THE SNAKES OF SURINAM, PART XIX: FAMILY *VIPERIDAE*, SUBFAMILY *CROTALINAE* (GENUS *CROTALUS*).

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THE SUBFAMILY *CROTALINAE*

In many ways the representatives of this subfamily from America look like those of the subfamily *Viperinae* (adders) from Europe, Africa and Asia. Not only do we find similarity in their behaviour (hunting method and combat ritual between rivals), the shape of the head (broad, triangular and somewhat flattened), the vertical pupils and the keeled scales, but especially in the high level of development of the venom apparatus.
A clearly visible difference between the two subfamilies is the presence of a pit between the nostrils and the eyes in crotalines. The name "pitvipers" for the snakes of this subfamily is derived from this. The pit embraces a heat-sensitive organ which enables the snake to detect the presence of a warm-blooded animal in the darkness, when the eyes cannot be used to maximum effect.
The representatives of this subfamily all live in America or Asia.
The genera that are placed in the subfamily *Crotalinae* are:

The genus *Agkistrodon*	(North and Central America and Asia).
The genus *Bothrops*	(Central and South America).
The genus *Crotalus*	(North, Central and South

America).
The genus *Lachesis* (Central and South America).
The genus *Sistrurus* (North America).
The genus *Trimeresurus* (Asia).
The genus *Hynale* (Asia, mainly Sri Lanka).

The poison mechanism

The subfamily *Crotalinae* belongs to the group of solenoglyph snakes (solenoglypha = closed furrow) which possess a highly developed venom-injecting mechanism consisting of:

1. Shortened upperjaw bones and hinge system to align fangs for strike (fig. 1+2).
2. Hollow or perforated fangs, many times larger than the other teeth (fig. 3). The hinge system makes it possible to fold the fangs backwards when the mouth is closed. This is mainly because of the length of the fangs which would otherwise perforate the lower jaw when the mouth is closed (fig. 1). With a widely opened mouth during the strike the fangs are perpen-

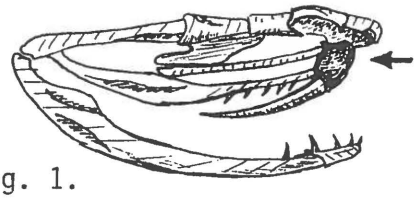


Fig. 1.

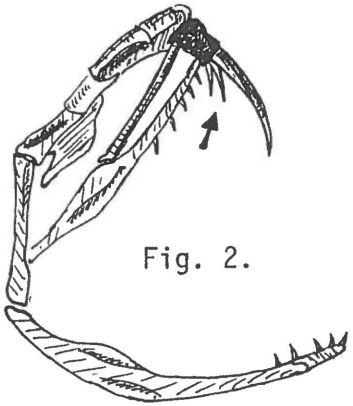


Fig. 2.

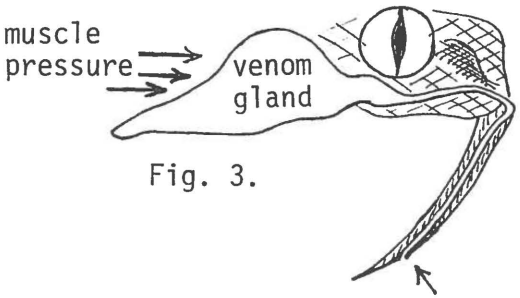


Fig. 3.

dicularly swivelled to become erect (fig. 2).

3. Spare fangs in successive stages of development. These lie directly behind the currently operational fang (fig.2).
   The thin and hollow fangs are often subject to wastage and damage. Every year those teeth are shed 2-4 times. When a fang breaks off prematurely (for example by biting on a bone) the first spare fang will move forwards within a short period (about 10 days) and develop rapidly to become full-sized.
   The released or broken tooth, if still sticking in the prey, passes through the snake's digestive tract and will eventually appear in its faeces.
4. Large venom glands (one behind each eye) containing a strongly effective toxin (fig. 3).
   The venom of the pitvipers is, with a few exceptions, haemotoxic (see also part XVII, family *Elapidae*). To bring about the best effect the venom has to be injected in the bloodstream of the prey. The most effective instrument for this is the hollow or perforated fang. In principle, the effect of this tooth can be compared with that of a hypodermic needle. The strike of a pitviper is aimed to sink the fangs deep in the body of the prey. Simultaneously a jaw muscle pushes on the venom gland, and the venom flows along a small duct to the front of the tooth base (fig. 3a), through the hollow tooth, and squirts powerfully out of the opening. In contrast to the hypodermic needle the opening is not placed at the apex, but some millimeters above it (fig. 3b). The advantage is that there is more space for the venom to stream forth and the chance of a blockage is minimised.

Remark

With their hinged, shortened upperjaw bones the pitvipers are able to accomodate considerably larger and longer fangs in their oral cavity than can the poisonous snakes of the family *Elapidae*. With a single strike they can inject the venom deep into the body of the prey; the pressure of the tissue around the small but deep wound closes the opening immediately after the bite, so no toxin gets lost.
A number of genera from the family *Elapidae* (coral snakes, like the American *Micrurus*-species) have to bite several times or even have to chew with their smaller fangs to get enough venom under the skin of their prey.
During an offensive bite the snake will consciously squirt a maximum dose of venom. A defensive bite does not always involve a venom-expulsion.
In the statistics (G.J. Molenaar, Lacerta 1986) it appears that only 2.4% of the total number of snake bites in the world that are inflicted by potentially lethal snakes end in fatalities. This average however can rise up to about 30%, dependent on country or region. When we look at the statistics for individual snake species, then the fatality rate can rise even up to 100%. This is the case with the black mamba (*Dendroaspis polylepis*). In India is the percentage about 30%; largely responsible for this is the Russells viper (*Vipera russelli*) and not, as one might think, the cobras. The cobras from India cause fatalities in 16% of their victims (Grzimek, 1973). The total of actual victims in Southeast Asia is yearly about 20,000 (G.J. Molenaar, Lacerta 1986). Next to the above mentioned Russells vipers and the cobras, is the strongly feared Malaysian moccasin snake (*Agkistrodon rhodostoma*). In the world (excluding Europe, the Soviet Union and China) 40,000 people are killed annually as the result of snake bites.

We should note that this is only one third of the number fatalities caused by bee stings.
Returning to the subject of the pitvipers of South America, we can see that 90% of the fatal snakebites in this part of the world are accounted for by a number of *Bothrops*-species: *Bothrops jararaca*, 52%; *Bothrops jararacussu*, 10%; *Crotalus durissus* (South American rattlesnake), 10% and the notorious *Lachesis muta* (Bushmaster) only 0.2% (G.J. Molenaar, Lacerta 1986). The great number of victims resulting from bites of *Bothrops*-species is not linked with any great degree of aggressiveness in the snakes of this genus, but is because they are present in such large numbers. The total number of bites (fatal and non-fatal) recorded from *Bothrops jararaca* registered in a period of 42 years, is 3600. In the same period there were 837 bites registered (Grzimek, 1973) from *Crotalus durissus* (South American rattlesnake).

The thermoreceptor (Heat-sense organ)

The pit, sometimes also called the infrared eye, includes a membrane that contains about 150,000 temperature sensitive sense organ cells (these are nervule endings). The heat sensitivity of this membrane is so large, that a temperature difference of $0.003^{0}C$ can be noticed. Due to the reflector shape of the pits the snake picks up the heat radiation (this is infrared heat) of the prey or enemy out of two conical, defined areas. By moving the head to and fro, it can determine the size and shape of the potential prey. The heat-radiation of a (small) mammal or bird is projected on the membrane, so the snake "sees", as it were, its prey or enemy when it goes hunting during the night (also see Schiereck, 1986).

Operation of the heat sense organ (infrared eye)

Out of the 5th cranial nerve there go 3 nerve branches to the left and right membranes. In each membrane these then ramify into the about 150,000 nerve ends. The small channel ensures the temperature of the inner chamber stays the same as that of the pit. When the heat sense organ comes into operation, the channel is closed muscularly. A slight heat increase from the outer area or pit is picked up by the membrane.

Remark

The pit of the pitvipers has evolved from the fusion of two lip grooves. This places the pitvipers at the highest degree of development of all snake families (Grzimek, 1973).
The upper lipscales of the *Boa constrictor* or the lip grooves of the other genera of the *Boinae* and the *Pythoninae* have a similar operation. The heat sensitivity however is less, but still detects changes of 0.026°C.

THE GENUS *CROTALUS*

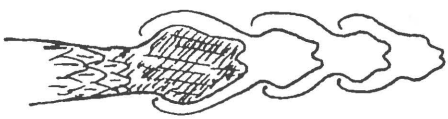
There are 26 species (mainly in North America and Mexico) of which only two species appear in South and Central America. One of these species (*Crotalus durissus*) however, has 12 subspecies, of which one occurs in Surinam (J.A. Peters, 1970).

General data and features of the genus.
Head: When viewed from above, the head is broad and of a rounded triangular shape. Some of the nine large head shields present in many colubrids still occur in *Crotalus* sp. (the frontal and the parietals are absent). The front of the snout attracts attention because of the robust nasal and preocular scales. The pit lies in the

subpreoculars (the lowest of two preoculars). Due to the short snout the pit lies more or less beneath the nostril; in most pitvipers it lies between the eye and nose.
The eyes have a vertical, elliptic pupil and are protected by the protruding supraoculars.

Trunk: Solid to thick. In profile the trunk is mostly triangular. The scales are keeled.

Tail: The tail is short and provided with the so-called "rattle" (hollow, conical caps that fit into one another like encircled ball-and-socket joints, thus revolving and hinging with each other). This mechanism at the end of the tail is used as a warning (aposematic) organ. By making vibrations with the tail when under threat (with a speed of about 50 vibrations per second in cool weather and about 95 vibrations per second in warm weather) the rattlesnake gives a penetrating, buzzing, warning sound (Grzimek, 1973).



The rattle consists of transformed, end-tail-scales, which remain on the end of the tail after sloughing (see drawing). In due course the rattle will become much too long and its effectiveness will be reduced; a long rattle produces a sound that is less penetrating. A snake that is crawling is able to keep about 8 rattle-caps free from the ground. When the rattle grows longer, it starts to drag along the ground. Due to a natural wastage process the rattle will then break off between the 6th and 8th rattle-cap. As always there are exceptions to this rule. The longest rattle that was

Foto 1. *Crotalus durissus dryinus*. Foto: A. Abuys.

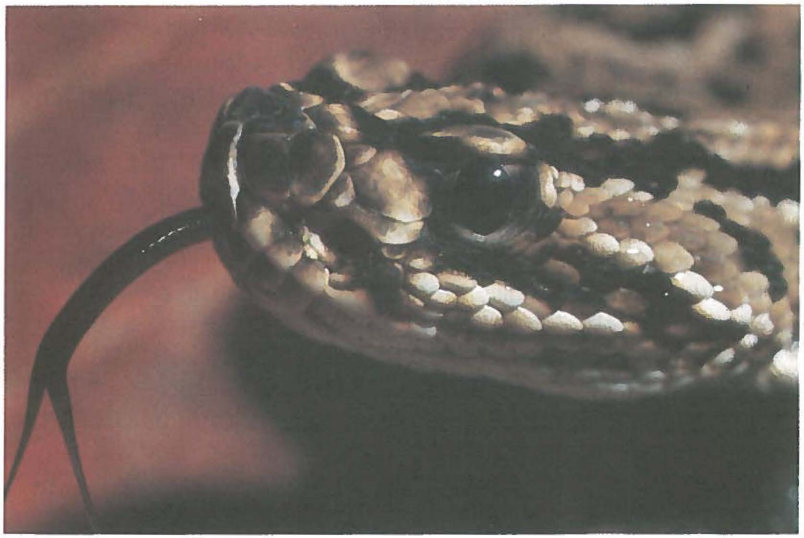


Foto 2. *Crotalus durissus dryinus*. Foto: A. Abuys.

observed on a snake at random had 23 rattlecaps. In captivity a rattlesnake had a rattle of 29 caps. The tail (without the rattle) of the males is proportionately longer than that of females of the same size. On the island of Santa Catalina there is a rattlesnake-species without a rattle (Grzimek, 1973).

Behaviour: Terrestrial. Food is hunted mainly by night. The possession of the thermoreceptors (heat sensitive pits) is of great importance during nocturnal searches for prey.

Food: Consists of small mammals (including squirrels), birds, and occasionally lizards and snakes (including rattlesnakes) and exceptionally fish.

Habitat: Particularly rocky terrain or savannah. The Surinam subspecies is mainly found in the savannahs or on the coastal sandy areas.

Reproduction: Ovoviviparous. The young are born between August and October. The pregnancy lasts about 150 days. The number of young, dependent on the size and age of the mother-snake, varies between 10-30 individuals.
During the breeding season males engage in ritual combat as they vie for females. The snakes are adult after about 3 years.

Specific details: The South American rattlesnake is the most dangerous of the rattlesnakes. Its venom has both haemotoxic (affecting blood and bloodstream) and neurotoxic (acting on the nerve system) components. The effect of the venom can be compared with the bite of a puff adder and a cobra at the same time (Grzimek, 1973). South American rattlesnakes deliver an average of about 33 mg poison in one bite. This may reach a maximum of about 180 mg per bite, while 25 mg is enough to kill someone (J. Karbaat, 1972). Nevertheless the rattlesnake has many enemies: man (the biggest), peccaries

(muscus pigs), birds of prey and the Mussurana (*Clelia clelia*)

Crotalus durissus dryinus (Linnaeus, 1758).

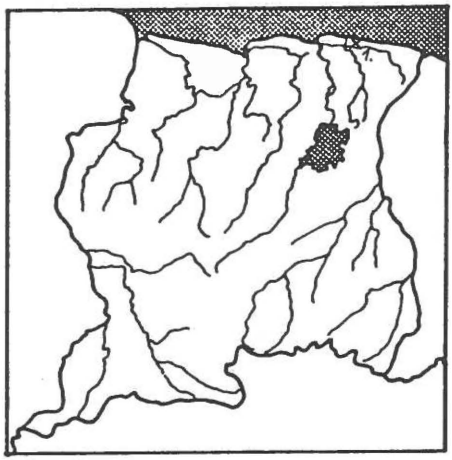
Dutch name: Surinaamse ratelslang.
English name: Green rattlesnake, Jungle rattlesnake or Cascabel.
Surinam name: Sakka sneki ("Sakka" in Surinam for "bag"; in the language of the Aukaner Maroons it means: "rattle").
Maximum length: About 180 cm.
Scalation: Dorsals in about 30 rows (scales strongly keeled); about 175 ventrals; about 24 subcaudals; a single anal scale; 2 preoculars (upper large, lower small and narrow); 3 suboculars; 2 postoculars; 2 loreals (small); about 13 supralabials (small), 1st and 5th enlarged; about 17 sublabials (small). (Scalation data from Gasc & Rodrigues, 1980).
Features: See also the general data and features of the genus. The head is, from above seen, more egg-shaped than triangular. Seen from the side a number of head scales appear very robust. They include the divided nasal scales (the small distal part contains the nostril) and the two preocular scales, of which the upper is very large and the lower is small and narrow. A further striking feature are the two small, just separated, loreal scales. Directly under the preoculars lies the pit (thermo-receptor). This is surrounded by the subpreoculars. Another feature, generally applicable to all the South American species of *Crotalus* are the remaining enlarged head scales: the internasals (somewhat small and triangular shaped), the prefrontals and supraoculars. The frontal scale and the parietals are absent (broken into small scales).

The supraoculars which protrude over the eyes, attract attention by their light colour (light brown to beige), accentuated by an irregular, black bordering. These spots look somewhat like eyes and are a distinctive feature.
A black transverse stripe lies just in front of and a little over the supraoculars. Lateral to this lies a black stripe, as a sort of continuation of the afore-mentioned transverse stripe, running from the eye obliquely to the rear of the upper jaw. At a distance of about 4 scale lengths and parallel to that lies another, irregular, thin, oblique, black stripe. From the supraoculars run two black longitudinal stripes which are parallel to eachother until well past the neck. After that the stripes change into black, diamond-shaped markings with a brown centre. Each diamond has a narrow, beige border with a broadth of one scale length. These scales are actually light brown with a white spot on their ends; this gives the impression of the overall beige colour.
The sides of the snake's body have a light brown ground colour covered with black, sometimes brown, irregular, blotches or stripes. These irregular markings cover 2-5 scales. The belly is off-white or yellowish, while the distal part of the tail is totally black, on both dorsal and ventral surfaces. The tail end consists of the famous rattle.

Remarks: The description above was from a juvenile specimen, which had not yet grown a rattle. It was the only rattlesnake from Surinam that I examined alive.
The basic colour of these snakes can vary between light brown and olive green.

Distribution: The Guianas.

Locality records in Surinam: 1. Matapica beach (Bouwmans, 1975).



Crotalus durissus trigonicus Harris & Simmons, 1977.

(Up to now only known from the Rupununi savannah in Guyana).
Dutch name: Guyanese ratelslang.
English name: Guyana rattlesnake or Rupununi rattlesnake.
Surinam name: Sakka sneki.
Maximum length: About 120 cm (biggest length up to now is 115.7 cm).
Scalation: Dorsals in 29 or in 31 rows (the foremost dorsals are strongly keeled); 170-172 ventrals (males) and 177-178 ventrals (females); 29-31 subcaudals (males) and 21-23 subcaudals (females); a single anal scale; 2 preoculars (the uppermost is larger); 2 suboculars (sometimes 1); 2 loreals (small); 14 supralabials (small; 1st and 4th enlarged); 16 sublabials (small).
(Scalation data from: Harris & Simmons, 1977).
Features: See also "general data and features of the genus".
All features, except for a small exception, are

similar to those of *Crotalus durissus dryinus*. The small number of specimens which have been found up to now in the Rupununi savannah, have an olive-green basic colour. The features of *Crotalus durissus dryinus* are the same as those of the present subspecies except in stead of "brown or light brown basic colour", an olive-green basic colour exists in the case of *Crotalus durissus trigonicus*.

Harris & Simmons (1977) mention the difference between the subspecies *Crotalus durissis dryinus* and *Crotalus durissus trigonicus* in their article: "A new subspecies of *Crotalus durissus* from the Rupununi savannah of Southwestern Guyana". According to them *Crotalus durissus trigonicus* has the scales of the light-coloured bordering of the "diamonds" white spotted at the end, while this would not be so in *Crotalus durissus dryinus*.

The only rattlesnake that I obtained in Surinam was, according to the literature, a specimen of *Crotalus durissus dryinus*. However, it had more or less the same white or ivory coloured spots on the end of the relevant scales. However, I noticed another clear difference. In the article by Harris & Simmons are pictures of *Crotalus durissus trigonicus* in which you can clearly see two black transverse stripes between the supraoculars. The anterior transverse stripe goes just past the front of the supraoculars and just over the back of the prefrontals. A prolongation of this anterior transverse stripe (on both sides of the head) reaches obliquely from above the eye to the back of the upperjaw. The posterior transverse stripe travels behind and partly over the back of the supraoculars. Here there is also an oblique prolongation running parallel to the anterior stripe. The *Crotalus durissus dryinus* (from

Surinam) lacks the posterior transverse stripe, but the oblique prolongation to this stripe is still present.
Conclusion: *Crotalus durissus trigonicus* has two transverse stripes between the supraoculars, whilst *Crotalus durissus dryinus* (from Surinam) has only one.

Remarks: The question is whether you can use this difference in head marking as a visual feature to distinguish the two subspecies from each-other. In my opinion we are dealing with a variety in marking and must see these "two subspecies" as one and the same subspecies.

Distribution: Guyana.

Locality records: Rupununi savannah (southwest Guyana).

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Translation: Fons Sleijpen.