RED ON YELLOW, KILL A FELLOW...
HOW DOES THAT WORK IN THE NEOTROPICS?
AN INTRODUCTION TO THE CORAL SNAKES OF COSTA RICA AND BEYOND

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**Photos by the author, except otherwise stated.*

The family Elapidae constitutes a globally significant and diverse lineage of venomous snakes, renowned for including some of the most iconic species such as cobras, mambas, kraits, sea snakes, and the vibrant coral snakes. A defining morphological feature of this family is their proteroglyphous dentition: a pair of fixed, hollow fangs located at the front of the upper jaw, optimized for the efficient delivery of a potent neurotoxic venom. With over 360 species, elapids have successfully colonized a vast range of habitats across tropical and subtropical regions of the world, from the arid landscapes of Australia to the dense rainforests of South America and the marine environments of the Indo-Pacific. This evolutionary success is a testament to their sophisticated venom systems, which primarily serve to rapidly incapacitate prey, but also function as a formidable defense, making them a subject of profound medical and scientific importance.

In the Americas, the assemblage of snakes known as coral snakes is represented by two or three distinct genera: *Micruroides*, which is monotypic, represented solely by the Arizona coral snake *Micruroides euryxanthus* (Kennicott, 1860) of the southwestern United States and northwestern Mexico. *Leptomicrurus* contains just a few species of slender Amazonian coral snakes (and its validity is still in debate).

Figure 1. Brown's coral snake (*M. browni*) from Chiapas, Mexico, found under a log.

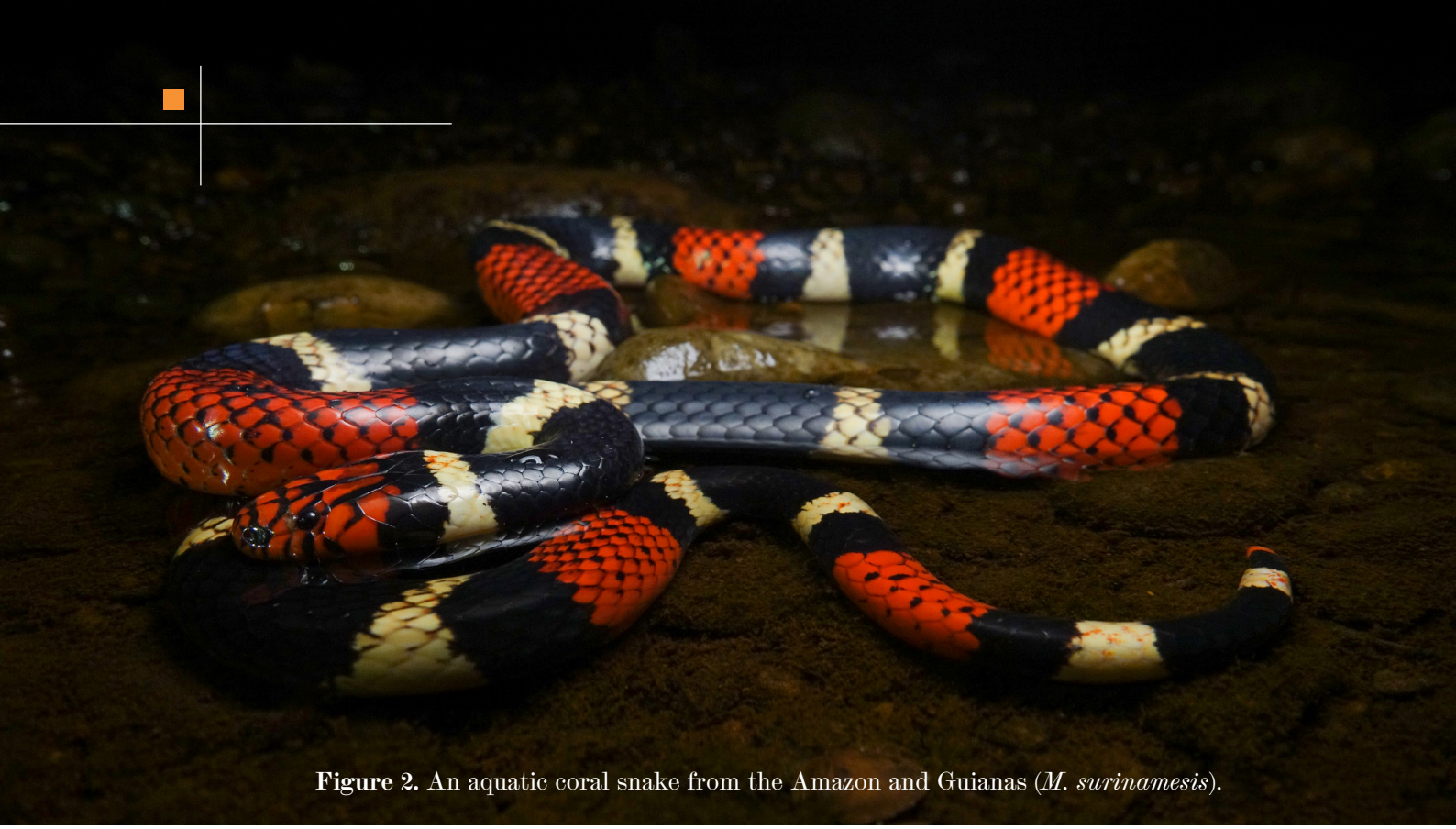

Figure 2. An aquatic coral snake from the Amazon and Guianas (*M. surinamesis*).

The genus *Micrurus* is the group's evolutionary centerpiece. It currently comprises over 80 recognized species, making it the most diverse elapid genus in the New World. As a whole, American coral snakes are distributed broadly from the southern United States southward through Central America and across the majority of South America, occupying an impressive variety of ecosystems. Their striking patterns of red, yellow (or white), and black rings are a classic example of aposematism (warning coloration), signaling their dangerous potential to would-be predators (but see below some thoughts about).

The genus *Micrurus*, whose name originates from the Greek words *mikros* (small) and *oura* (tail), alluding to the characteristically short tail seen in many species, encompasses the quintessential New World coral snakes. These are typically elusive, often fossorial or semi-fossorial snakes, spending a great deal of their lives concealed within leaf litter, beneath logs (Fig. 1), or in subterranean burrows. A few are semi-aquatic (Fig. 2), and as we will see, we report a new case of arboreality in coral snakes, reviewing other cases. Their activity is mainly nocturnal, but they can be found during the day when it is cloudy or rainy, or very early in the morning or at dusk.

This secretive nature means encounters with humans are relatively infrequent. Their diet is highly specialized, consisting primarily of other elongate vertebrates, including other snakes, lizards, amphisbaenians, caecilians and long fish such as eels. As oviparous reptiles, females lay clutches of eggs to reproduce.

The potent defensive capabilities of *Micrurus*, advertised by their conspicuous coloration, are so effective that they have spurred the evolution of numerous non-venomous snake species that mimic their patterns, a phenomenon known as Batesian or Müllerian mimicry (see below).

Their defensive methods, however, go far away, and normally will flee quickly to escape, or rise their tail coiled moving it and distracting the predator from the most-valuable head (Fig. 3), or even fake their own death (thanatosis; see Barrio-Amorós & González, 2022).

The coral snakes of Costa Rica

Costa Rica, a country celebrated for its immense biodiversity, is home to a fascinating array of reptiles, including several species of the genus *Micrurus*, commonly known as coral snakes. These venomous snakes, as many others, are often shrouded

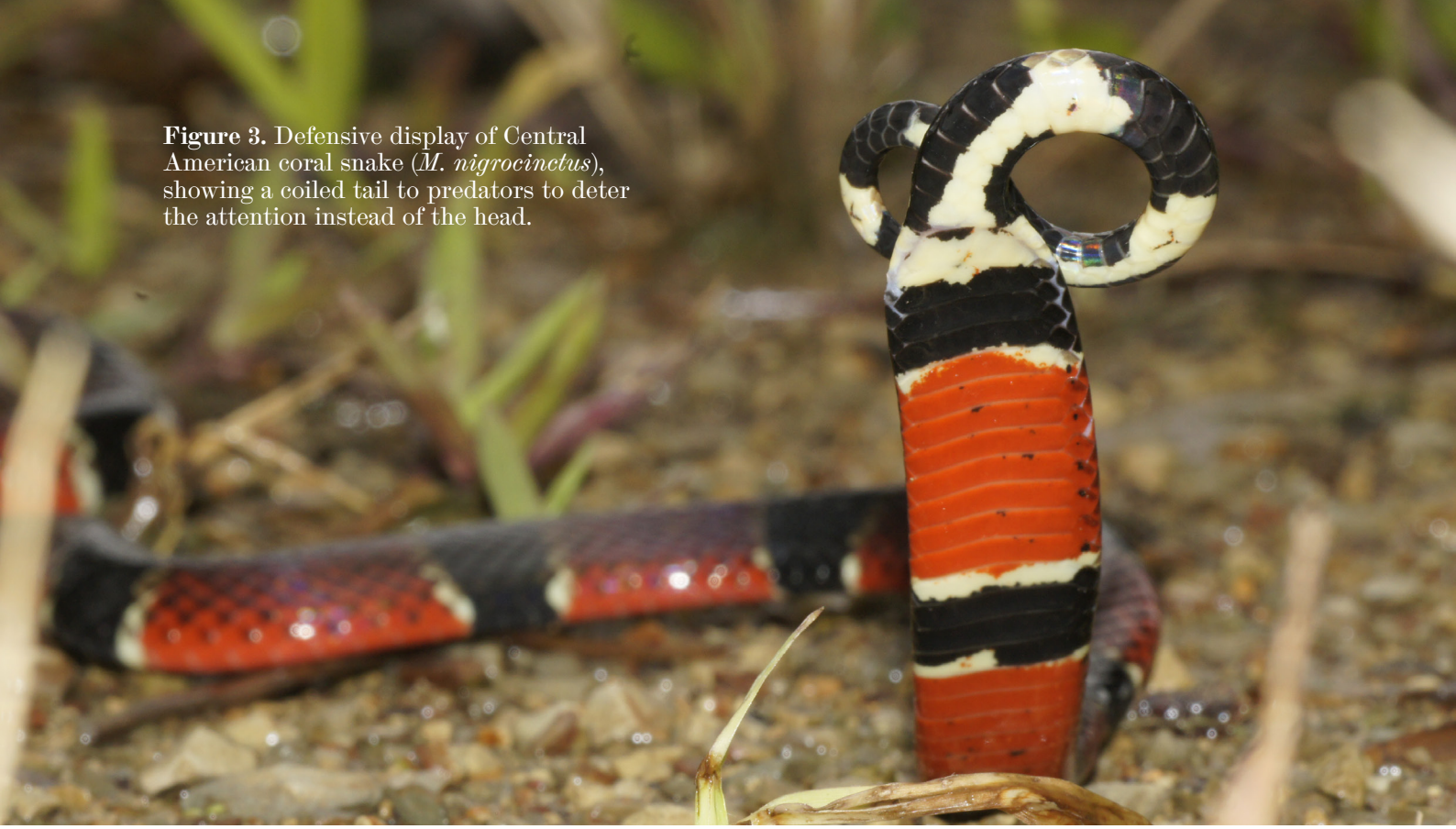

Figure 3. Defensive display of Central American coral snake (*M. nigrocinctus*), showing a coiled tail to predators to deter the attention instead of the head.

in myth and misconception. While they possess a potent neurotoxic venom, they are generally secretive and reclusive, posing little threat to humans unless provoked.
The coloration of Costa Rican coral snakes typically follows a repeating pattern of red, yellow (or white), and black bands, in a pattern known in Spanish as RANA (rojo-amarillo-negro-amarillo = red-yellow-black-yellow) or monodal. This aposematic coloration serves as a powerful warning to potential predators (and should be to humans as well, but see below). This is present in 5 of the 7 species of "corals" in the country. Two more fall in the bicolor patern. It is important to note that distinguishing between venomous coral snakes and their non-venomous mimics can be challenging and requires careful observation of their specific banding patterns and other characteristics.

Here's a look at the confirmed *Micrurus* species in Costa Rica:

- ***Micrurus alleni* Schmidt, 1936**. Known as Allen's coral snake, this species is found in the lowlands of the Caribbean versant of the country. It's identifiable by its distinct black indentation in its yellow cap; and thin white to yellow (Fig. 4) rings bordering the sold black rings; the red bands are interspersed with black flecks. It has the most aquatic habits among Costa Rican coral snakes, being found often

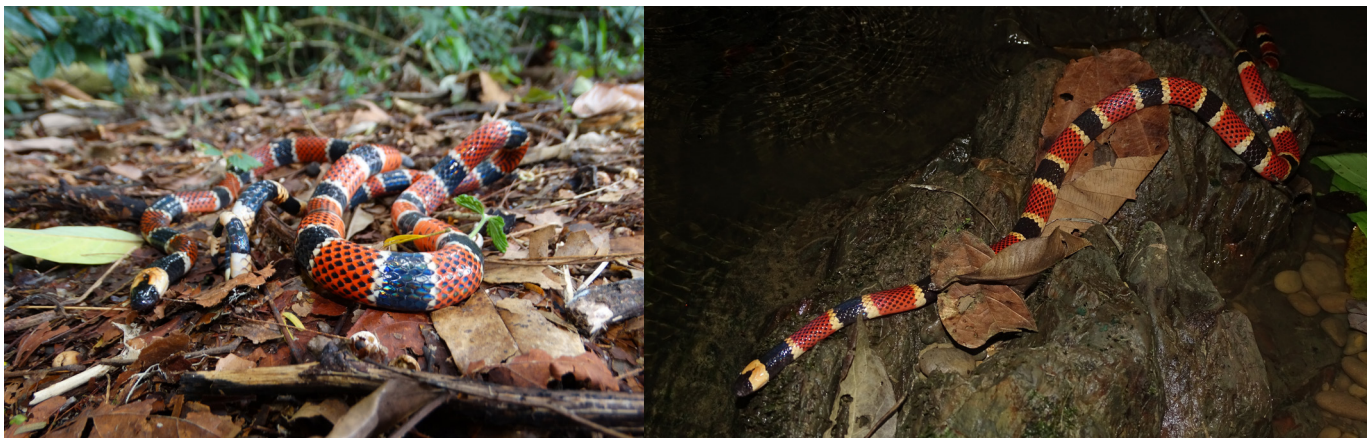

Figure 4. *M. alleni* from Matina, central Caribbean section of Costa Rica, showing white rings (left) and Puerto Viejo, southern Caribbean section of Costa Rica, showing yellow rings (right).

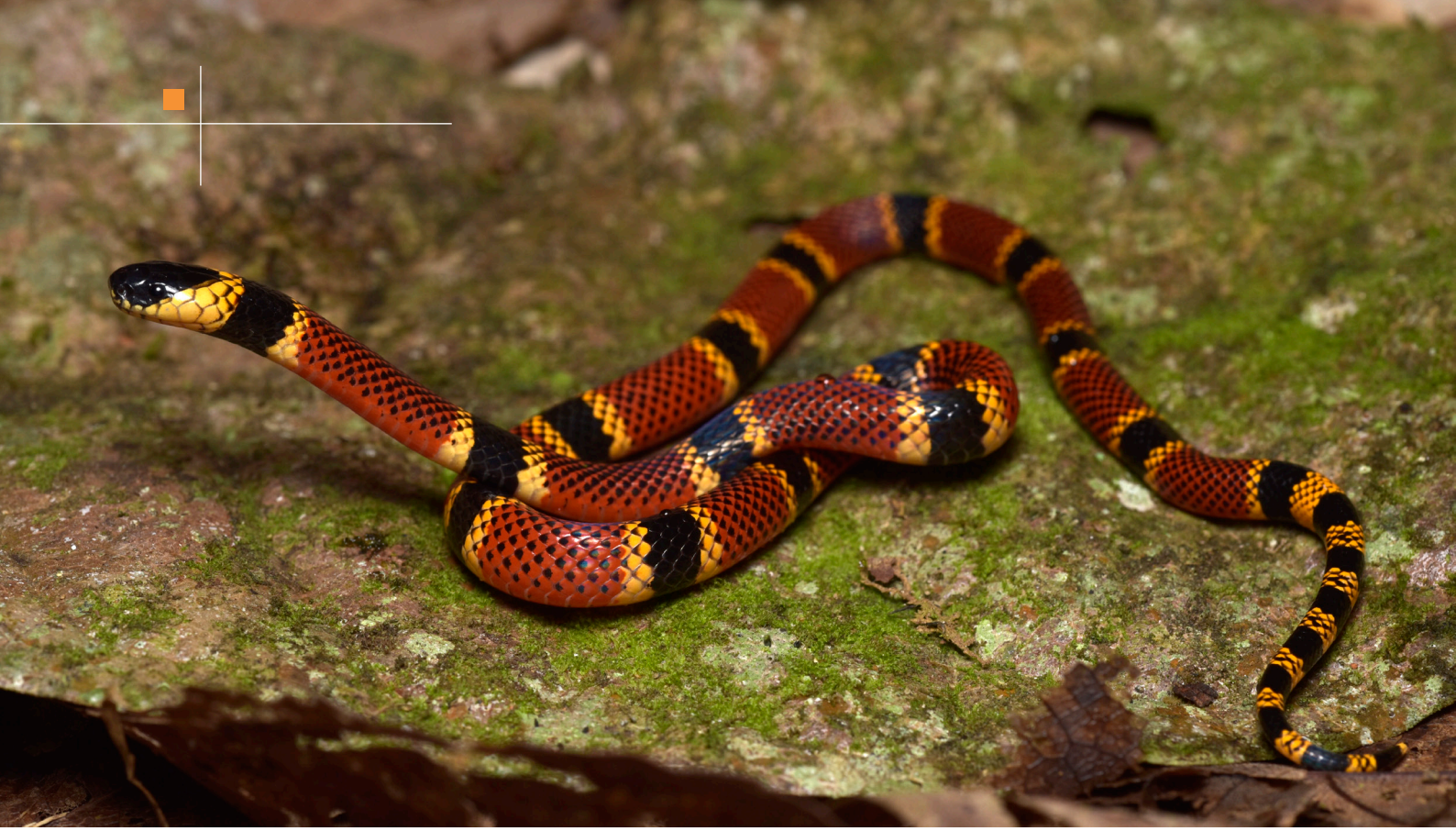

Figure 5. *M. clarki*, the rarest species of Coral snake in Pacific Costa Rica; in 14 years living in the same area they occur, I've only seen four. This is a juvenile individual from Uvita, Puntarenas, Costa Rica.

swimming or diving, usually foraging in the bottom of rivers or swamps. They feed on elongated fish like eels or knife fish, and caecilians. This species is the biggest of the genus in Costa Rica and can grow up to 132 cm (51.96 in).

- ***Micrurus clarki* Schmidt, 1936**. Clark's coral snake is a less common species with a more restricted range, often found in the southern Pacific lowlands, but also extending into Panama and northern Colombia (Fig. 5). It's distinguished by its unique banding pattern, where the red bands are quite wide; the most distinctive character is the yellow chicks mottled with black, and the extensive black head. Little is known of this species, which is very rarely found, but the general natural history must apply here as well; a semi-fossorial hunter of elongated prey such as lizards, snakes and caecilians.

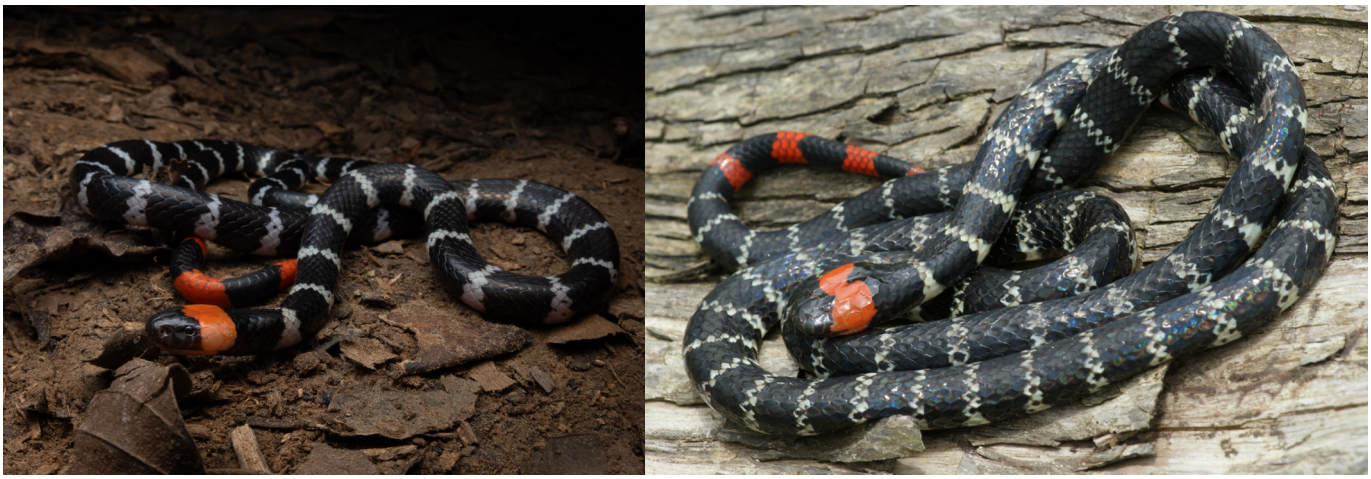

Figure 6. While being quite well distributed in Panama and northern Central America, *M. mipartitus* is extremely rare in Costa Rica; taken in the southern Caribbean (photo Sandro Pérez Veltman) (left) and *M. m. anomalus* from Andean Venezuela (right).

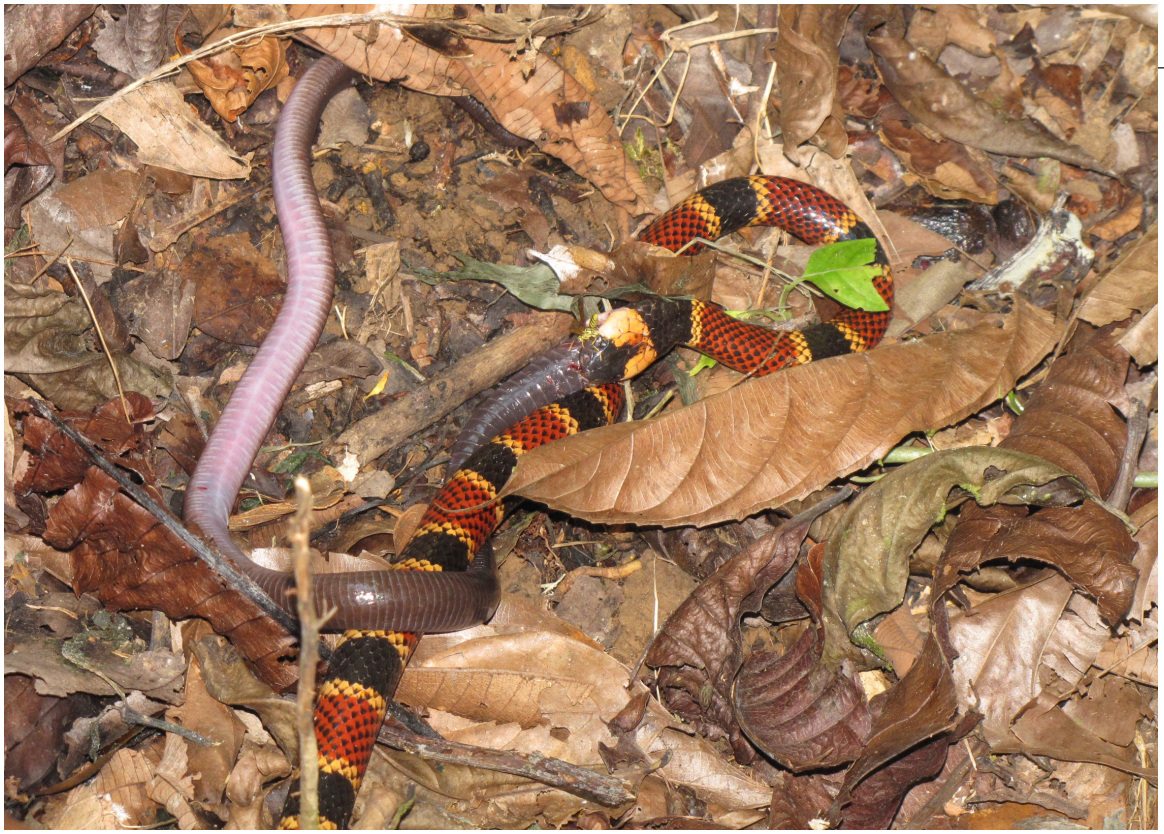

Figure 7. As said, coral snakes are attracted by elongated prey, such as snakes, lizards, eels and caecilians. In this case, a *M. yatesi* near Dominical, Puntarenas, Costa Rica, is swallowing a caecilian during the morning. Photo by Gary Kritzinger.

- ***Micrurus mipartitus* (Duméril, Bibron & Duméril, 1854)**. Also known as the red-tailed coral snake, this species has a wide distribution from southern Caribbean Costa Rica (Fig. 6), where it is extremely rare, to northern South America, where it can be quite common in Venezuela (Fig. 6) and Colombia. A key characteristic is its bright red or orange head band and 3-4 orange-red rings on the tail, which contrasts with the black and yellow bands on its body. They can reach up to 140 cm (55.11 in). They have been seen feeding on snakes (even their own kind), lizards, caecilians (Fig. 7) and earth worms.
- ***Micrurus mosquitensis* Schmidt, 1933**. This species was described as a subspecies of *M. nigrocinctus*, from which is quite different. These bands or rings are quite wide and clean, more than other species where the red bands are usually speckled

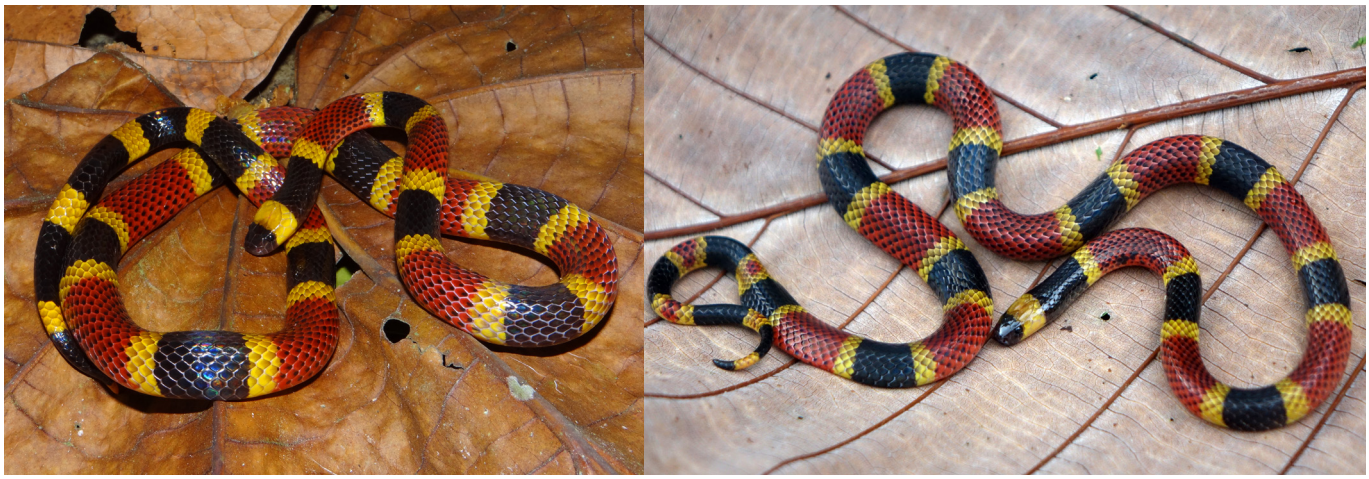

Figure 8. One of the most abundant coral species in the Caribbean side of Costa Rica is *M. mosquitensis* (individual from Pandora, Limon, Costa Rica (left)) and another individual of *M. mosquitensis* from Liverpool, Limon, Costa Rica (right).

Figure 9. A very rare individual of *M. mosquitensis* from the Pacific side of Costa Rica, this population is under study.

with black. This can happen in *M. mosquitensis* but to a lesser degree (Fig. 8). This species is medium-sized, reaching up to 120 cm, but normally much less. In Costa Rica it can be found on the Caribbean slopes (Fig. 7), extending to Panamá and Nicaragua, but most recently, some individuals from the Pacific side have been also determined as "*mosquitensis*" (see Jowers et al., 2022) (Fig. 9).

- ***Micrurus multifasciatus*** **(Jan, 1858).** This species, often called the many-banded coral snake, is only found on the Caribbean slopes, in rainforest. As its name suggests, it has a high number of narrow black with narrower orange to red bands in between (Fig. 10). It can reach up to 120 cm, but smaller animals are much more common. Barrio-Amorós & González (2022) reported an interesting case of thanatosis in this species, a defensive strategy not usually used by coral snakes.
- ***Micrurus nigrocinctus*** **(Girard, 1854).** The most widely distributed and commonly encountered coral snake in Costa Rica, the black-banded coral snake, is found throughout the country's dry forests. Its pattern consists of alternating black and red bands separated by very

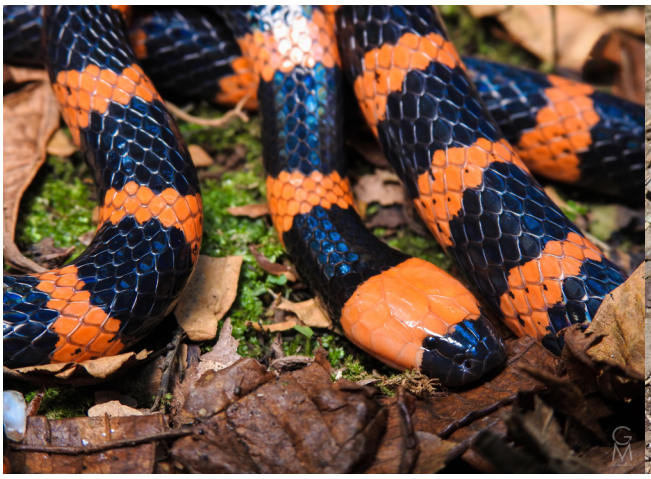

Figure 10. Another difficult species to find in Costa Rica is *M. multifasciatus*, a semi-fossorial snake, Heredia province, Costa Rica (photo by Tavo Murillo).

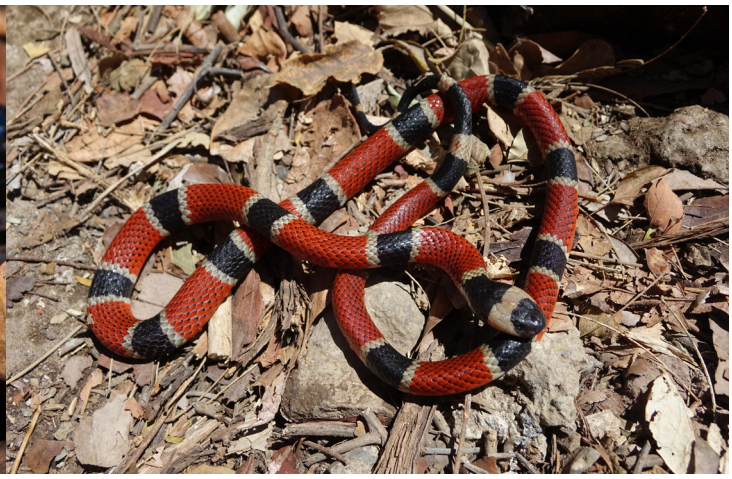

Figure 11. This name, *M. nigrocinctus*, presents a taxonomic problem difficult to solve: the populations from NW Costa Rica will be probably name in a future *M. zunilensis*.

narrow white to creamish rings (Fig. 11). The head is typically creamy with a black snout. The taxonomy is far from being resolved (Jowers et al., 2023), and is quite obvious that this name will change in the near future. Probably, the name "*nigrocinctus*" cannot be applied to Costa Rican populations. Several subspecies have been described, and probably some will rise as valid species. In Costa Rica very probably the northwestern animals will use the name *M. zunilensis* (M. Jowers; pers. comm.).

- ***Micrurus yatesi* Dunn, 1942**. This species, Yates' coral snake, has a somewhat confusing taxonomic history. Some sources consider it a subspecies of *M. alleni*. It is generally found in the Pacific lowlands of Costa Rica and Panama. Its appearance is similar to *M. alleni*, often with subtle differences in band width and color (Fig. 12). The venoms are different enough (Mena et al., 2022) but this is not considered as a valid taxonomic character. However, the name is being considered as valid by the newest Checklist of Costa Rican herpetofauna (Sasa et al., 2025).

The Aposematism Paradigm in Coral Snakes

Aposematism is an evolutionary strategy in which prey advertises its danger or unpalatability to potential predators through conspicuous warning signals. It is a form of "honest advertising" in nature. The signal—typically visual (bright colors), but also auditory or chemical—is associated with a real defense, such as venom, skin toxins, or an unpleasant taste. In the case

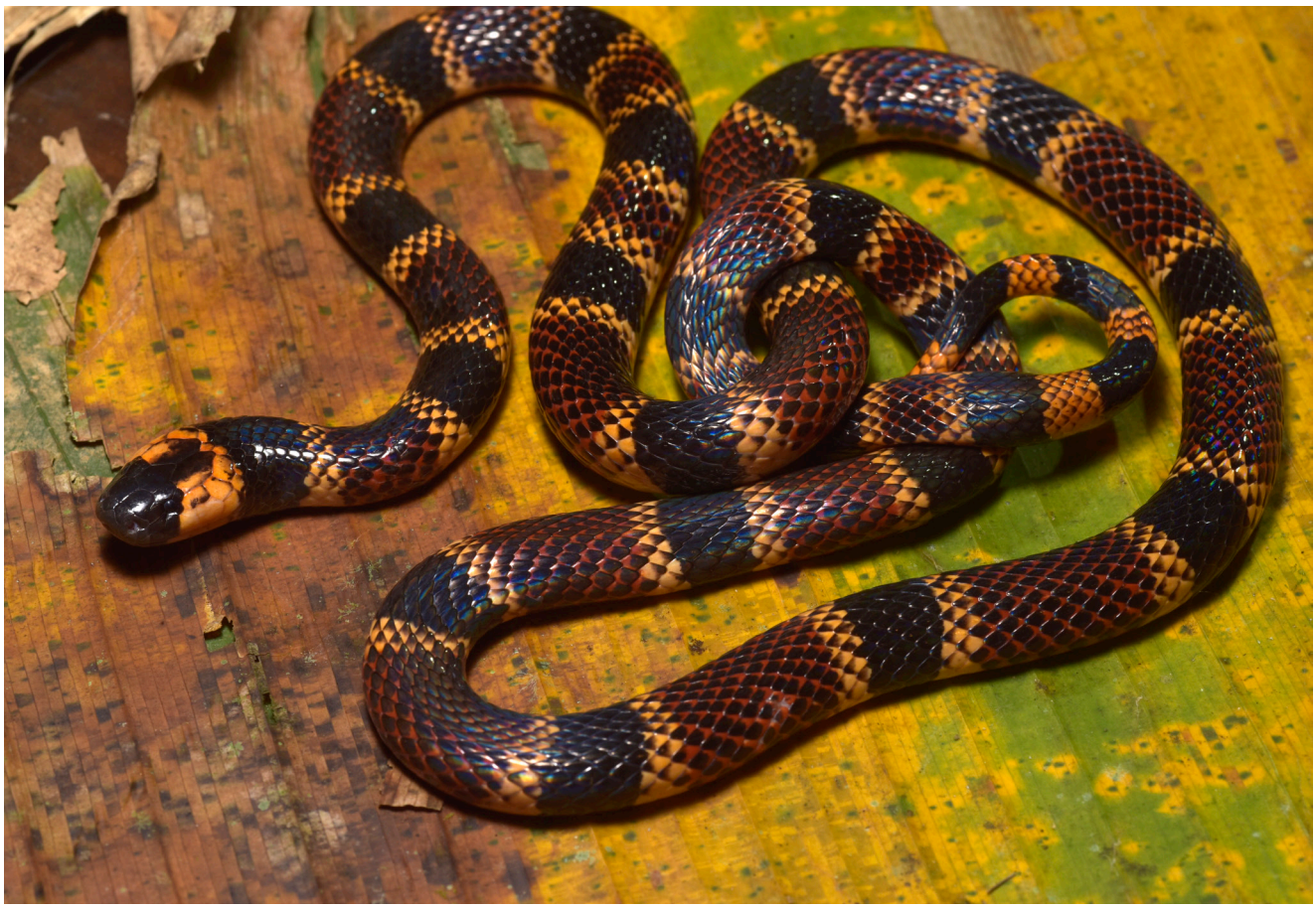

Figure 12. Another taxonomic problem is presented by the *M. alleni* populations from the pacific versant of Costa Rica: without being totally resolved, nowadays the name *M. yatesi* is used for those.

of coral snakes of the genus *Micrurus*, the pattern of vibrant color rings—red, yellow/white, and black—is the canonical example of aposematism. The classical hypothesis posits that a visual predator, such as a raptor, attacks a coral snake once, suffers the consequences of its potent neurotoxic venom, and, if survives, learns to associate the ringed pattern with that negative experience, avoiding any similarly colored snake in the future. This mechanism is so effective that it has driven the evolution of Batesian mimicry, where harmless species, such as false coral snakes (*Lampropeltis* spp. among many others), imitate the pattern to deceive predators and gain protection without the cost of venom production.

Questioning the Infallibility of the Signal

Despite being a textbook model, the aposematic function of coral snake coloration is the subject of intense scientific debate, as it presents several significant paradoxes that challenge a simplistic explanation. Some field experiments—often using plasticine snake replicas to record attack marks—have yielded mixed results. While certain avian predators have been shown to learn to avoid the ringed pattern, others do not. For example, ophiophagous predators (snake-eaters), such as other snakes e.g., *Clelia clelia* (Daudin, 1803), the mussurana, or some mammals, may not be deterred by the coloration. The selective pressure exerted by predators is not uniform; thus, the "protection" offered by the color pattern is not universal, depending heavily on the local predator community and whether their aversion is learned or innate (Brodie, 1993).

One of the strongest criticisms of the aposematic hypothesis is the predominantly crepuscular and nocturnal behavior of many *Micrurus* species. A warning signal based on bright colors loses much of its effectiveness in low-light conditions. Moreover, many of their potential predators—such as carnivorous mammals (e.g., skunks, coatis, opposums) and some nocturnal raptors—have poor or no color vision. For these animals, the pattern would be perceived in grayscale, where the high contrast between light and dark rings might be more relevant than the specific hues, possibly functioning more as a disruptive pattern than a chromatic warning signal (Savage & Slowinski 1992). Some false corals, such as *Pliocercus*, *Oxyrhopus* or *Rhinobothruym* (Fig. 13) are also nocturnal.

Figure 13. *R. bovallii*, a false coral snake with "red and yellow – or white – ", nocturnal and arboreal species of colubrid from Central América and Nortwestern South America.

Also, when threatened, coral snakes do not remain static to display their pattern. Instead, they perform erratic, spasmodic defensive movements, hiding their head under the body and frantically waving their tail (Fig. 3). This rapid action can create a flicker-fusion effect, which in the predator's visual system blurs the distinct color rings into a more uniform perception (possibly brownish or orange). This behavior seems counterproductive if the primary goal is to present a clear, static warning pattern. Therefore, it has been suggested that the coloration may serve a secondary function, or that the movement itself is a deimatic (startle) signal that complements—or even overrides—the color signal at the critical moment of encounter (Greene 1997).

Why are there so many false coral snakes?

In the Americas, there are a bunch of species that are often known as false or fake coral snakes, as they usually show highly contrasted coloration in a ringed pattern. We, humans, do not know how to distinguish among them and actually, that's the main purpose of those snakes, isn't it?.. How and why does this happen?

Mimicry is an evolutionary adaptation where one species, the mimic, evolves to resemble another species, the model, to deceive a third party, often a predator. This resemblance can be in appearance, sound, scent, or behavior. There are two primary forms of mimicry: Batesian mimicry and Müllerian mimicry, each with a distinct purpose and outcome. In Batesian mimicry, a harmless or palatable species (the mimic) imitates the warning signals of a harmful or unpalatable species (the model, a coral snake). This relationship is one-sided; the mimic benefits from the model's bad reputation with predators, while the model receives no benefit and may even be harmed if predators learn the warning signal isn't always reliable. A classic example is the harmless scarlet kingsnake *Lampropeltis elapsoides* (Holbrook, 1838) mimicking the venomous eastern coral snake *Micrurus fulvius* (Linnaeus, 1766).

Additionally, Müllerian mimicry involves two or more harmful or unpalatable species that share a similar warning signal. This mutual resemblance benefits all species involved because predators only need one negative experience to learn to avoid all members of the mimicry ring. This shared defense mechanism makes the learning process faster and more efficient for predators, reducing the overall mortality for all species in the group. Some examples include opistoglyphous false coral snakes such as *Rhinobothryum bovallii* (Andersson, 1916), *Oxyrhopus petolarius* (Linnaeus, 1758) and very especially *Erythrolamprus* (*sensu stricto*).

So, at last, can we trust the famous rhyme "Red on yellow, kill a fellow; Red on black, friend of Jack"?

The famous rhyme, «Red touch yellow, kill a fellow; Red touch black, friend of Jack,» is an unreliable and potentially dangerous oversimplification. While it may hold true for the coral snakes found in the United States and the monodal species, it is not a reliable rule for identifying coral snakes in other parts of the world, especially in regions with high biodiversity like Central or South America.

The rhyme was developed to distinguish the venomous Eastern Coral Snake (*Micrurus fulvius* (Linnaeus, 1766)) from its non-venomous mimics, the Scarlet Milksnake (*Lampropeltis elapsoides* (Holbrook, 1838) or other *Lampropeltis*; Fig. 14), primarily in the southeastern United States. In that specific region, the venomous coral snakes have bands in a «red-yellow-black» pattern, while the non-venomous mimics have a «red-black-yellow» pattern (although this happens on all tricolor species of that genus).

However, once you move south into Mexico, Central, and South America, this rule completely falls apart.

Pattern Variation. There is a tremendous diversity of coral snakes in the Neotropics and many of them do not follow the «red-on-yellow» pattern. The blog post correctly points out that in Mexico alone, there are 16 species of coral snakes, and only 7 of them have the typical (or monodal) pattern. In South America,

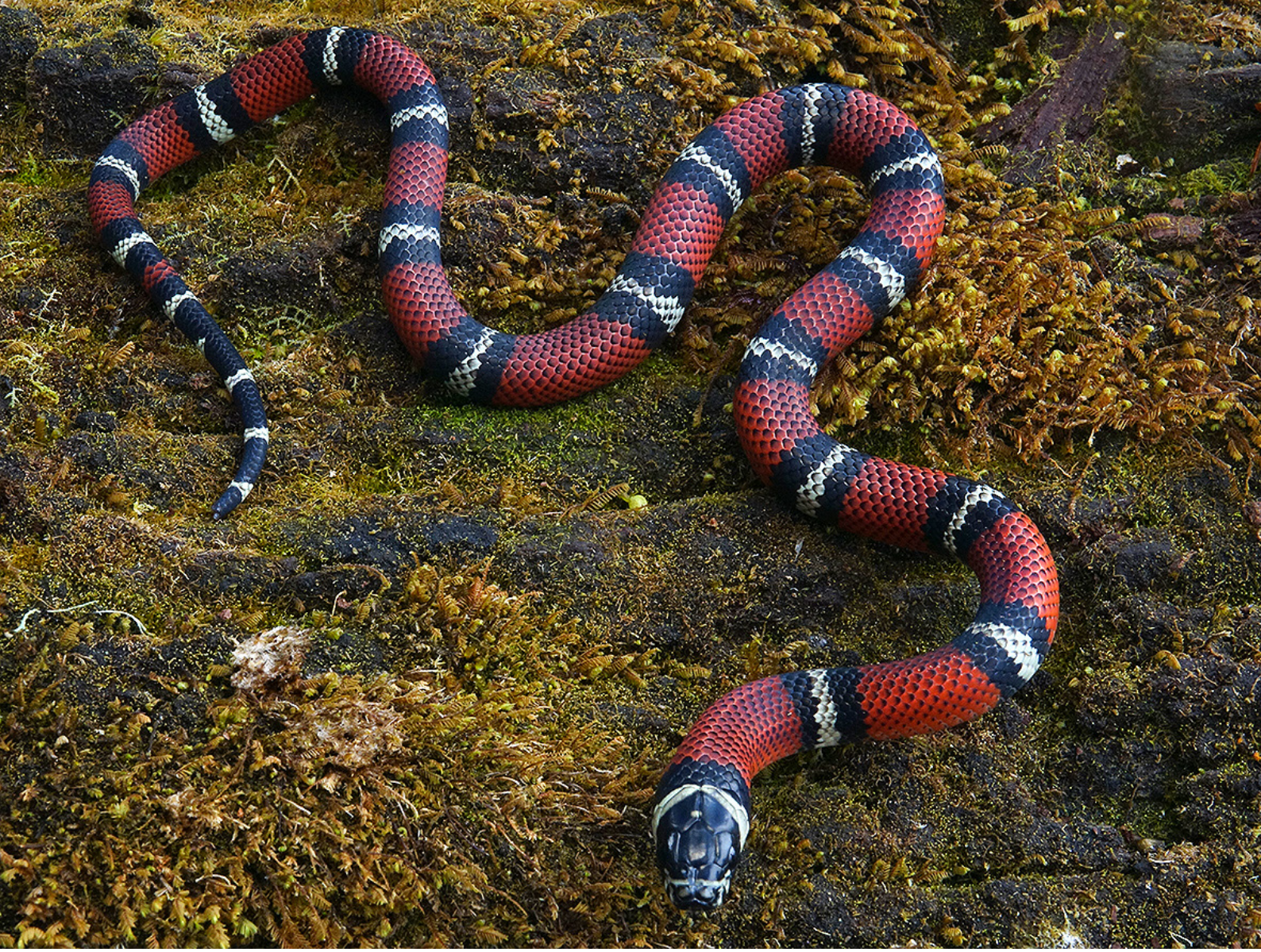

Figure 14. *Lampropeltis triangulum* subsp. *gaigeae* Dunn, 1937 (falsely identified as *Lampropeltis micropholis* Cope, 1860) from Costa Rica, showing the common false coral snake pattern of "red and black".

the number of coral snakes that don't follow the R.A.N.A. (Rojo-Amarillo-Negro-Amarillo) pattern is greater than those that do.

Triads. The most common coral snake pattern in South America (beared by around 60% of the species) is one that makes the rhyme totally false. The triads are groups of rings that encompass three black rings with two white or yellow ones inside, separated by a wide red band (Fig. 15). Each of these groups are known as triads and of course, display red and black, which supposedly would be innocuous.

Mimicry Reversal. To make matters more confusing, there are non-venomous «false» coral snakes in these regions that do have the «red-on-yellow» pattern, perfectly mimicking the venomous ones. Relying on the rhyme could lead someone to mistakenly handle a venomous snake.

Aberrant Patterns. Even within a single species, individual snakes can have aberrant patterns that deviate from the norm.

The danger lies in a false sense of security. Someone relying on this rhyme might misidentify a dangerously venomous coral snake as a harmless species. The advice is simple: never rely on rhymes or simple tricks to identify a snake. The only safe way to interact with snakes, especially in a place as biodiverse as Costa Rica, is to admire them from a safe and respectful distance. Do not attempt to handle or get close to any snake you cannot identify with 100% certainty. In short, the rhyme is a piece of folklore that should be retired out of the United States. When it comes to snakes, it's always better to be safe than sorry.

Figure 15. A large *Micrurus diutius* (Burger, 1955) from eastern Venezuela showing the triad pattern typical to many species of South American corals, and demonstrating that the phrase "red touch black, friend of Jack" is totally wrong outside the U.S.A.

A case of arboreality in Coral snakes

by Stejn Pulles & César Barrio-Amorós

On 6 September 2024 around 20.00 in Kekoldi Indigenous reserve in Southern Caribbean of Costa Rica (Limon province), the authors observed an interesting case. While searching for herps at night, we found a very ring-colored snake around 5 m high in a tree (Fig. 16), and at first glance, because of the size (around 80-90 cm) and the conditions, we figure out that it was an arboreal fake coral snake *R. bovallii*. Those large fake corals are fairly common in the area and often found high in trees. Their pattern is very similar to that on a monodal coral snake, so, it was not a surprise to find, until CBA zoomed in. The result was unexpected, as it was a real coral snake, *M. mosquitensis* (Fig. 16), climbing the tree. It was not just climbing the bark, but deciding on each step where to head next. It was exploring very carefully the bark and changing directions quite often, as if it was not really sure about its action. We observed that episode for several minutes, trying to decide if it was searching for something in specific or just wandering around. At the end, we needed to continue the walk and left the animal without knowing its purpose.

Interestingly this is the first case of a *Micrurus* so high in a tree foraging or

exploring without being disturbed, as other cases, like the one mentioned by Getelina et al (2018) where a *M. altirostris* of 60 cm (23.6 in) escaped from researchers climbing a little bush up to 83 cm (32.7 in), or a *M. surinamensis* of 25 cm (9.8 in) mentioned by Hartdegen and Anucone (2001), coiled on a bush at 1.35 m (53.1 in) above ground, or Sadjak (2000) reporting a 40 cm (15.7 in) *M. circinalis* climbing a tree at 2.75 m (108.3 in) in Trinidad; or the case of a *M. diastema* of 60 cm (23.6 in) around 40 cm (15.7 in) from the ground in Mexico (Valencia-Herverth et al. 2016) and the one of *M. distans* reported by Suazo-Ortuño et al. (2004) in Mexico, which is the most similar case, of a 79 cm (31.1 in) animal being found at 4.5 m (177.2 in) on the bark of an adult tree. Our case shows by far the animal found at a higher altitude on a tree (5 m (196.8 in)), and the biggest animal (around 80-90 cm (31.5-35.5 in); not measured, but based on the experience of the authors). Here is the raw video of the case: https://www.youtube.com/watch?v=tydpBSBWlnQ

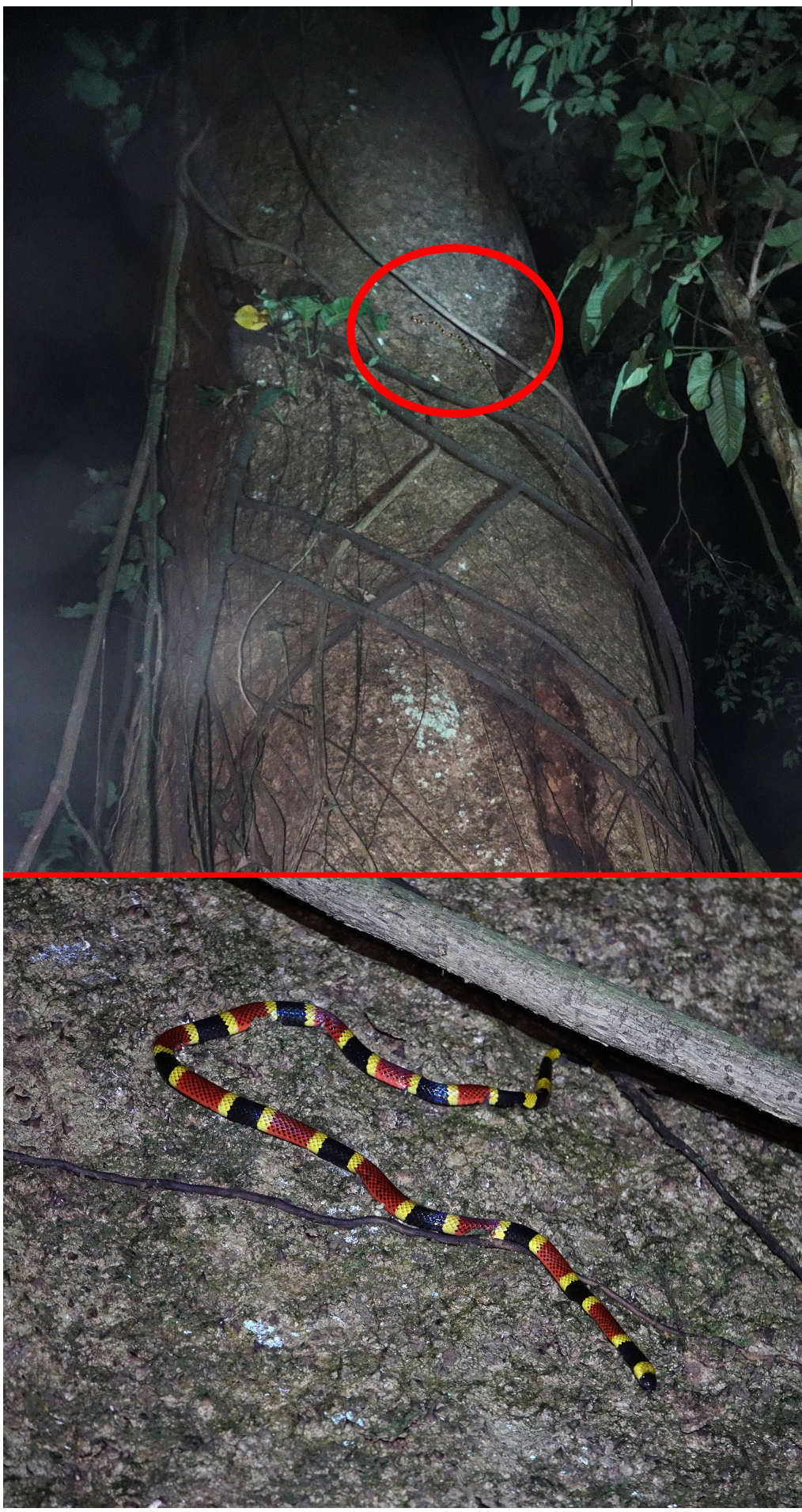

Figure 16. Adult *M. mosquitensis* of around 80-90 cm at around 5 m high climbing a large tree in the Southern Caribbean of Costa Rica

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