10-13 narrow, white, buff, or yellow transverse bars; subcaudals dark-edged.

The above description of juvenile specimens does not entirely apply to hatchling specimens collected in Nakhon Si Thammarat province, Thailand, by Messrs. C.J.P. Ionides and J.H.E. Leakey. These were examined by the author and a typical representative of them was coloured as follows:

Head black with four bars, last two very thinly split up into sections at sutures of scales; interspaces between all bars with central pale or whitish areas.

Body black, lowest costal rows being white, with 80 thin white crossbars each less than a costal wide, except first few on nape, which were more than a costal width; almost every black costal pale centrally, i.e., dark-edged (giving impression that body was vaguely spotted); venter immaculate white except for last dozen or so ventrals, which were each dark-edged on their posterior margin.

Tail black dorsolaterally, with white spots on almost every scale (by no means barred or traversed by crossbars); subcaudal region white, each scale black-edged; terminal scale white.

Among these same specimens it was noted that much variation in colour and colour schemes occurred from individual to individual, even among specimens coming from the same clutch of eggs. Some were more distinct than others, some had vague markings, and others were intermediate between these two extremes; however, it was noted that as a rule the young of a single clutch of eggs tended to be similar to one another, that is to say, all distinctly marked, all vaguely marked, or all of some other category.

Much variation among these specimens was noted in the amount of yellow present on the head and throat. In some individuals there was no yellow whatsoever, while in others varying amount of this pigment were present. Regardless of the amount of yellow present on the head and throat, all other light areas of the body and tail were invariably white.

In some specimens throat or hood markings were present, composed of four small black spots. Two of these were set at opposite edges of the hood at about the middle of its length and two others were set lower down and farther apart. However, in many of the specimens examined the throat was immaculate white.

Adult: Head black, blackish brown, brown, olive-brown, olive-green, or yellowish above, scales usually black-edged in lighter specimens; chin yellow or cream, invariably immaculate; throat cream, yellow, orange-yellow, orange, deep orange-red, brownish orange, brownish, or bluish,

with irregular black, grey, or greyish-olive markings which are sometimes conspicuous on spread hood; first light band on neck V-shaped, its apex directed toward head, its margin narrowly outlined in black. Iris golden or golden brown minutely spotted with black; tongue black, bluish black, or red-brown.

Body immaculate black, blackish brown, olive-brown, olive-green, or yellowish, or any of these colours with distinct or vague crossbars (usually less distinct anteriorly) which are largely on interstitial skin; these crossbars narrower than their interspaces, with or without black margins; scales on anterior part of body and on hindbody usually black-edged; venter uniform, mottled, or barred with bluish grey, brown, yellowish green, or white. Interstitial skin with indistinct, narrow, whitish reticulations and traces of crossbands.

Tail as body, but usually darker; juvenile crossbands or marks, if not yet lost, usually more distinct than on body inasmuch as black margins of bands encroach on ground colour and entirely supplant it. Subcaudal region usually darker than venter of body, scales sometimes black-edged.

The colour changes that occur in the transition from juvenile to adult are the change of the entire colour scheme usually from a darker to lighter shade, and the partial or complete loss of the juvenile crossbands. The latter, however, are often retained partially or distinctly on the hindbody and tail. In juvenile specimens the crossbands usually cover the scales which they involve as well as the interstitial skin, but in the adult the same markings are usually retained only on the interstitial skin.

A juvenile and an adult of this species, when compared with each other on the basis of coloration, appear to be two entirely different types of snake. The change in colour seems to occur about the time a juvenile specimen reaches a metre in length, but as stated above, some adults always retain some of their juvenile markings.

All large adult specimens of *hannah* from Thailand examined by the author have been yellowish olive-brown with little or no trace of juvenile markings.

d. ***Lepidosis :***

Head : Rostral wider than high, visible from above; supralabials 7, third highest and touching posterior edge of nasal, seventh longest, third and fourth touching orbit; nasal very large, completely sutured, in contact with three supralabials; oculars 1 (rarely 2) + 3; temporals 2+2, anterior very large, lowermost fifth, sixth, and seventh supralabials; internasals semiquadrangular, as long as or a little shorter than prefrontals, bordering nasals, separated from preoculars; each prefrontal touching internasal, nasal, preocular, supraocular, and frontal; frontal longer than wide, less than or as wide as supraoculars, as long as or slightly shorter than its distance from tip of snout, much shorter than parietals; a small scale sometimes present at posterior end of parietal suture; parietals longer than wide; occipitals 2, both large and in contact with each other; mental wider than high; infralabials 8-9, first pair in contact behind mental, four in contact with anterior genials, fifth largest; genials subequal, anterior pair as long as or a little longer than posterior pair.

Body : Vertebral row usually enlarged on much of body. sometimes with both its adjacent rows also somewhat enlarged; costals smooth, imbricate, with rounded tips, 17-21 (nape), 13-17, usually 15 (most of body), 15 (front of vent); two lowest costal rows largest; ventrals angularly-bent, 215-266; anal single.

Tail: Subcaudals 76-120, usually single anteriorly and biserial posteriorly (majority being invariably biserial), transition from one condition to other not always distinct, i.e., with alternating groups or single scales of each condition occurring between both conditions. In Asia *Bungarus f. flaviceps* also possesses subcaudals some of which are arranged singly and the others biserially, being the only other Asian elapid to have them thus. However, in Australia the snakes of the genus *Pseudechis* usually have their subcaudals thus disposed.

Sexual dimorphism is evidenced in ventral counts, according to LEVITON (1964, p. 547). He wrote that males average fewer ventrals than do females, but that both sexes have about the same number of subcaudals.

e. ***Hemipenis:*** This organ is excessively long in this species. WALL (1925, p. 820) mentions the hemipenis of a Burmese specimen which measured about 152 mm in length from the point of bifurcation to the extremity. The snake itself measured 3680 mm long.

The hemipenis of *O. hannah* extends to the 28th or 30th subcaudal (presumably when in situ) and is forked opposite the fourth subcaudal. Its basal 4/5 is surrounded by prominent, transverse, somewhat imbricate folds most of which completely circumscribe the entire organ. The area of bifurcation contains a few large and strong spines and the rest of the organ is strongly flounced except for the distal extremity, which is calyculate. The sulcus spermaticus is forked and the lips of the sulcus are smooth.

3. **Biosis**

a. ***General Habits:*** The most controversial elapid in all of Asia is *Ophiophagus hannah*. Most of the controversy over it is centred around its habits and behaviour, herpetologists being in wide disagreement over its celebrated habit of unprovokedly attacking human beings. Some feel that it attacks without provocation and that the females do so more readily when brooding their eggs. Others feel that it is unaggressive and does not attack humans without genuine and considerable stimulus. While there are published accounts of what might be considered unprovoked attacks there are also numerous reports of unaggressive behaviour.

The present author believes that the habit of unprovoked aggressiveness is nonexistant in *O. hannah* for the following four reasons: (1) his own observations made on living examples support this belief; (2) all information concerning this topic transmitted to him by other herpetologists has been in agreement that the species is by nature unaggressive; (3) no entirely undisputable account of an unprovoked attack against man is available and no such account has been made by a competent herpetologist who was himself the intended victim; and (4) numerous competent herpetologists have reported on the unaggressive nature of this species. However, the present author does not discount all reports of aggressiveness in this species as false.

It should be pointed out that as is the case with virtually all snakes, *O. hannah* will become aggressive if sufficient stimulus in the form of provocation is provided.

O. hannah is markedly diurnal and capable of being both semiaboreal and semiaquatic. Captive specimens of it are said to exhibit a high level of intelligence in being able to differentiate between desirable and undesirable foodstuffs, in detecting the glass which covers its cage in captivity and thus avoiding injury on it, and in recognizing the persons who care for it while evincing antagonism towards strangers.

A thoroughly aroused specimen of *O. hannah* is able to raise the anterior third of its body off the ground in a warning posture. It forms its hood, and with it spread confronts its adversary. Its defensive posture is with its neck bolt upright—not swanlike—with the head bent sharply forward at the first or second vertebrae.

With hood erect a specimen will sway back and forth only slightly. As DITMARS (1960, p. 161) fittingly put it, there is none of the nervous swaying or marked arching of the neck that is seen in the common cobra *(Naja);* the attitude is one of intense scrutiny. HARRISSON writes (1950, p. 327) that specimens are capable of emitting loud bellowing sounds, apparently by intentional movement of their ribs (the present author twice observed similar sounds made by thoroughly irritated specimens of the nonvenomous *Ptyas mucosus*, which is often popularly confused with *O. hannah*; in both cases these sounds appeared to be made by the snake's violent exhalation).

The striking range of this species is determined by the same factors which determine that of *N. k. kaouthia*, *viz.*, the height to which the snake has raised its head above the ground. Further, this range cannot be appreciably altered unless the snake changes the height at which its head is held. The strike itself is in a forward and downward direction, and is accompanied by a sharp, sneezelike hiss. An irritated specimen may distend its body with air.

As far as is known *O. hannah* is almost entirely ophiophagous, specimens having been recorded consuming specimens of *Python* spp., *Ptyas mucosus*, *Lycodon fasciatus*, *Natrix (? Rhabdophis) platyceps*, *Blythia*

reticulata, *Dryophis mycterizans*, *Boiga dendrophila melanota*, *Bungarus fasciatus*, *Naja naja*, *Ophiophagus hannah*, and *Maticora bivirgata*. SHEBBEARE (1947, p. 32) mentions a 3658 mm long specimen consuming a 2794 mm long python, a specimen eating 82 snakes in one winter, and a 4268 mm long specimen eating 13.7 metres of snakes between July and March. FAYRER (1874, p. 9) wrote of one specimen that ate two dead specimens of *Dryophis mycterizans* that had recently been killed by a cobra (N.B. : Whether or not those individuals might now be considered *mycterizans* is questionable, inasmuch as this form has undergone considerable revision since 1874). TAYLOR (1965, p. 956) writes that as the species is ophiophagous it requires a considerable territory for food-finding.

Although primarily ophiophagous, *hannah* occasionally takes animals other than snakes as food. Various authorities have reported that captive individuals have eaten monitor lizards (*Varanus* spp.) and small mammals (*Mustela flavigula*, etc.). Living specimens in Mr. Y. Siah's Bangkok Reptile Grove for a time thrived on adult specimens of *Varanus bengalensis nebulosus*. These they would subdue by grasping a part of the animal, usually a limb, and tenaciously hanging on to it until the lizard expired. This sometimes would take half an hour, during which time the snake would occasionally "masticate" the limb.

WALL (1924, p. 191) writes that in its wild state *O. hannah* may live from ten to fifteen years.

b. ***Reproduction:*** Much is known of the reproduction of this species. Pairs "in copula" have been discovered in the wild in January, early March, and late April or early May. A 3658 mm long specimen in the collection of Mr. Y. Siah (which was collected in Nakhon Si Thammarat province, Thailand) laid six eggs on 10 August 1965, but these may have been abnormalities as they were infertile and did not hatch. The "gestation" period is not definitely known, but nests containing eggs have been found in April, May, and June. The nests themselves are constructed by the female, who by utilizing the folds and coils of her body, pulls together and packs down a mound of vegetable debris. The eggs which she subsequently lays are said to measure about 55 × 27 mm, and the hatchlings from 500-535 mm long.

Much valuable information concerning the reproduction of this species was supplied to the author by Messrs. C.J.P. Ionides and J.H.E. Leakey (personal correspondence, 1966), who during a collecting trip to Nakhon Si Thammarat province, Thailand, collected 16 adult specimens along whit 458 of their eggs. Messrs. Ionides and Leakey assured this author that they will eventually publish their entire findings in *The East African Nature Journal*, but very kindly allowed him to include here the following information.

Messrs. Ionides and Leakey found 15 *O. hannah* nests. The first was examined on 8 May 1966 and the last on 23 May 1966. All nests contained eggs and the majority were being watched by a female parent. The number of eggs varied from 20-43. Those females that were in close proximity to their eggs were either coiled on top of the nest or at its base; in one case the female was two metres from her nest under some bamboo debris. In absolutely no instance of an encounter with a brooding female was any sign of aggressiveness on the part of the snake observed.

All females which retreated from their nests at the approach of the collectors invariably returned to their nests within a matter of hours; this was the case even in one instance where the vision of the female was obscured, the snake being in the last stages of preparing to slough.

The nests themselves were circular or nearly so, ranging in size from 559-965 mm by 483-1016 mm, and from 108-280 mm from the top of the nest to the top of the egg clutch. One nest was composed of large decaying leaves and situated in a woody area, whilst the remaining 14 were composed of bamboo leaves and situated in bamboo thickets. Two of the nests were found about 380 mm apart from each other. The leaves composing the bamboo nests were piled neatly on top of one another and packed down very tightly (see Fig. II).

The eggs taken from the nests were whitish, soft, narrowly oval (51-64 $\times$ 38 mm each), and more or less adhered to one another. They were laid in hollows in the earth which were apparently constructed by the parent, and were separated from the earth itself by a cushion of piled bamboo leaves 25-75 mm deep. The nest proper was constructed over this hollow. The hollows themselves were about 125 mm deep and varied in size from 190-230 mm in diametre. The clutches of eggs

usually filled up most of the hollows, but usually left about 13 mm to spare all round. They were not always directly under the centre of the nest, being in a few cases off to one side. Other than the clutch hollow there were no hollows or compartments in the nest.

The eggs evidenced high tolerance to ants and termites; from several eggs which had been perforated by ants there hatched normal, healthy juveniles. Messrs. Ionides and Leakey found that the nests showed wide variation in relative dampness : some were very damp, others noticibly dry, while still others were damp in their top strata but dry near the clutch proper.

The findings of Messrs. Ionides and Leakey shed light on one controversial aspect of the biosis of this species : the generally accepted belief is that the nest of the hamadryad contains two compartments, one for the egg clutch and the other for the brooding female. Messrs. Ionides and Leakey showed that this was not the case in the nests of certain Thai populations. Granted, the female may lie above or in close proximity to her eggs, often under a layer of leaves, but there is nothing to suggest that she actually builds a separate compartment for herself.

While the specimens collected by Messrs. Ionides and Leakey showed no aggressiveness in protecting their young the fact that they were with their eggs and showed a desire to remain so shows that some sort of "guarding" instinct was involved.

c. ***Habitat :*** SMITH (1943, p. 438) writes that in the western part of its range *O. hannah* is found in the mountains, whilst in the eastern parts of its range it occurs predominantly in the plains. Specimens have been reported from elevations of up to 2135 metres.

O. hannah is essentially a forest or jungle form, but occasionally is found in scrub brush areas, open fields, or near towns. It is often found near water. AAGAARD (1924, p. 315) wrote that they live in holes in the ground, usually ant hills, and GÜNTHER (1864, p. 343) reported that they inhabit hollow trees. TAYLOR (1965, p. 959) found one in a cave.

d. ***Observations :*** Specimens of *O. hannah* suffer from a variety of enemies. Worms, ticks, and leeches infest it, and many of the larger vertebrates kill it. Young specimens have been known to be killed by

fresh-water crabs. Man also kills it whenever he can, although there are reports of large specimens being run over by automobiles and evidently experiencing no damaging effects.

Many of the larger Colubrid snakes in Thailand are often mistaken for *O. hannah*. Some of these are *Ptyas korros*, *P. mucosus*, and *P. carinatus*. FAYRER (1874, p. 7) writes that in some parts of India a belief persists to the effect that all female *hannah* are venomous and all males nonvenomous, *Ptyas mucosus* being generally considered the male of the species and the true *hannah* of both sexes invariably considered to be the female. Young *O. hannah* have been popularly confused with the young of *Boiga dendrophila melanota*.

4. Distribution in Thailand

This species probably occurs throghout the whole of Thailand. It has been recorded from the following Thai provinces : Chiang Mai, Lop Buri, Nakhon Pathom, Nakhon Ratchasima, Nakhon Si Thammarat, Narathiwat, Pattani, Petchabun, Phatthalung, Prachuab Khiri Khan, Rayong, Samut Prakan, Samut Sakhon, Saraburi, Thon Buri, Trang, and Yala. GYLDENSTOLPE (1916, p. 25) reported it from Koh Lak, an island in the Gulf of Siam (probably off the coast of Southern Thailand). PURANANANDA (1957, p. 4) states that "It can be found ... in the orchards of Thon Buri and Samut Prakran but is very rare".

5. Significance to Man

This form is of importance to man as a potential menace to domesticated catte and elephants, as well as man himself. While not possessing an extremely virulent venom, *hannah* is able to inject great quantities of venom during a single bite. This, combined with the factor of fear, which figures greatly in a *hannah* bite, renders *O. hannah* the most dangerous snake in all of Asia.

In a series of twelve case reports available to the author, in which humans died as a result of being bitten by *O. hannah*, the time lapse between the injection of the venom and death ranged from within a few minutes to six hours. Symptoms involved were immediate pain which gradually increased in intensity, local swelling, numbness of the bitten

part, dizziness, nausea and vomiting, drooping of the eyelids and inability to keep the eyes open, stiffness of the jaws, difficulty in swallowing, dyspnoea, coma, weak pulse, laboured, breathing, prostration, and spasms. Death, if the outcome of a bite, is the result of respiratory or cardiac failure. *O. hannah* venom has little effect on the blood and circulatory system so that bleeding or bloody discharges are usually not experienced.

It should be noted that not all *hannah* bites prove fatal, but this of course is true in all venomous animals. WALL (1913, p. 89) wrote:

> "It is interesting to note that Dr. Nicholson reported a case where a Burman snake-catcher was bitten by a ten-foot specimen in good condition. He chewed some vegetable pulp and applied it to the wound, and 'was none the worse for the bite'."

(N.B.: This report should be interpreted to mean that not all bites prove fatal, and not that the mastication and application of vegetable pulp to the wound can avert a fatal outcome.)

It should be further noted that very young *hannah* are not as dangerous to man as are older ones, this being due to the minuteness of their fangs. Mr. Y. Siah, who was bitten by a few-days old specimen, suffered no ill consequences because the infant serpent's fangs failed to penetrate his skin.

O. hannah is important to certain groups of people commercially and religiously. Both large and small specimens command handsome prices in zoos and private collections in Europe and America, and in Asia various parts of their bodies are used as food and medicine by some peoples. When in Hong Kong in 1964 the author noted specimens in various snake shops; these were meant for human consumption. SHEBBEARE (1947, p. 32) wrote that certain hill tribes in Burma venerate it, and the same is true of certain groups of people in India.

6. Conclusions

a. While the author herein uses the generic name *Ophiophagus* to designate the hamadryad he realizes that there is wide disagreement over which of the many names that have been used for it is indeed correct.

b. No subspecies of *O. hannah* are presently recognized. However, various authors have suggested that this form as now recognized may be in reality a composite of several subspecies or even distinct species. The present author tends to agree with this view, and feels that an evalution of the material at hand would reveal a number of distinct forms now incorrectly named *O. hannah.*

BOGERT (1943, p. 304: cited by LEVITON, 1964, p. 545) suggested that dental characters might provide a basis for the segregation of subspecies or species of the hamadryad. DERANIYAGALA (1960, pp. 57-59) discussed nine apparent geographical races of this snake, stating that these races, together with apparent variations in lepidosis, coloration, and other characters, suggest the existence of six different subspecies. In a later paper (1961, pp. 228-230) he discusses a *forma typica*, two questionable subspecies, and a further geographical race. He suggests that the coloration of juvenile specimens as well as the ventral + subcaudal counts would appear to have diagnostic value in the evaluation of the problem.

DERANIYAGALA'S above-mentioned studies are enlightening but may be disputed, so that until such time as a more intensive study is made it would seem best to consider the hamadryad as it has long been considered, *viz.*, a single species having no subspecies. This is how it has been treated in this paper.

c. This is the longest venomous snake in the world.

d. Its hood is not oval and curved as is that of *N. k. kaouthia*, but is relatively narrow and tapering.

e. There is much variation in colour among specimens of the same age as well as great differences between the coloration of juveniles and adults.

f. This is one of the few Asian snakes in which some of the subcaudals are arranged singly and the others biserially.

g. It has a pair of occipital scales which are in contact with each other and these, arranged thus, are absolutely diagnostic of it, being found in no other known Asian snake.

h. Sexual dimorphism is evidenced in ventral counts.

i. It is terrestrial, diurnal, ophiphagous, and oviparous.

j. It does not attack without provocation.

k. It possesses a relatively high level of intelligence.

l. The brooding female does not aggressively protect her eggs but does show definite "guarding" instincts.

m. A nest is constructed, evidently by the female, and the eggs are laid in it, but there ir no second compartment for the female herself.

n. It can be found in a wide variety of habitats, and does not show preference to any one type of geological or biological zone.

o. It is evidently distributed throughout the whole of Thailand.

p. Its bite is usually fatal to man. It is also of some significance to man commercially.

V. GENUS *MATICORA* GRAY, 1834 (Coral Snakes)

Elaps Schneider, (part.), Hist. Amph., 1801, vol. 2, p. 289.

DIAGNOSIS: Head relatively small, subovate, not or only slightly wider than neck; eye size small; pupil circular; scales large, smooth; nasal sutured; loreal absent; maxillary bone extending forward beyond palatine bone; prefrontal bones in contact with each other; maxillary teeth 0-1, in addition to a large venom-conducting fang which is distinctly grooved anteriorly; mandibular teeth subequal; venom glands elongate, increasing in diameter posteriorly, terminating in front of heart in club-shaped ends; these glands extending into body cavity along either side of anterior third of body and causing a thickening of cardiac region in second third of body; heart situated in second third of body. Body cylindrical, very elongate and slender; costals smooth, pitless, number on anterior third of body equal to number on posterior third of body; anal single or double; hypapophyses present throughout vertebral column. Tail length short; subcaudals biserial.

OBSERVATIONS : According to TWEEDIE (personal correspondence, 1966), these snakes are called "matahari" (=sun), or "sina matahari" (=sunbeam), by the people of Malaya. These names would suggest a possible source of the generic name *Maticora*.

The most remarkable feature of the snakes of this genus is the extraordinary development of their venom glands. It immediately distinguishes them from species of *Calliophis*, to which they are very closely-related and in which genus they were once placed, and from all other Asian serpents. It is interesting to note, however, that in the snakes of the African genus *Causus* (four species) the venom glands are also elongate.

The snakes of the genus *Maticora*, like many elapids, indulge in curious defensive behaviour when in certain emotional states. When stimulated by fear, irritation, or anger, they writhe and tumble about, flaunting their conspicuously coloured tails and sometimes making darting movements with them in evident attempts to draw attention away from their heads.

The two forms known to occur in Thailand are *bivirgata flaviceps* and *intestinalis intestinalis*. They may be differentiated from one another by the following key:

A Key to *Maticora* Presently Known from Thailand

1. Body black, head and tail red, venter immaculate red . . . . . ***bivirgata flaviceps***

   Boby with eleven longitudinal stripes, venter with black and yellowish crossbars . . . ***i. intestinalis***

A. ***Maticora bivirgata flaviceps*** (Cantor), 1839 (Ngu fai; White-striped Coral Snake)

Elaps bivirgatus H. Boie (*in* F. Boie), Isis, 1827, p. 556, (type-locality, by inference, Java). Plate XXXIII.

1. Identifying Characteristics

Head red or orange, body black, tail red or orange; subcaudals biserial; venom glands extending into body cavity.

2. Physical Description

a. ***Dimensions:*** A large snake, the largest coral snake *(Maticora* or *Calliophis)* occurring in Thailand. TAYLOR (1965, p. 962) writes that it reaches a length of 1810 mm. Measurements made by the present

author of a specimen in the Chulalongkorn University Collection (No. 2602) are given below to show the relationships between various dimensions (in mm):

Total length	1345
Length of head	23
Length of body	1172
Length of tail	150
Width of neck	12
Width of midbody	14
Width of tail base	9

As can be seen from the above list of measurements the body is relatively thin. The tail is likewise relatively short in comparison to the length of the body, and this is true in most specimens.

b. ***Physical Characteristics:*** Head subovate; nostril large; diameter of eye nearly equal to distance from eye to oral margin; venom glands extending into body cavity as opposed to being confined to temporal region of head; anterior part of larynx, instead of adhering to upper part of membranous sheath which encloses tongue, free and projecting into mouth like a small tube (*vide*, CANTOR, 1847, p. 110).

c. ***Coloration:***

Juvenile: As in adult, except perhaps with more distinct markings.

Adult: Head bright coral red, slightly darker red in occipital region, slightly lighter red on chin; this colour extending back on sides of neck behind mouth angle; eye circumscribed by a narrow black ring or only partially circumscribed; a black line along interparietal suture to frontal extending out of black of nape.

Body highly iridescent dark blue to black, each scale somewhat light-edged, with a pale or whitish lateral stripe beginning a short distance behind head on either side and laying along two lowest costal rows; this stripe separated from red of venter by a narrow dark line formed by outer edges of ventrals being blue-black or black; venter bright red. Interstitial skin greyish or black.

Tail bright red with a relatively thin, posteriorly tapering, dorsal line of dark blue or dark purplish blue which is continuous with dark dorsal colour of body.

d. ***Lepidosis :***

Head : Rostral wider than high, visible from above; supralabials 6, third and fourth touching orbit, sixth largest; nasal sutured; oculars 1+2, preocular touching third supralabial, lower postocular narrow and elongate; temporals 1+1 or 1+2, anterior large and touching fifth and sixth supralabials; internasals small, wider than long, each narrowed to a point laterally; prefrontals about as wide as long, each touching internasal, nasal, preocular, supraocular, and frontal; frontal large, longer than wide, equal to or a little longer than its distance from tip of snout, as long as or a little shorter than parietals; infralabials 6, fourth largest, touching two scales behind; genials subequal, anterior pair usually a little longer than posterior pair and in contact with 3 or 4 infralabials.

Body : Vertebrals not larger than scales in adjacent rows; costals 17 (neck), 13 (rest of body), smooth, pitless; ventrals 244-294; anal single.

Tail : Subcaudals 34-52, biserial (or rarely a few single as an aberrant character).

In some of the older literature it is sometimes difficult to determine exactly which subspecies was being referred to. For this reason the author uses TAYLOR's (1965, p. 961) ventral and subcaudal counts of 294 and 52 respectively for a Thai specimen of *flaviceps* as the maximum known counts in each category for this subspecies.

TAYLOR *(ibid.)* writes that the ventral+subcaudal counts of specimens of *flaviceps* from Sumatra is usually distinctly less than it is for specimens from the Malay Peninsula. He further states that available counts for male specimens from Malaya show the ventral+subcaudal counts varying from 326-346 and that a male and a female specimen from Yala province, Thailand, had counts of 346 and 298 respectively.

e. ***Hemipenis :*** In the source material examined in the preparation of this paper no mention of the hemipenis of any of the subspecies of *M. bivirgata* was found.

3. **Biosis**

a. ***General Habits :*** This subspecies is representative of the known Thai elapids in that it is terrestrial, probably nocturnal, and apparently

mainly ophiophagous. Its diet has been known to include the following snakes: *Pareas margaritophorus*, *Calamaria vermiformis*, *C. pavimentata*, *C. gimletti*, and *Maticora intestinalis*.

Judging by the observations made by various authors this subspecies seems to behave somewhat like the closely related *Bungarus fasciatus* in that when annoyed or irritated it flinches convulsively but does not attempt to defend itself effectively. CANTOR (1847, p. 110) wrote that in such cases "they make a few strenuous efforts to slide away, but soon stop, and if further pursued make some irregular spasmodic-like movements, but have not been observed to bite..."

Dr. E. H. TAYLOR writes (1965, p. 962):

> "While collecting on Fraser's Hill in Malaya I unexpectedly came upon one under a rock, where I had chased a *Mabuya*. As I lifted the rock the snake suddenly emerged, its teeth becoming caught in my sleeve at the wrist, from where it writhed and twisted as I tried to shake it loose."

Taylor's experience was purely accidental *(vide*, personal correspondence to the present author, 1966). Most individuals, even if much annoyed, simply raise and gently wave their tightly coiled and brightly coloured tails. ALFRED (1960, p. 140) writes that upon considerable provocation some individuals were observed to vibrate their tails.

A humerous account given by BATCHELOR (1960, p. 132) concerns a specimen of this form. He writes:

> "A Blue Coral Snake, *Maticora bivirgata*, learnt to associate interference with the movement of the glass front to its cage and a soft tap on this would immediately set the snake tying itself into knots. I noticed it do this one day when a Borer-Bee had careened inadvertently into the glass."

M. b. flaviceps has the habit of resting with its body thrown into irregular loops and folds and not proper coils, a habit which the author has also observed in *Calliophis maculiceps maculiceps*.

b. ***Reproduction:*** Unknown.

c. ***Habitat:*** Specimens of the constituent forms of *bivirgata* have been taken at both high and low elevations. The highest such is

apparently 1200 metres (*vide*, de Rooij, 1917, p. 252). Tweedie (1961, p. 98) writes that it is common everywhere in the lowlands of Malaya.

This form *(flaviceps)* is evidently essentially forest-dwelling, but specimens of it have been recorded as being commonly found in strips of mature rubber trees and in patches of jungle. Taylor's above-mentioned experience shows that specimens may be looked for under rocks and stones. Smith (1930, p. 68) mentioned one taken in a bungalow in Songkhla province, Thailand.

d. *Observations:* This subspecies evidently does not often come into contact with human beings, and this may be one reason that a belief concerning it has sprung up among certain peoples in parts of Thailand. Mr. O. Gordon Young related to the author the fact that in Peninsular Thailand this subspecies is reputed to travel through dry grasses in the dry season so rapidly that the grasses are ignited. The originators of this obviously false belief were probably led to that conclusion by seeing the bright red of a specimen as it vanished from sight into some dry grasses. They probably also heard the swishing and crackling of the snake as it made its way through the grass and mistook this to be the crackling of sparks and flames.

4. Distribution in Thailand

In Thailand this form has been collected only in the peninsula, having been taken in the provinces of Narathiwat, Pattani, Songkhla, and Yala. Further, there is little to suggest that it extends up the peninsula for any great distance, i.e., it probably occurs in Thailand only in the peninsula.

5. Significance to Man

This form is known to be capable of killing a human being with its venom, there being several documented case records of such deaths. The first is evidently that of Harrison (1957, p. 130) concerning a two-year-old Malayan child. Harrison writes:

> "At sunset one day last October a two-year old girl was playing on the concreted space outside her house near Malacca when she suddenly began to cry. Her father came out to comfort her, and on picking her up, saw a brightly coloured snake disentangle itself from her arm and glide

away. A neighbour killed the snake before it went more than a couple of yards. The child was taken to the house of the estate Hospital Assistant a few hundred yards away, and he found the bite as a chocolate-coloured patch, about the size of the end of a pencil, on the hand between the roots of the thumb and first finger. The child was given some first aid and hurried to the nearest hospital, but she died on the way."

KEEGAN, *et. al.* (1964, p. 35) write that "REID (1958) reported two additional cases, neither of which was serious".

Besides being a potential menace to human life this form may be of use to man in helping him to comprehend the relationships between various animals which are similar to each other in the study of mimicry.

6. **Conclusions**

a. KLEMMER (1963, pp. 299-300) lists three subspecies of *bivirgata*, *viz.*, *M. b. bivirgata*, *M. b. flaviceps*, and *M. b. tetrataeniata*. These are apparently fairly distinct from one another.

b. This is one of the larger elapids known to occur in Thailand and is the largest member of the coral snake group (maticorids and calliophids).

c. Its venom glands, instead of being confined to its head region, extend into the body cavity along the anterior third of the body.

d. There is apparently very little difference in the coloration of juveniles and adults.

e. Specimens from mainland Asia evidently have distinctly greater ventral+subcaudal counts than do those from Sumatra.

f. Apparently nothing has been published on the hemipenis of this form, or at least no information concerning it is readily available.

g. It is terrestrial, apparently nocturnal, and evidently largely ophiophagous.

h. When annoyed or provoked it makes no effort to defend itself effectively but instead flinches convulsively and attempts to draw attention away from its head by tightly curling its brightly coloured tail and waving it at its source of annoyance.

i. No information is available concerning its reproductory habits.

j. It has been taken at both high and low elevations and evidently does not show preference to either condition. It is occasionally met with near human habitations.

k. In Thailand it is evidently found only in the peninsula, where it is uncommon.

l. It is signigicant to man as a potential danger.

m. The closely related *Bungarus f. flaviceps* has a colour scheme which, because of the fact that it is very similar to that of the present form, may suggest a mimetic relationship. The nonvenomous *Calamaria leucocephala* is likewise coloured much like the present form and a mimetic relationship may also occur between these two.

B. ***Maticora intestinalis intestinalis*** (Laurenti), 1768 (Known to the people of Pattani province as "Ular sina matahari"; Belted Coral Snake)

Aspis intestiualis Laurenti, Specimen medicum exhibens synopsin reptilium emendatum, 1768, p. 106, (type-locality, based on Seba, vol. 2, fig. 7). Plate XXXIV.

1. **Identifying Characteristics**

Head and tail not red or orange; body with eleven longitudinal stripes; venom glands extending into body cavity.

2. **Physical Description**

a. ***Dimensions:*** A small snake. The maximum total length recorded for this subspecies is apparently 580 mm; BOULENGER (1890, p. 387, subspecies uncertain) gave the total length of *M. intestinalis* as 608.9 mm.

Male specimens are evidently larger and longer than are female specimens, and males usually possess relatively longer tails. This was the case in two specimens reported by TAYLOR (1965, p. 965, measurements in mm):

Sex	male	female
Total length	446±	366
Length of head	9.5	8
Length of body	?	335
Length of tail	?	23
Width of head	7	5
Width of body	8	5.5

b. ***Physical Characteristics :*** Head subovate, not wider than neck; snout rounded; diameter of eye less than its distance to oral margin; nostrils very large; venom glands, instead of being confined to head, extending into body cavity and occupying anterior third of body; body thin, elongate, subcylindrical; tail relatively short and tapering to a conical point.

c. ***Coloration :***

Juvenile: Unknown.

Adult: Head variegated black and brown with some indefinite pinkish spots on prefrontals; labials olive with blackish flecks; tip of chin greyish black, remainder of chin whitish; throat whitish graduating to greenish yellow.

Body with eleven longitudinal stripes, *viz.*: (1) a scarlet or rose vertebral stripe, broken up at regular intervals on each scale with a coral-red chevron in its latter half; (2) and (3) this stripe bordered on each side by a black line one and one-half costals wide, below which is (4) and (5) a yellowish brown line comprising one costal row and adjacent edges of other rows; below this (6) and (7) another black stripe, bordered by (8) and (9) a cream line between two outer costal rows; (10) and (11) lowest costal rows black; venter yellow or greenish yellow with from 35-39 black quadrangular bars, light interspaces being about equal in length to dark spaces.

Tail with scarlet or rose vertebral stripe of body replaced by a zigzag scarlet or rose line situated between two enlarged median scale rows; subcaudal region coral-red with one or two black bars (which may be incomplete).

d. *Lepidosis :*

Head : Rostral width equal to height, part of scale visible from above; supralabials 6, third and fourth touching orbit; nasal sutured, anterior portion largest; oculars 1+2; temporals 1+2, anterior largest and touching both postoculars; internasals smaller than prefrontals, terminating laterally in a point; prefrontals relatively large; frontal as long as or longer than wide, longer than its distance from tip of snout, shorter than parietals; supraoculars not as wide as frontal; infralabials 6, last 2 very small; genials subequal, 4 infralabials touching each anterior one.

Body : Costals smooth, pitless, 17 (nape), 13 (body); ventrals 224-255; anal single.

Tail: Vertebral row of body disappears at base of tail and is replaced by two enlarged median scale rows; subcaudals 22-26, biserial.

e. *Hemipenis :* LEVITON's (1963, p. 530) description of this organ in *M. intestinalis* (not specifically this subspecies) is as follows: "Hemipenis extend to twelfth subcaudal plate, forked at tenth plate; sulcus spermaticus unforked; walls of organ uniformly spinose except at basal end".

3. **Biosis**

a. *General Habits :* This subspecies evidently shows no tendency towards being specifically either nocturnal or diurnal. It is terrestrial and may be found near water.

In its movements this form is sluggish and seemingly awkward. When resting it holds its body in numerous irregular folds and not proper coils. If a wild specimen is touched it will usually make an attempt to escape. If, however, it is further irritated and prevented from escaping it will follow a stereotyped defensive behaviour pattern. It raises and displays its tightly coiled and brightly coloured tail and flops and writhes about erratically, sometimes actually throwing its entire body from the earth. At such times it normally does not attempt to bite its tormentor.

There is a remarkable similarity between the behaviour of this snake and that of the nonvenomous *Cylindrophis rufus rufus*. The latter,

when irritated, will also raise up its tail to display its bright subcaudal region, and will flatten its body and make erratic movements.

The diet of this form is not definitely known. It may be partially insectivorous, and has been known to eat snakes *(Calamaria vermiformis).*

b. ***Reproduction:*** According to KOPSTEIN (in 1938a, pp. 81-167) this subspecies is oviparous, laying from 2-3 very oblong—almost sausage-shaped eggs. These measure from 35-36 mm long by 9 mm in diameter and weigh approximately 1.75 gm. The incubation period of one batch of eggs was 84 days. In Java, gravid females have been found in April, May, and June, and eggs are laid in July and hatch in October. KOPSTEIN *(ibid.)* writes:

"Ein bei Wonosobo gefangnes Weibchen legte am 9. Juli 1936 . . .2 Eier, welche 35-36 mm. lang und 9 mm. dick waren. Ihr Gewicht betrug durchschnittlich 1,75 g. Aus diesen Eiern schlüpften am 1. Oktober, nach 84 Tagen, beide Junge aus."

c. ***Habitat:*** The subspecies of *intestinalis* have been found both at high and low elevations. There are also records of them being found in forest and jungle areas as well as scrub areas and the vicinity of human habitations. TAYLOR (1965, p. 965) mentions a specimen of the *forma typica* which he routed from a small termite-riddled piece of log in a grove of rubber trees.

d. ***Observations:*** *M. i. intestinalis* is similar in its ventral colour aspects to two nonvenomous species of snake, *viz.*, *Cylindrophis r. rufus* and *Oligodon bitorquatus*, and almost identical in this respect to *Calliophis gracilis.* It is interesting to note that all of these react to human provocation in a similar manner, that is to say, curl their tails up and writhe about. Regarding the present form and *C. r. rufus* we have a case in which a harmless animal assumes the conspicuous livery of an aposematically coloured one and so finds protection under the shield of the latter's sinister reputation, the two being known as mimic and model respectively (according to TWEEDIE, 1961, pp. 12-13).

4. Distribution in Thailand

In Thailand this form has been taken in the provincas of Nakhon Si Thammarat, Pattani, and Yala. The fact that no specimens have been

reported from any other locality in Thailand would suggest that this is an essentially peninsular form. However, judging from this form's distribution in countries near or adjacent to Thailand, it may be found to occur much farther north in Thailand than is presently recognized. Indeed, it has been recorded from Viet Nam to the east of Thailand, and from Burma and India to the west. (N.B.: The validity of GÜNTHER's report of a specimen from Central India (1864, p. 349) has been questioned by various writers.)

5. Significance to Man

Due to its small size, diminutive mouth and venom-conducting fangs, secretive habits, and sluggishness, this form can hardly be called a dangerous serpent. However, it does have a virulent venom. Dr. E. Jacobson, while in Bandoeng, Java, to collect snakes, was bitten by one of this form which measured 492 mm long. The snake, probably with full venom glands as a result of having recently sloughed (snakes do not feed during the later stages of sloughing), bit him on the skin at the base of the index finger of his left hand, implanting only one fang. The account of the circumstances which followed is given below (JACOBSON, 1937, pp. 78-79):

> "Immediately after the bite I felt a slight stinging pain in the wound. Gradually some swelling and redness of the skin showed at the base of the index finger at the inner side of my hand, which spread to the base of the middle and ring fingers. About an hour later the redness had disappeared and also the oedema was less. Only an insignificant swelling remained which made it a little difficult to close my hand. I thought that all ill-effect of the bite had disappeared, when two hours and a quarter later I was suddenly overcome by a severe fit of oppression and dizziness. I rushed to the telephone to summon a doctor, but was not able to do so, owing to giddiness, and I could hardly stand on my feet. When I managed with difficulty to reach my bed and lay down the symptoms gradually decreased. My wife immediately summoned the family doctor and also telephoned to the Institute Pasteur for anti-venine.

"During the dyspnoea my face showed an excessive pallor, the mouth became very dry and the throat was swollen, so that it was difficult to swallow. I wildly tossed myself to and fro under the influence of the threatening suffocation. When the doctor arrived three hours after I had been bitten he administered at once two camphor injections as excitansia.

"After a quarter of an hour a second attack occurred. The respiration was very difficult, cold perspiration broke out, and vomiting set in. These attacks succeeded each other with gradually increasing intervals of fifteen to thirty minutes, each one not lasting more than five to ten minutes. In all I suffered five or six heavy attacks as well as some lighter ones.

"The peristaltic movement of the bowels was very much increased and frequent evacuations of watery stools took place.

"During the intervals between the attacks my condition was not alarming and I was able freely to converse with the doctors . . .

"Whereas the poison of other *Elapinae* such as *Bungarus*, *Naja*, and *Acanthophis* causes first an acceleration, followed by a steadily decreasing and finally a standstill of the pulse, in my case the pulse was only a trifle accelerated, viz., 80, my normal pulse being from 75 to 78. The body temperature also remained normal. The whole evening I felt a slight pain at the back of my head.

"Some five hours after I had been bitten I was overtaken by chattering of the teeth, shivering of the whole body, and a slight cramp of my jaw. At the same time my feet and hands were icy cold, but the temperature of my body remained normal.

"Gradually all alarming symptoms subsided and six hours after the bite the attacks ceased altogether. After taking some tablets of Bromural I slept an uneasy sleep, interrupted by repeated evacuations.

"The next morning I felt rather shaky as if I had pulled through a severe illness, and the whole day I had frequent motions."

JACOBSON ends his account by stating that his case demonstrated that the venom of *Maticora* may cause more serious symptoms in man than it had been assumed to be able to cause.

Other than possessing a dangerous venom this form would seem to be of little significance to man.

6. Conclusions

a. There has been some disagreement over the number of subspecies of *M. intestinalis*, and there is evidence to suggest that certain forms currently recognized as subspecies should be actually considered distinct species. LEVITON (1963, p. 530) states that variations in ventral and subcaudal counts might be incorporated in the distinguishing of already existing subspecies as characters supplementary to coloration.

b. A single subspecies of *M. intestinalis*, *viz.*, the *forma typica*, occurs in Thailand.

c. Its venom glands, instead of being confined to the head, extend into the body cavity for a third of its length.

d. Males seem to be larger and longer than females.

e. Whether or not juvenile specimens are coloured similar to adults needs to be verified.

f. There is not much variation in its overall lepidosis.

g. It evidently shows no preference to being either nocturnal or diurnal. It is terrestrial.

h. When irritated or provoked by humans it does not attempt to defend itself but indulges in a stereotyped defensive behaviour pattern in which it writhes and flops about. It does not attempt to bite.

i. Its exact food preferences are not known, but it is probably either ophiophagous or insectivorous.

j. It is oviparous.

k. It evidently shows no preference to either high or low elevations, being found in both, and it is sometimes found near human habitations.

l. It is presently known in Thailand only from the peninsula, but may be found to occur farther north.

m. It is a potential danger to man, but because of its small size, diminutive mouth and venom-conducting fangs, secretive habits, and awkwardness, it can hardly be considered deadly.

VI. GENUS *CALLIOPHIS* GRAY, 1834 (Coral Snakes)

Calliophis Gray, Illustrations of Indian Zoology, vol. 2, 1834, p. 86, fig. 1, (type of genus, *gracilis*).

DIAGNOSIS: Head small to very small, subovate, not wider than neck; eye size small; pupil circular; scales smooth; nasal sutured; loreal absent; maxillary bone extending forwards beyond palatine bone; prefrontal bones in contact at median line; maxillary teeth small, 0-6 in addition to a small or extremely small venom-conducting fang which is distinctly grooved anteriorly; mandibular teeth more or less equal in length; venom glands not extending into body cavity. Body cylindrical, slender, moderately long to very elongate; costals smooth, pitless, number on anterior third of body equal to number on posterior third of body; hypapophyses developed throughout vertebral column. Tail short; subcaudals biserial (rarely a few in the subspecies of *macclellandii* single).

OBSERVATIONS: The generic term "Calliophis" is derived from the Greek "kallos" meaning beautiful and "ophis" meaning snake. This alludes to the pleasant coloration of these snakes, all or most of which are resplendent in reds, oranges, yellows, and blues.

The genus *Calliophis* is very closely related to the genus *Bungarus*, from whence it is very likely derived. It was for a long time considered to contain forms which are now placed in the genus *Maticora* on the basis of the elongation of their venom glands. It differs from the South African and Tropical American genus *Elaps* in having a groove along the entire length of the maxillary and in having prefrontal bones.

In the past there has been some disagreement over the question of whether or not the genus *Hemibungarus* should be united with the present genus. SMITH (1943, p. 419) united the two for the reason that the presence or absence of maxillary teeth behind the venom-conducting fangs was not a stable enough character to use in the separation of them. TAYLOR (1965, p. 966), however, questioned the wisdom of SMITH'S decision, but noted that "A review of the matter is to be desired".

The snakes of the genus *Calliophis* are terrestrial and secretive, and are for the most part crespucular or nocturnal. Their dietetic preferences are unknown in many cases but they would appear as a rule to be either

insectivorous or ophiophagous. They are found at both high and low elevations. The snakes of the nonvenomous genus *Calamaria*, which are often eaten by those of the present genus, are similar to the latter in habits, physical charcteristics, and geographical distribution (*vide*, CANTOR, 1864, p. 347).

BANERJI (1956, p. 83) reports that a thirty-two year old woman of the Punjab, India, was bitten in the temple by a "coral snake" *(? Calliophis)*. She received treatment for her wounds three minutes after sustaining them and subsequently survived! However, the present author looks askance at this record.

Five forms of this genus are known to occur in Thailand, *viz.*, *C. macclellandii*, *C. gracilis*, *C. hughi*, *C. maculiceps maculiceps*, and *C. maculiceps malcolmi*. They may be differentiated from each other by the following key:

A Key to the *Calliophis* Presently Known from Thailand

1. Black marks on dorsolateral regions:
   —not present; tail with two black crossbands . . . . . ***hughi***
   —present 2

2. Black marks on venter:
   —not present; tail with two black crossbands; dorsal aspects with black dots or blotches or a black vertebral stripe . . . . . ***maculiceps***

   Body yellowish orange to yellowish brown, with small black dots and/or blotches on dorsolateral aspects; ventrals 174-247 . . . . . ***m. maculiceps***

   Body without black dots or blotches and with a conspicuous black vertebral stripe; ventrals 173-198 . . . ***m. malcolmi***
   —present 3

3. No longitudinal stripes on body; venter with black blotches . . . . . ***m. macclellandii***

   Longitudinal stripes on body; venter with black crossbands . . . . . ***gracilis***

A. *Calliophis macclellandii macclellandii* (Reinhardt), 1844
(Macclelland's Coral Snake)

Elaps macclellandii Reinhardt, Calcutta Journ. Nat. Hist., vol. 4 1844, p. 532, (type-locality, Assam). Plate XXXV.

1. **Identifying Characteristics**

Body reddish or brownish with thin black crossbars; supralabials 7, a single temporal touching fifth and sixth supralabials only; anal biserial.

2. **Physical Description**

a. ***Dimensions:*** A relatively small snake but one of the larger members of the genus. The maximum recorded length for this form is evidently that of WALL (1918, p. 630) for a specimen which measured 812.8 mm long. However, the average length of adults is considerably less than this. The tail, which is relatively longer in males than in females, accounts for from 1/8 to 1/11 of the total length of a given specimen.

The following measurements (in mm) are taken from an adult Thai specimen reported in a recent paper by the author (1966a, p. 38). This specimen is now C.T.N.R.C. No. 523-85.

Total length	511±
Length of head	18
Length of body	442±
Length of tail	51
Width of neck	8.5
Width of midbody	11
Width of tail base	6

TAYLOR (1965, pp. 966-969) describes and figures a young male specimen 266 mm long.

b. ***Physical Characteristics:*** Head small, depressed above, subovate, not or only slightly wider than neck; nostrils large or small, laterally situated, inconspicuous, circular; eyes small, inconspicuous, diameter of each much less than its distance to oral margin; a very small and solid maxillary tooth situated a short distance behind venom-conduc-

ting fang usually present; palatine teeth 6-8, decreasing in size in both directions from fourth or fifth and grooved on their outer edges. Body subcylindrical, slender, and elongate. Tail short, moderately stout, tapering from broad base to stubby end; terminal scale cone-shaped.

c. *Coloration :*

Juvenile: Apparently as in the adult but probably brighter with more distinct markings.

Adult: Head and anterior portion of nape black to dark brown above; a small area (usually not seen from above) at or near tip of snout often pale in colour, sometimes very distinct; a conspicuous, broad, irregularly shaped cream or ivory-white crossbar touching or behind eyes and extending to oral border; chin and throat creamy white or white to very light grey with or without dark spots or flecks. Eye dark grey to black, sometimes with an arc or ring of ruddy gold bordering pupil; tongue greyish.

Body reddish to pinkish brown above, each scale dark edged and thus conspicuous, with 16-37 almost equidistant narrow black or dark brown crossbars, each narrowly bordered anteriorly and posteriorly with cream, light brown, or vermillion, and covering from one to two costal rows; these crossbars may or may not reach ventrals; small black spots or flecks sometimes present between crossbars; dorsolateral region progressively lighter towards venter; yellowish or white below, distant edges of ventrals sometimes clouded with light brown; 50-70 conspicuous black blotches, each covering from one-half to eight ventrals, run length of venter; these blotches may be separate or partially fused with one another, and may be continuous with dorsolateral crossbars.

Tail reddish to pinkish brown above, each scale dark-edged; 2-7 almost equidistant narrow black or dark brown crossbars, last a very short distance from tip; subcaudal region grey or creamy white with scattered dark spots or flecks and distinct black bands or blotches which are more or less continuous of dorsal crossbands.

d. *Lepidosis :*

Head: Rostral wider than high, bluntly rounded part of scale visible from above; supralabials 7, third and fourth touching orbit, third sometimes touching nasal; nasal sutured; oculars 1+2, anterior in contact

with or separated from nasal; temporals 1+1 (rarely 2), anterior touching fifth and sixth supralabials; internasals wider than long, shorter than prefrontals; prefrontals large, broadly in contact with supraoculars, larger than internasals; frontal longer than wide, as long as or a little longer than its distance from tip of snout, as long as or shorter than parietals; supraoculars longer than wide, not as wide as frontal; mental triangular; infralabials 6, fourth largest; genials subequal, 3-5 infralabials in contact with each anterior genial (second rarely failing to make contact), third and/or fourth infralabial in contact with posterior genial on each side.

Body: Vertebrals not larger than scales of adjacent rows; costals imbricate, pitless, 15 (nape), 13 (most of body); ventrals 182-244 (males 182-212, females 208-244, *vide*, SMITH, 1943, p. 424), somewhat angularly bent (several may be biserial as aberrations); anal usually divided.

Tail: Subcaudals 20-41 (males 28-36, females 25-33, *vide*, SMITH, *ibid.*), biserial (or several single as aberrations).

e. *Hemipenis:* The hemipenis of *macclellandii* extends to the sixth to eighth subcaudal and is forked near its tip opposite the sixth subcaudal. It is spinose and calyculate throughout, the spines being fairly numerous, short, relatively uniform in size (except near tip of organ where they are smaller), and set on the margins of the calyces. Proximally the spines are set along low, longitudinal, fleshy ridges, while mesially and distally each one is mounted on a rather globular base. Some of these bases are divided on their distal aspects, the resulting branches being more or less connected with adjacent bases by low ridges. Two short, conspicuous ridges, beset with numerous small spines, lie adjacent to the sulcus and somewhat nearer to the point of forking than to the base of the organ. The lips of the sulcus are well developed and devoid of spines proximally (based on information given by SMITH, 1943, p. 424, and POPE, 1935, p. 342).

3. Biosis

a. *General Habits:* This nocturnal form is normally slow-moving and inoffensive yet is said to be very lively when trying to escape any impending danger. If an alert specimen is touched by a foreign object

it will usually flatten its whole body to a remarkable degree. Like most Asian elapids it is reluctant to bite but can and will attempt to do so if the necessity arises. WALL (1925, p. 821) writes:

> "One was encountered one evening in Maymyo. It escaped quickly into a bamboo clump. Captain Donelly seized it by the tail, and pulled it out, but narrowly escaped being bitten by a determined snap of its jaws."

The anal glands of *macclellandii* are said to secrete a custard-like substance which may be of use in discouraging the advances of potential enemies (*vide*, WALL, 1918, p. 630).

C. macclellandii would appear to be a predominantly ophiophagous form, and it has been recorded to have eaten specimens of *Typhlops braminus* and *T. diardi*, as well as the lizard *Ophisaurus gracilis*.

b. ***Reproduction:*** *C. m. macclellandii* is oviparous, producing from 4-14 oblong eggs. Judging from the observations of WALL (1912, p. 693) and POPE (1935, p. 343) these are laid in August, September, or October).

WALL (1912, p. 693) records a female 584 mm long killed in August in Shillong (Assam) which contained six eggs, two in one ovary and four in the other. The largest of these measured 33.3×10.9 mm. These eggs contained embryos which measured from 25.4 to 38.1 mm. long. The embryo contained in the largest egg was found to be lying in a chamber just beneath the ovicular membrane. Its head was formed, the eye, mandible, and beaked snout evident, and the heart visible outside the abdomen.

The same author (1926, p. 566) recorded a second gravid specimen which was killed on 8 July. It measured 598 mm in length and was found to contain 14 eggs in its oviducts. The eggs contained embryos which measured about 25 mm in length.

POPE (1935, p. 343) records a female specimen collected by him between 12 June and 20 July which was found to contain four well-developed eggs. These averaged 20×12 mm, and the embryos contained in them were not large enough to be revealed by examination.

c. ***Habitat :*** *C. m. macclellandii* is essentially a montane form, being found at elevations of up to 1828 metres. There are, however, records of its being found at considerably lower altitudes. ROMER (1965, p. 3) writes that specimens in Hong Kong have been taken as low as 55.5 metres above sea level, and KUNTZ (1963, p. 59) records one specimen discovered in the compound of a home near Taipei.

Almost all authorities agree that *macclellandii* is usually found in well-forested or jungle-covered localities. POPE, however, writes (1935, p. 343) that it has been collected in open, level country.

d. ***Observations :*** This form is quite distinctive in its colour scheme and it would be difficult to confuse it with any other form of snake occurring within its range. However, it is of interest to note that in the juveniles of a number of forms (notably *Xenopeltis unicolor*) the coloration of the head suggests that of *C. m. macclellandii.* The dorsal aspects of the colour scheme of the head of the Chinese *Calliophis kelloggi* is also said to resemble that of the present form.

4. **Distribution in Thailand**

This widespread form has only recently been found to occur in Thailand. TAYLOR (1965, pp. 966-969) recorded two specimens from Chiang Mai province and the present author (1966a, pp. 35-39) recorded a third from Khao Yai National Park (a locality situated at the junction of the provinces of Nakhon Nayok, Prachin Buri, Saraburi, and Nakhon Ratchasima—latitude 14° 5′ to 14° 15′ North, and longitude 101° 5′ to 105° 50′ East). These are presumably the only specimens that have been reported from Thailand.

The view that this subspecies is essentially montane is upheld by the fact that the three above-mentioned specimens were taken at high elevations.

The fact that a specimen of this form was taken in Khao Yai—far south of its previous known in Southeast Asia--suggests that this form may be looked for and found in any part of Thailand wherein there are high mountains or hills.

5. **Significance to Man**

This form may be considered capable of accounting for deaths in man, even though no actual records of this happening are available, and it should be considered dangerous. However, because of its secretive and nocturnal habits, relatively small size, and montane habitat preferences, it must seldom come into contact with human beings (this probably being the reason for its not having been reported from more localities in Thailand than it has). As is the case with all Asian elapids, however, deaths from the bite of this form probably do occur from time to time but fail to be subsequently recorded in scientific journals.

6. **Conclusions**

a. It is one of three subspecies of *macclellandii* presently recognized, the other two being *swinhoei* and *univirgatus*. M. SMITH (1943, pp. 424-425) placed a number of "colour varieties" *(univirgatus, nigriventer, gorei,* and *concolor)* as synonyms.

There has been a fair amount of controversy in the past over the question of whether or not it is correct to recognize Formosan specimens (which have much higher ventral counts than normal) as species apart from the *forma typica*. POPE (1935, p. 343) saw virtue in this division, but SMITH (1943, p. 425) gave reasons for not considering the Formosan form (designated *C. formosensis*) different. KLEMMER (1963, p. 284) puts *formosensis* in the synonmy of *C. m. swinhoei*.

b. It is closely related to the Japanese *Calliophis iwasakii*, which differs from it in having temporals 1+2 and in certain aspects of its coloration.

c. It is one of the largest members of its genus and is the largest member presently known to occur in Thailand.

d. Sexual dimorphism is evidently evidenced in tail lengths, which average longer in males than in females.

e. There is apparently not too much colour variation in this form, regardless of the fact that the head and ventral markings are usually very irregular.

f. It is terrestrial and nocturnal, and although normally inoffensive and timid can and will attempt to bite when the need to do so arises.

g. It is oviparous, laying from 4-14 eggs during August, September, and October.

h. It is essentially a montane form.

i. It usually inhabits well-forested or jungle-covered localities.

j. It is one of the most, if not the most, widespread member of its genus, but has been recorded from Thailand only three times. However, it is probably more widespread in Thailand than it is presently known to be.

k. Being relatively large and possessing a venom, this form must be accounted as potentially dangerous. However, there are no available reports of a specimen biting a human being.

B. ***Calliophis gracilis*** Gray, 1834 (Spotted Coral Snake)

Calliophis gracilis Gray, Illustrations of Indian Zoology, vol. 2, 1834, pl. 86, fig. 1, (type-locality, Penang Island, Malaya). Plate XXXVI.

1. **Identifying Characteristics**

Body with nine dark longitudinal stripes which pass through three series of dark spots; venom glands confined to head region.

2. **Physical Description**

a. ***Dimensions:*** A relatively small snake. The maximum length recorded for this species is evidently that of GÜNTHER (1864, p. 349) of a 748 mm long specimen, of which 38 mm was the length of the tail. De ROOIJ (1917, p. 251) wrote that for a specimen 740 mm long the head and body accounted for 705 mm and the tail for 35 mm.

The following measurements of a specimen of this species were compiled by the author after an examination of C.T.N.R.C. No. 523-677. They should serve to show the relationships between various dimensions (in mm):

Total length	375±
Length of head	6
Length of body	342±
Length of tail	27
Width of neck	4.5
Width of midbody	6
Width of tail base	4

b. ***Physical Characteristics :*** Head subovate, distinctly depressed above; nostrils comparatively large; eye minute, its diameter approximately one half its shortest distance to oral margin. A very small solid maxillary tooth sometimes a short distance behind each grooved venom-conducting fang. Body very slender and subcylindrical. Tail short in comparison to body, blunt, and terminating in a large rounded scale.

c. ***Coloration :***

Juvenile: As in adult but with a lighter and usually more reddish ground colour.

Adult: Head yellowish brown to brown above, with symmetrical markings (each scale with a pale black or light brown streak, spot, or blotch); orbital border brownish; a black or light brown streak running from snout or from posterior edge of eye back to oral angle; lips yellowish white, sometimes spotted with grey or blackish grey; chin and throat white to yellowish white with brown or grey markings. Iris black; tongue bluish grey.

Body reddish, greyish, or pale brown above (those scales so coloured being dark-edged and thus conspicuous), with nine dark longitudinal stripes, *viz.*: (1) a distinct straight-edged dark brown or black stripe running length of, but not quite covering, vertebral row, and bifurcating on parietals; a series of small, white-edged, dark brown or black spots set on this stripe at intervals of approximately 25 mm in adults; this stripe bordered on each side after a space of nearly two costal rows by (2) and (3) a greyish or light brown stripe set on adjacent edges of fourth and fifth costal rows, and passing through a series of 26 large dark brown or black blotches which almost touch vertebral stripe and extend down to about third lowest costal row, and which are placed opposite a similar series of spots on other side of body midway between spots on vertebral stripe (i.e., spots on rows (2) and (3) in pairs and alternating in position with spots on row (1); first pair of spots on nape noticibly elongate; almost two costal rows below this stripe a thicker, darker stripe, (4) and (5), set on lower half of third lowest costal row and upper half of second lowest costal, and bordered above by white or pale yellow; each of these stripes bordered below by white

or pale yellow, below which is (6) and (7) a thin serrate black or dark brown stripe set on adjacent edges of first and second lowest costal rows, whose scales are each heavily edged with black or dark brown and thus very conspicuous; these stripes bordered below by yellow-white, below which is (8) and (9) a black or dark brown serrate stripe set on adjacent edges of lowest costal row and ventrals; venter alternately crossbanded with 50 pure white, yellowish, or pale citrine spaces and an equal number of iridescent black spaces, latter covering from one to six ventrals and former covering from one-half to eight ventrals.

Tail reddish, greyish, or pale brown above (usually same as body), with two large black transverse, sometimes white-edged, blotches, first near base and second toward tip; tail with five dark longitudinal stripes which extend to terminal scale (which is black with a yellow or white tip), *viz.*, (1) continuation of vertebral stripe of body; this stripe bordered on each side after a space of two scale rows by (2) and (3) a straight-edged stripe whose thickness equals that of first stripe and which is set on adjacent edges of lowermost and second lowest rows of scales; each of these stripes bordered below by a white or yellow stripe of equal thickness below which is (4) and (5) a smaller serrate stripe set on adjacent edges of subcaudals and lowest scale row; subcaudal region red or vermillion below with two to three thin crossbands, each 1-2 subcaudals wide, which are sometimes continuous with dorsal blotches. (N.B.: In the opinion of the author *C. gracilis* is the most handsome member of the family Elapidae.)

d. ***Lepidosis:***

Head: Rostral wider than or as wide as high, visible from above; supralabials 6, third and fourth touching orbit, first smallest, fifth and sixth largest; nasal sutured, anterior part largest; oculars 1+2, anterior triangular; temporals 1+1, anterior largest and touching fifth and sixth supralabials; internasals wider than long, pointed laterally, smaller than prefrontals, not bordering nostril; prefrontals nearly as long as frontal; frontal about as long as wide, as long as or shorter than its distance from tip of snout, much shorter than parietals; supraoculars very small, nearly as wide as frontal; parietals very narrow, elongate, sharply truncate, their length similar to their distance from tip of snout; mental

nearly triangular; infralabials 6-7, third or fourth largest, fifth on each side in contact with each other; genials elongate, narrow, subequal, anterior pair in contact with four infralabials.

Body: Costals smooth, pitless, with rounded ends, 15-20 (nape), 13 (body); ventrals 238-324; anal divided.

Tail: Scales in 8 rows at or near base, 6 at terminus; subcaudals 21-30, biserial.

3. **Biosis**

a. ***General Habits:*** This from has been recorded as being diurnal, but the author strongly suspects it to be either predominantly or entirely nocturnal. The fact that so little is known about many aspects of this species is probably due to there having been few specimens diligently studied, which suggests that the species is either rare or nocturnal–most probably the latter.

Calliophis gracilis is sluggish and awkward in its movements, and when resting lies with its body not coiled but thrown into many irregular folds. If touched by a foreign object a specimen will usually behave in the manner common to many elapids under similar conditions, *viz.*, it will make some attempt to escape but will soon stop, and if additionally irritated will flinch its body convulsively and writhe about. It also displays its conspicuously coloured tail, but does not attempt to bite or defend itself effectively.

This form probably thrives on insects and cold-blooded vertebrates. Its diminutive mouth and throat could not, however, take any but the smallest of lizards or amphibia.

b. ***Reproduction:*** Unknown.

c. ***Habitat:*** *C. gracilis* has been taken at elevations of up to 915 metres but has also been taken in foot hill country and in plains regions. Cantor (1847, p. 110) observed that at Penang it appears to exclusively inhabit the hills at considerable elevations, but on the Malay Peninsula and at Singapore it occurs in the valleys.

Various specimens have been taken in forest areas, under roots of trees, or in crevices in rocks.

d. ***Observations :*** This species resembles *Cylindrophis rufus rufus*, *Oligodon bitorquatus*, and *Maticora intestinalis intestinalis* in the coloration of its ventral aspects. It is interesting to note that all four forms possess similar defensive behaviour patterns; when provoked they writhe and flop about but do not attempt to defend themselves effectively.

4. Distribution in Thailand

In Thailand this species has been taken only in Pattani province, evidently only a few times. The first recorded Thai specimen was taken in Na Pradoo and recorded by TAYLOR (1965, pp. 969-971).

This species would seem to be an essentially Malayan form which extends its range a short ways up Peninsular Thailand. Although de ROOIJ (1917, p. 251) includes "Bangkok" in its range there would seem to be every reason to assume this record to be in error if Bangkok, Thailand, was being rsferred to; the latter locality is very likely far north of the actual range of this species.

5. Significance to Man

The author was able to find no record of a human being bitten by a specimen of *C. gracilis*. Apparently the only writer to discuss the venom of this form was CANTOR (1847, p. 111), who wrote :

> "After several unsuccessful attempts to make an adult *Elaps nigromaculatus* spontaneously bite a fowl, the jaws were forcibly closed over a protracted fold of the skin on the inner side of the left thigh of the bird. On account of the small gape, some difficulty was experienced in making the jaws close over the fold of the skin, and, as it appeared doubtful if the fangs had penetrated, the serpent was in a quarter of an hour compelled again to wound the fowl in the skin below the right eye. Twenty minutes after the first wound the fowl became purged, and manifested symptoms of pain in the left thigh, which was continually drawn up towards the body, although the wounds inflicted there, and below the eye, were, from the smallness of the fangs, barely visible. Twenty eight minutes after the first wound the bird commenced drooping, occasionally attempting to raise itself,

> and in 10 minutes more soporism occurred, interrupted by spasms of the neck, flow of saliva, and pecking the earth with the beak, while the pupil was spasmodically contracted, and alternately dilated. The latter symptoms continued during thirty minutes, when death occurred in an hour after the first wound had been inflicted."

While *gracilis* obviously possesses a lethal venom it should not be considered of much significance to man as a danger because of its diminutive size and consequent inability to inflict a wound. As far as is recorded this form is evidently of no nutritional, religious, commercial, or medicinal value to man.

6. **Conclusions**

a. It is a fairly stable species in that it presents no distinct taxonomic problems.

b. No subspecies of it are recognized and it is fairly easy to distinguish it from all forms to which it is closely related.

c. It is a small snake but is very slender (the most slender elapid known to occur in Thailand).

d. Juveniles are coloured like adults but are lighter and more reddish overall.

e. The number of ventrals is quite variable, being from 238-324 (a difference of 86 scales).

f. Nothing is known of its hemipenial characters.

g. It is terrestrial and occurs at both high and low elevations.

h. When irritated or provoked it does not attempt to defend itself effectively but instead indulges in a stereotyped defensive behaviour pattern.

i. Its reproductory habits are unknown.

j. The fact that at least three other forms of snake very much resemble it in colour and behaviour may suggest a mimetic relationship.

k. It probably is an essentially Malayan form whose range extends a short distance up Peninsular Thailand.

l. It is of little significance to man because of its diminutive size, there being no records of it biting a man.

C. *Calliophis hughi* Cochran, 1927

Callophis hughi Cochran, Proc. Biol. Soc. Washington, vol. 40, Dec. 2, 1927, pp. 190-191, (type-locality, Koh Tao, Gulf of Siam). Plate XXXVII.

1. **Identifying Characteristics**

Body reddish brown without small black spots or a black vertebral stripe; ventrals 285. (N.B.: Known only from the type.)

2. **Physical Description**

a. ***Dimensions:*** A small snake. The dimensions of the type as given by COCHRAN (1927, p. 191) were total length 260 mm, tail length 26 mm.

b. ***Physical Characteristics:*** In general bodily appearance and anatomical features this form apparently much resembles *C. m. maculiceps* and *C. m. malcolmi.* In all three the shape of the body, relative size and length of the tail, and configuration of the head are evidently more or less the same. Each eye of the type specimen of *hughi* is as long as its distance to the mouth.

c. ***Coloration*** (from type-description):

Head entirely black above excepting for outermost portions of parietal region and outer halves of internasals which are light brown; a black ring covering nape and ending below and behind commissure of mouth (not completely encircling neck); sutures between anterior infralabials and supralabials marked off by black (most decided mark existing between third and fourth supralabial); posterior labials entirely white.

Body uniformly reddish-brown above, exterme edges of each scale powdered with minute grey dots; no trace of spotting or striping; belly immaculate, cream anteriorly graduating to pink posteriorly.

Tail with a complete black ring at base followed by four very irregular spots ventrally and a second black ring which does not quite meet dorsally; subcaudals bluish white.

Dr. COCHRAN writes (1927, p. 190): "A note furnished by Dr. Hugh M. Smith states that in life the general color was 'reddish-brown, lighter

on belly; underside of tail light blue, with black spots; a black ring around neck, another near end of tail; throat bluish-grey . . . "

e. ***Lepidosis*** (from type-description):

Head: Rostral wider than high; supralabials 7, third and fourth touching orbit; oculars 1+2; temporals 1; frontal as long as its distance from end of snout, much shorter than parietals; second pair of infralabials much reduced in size, not touching genials; first pair of genials larger than second pair, in contact with first, third, fourth, and fifth infralabials on each side.

Body: Costals 13; ventrals 285; anal double.

Tail: Subcaudals 27, biserial.

e. ***Hemipenis:*** Undescribed.

3. **Biosis**

a. ***General Habits:*** Terrestrial; probably secretive. This form is probably either insectivorous or ophiophagous.

b. ***Reproduction:*** Unknown.

c. ***Habitat:*** The type specimen was collected under rubbish (decaying vegetation ?) in evergreen jungle.

d. ***Observations:*** As with *C. m. maculiceps*, this form is somewhat similar in size and, to a lesser degree, in colour, to several of the Thai *Calamaria*, and consequently may be confused with them.

4. **Distribution in Thailand**

This form is known from a single specimen taken by Dr. Hugh M. Smith on Tao, an island in the Gulf of Siam. While the exact location of this island was not given in the type-description, it is presumed herein that the island referred to is Tao, an island off the coast of Chumphon province. SMITH (1943, p. 421) suggests that this form may be an island race of *maculiceps*.

5. **Significance to Man**

Minimal.

6. **Conclusions**

a. It is known from a single specimen, the type.

b. No subspecies of this form are recognized. SMITH suggests that this form may be an island race of *C. m. maculiceps* (1943, p. 421).

c. It is closely related to *C. maculiceps*, the principal difference between the two being found in coloration and ventral counts. It has been shown by SMITH (1914, pp. 124-125) and TAYLOR (1965, pp. 973-978) that a great amount of variation occurs in the coloration of *maculiceps*, and it would seem that the absence of black dots in *hughi* is not an extremely stable diagnostic feature. KLEMMER (1963, p. 284) lists *hughi* as a subspecies of *maculiceps*, a step which the present author feels may not be altogether unwisely taken.

d. It has a much higher ventral count than do the subspecies of *maculiceps*.

e. Its hemipenis is undescribed.

f. Nothing is known of its biosis.

g. It is of minimal significance to man.

D. ***Calliophis maculiceps maculiceps*** Günther, 1859 (Small-spotted Coral Snake)

Elaps maculiceps Günther, Catalogue of the Colubrine snakes in the British Museum, 1859, p. 232, (type-locality, "East Indies").

Plate XXXVIII.

1. **Identifying Characteristics**

Body yellowish orange to yellowish brown, with small black dorsolateral dots or blotches; head blackish and tail with two black crossbands; venter immaculate pink or red; ventrals 174-247.

2. **Physical Description**

a. ***Dimensions:*** A relatively small serpent. The greatest recorded total length for this subspecies is evidently that of BOULENGER (1912, p.

204) of 485 mm. The tail grows to a maximum known length of 50 mm. According to SMITH (1943, p. 421), a male specimen may reach 435 mm and have a tail which reaches 50 mm in length while female specimens may reach 480 mm in length and have a tail length of up to 33 mm. From SMITH's observations it would seem that sexual dimorphism is evidenced in tail-length ratios.

To show the relationships between various dimensions of this form the following list of measurements (in mm) is given. It was compiled by the author after an examination of No. 2587 (Chulalongkorn Univ. Coll.):

Total length	390±
Length of head	11
Length of body	338±
Length of tail	41
Width of neck	8
Width of midbody	9.5
Width of tail base	6.5

No records are available to the author regarding the dimensions of hatchlings, but a very young specimen measured by him (C.T.N.R.C. No. 523-553) had a total length of about 100 mm.

b. ***Physical Characteristics:*** Head subovate, not much broader posteriorly than anteriorly; eye size moderate to minute, its diameter equal to or less than its distance to oral margin; 1-3 minute maxillary teeth behind venom-conducting fang. Body slender and relatively long (although short in comparison to other *Calliophis*), subcylindrical. Tail relatively stout throughout as compared to head size; terminal scale pointed, tending to turn down.

c. ***Coloration:***

Juvenile: As the adult, but much paler and with more distinct markings.

Adult: Head light brown or orange, reddish, pale yellow, or tan, lighter laterally and below, with more or less distinct—but very irregular and thus variable—black, olive, or grey marks above; these marks situated mainly on anterior part of head; nape with a black or dark greyish

brown irregular collar whose posterior margin may be concave; this collar extending along parietal suture as an irregular black or greyish brown bar and eventually confluent with dark marks on anterior part of head; marks on temporal region sometimes confluent with collar of nape and thus isolating two irregular, oblong, yellowish, orange, or reddish patches; these patches mainly on parietals; upper lips behind eye yellow or orange, last few supralabials sometimes whitish; chin and begining of throat dirty white or ivory-white, gradually becoming pinkish and then orange; throat sometimes with blackish or grey flecks or dots. Iris black; tongue black.

Body light brown or orange; reddish, pale yellow, or tan above, lighter laterally; each scale except ventrals wholly or partially dark-edged and thus conspicuous; numerous black (rarely white-edged) spots or blotches usually present (or spots and blotches together) which are set in recognizable longitudinal rows or in alternating series; vertebral row often darker than ground colour of body; venter more or less bright coral red, pinkish anteriorly graduating into a more intense shade towards and at vent. Interstitial skin whitish or yellowish.

Tail light brown or orange, reddish, pale yellow, or tan above, with two black or brown crossbands, one at base which is not narrowed laterally and another, nearly as wide as first, towards tip and usually laterally narrowed; these crossbands usually lighter centrally; small black dots sometimes present between crossbands; each scale of tail except subcaudals wholly or partially dark-edged and thus made conspicuous; uppermost row of scales sometimes dark, being a continuation of the darkish vertebral row of body; subcaudal region pale blue, grey, or white, usually with continuations of dark dorsolateral crossbands as well as several irregular black or brown markings (but sometimes immaculate except for continuation of crossbands), or nearly uniform black with a few light-coloured scales.

d. ***Lepidosis :***

Head: Rostral wider than high, visible from above; supralabials 7, first smallest, seventh largest, third and fourth touching orbit, fifth to seventh touching anterior temporal; nasal sutured, anterior part largest;

ouclars 1+2, anterior in contact with nasal and thus preventing prefrontals from contact with labials; temporals 1+2, anterior very long and touching both postoculars; internasals wider than long, angular anteriorly; prefrontals little wider than long, larger than internasals, each touching one or both internasals, posterior edge of nasal, preocular, supraocular, and frontal; frontal hexagonal, its longest sides parallel, as long as or shorter than its distance from end of snout, much shorter than parietals; parietals relatively large; mental small, triangular; infralabials 7, fifth (rarely fourth) largest, fifth touching two scales posteriorly; genials subequal, 4-5 infralabials in contact with each anterior genial (sometimes four on one side and five on the other).

Body: Vertebrals not larger than scales of adjacent rows; costals 13 throughout; ventrals 174-247 (males 174-186, females 189-203, *vide*, SMITH (1943, p. 421): in Thailand, males 177-198, females 192-199, *vide*, TAYLOR (1965, p. 977); anal double.

Tail: Subcaudals 20-32 (males 25-31, females 21-25, *vide*, SMITH (1943, p. 421): in Thailand, males 29-32, females 21-29, *vide*, TAYLOR (1965, p. 977).

e. ***Hemipenis:*** According to SMITH (1943, p. 421) the hemipenis of *C. maculiceps* is as follows:

> "Hemipenis extending to the 10th caudal plate; sulcus not divided; the tip of the organ has a number of small longitudinal folds, the middle and proximal part have three much larger ones; there are no calyces or spines".

3. Biosis

a. ***General Habits:*** *C. m. maculiceps* is predominantly nocturnal and is terrestrial. Observations made on living specimens show it to be normally slow-moving but capable of being very fast and active. One specimen (now C.T.N.R.C. No. 523-139) taken by the author in Prachuab Khiri Khan province, Thailand, was discovered in the sand under a wood pile. Its head was beneath its coils, which were arranged in a series of loose folds and appeared much like a discarded garden hose. When merely touched with a small stick this specimen showed great speed and

agility of movement by making several thrashing and well-coordinated attempts to escape. All the while it displayed its conspicuously marked venter and underside of tail by holding them up over its body, and the exertion needed by it to accomplish this evidently hindered it from marking good its escape. It did not attempt to bite, but flickered its tongue regularly and rapidly.

A second specimen from Chon Buri province, Thailand, was discovered as it was crossing a country road at about 6.00 p.m. Upon very little provocation it became quite irritable, making every effort to bite its collector and not in the least concentrating on escape.

This form has been known to eat *Typhlops nigroalbus*. It may also feed on insects and arachnids.

b. ***Reproduction:*** Unknown.

c. ***Habitat:*** This subspecies has been taken at elevations of up to 1300 metres, but also occurs at much lower elevations. Three specimens collected by the author in Chon Buri and Prachuab Khiri Khan provinces, Thailand, were each within one-half kilometre of the sea and at or nearly at sea level. TAYLOR (1965, p. 977) mentions a specimen he capturdd at Bang Saen, a locality near the sea in Chon Buri province, Thailand.

Specimens of this secretive form have been taken by the present author and other collectors in the following microhabitats: among cultivated tapioca plants, under piles of wood in dry and sandy soil, at the base of a recently excavated sandstone bank, and under the bark of small logs.

d. ***Observations:*** Even though this form is probably quite common in parts of Thailand little is known about many of its aspects. This is largely or enitrely due to the fact that it is small, secretive, and nocturnal.

According to GHARPUREY (1962, p. 52) this form strongly resembles *Calliophis melanurus* in coloration.

4. Distribution in Thailand

This form is one of the most widespread elapids occurring in Thailand. It has been reported from the provinces of Chiang Mai, Chiang Rai, Chon Buri, Nakhon Si Thammarat, Nong Khai, Pattani, Prachuab Khiri Khan, and Trang. COCHRAN (1930, p. 36) reports it from "Nong Khor", and SMITH (1914, p. 124) lists it from Koh Si Chang (off Chon Buri province), Siracha (Chon Buri province), Kanburi (Kanchanaburi province), and Pak Jong (Nakhon Ratchasima province).

In can be seen by the above that the form is apparently ubiquitous in Thailand. Yet it is evidently widespread only in Thailand, for while found in Malaya, South Vietnam, Burma, and Cambodia it is evidently uncommon in all of these countries. Its distribution in Thailand is without apparent preference to any particular biological or geographical zones.

5. Significance to Man

Like many of the smaller calliophids this subspecies is of little importance to man. It is too small to be utilized commercially and for the same reason is not dangerous to man. However, it should be treated at all times with respect.

6. Conclusions

a. Three subspecies in addition to the *typical form* are currently recognized, *viz.*. *michaelis*, *punctulatus*, and *malcolmi*.

b. It is a relatively small snake.

c. Sexual dimorphism may be evidenced in body-tail lengths, females attaining greater lengths but having shorter tails than males.

d. It is a slender snake but short in comparison to various other calliophids.

e. There is great variation in the number, intensity, and shape of the black marks of the body.

f. It is secretive, predominantly nocturnal, and terrestrial. It may be ophiophagous or insectivorous.

g. If provoked or irritated it may attempt to defend itself.

h. Nothing of its reproductory habits is known.

i. It has been taken at both high and low elevations but is probably most common in the latter.

j. Much is still unknown regarding its biosis.

k. It is widespread in Thailand (one of the most widespread elapids) but is apparently uncommon in all countries outside of Thailand in which it is known.

l. It is of little importance to man because of its diminutive size, and nothing is known about the effects of its venom in man.

E. ***Calliophis maculiceps malcolmi*** Smith, 1914

Callophis maculiceps univirgatus M. Smith, Journ. nat. Hist. Soc. Siam, vol. 1, Aug. 1914, p. 123, (type-locality, Nong Kai Ploi, Thailand). not *Elaps univirgatus* (Günther) 1859.

1. Identifying Characteristics

Yellowish brown to olive above, immaculate coral pink to red below; tail with two black crossbands; a black vertebral stripe but no other black marks on body.

2. Physical Description

a. ***Dimensions:*** A small snake. The greatest recorded total length for this subspecies is evidently that of TAYLOR (1965, p. 978) of a specimen which measured 306± mm long. Of this the tail accounted for 24± mm. SMITH's measurements of a series of specimens from Thailand (1914, p. 124) were, total length 220-260 mm, of which the tail length was 20-25 mm.

Measurements of hatchlings are unavailable and whether or not sexual dimorphism is evidenced in relative dimensions is unknown.

b. ***Physical Characteristics:*** Similar to the *forma typica* except that the head may be somewhat more slender. Three small teeth follow the venom-conducting fang after a diastema, and on the lower jaw two large mandibular teeth are followed after a diastema by six more small teeth on either side.

c. *Coloration :*

Juvenile: Unknown.

Adult: Head black with some indistinct light and dark markings and with a pale yellowish line along each upper lip which is interrupted below eye; nape black.

Body light yellowish brown to olive above, lighter laterally, scales somewhat dark-edged, with a single conspicuous black vertebral stripe covering vertebral row and edges of adjacent rows, and extending whole length of body; venter coral pink graduating to deep reddish orange toward and at vent.

Tail light yellowish brown to olive above with two conspicuous black crossbands and a continuation of conspicuous black vertebral stripe of body (which extends whole tail length); blue-black below with some bluish white spots or more or less thickly spotted with black.

d. *Lepidosis :*

Head: Rostral wider than high, visible from above (the visible part being triangular); nasal sutured, anterior part largest and largely containing nostril; oculars 1+2; internasals smaller than prefrontals; frontal with its longest sides parallel, its length equal to or slightly greater than its distance from tip of snout; 5 infralabials touching each anterior genial.

Body: Costals 13 throughout; ventrals 173-198; anal double.

Tail: Subcaudals 21-25.

e. *Hemipenis :* Unknown.

3. **Biosis**

a. *General Habits :* Little is known of the habits, aspect has to do with appearance for the most part. It is very probably nocturnal and either ophiophagous or insectivorous. It is terrestrial.

b. *Reproduction :* Unknown.

c. *Habitat :* This form is evidently largely or entirely a lowland form, most specimens evidently having been taken at low elevations. TAYLOR (1965, p. 978) records a specimen taken in an open field near buildings. This form is undoubtedly a secretive one.

d. ***Observations:*** This form is very similar to *Calliophis macclellandii univirgatus* in certain aspects of its coloration.

4. **Distribution in Thailand**

This subspecies is known only from Central and Southeast Thailand. The localities from which it has been reported include Nong Kai Ploi (Chon Buri province), Lop Buri (based on a specimen mentioned by SMITH, 1914, p. 124, which had black dorsal dots as well as a black vertebral stripe), Paknampo (Nakhon Sawan province), and Saraburi province. As stated previously, this form evidently is essentially a lowland form, and it is logical to assume that it may be looked for and found in any part of Central or Southeastern Thailand at low elevations.

TWEEDIE (personal correspondence to the present author, 1966) pointed out that this subspecies appears to live sympatrically with the *forma typica* and without any apparent ecological, geographical, or altitudinal barriers to prevent interbreeding.

5. **Significance to Man**

Minimal; the effects of its venom in man are unknown.

6. **Conclusions**

a. Very little is known about it because of the fact that so few specimens of it have been collected. Evidently no specimens have been studied at length when alive, and this has resulted in there being a dearth of information concerning many aspects of its biosis.

b. It is a small snake.

c. There is evidently much variation in coloration (judging from Smith's above-mentioned specimen which had black dorsal spots as well as a black vertebral stripe).

d. Its hemipenial characteristics are undescribed.

e. It is terrestrial and secretive, and is probably nocturnal and ophiophagous or insectivorous.

f. Nothing is known of its reproduction.

g. It is evidently an essentially lowland form.

h. It is indigenous to Thailand, having been taken only in the Central and Southeastern parts of that country.

i. It is evidently of little significance to man, but should be considered dangerous. Nothing is known about its venom.

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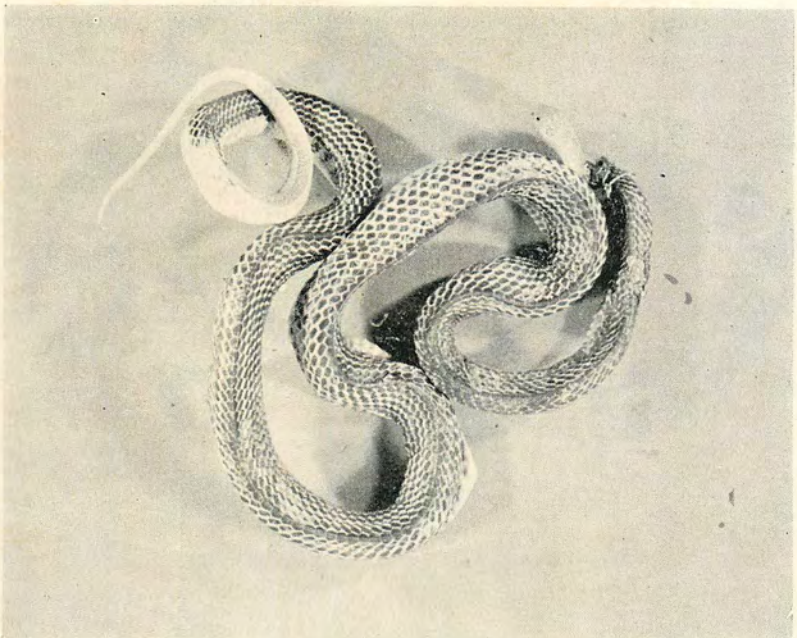

Fig. 1. *Bungarus flaviceps flaviceps* Reinhardt. United States National Museum, Smithsonian Institution, No. 70361, collected in Ratchaburi.

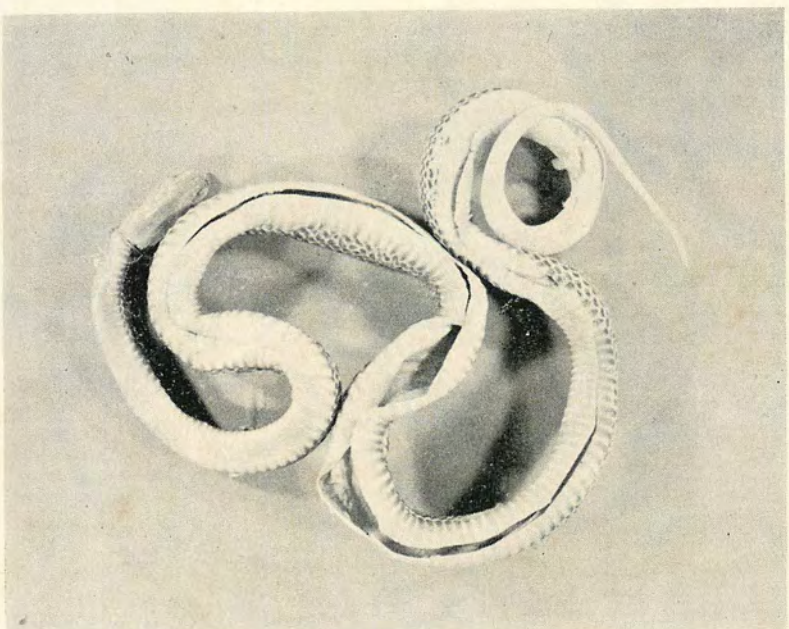

Fig. 2. Underside view of USNM No. 70361.

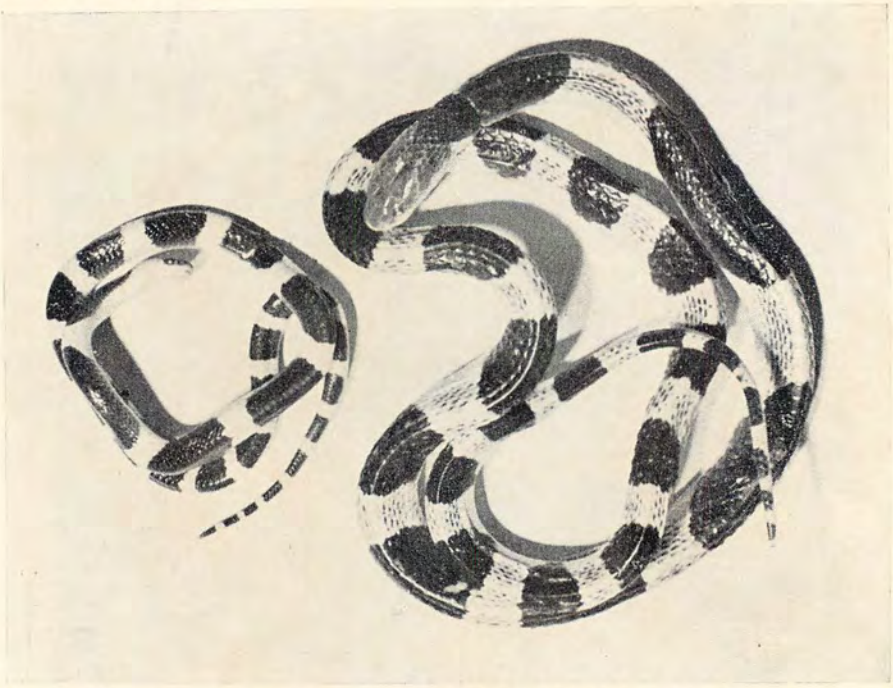

Fig. 1. *Bungarus candidus* (Linnaeus). An adult (CTNRC No. 523-263) and a juvenile (CTNRC No. 523-1031), from Thailand: Khon Kaen, and Malaya: Goping, respectively.

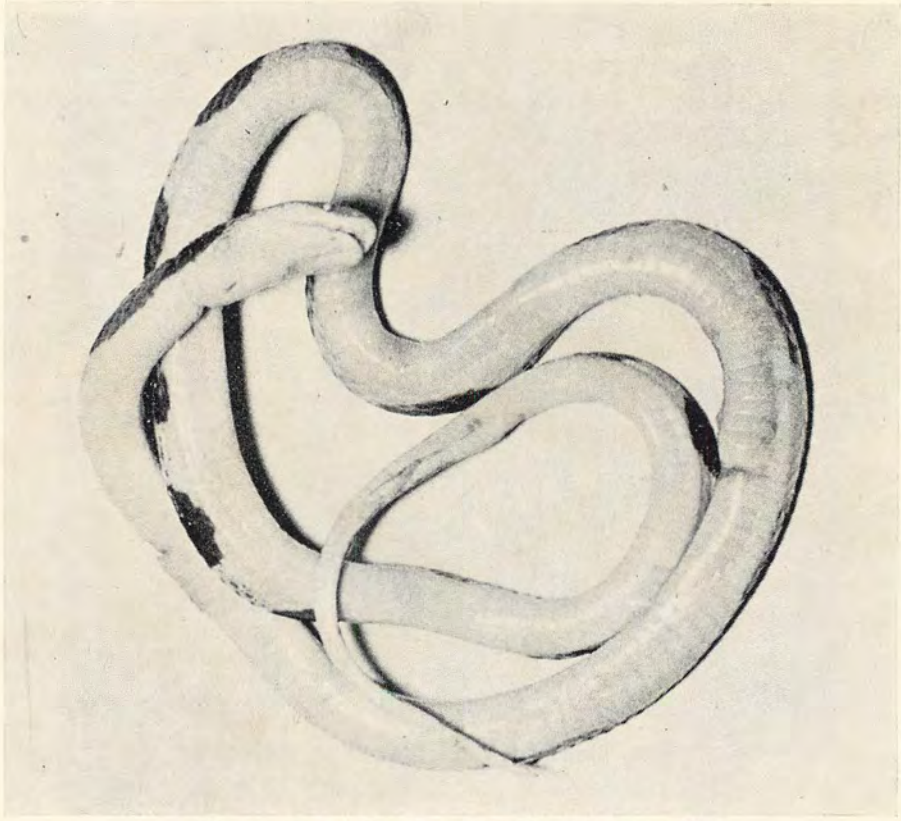

Fig. 2. Underside view of CTNRC No. 523-263.

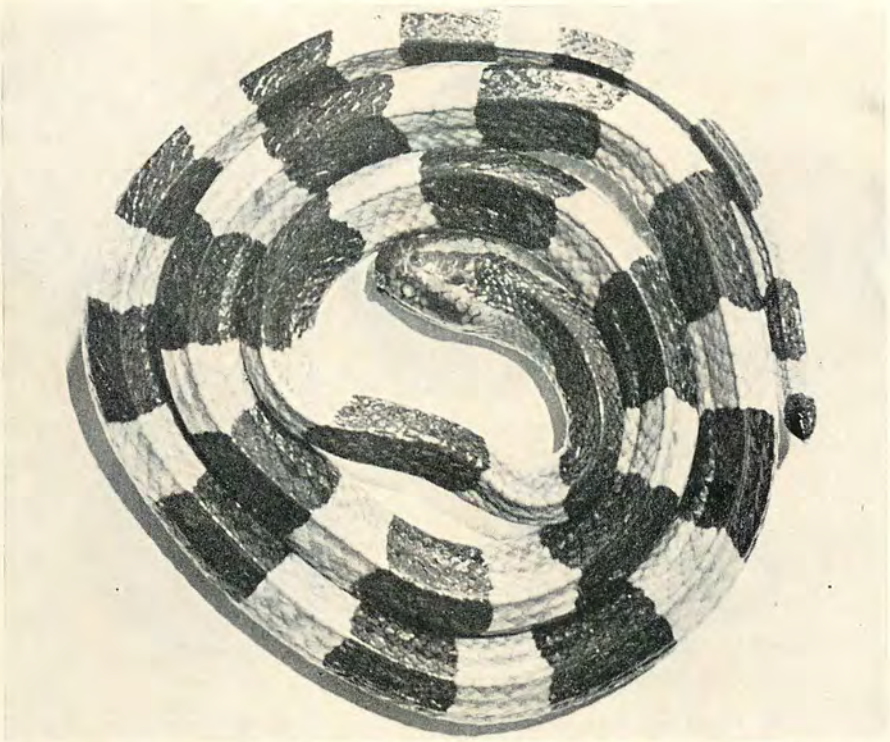

Fig. 1. *Bungarus fasciatus* (Schneider). CTNRC No. 523-809, an adult collected in Chiang Mai.

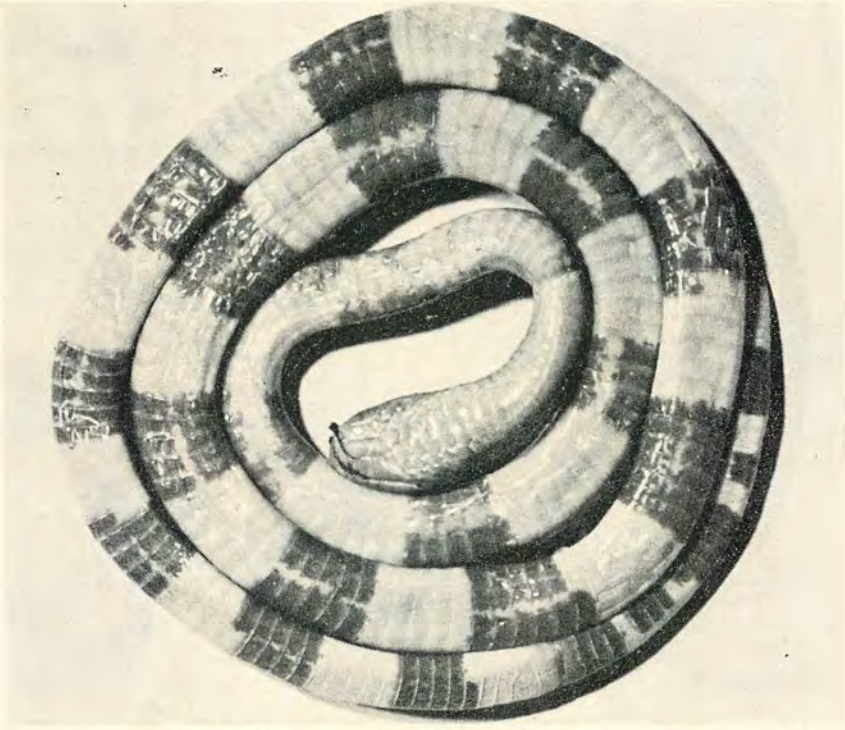

Fig. 2. Underside view of CTNRC No. 523-809.

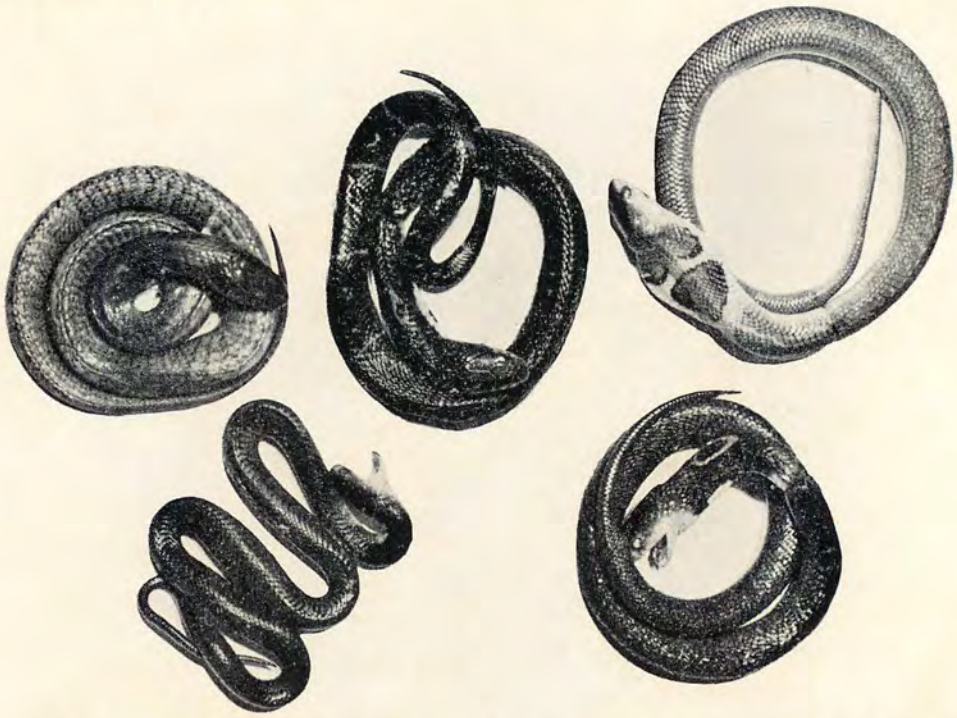

Fig. 1. *Naja kaouthia kaouthia* (Lesson *in* Férussac). A series of juvenile specimens from Thailand (in clockwise order begining with banded specimen at top): CTNRC No. 523-551, Khao Yai National Park; CTNRC No. 523-213, Thonburi (Nong Khaem); CTNRC No. 523-425, Phra Nakhon; 523-550, Songkhla (Khao Roop Chang); CTNRC No. 523-811, Chiang Mai (Mae Taeng).

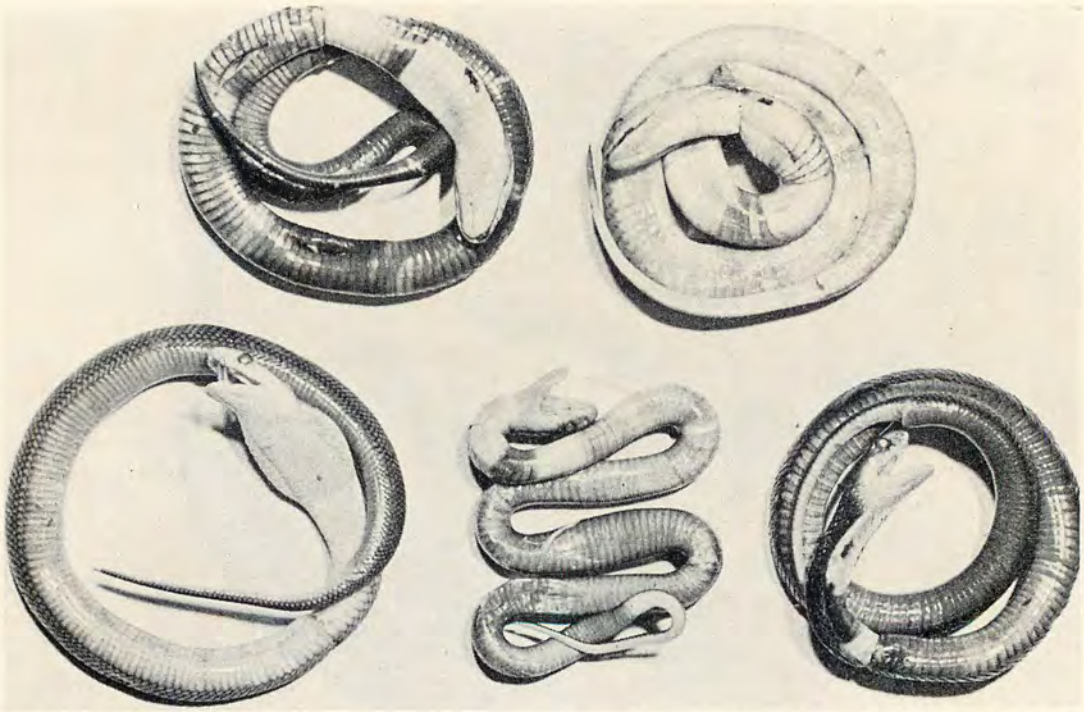

Fig. 2. Underside views of the same series : top row left to right, CTNRC Nos. 523-551 and 523-811; lower row left to right, CTNRC Nos. 523-213, 523-550, and 523-425.

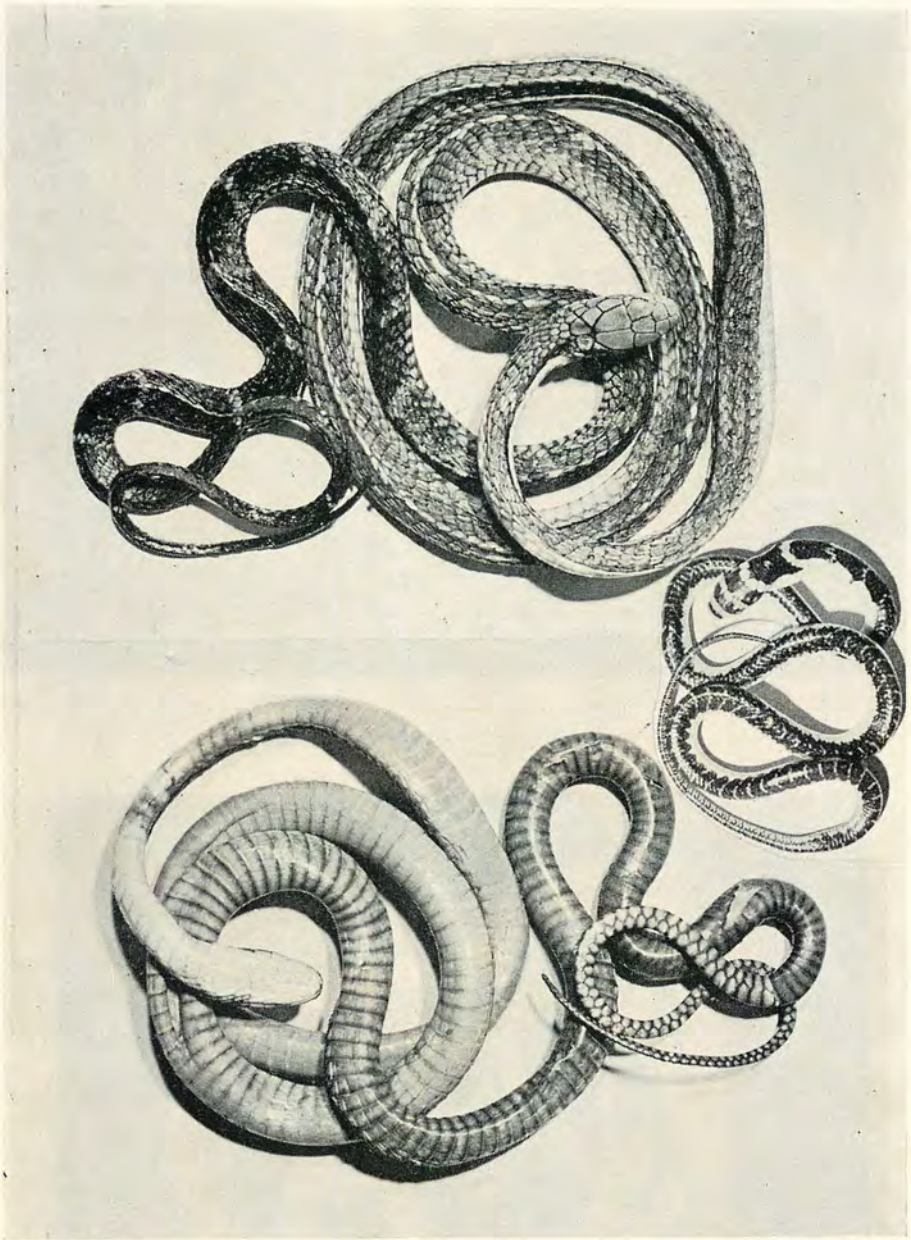

Fig. 1. *Ophiophagus hannah* (Günther). Dorsal and underside views of CTNRC No. 523-735, a young adult collected in Nakhon Si Thammarat. Inset: CTNRC 523-858, a juvenile from the same locality.

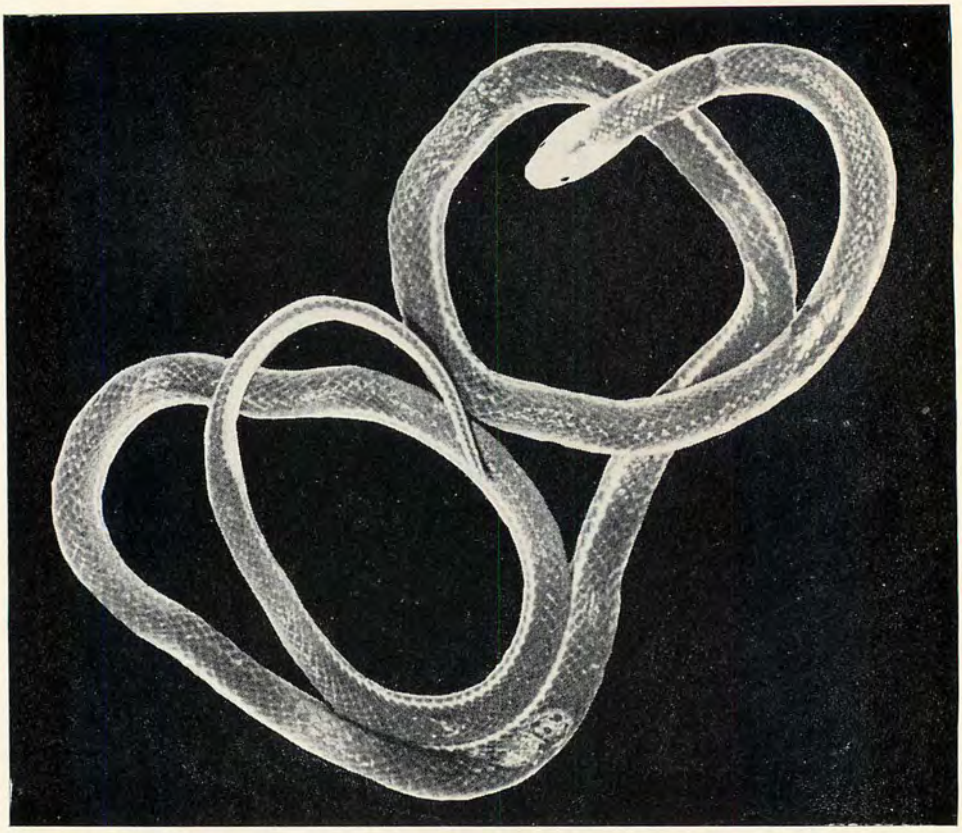

Fig. 1. *Maticora bivirgata flaviceps* (Cantor). CTNRC No. 523-488, a young adult collected in Pattani (Na Pradoo).

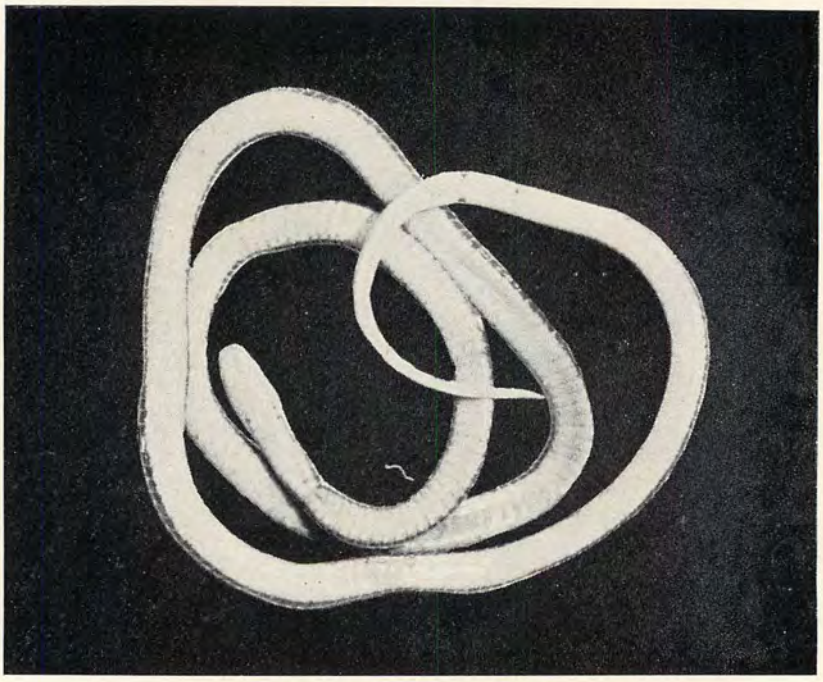

Fig. 2. Underside view of CTNRC No. 523-488.

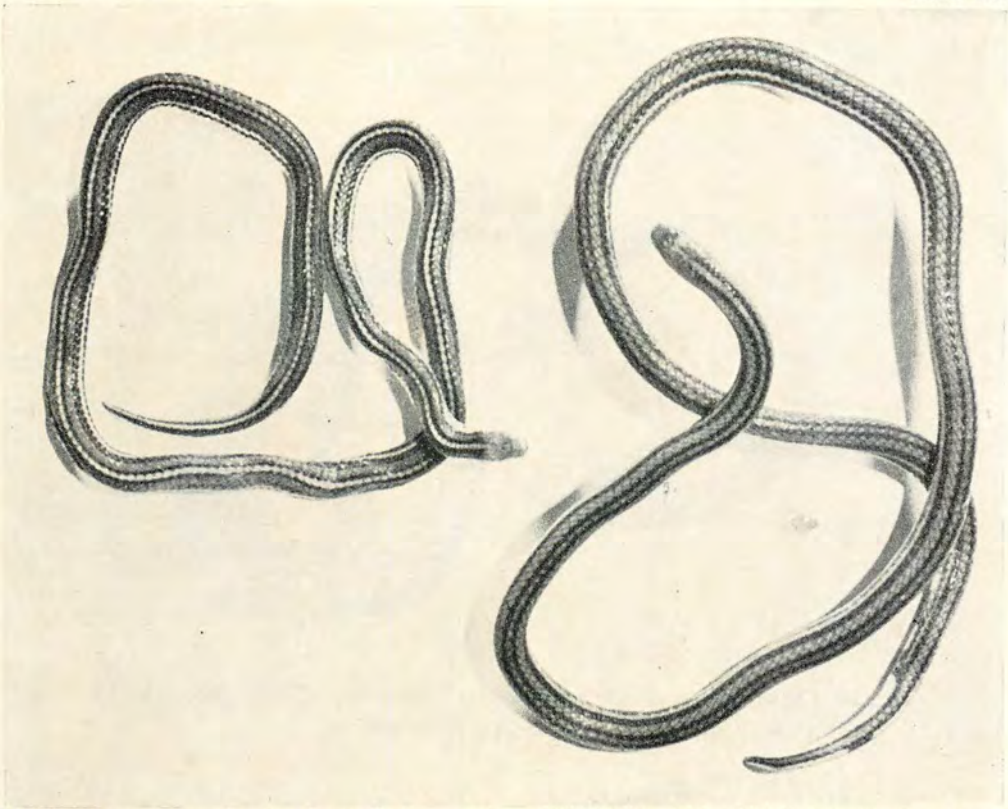

Fig. 1. *Maticora intestinalis intestinalis* (Laurenti). CTNRC No. 523-1032 (larger specimen) and CTNRC No. 523-1033, two young adult specimens collected in Pattani (Na Pradoo).

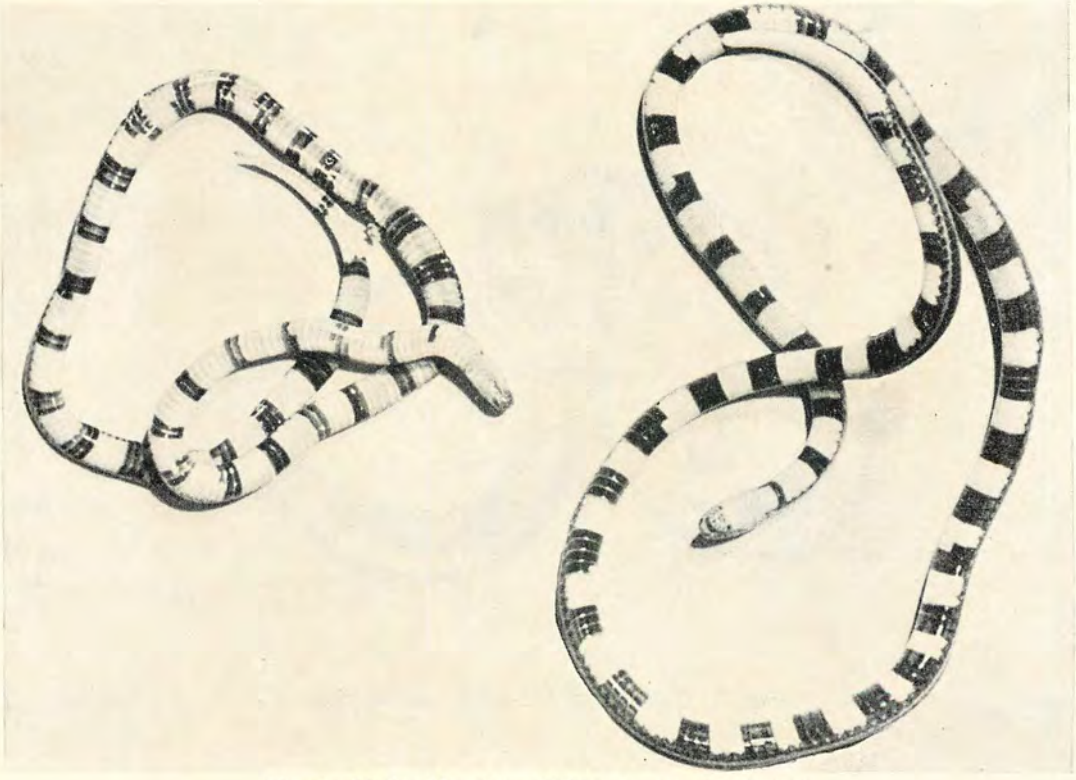

Fig. 2. Underside views of the same two specimens.

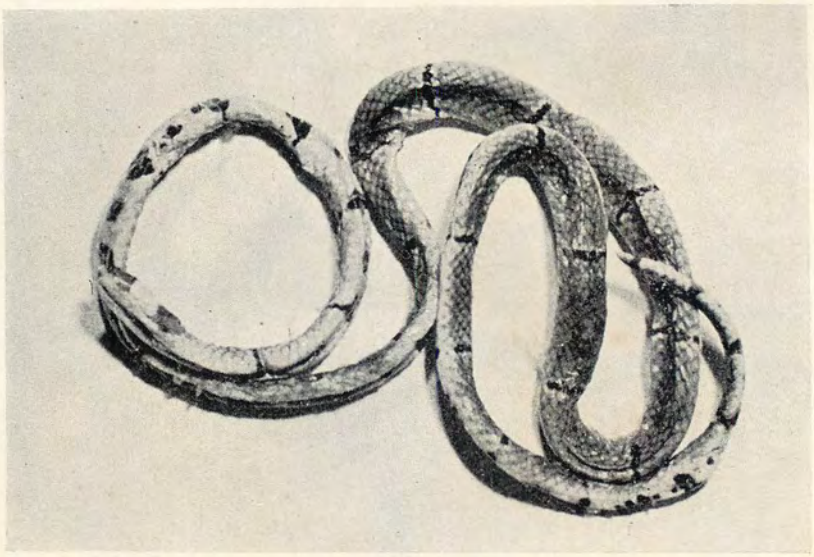

Fig. 1. *Calliophis macclellandii macclellandii* (Reinhardt). CTNRC No. 523-85, an adult specimen from Khao Yai National Park.

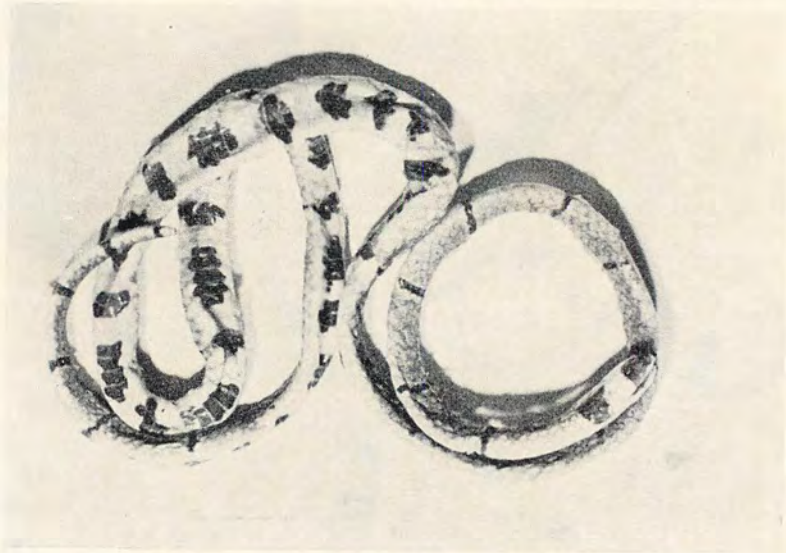

Fig. 2. CTNRC No. 523-85, a reversed view.

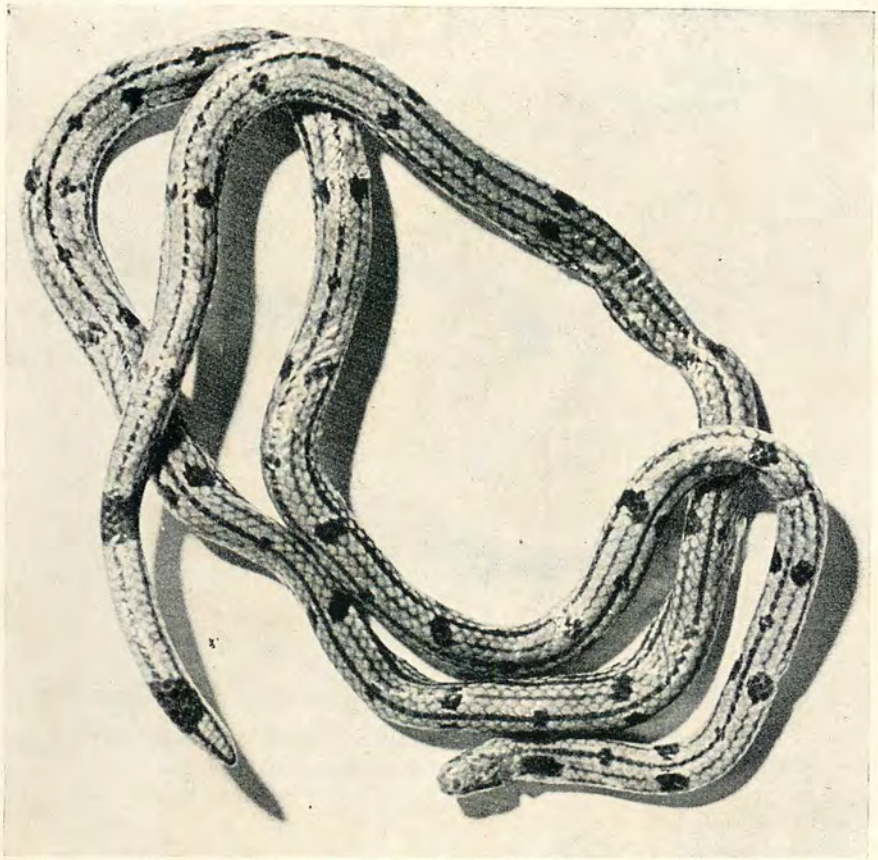

Fig. 1. *Calliophis gracilis* Gray. CTNRC No. 523-677, an adult specimen from Pattani (Na Pradoo).

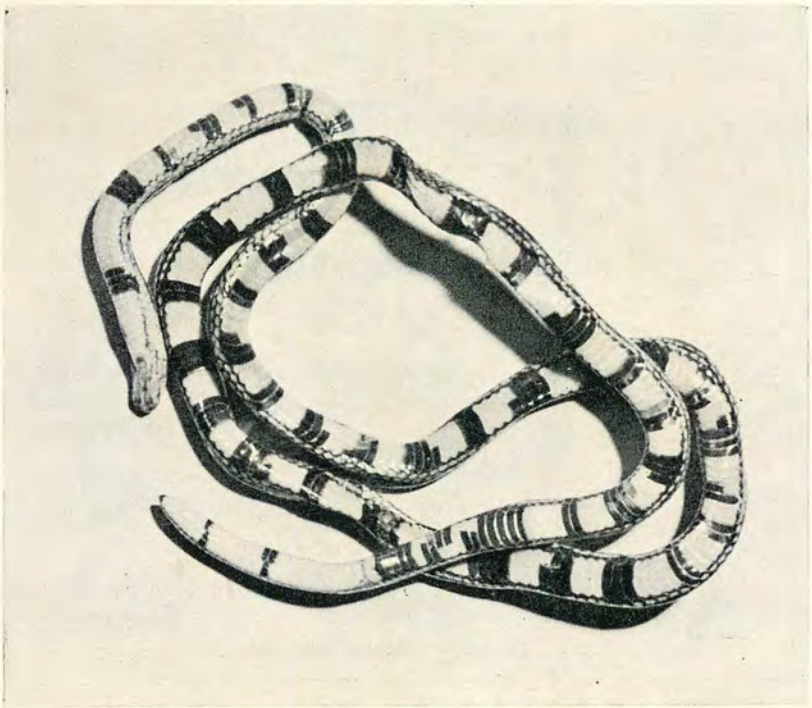

Fig. 2. Underside view of CTNRC No. 523-677.

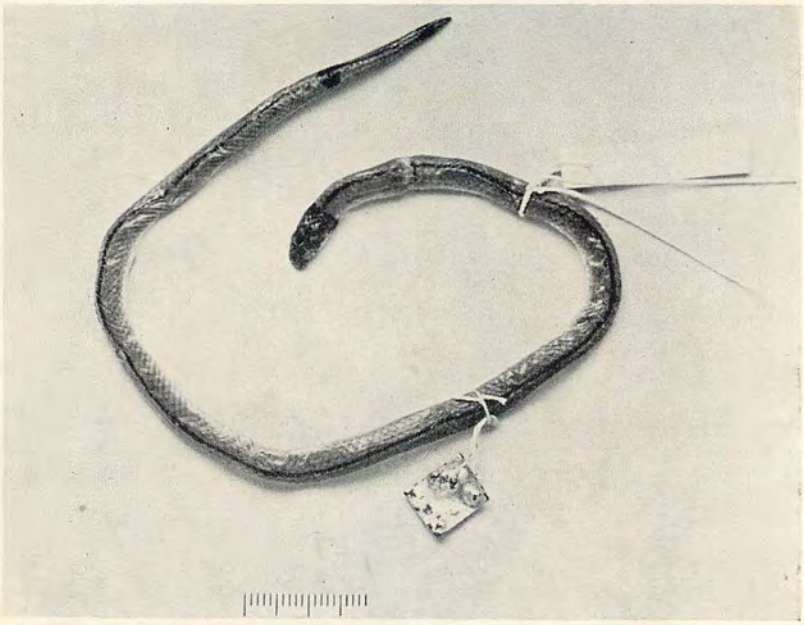

Fig. 1. *Calliophis hughi* Cochran. The type specimen, United States National Museum, Smithsonian Institution No. collected in Chumphon (Koh Tao).

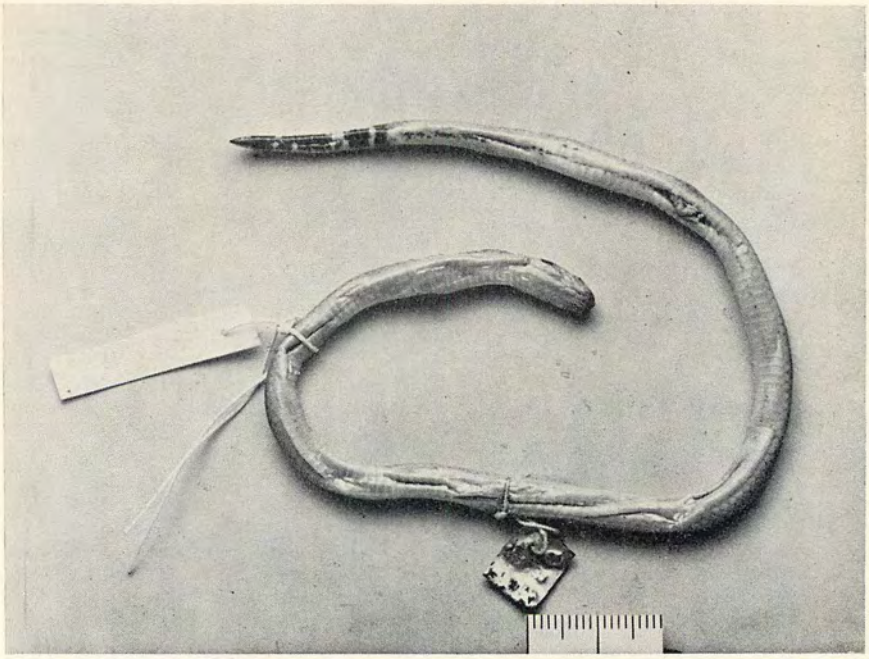

Fig. 2. Underside view of USNM No.

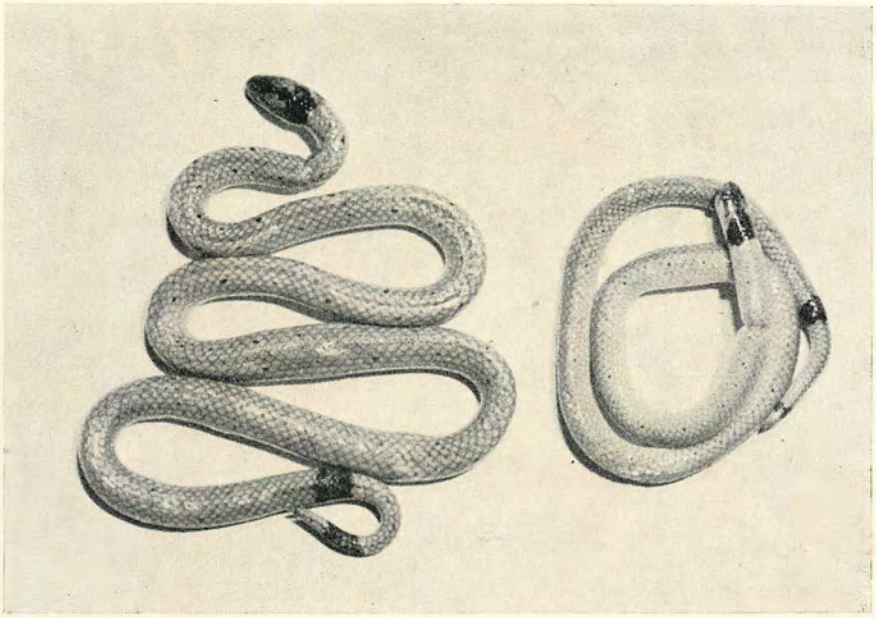

Fig. 1. *Calliophis maculiceps maculiceps* (Günther). CTNRC No. 523-492 (larger specimen), an adult from Chon Buri, and CTNRC No. 523-139, a young adult from Prachuab Khiri Khan (Nong Kae).

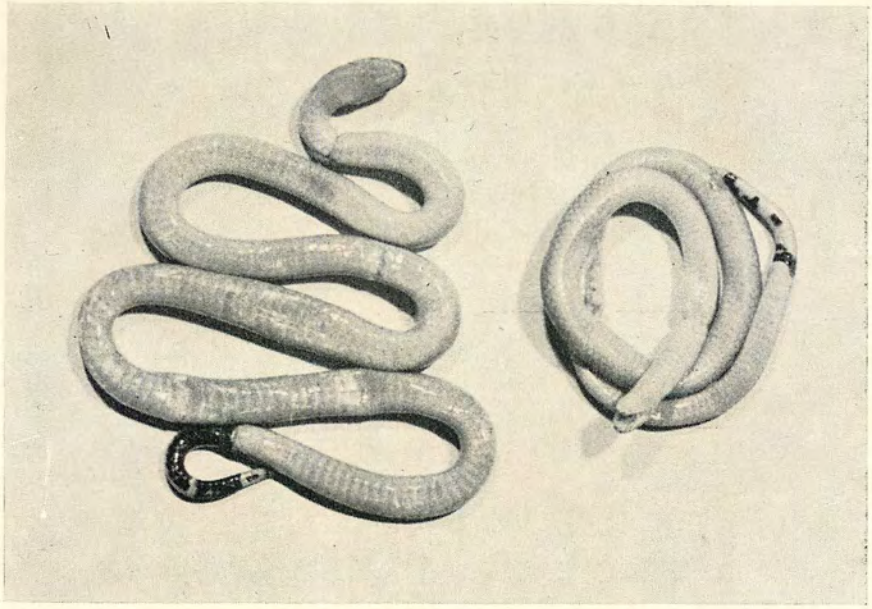

Fig. 2. Underside views of the same two specimens.

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