

THE SNAKES OF RARA AVIS, COSTA RICA.

I. Coral snakes (Elapidae, genus *Micrurus*)

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INTRODUCTION

Although a lot of research is being done in Costa Rica, and the herpetofauna receives a lot of attention as well, little is known about the snakes that occur in this country. In Costa Rica, 128 species of snakes occur, of which 17 are venomous (*Elapidae*, *Hydrophiidae*, *Viperidae*). A relatively large amount of research has been done on these venomous snakes, with an emphasis on the toxicological aspects. Therefore, people who get bitten by one of these snakes have a very good chance of surviving in this country. Unfortunately, the remaining 111 species do not have a direct ground for closer examination. Usually nothing more than the sole occurrence of a particular species is known.

Most snakes can be keyed out reasonably well with the aid of the book of Savage and Villa (1986). Since the appearance of several species is highly variable, identification takes place on the basis of scalation characteristics. This implies, however, that one has to catch and handle the snakes, which is not always possible or without danger.

In these articles a description of the snakes observed by the author is presented. In addition, some data on species-distribution and natural history is presented. Whenever possible, a photograph or drawing is added in order to ease recognition in the field.

RARA AVIS: SITUATION AND CLIMATE

From April to October 1993, I conducted fieldwork for a research project on coral snake mimicry. I spent the major part of this period in a rain forest reserve, Rara Avis. This reserve comprises an area of approximately 1300 hectares, covered with primary premontane rain forest and a small area of secondary growth.

Rara Avis is situated on the Atlantic slope of the Cordillera Central, the central mountain range that divides Costa Rica (see also distribution map 1 to 3). The altitudinal range of the reserve is 500-800m above sea level.

The average annual temperature is 25,6°C and average annual rainfall is between 5600 and 8000mm (!). The beginning of the research period coincides with the end of the dry season. After that the daily precipitation level gradually increases, until in October-November

the new dry season starts. During the research period, the average monthly temperature was practically constant, with a temperature range of 13-26°C (mean 19°C) at night, and 24-37°C (mean 31°C) in daytime. The relative humidity inside the jungle is always close to 100%. On certain sunny locations it rarely reaches approximately 70%.

Because of the wide treetops and the dense vegetation that can be found in premontane rain forests, only $\pm 2\%$ of the sunlight reaches the forest floor. This means that cold-blooded animals like snakes have to find open areas to sunbathe. That is why most snakes are found in places of treefall (the so-called 'light-gaps') and also on the sides of the trails, since a trail is nothing more than an elongate light-gap. This also explains the relative abundance of snakes around human settlements in the forest. In order to find snakes it is therefore not always necessary to go deep into the jungle.

Of course this is not the case with arboreal snakes, which only have to migrate upwards to reach a spot where sunlight can penetrate the leaves.

CORAL SNAKES GENERAL

In Latin America, any snake with a considerable amount of red in its colouration is called 'coral'. This name is used irrespective of the snake family to which the animal belongs.

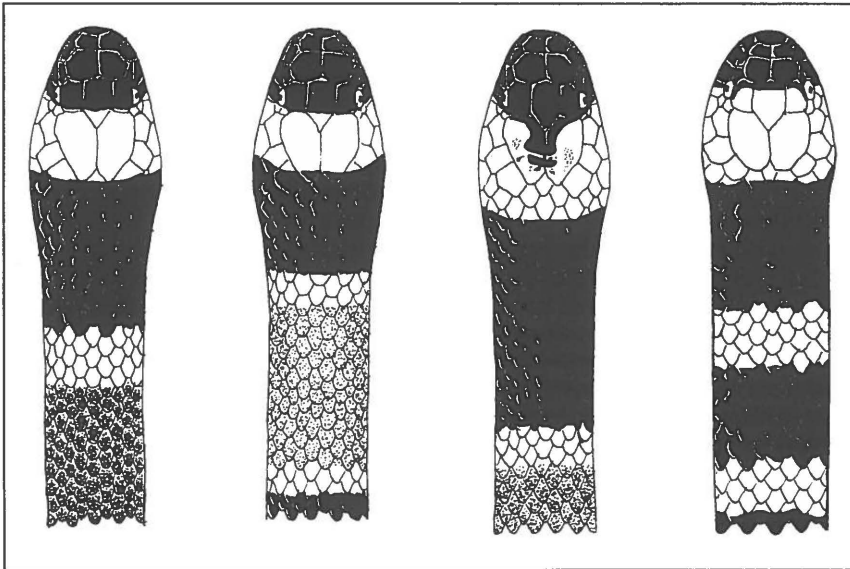


Figure 1: Headpatterns of *Micrurus nigrocinctus mosquitensis* (A), *M. n. nigrocinctus* (B), *M. alleni* (C) and *M. mipartius* (D) (drawings: Twan Leenders).

In English, however, the name coral or coral snake generally refers to the New World proteroglyphodont snakes of the family *Elapidae*. The elapid snakes of the New World are subdivided into two genera: *Micruroides*, a monotypic genus, and *Micrurus*, which currently contains approximately 53 species (Campell and Lamar, 1989). Several authors have proposed a third genus, *Leptomicrocrurus*, but its status is uncertain and needs further research before validation. The taxonomy of the coral snakes is still subject to a constant change, and a

lot of inter- and intraspecific relations are poorly understood (Roze, 1982; Campbell and Lamar, 1989).

Coral snakes differ from the other New World snakes in having one or more short, permanently erect, hollow (proteroglyphous) fangs near the front of the maxillae. Because of the relatively short fangs and the relatively ineffective venom delivery system, combined with the generally mild disposition of coral snakes, bite accidents are infrequent. Nevertheless, they possess a potent neurotoxic venom, and all species of coral snakes are capable of inflicting a potentially dangerous bite. Several fatalities, caused by cardiac or respiratory neuromuscular paralysis, are recorded (Campbell and Lamar, 1989).

A specimen of the Central American coral snake, *Micrurus nigrocinctus mosquitensis*, showed that at least juveniles of this species are not immune to their own venom. This snake, which had lived in captivity for several weeks and appeared to be in perfect health, was found dead one morning. Close examination of the animal revealed that it had bitten itself approximately 2.5cm behind the head, and held on until it was dead. Peterson (1990) reports seeing Mexican coral snakes (*Micrurus fulvius tenere*) biting and vigorously chewing themselves without any noticeable disadvantageous effect. This only happened in the presence of food, which was not the case in the *Micrurus nigrocinctus mosquitensis*. Possibly, the autoimmunity against its own venom had not developed yet in this particular juvenile.

NATURAL HISTORY

Being secretive fossorial animals, coral snakes are infrequently encountered. This may give a false impression of rarity, as these snakes actually may be quite common (Shaw, 1971; Campbell and Lamar, 1989). Coral snakes can be found in a wide variety of habitats, ranging from dry, rocky areas to marshes and rain forests, and even cultivated fields are not avoided. They spend most of their time in soil, leaf litter, logs, stumps, or rock crevices.

The widespread assumption that coral snakes are strictly nocturnal animals is at least partly incorrect. Several species of North, Central and South American coral snakes are known to be active during daylight. This is also the case for the species that occur in Rara Avis; both *Micrurus nigrocinctus mosquitensis* and *Micrurus mipartitus* have been observed, sunbathing in lightgaps in broad daylight. One specimen of *Micrurus nigrocinctus mosquitensis* was collected at 13.00h, while consuming another snake. This indicates that the hunt for food also (partly) takes place in daytime.

FEEDING

As has been noted before, coral snakes are ophiophagous animals, which means that their diet consists mainly of snakes. Snakes of the genus *Geophis* appear to play an important role in the food chain, although other small snakes are not avoided either. Coral snakes also do not hesitate to consume one of their relatives.

Other prey includes *Typhlopidae*, *Caeciliidae*, and snake-like lizards like skinks. Prey is detected with the aid of chemical cues. A sudden movement of the prey usually results in a rapid attack by the coral snake but because of its relatively poor eyesight this is often ineffective (Ernst, 1992).

Coral snakes usually seize their prey and hold on to it, in order to chew in the venom. In this way a sort of pre-digestion takes place. Once the victim stops moving, it is eaten

head first. Greene (1976) showed that coral snakes locate the prey animal's head by the overlapping scales.

BEHAVIOUR

When a coral snake feels threatened it displays a typical defense behaviour, in which the head is hidden under a coil of the body and the tail is waved at the threat. The tail, which is patterned differently from the rest of the body, is curled in order to resemble a head. In this way, the snake tries to direct the attention away from the real head. The snake even attacks the source of the threat with its false head.

Another frequently observed behaviour in coral snakes is a sudden erratic movement of the body. Because of this rapid movement the snake's bright colours blur to form a unicolour brown. This renders the snake momentarily 'invisible' against a background of dead leaves. Because the transition of motionlessness to movement is not perceptible to the human eye, a coral snake sometimes escapes although one is looking at it. This causes the local people to believe that coral snakes can make themselves invisible.

THE CENTRAL AMERICAN CORAL SNAKE, *Micrurus nigrocinctus* (GIRARD, 1854)

With its pattern of alternating black-yellow-red-yellow-black body rings, *Micrurus nigrocinctus* can be described as a typical coral snake. This species has a vast distribution, ranging from southern Mexico on the Pacific versant, and on the Atlantic versant from Belize, south towards Colombia. It can be found throughout entire Nicaragua, Costa Rica (Map 1) and Panama, until 1500m altitude.

Because of the large geographic range and the substantial variability of this species, several subspecies have been described. Of these, six have been acknowledged. The subspecies that occurs in Rara Avis, *Micrurus nigrocinctus mosquitensis* (Photo 1), can be found east of the Cordillera Central in Costa Rica. *Micrurus nigrocinctus mosquitensis* is a medium-sized coral snake with a maximum total length of approximately one meter. This subspecies is characterized by its relatively low number of red body rings (9-14), and the broad yellow rings. The scales in the red rings always show a constant amount of black tipping.

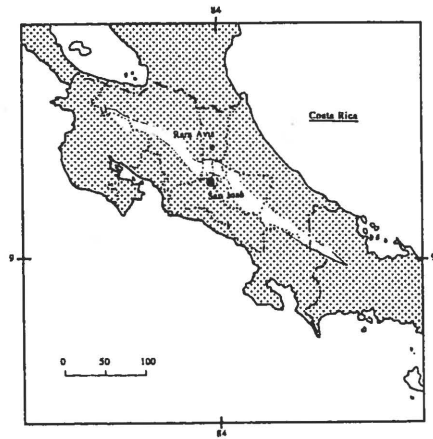
West of the Cordillera Central, on the Pacific versant, the nominate race *Micrurus nigrocinctus nigrocinctus* (Photo 2) occurs. This subspecies is characterized by a higher number of red body rings (11-23).

Juveniles of the latter subspecies display a pattern of bright orange-red, narrow white or yellow, and black rings. However, with increasing age the original conspicuous colouration is obscured by black pigment. Some of the specimens observed by me were not recognizable as being coral snakes initially because the dorsum was completely black. The venter, however, did show the original bright coral snake pattern.

Possibly *Micrurus nigrocinctus mosquitensis* will be granted species status in the near future, which means that it will be called *Micrurus mosquitensis*. This recognition is mainly based on chromosomal differences between *Micrurus nigrocinctus mosquitensis* and *Micrurus nigrocinctus nigrocinctus* (Gutiérrez & Bolaños, 1980). Additionally, some other differences like variation in venom composition, colouration and pattern are present. The number of body rings and the colours of *Micrurus nigrocinctus mosquitensis* are more constant than those of the nominate race. Also a distinct difference in behaviour is noted; specimens of the *mosquitensis*-subspecies are more nervous and excitable than those of *Micrurus nigrocinctus nigrocinctus*.

Juveniles of *Micrurus nigrocinctus* have been collected from the beginning of June. Most likely the eggs of this species are deposited at the end of the dry season (March-April). This is probably correlated with the reproductive cycle of a number of Costa Rican amphibians: most amphibians reproduce at the start of the rainy season. Therefore, a great amount of prey is available for the frog-eating snakes, which time their own reproduction with this event. The supply of juvenile snakes in this period is, in its turn, a welcome food source for the juvenile coral snakes.

The eggs of coral snakes are elongate, and are deposited in the soil or in leaf litter. Incubation probably requires 2-3 months (70-90 days in the Texan coral snake, *Micrurus fulvius tener* (Campbell, 1973)).



Map 1: Distribution of *M. nigrocinctus* in Costa Rica.

ALLEN'S CORAL SNAKE, *Micrurus alleni* (SCHMIDT, 1936)

Another species that belongs to the *nigrocinctus*-complex is Allen's coral snake (Photo 3). This species was previously considered a subspecies of *Micrurus nigrocinctus*. It is easily distinguished from the latter by the aberrant head pattern. In *Micrurus alleni* the black head cap extends posteriorly, following the suture of the parietal scales. In *Micrurus nigrocinctus* this is not the case (Figure 1).

Micrurus alleni occurs on the Atlantic versant of Nicaragua and Costa Rica, from sea-level to 1200m elevation. An allopatric (separated) population of this species exists in Southwest Costa Rica. Specimens of this population are considered by some authors to be a subspecies of Allen's coral snake, *Micrurus alleni yatesi*, or even a distinct species, *Micrurus yatesi* (Map 2).

Micrurus alleni has not been recorded for Rara Avis yet, but its occurrence is very likely since the specimen on photo 3 was caught in an adjacent reserve at comparable elevation. Perhaps this species has been mistaken for *Micrurus nigrocinctus* until now, since the two are very similar in the field.

The snake in photo 3 is a juvenile specimen, caught on 1st July. Therefore, the reproductive season probably coincides with that of *Micrurus nigrocinctus*.

THE BICOLOURED CORAL SNAKE, *Micrurus mipartitus* (WERNER, 1897)

As is already obvious from its name, this species has a somewhat different appearance than the previous species. The pattern of *Micrurus mipartitus* consists of 40-65 black body rings, alternated by orange, pink, red, or white rings. Some specimens have a pattern of alternating black and white rings, but a black and red head and tail.

It is possible that the Costa Rican population consists of two co-occurring species, *Micrurus mipartitus* and *Micrurus multifasciatus*. This has not been confirmed, however. Therefore, in this paper, it will be treated as one species, *Micrurus mipartitus*. The bicoloured coral

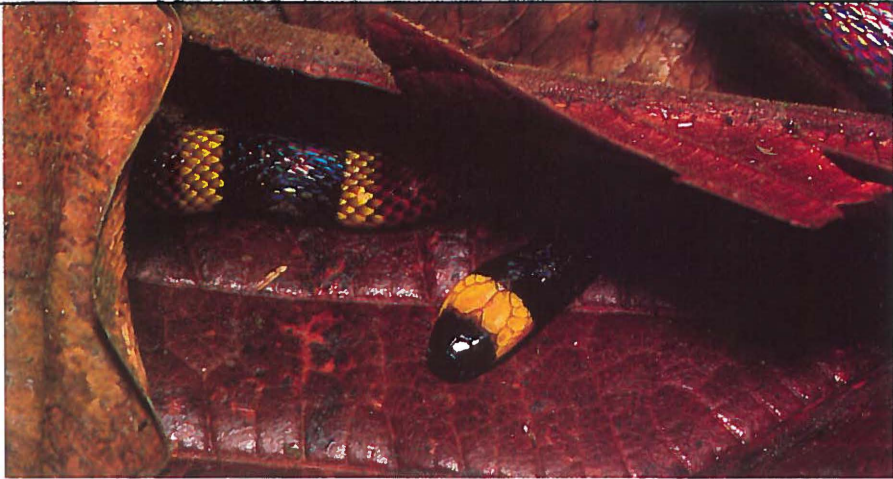


Foto 1: *Micrurus nigrocinctus mosquitensis*. Centraalamerikaanse koraalslang. Adult, 510 mm totale lengte. Vindplaats Rara Avis, Costa Rica.

Centralamerican coral snake. Adult, 510 mm total length. Find-spot Rara Avis, Costa Rica.

Foto: Twan Leenders.



Foto 2: *Micrurus nigrocinctus nigrocinctus*. Centraalamerikaanse koraalslang. Juveniel, 210 mm totale lengte. Vindplaats Cañas, Costa Rica.

Centralamerican coral snake. Juvenile, 210 mm total length. Find-spot Cañas, Costa Rica.

Foto: Twan Leenders.

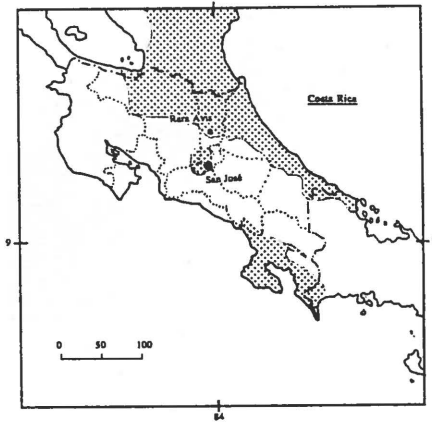


Foto 3: *Micrurus alleni*. Allen's koraalslang. Juveniël, 197 mm totale lengte. Vindplaats Parque Nacional Braulio Carillo, Costa Rica.
Allen's coral snake. Juvenile, 197 mm total length. Find-spot Parque Nacional Braulio Carillo, Costa Rica.
Foto: Twan Leenders.



Foto 4: *Micrurus mipartitus*. Tweekleurige koraalslang. Wit-zwarte vorm. Adult, 442 mm totale lengte. Vindplaats Rara Avis, Costa Rica.
Let op de omgekrulde staarpunt: typisch verdedigingsgedrag van koraalslangen.
Twocoloured coral snake. Black-white form. Adult, 442 mm total length.
Find-spot Rara Avis, Costa Rica. Note the curled tail-tip: typical defence behaviour of coral snakes.
Foto: Twan Leenders.

snakes found in Rara Avis belong to the subspecies *Micrurus mipartitus hertwigi*.



Map 2: Distribution of *M. allenii* in Costa Rica. By some authors the Pacific population is regarded as a separate species, *M. yatesi*.

an intermediate form which possesses black and light-orange body rings. In the latter specimen the black and orange rings were separated by narrow white rings, and the ventral colouration was black and white. This animal was actually an intermediate between a bi- and tri-colour coral snake. In addition, the head and tail rings were bright orange, in contrary with the pale body rings.

The entirely black and white form of *Micrurus mipartitus* is rare. Its first description by Villa (1972) was based on a single specimen collected near Rara Avis. It is extremely striking that both the black and white, and the black and orange morph occur in the same area. In fact, the collecting sites of the two specimens were less than 100m apart! It is obvious that the Rara Avis population either consists of two species, or that it is a case of polymorphism.

Juveniles of this species were collected from the second half of July onwards, so the reproductive cycle of the bicoloured coral snake is probably similar to that of the others.

Apart from the coral snakes that occur in and around Rara Avis, one other species of coral snake inhabits Costa Rica: *Micrurus clarki* (Schmidt, 1936). Of this species only a few specimens have been collected in the extreme Southwest of the country (map 3). It is, however, common on the other side of the border, in Panama. This species is distinguished from the other tricoloured coral snakes by a black head cap that almost completely covers the parietal scales (Savage & Vial, 1974).

CONCLUSIONS

The taxonomic situation of the different Costa Rican coral snakes is very unstable, and changes are made very often. A lot of research is required before a valid classification can be made.

Roughly, the Costa Rican coral snakes can be divided into two types: tricolour black-yellow-red-yellow-black species (*Micrurus allenii*, *Micrurus clarki*, *Micrurus nigrocinctus*) and

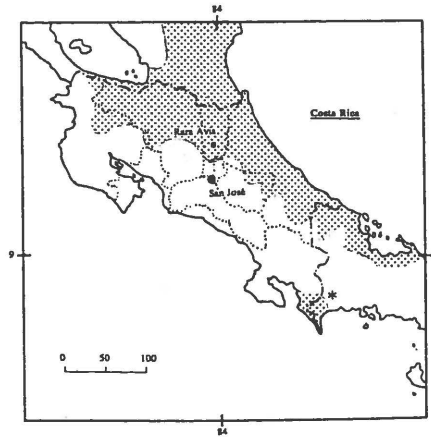
This is a slim species, with a maximum total length of one meter. Specimens of 50-80cm total length, however, are more common. *Micrurus mipartitus* is a relatively rare species, and hardly anything is known about the natural history of this snake. My experience is that it is a somewhat nervous species compared to the other species mentioned, which is not reluctant to bite. This is a very unpleasant characteristic, since bicoloured coral snakes possess a very strong neurotoxic venom and no functional antivenom against it exists.

Micrurus mipartitus can be found throughout the entire Atlantic versant of Costa Rica. Its altitudinal range is 0-1200 meter (map 3).

In Rara Avis three types of this species have been found: a black-orange version, the rare black-white version (Photo 4) and

a bicolour species (*Micrurus mipartitus*). The tricolour species are easily distinguished by the different head patterns (Figure 1). However, on certain localities in the country this may be a bit difficult, because of the intraspecific variation. An accurate determination can then be made only on the basis of scalation characteristics.

Recognizing the different coral snake species in the field is also troubled by the occurrence of several species of 'false' coral snakes, colubrid snakes that mimic the colour pattern and sometimes even the behaviour of real coral snakes. These species will be the subject of a subsequent paper.



Map 3: Distribution of *M. mipartitus* en *M. clarki* (*) in Costa Rica (Campbell & Lamar, 1989).

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