SNAKES OF ZAIRE AND THEIR BITES

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ABSTRACT The ophidiological survey made in Zaire revealed the presence of 152 species of snakes included in 60 genera and in 8 families. The family Colubridae contains the largest number of genera (45) and species (97). Their geographical distribution shows that the eastern part of Kivu region contains a wide variety of species (90 species). The density of Zairean snakes has not yet been known. But in some localities like Kamanyola in the Kivu province, the density is as high as 80 individuals per square kilometer for the vipers. Other areas like Kinsuka in the vicinity of Kinshasa has as many as 10 species within the same area. Snakes are found in the forest, the savanna and in the aquatic milieu. Some species are arboreal and others live in the mountain regions. Evolutionary considerations based on the anatomical observations indicate that the equatorial forest of the Northern Zaire contains some of the most ancient and conservative forms of snakes. Some are considered to be the most evolved and specialized form of snakes in the world.

The frequencies of the snake bites at the sanitary sectors are surveyed. According to the epidemiological data on snake bites, envenomations constitute a serious problem for the public health. Mortality is 6 to 14.3% (mean 8%) of the total snake bites from 1979 to 1986. Bites are most frequent during the agricultural activities. In the savanna of Kivu, which shows the tropical climate, the bites are recorded in the rainy season. The dangerous snakes have been identified: 79 species (51%) are venomous, including vipers, elapids and opisthoglyphous colubrids which are the most dangerous. The treatment of snake bites to reduce mortality and morbidity is applied according to the principles of modern medicine (using antivenom sera) and of the traditional methods (using traditional drugs). The phytotherapy against envenomation is known in Zaire and in many other countries of Africa. Phytochemical screening of these plant drugs is being made for testing their biological activities, and the pharmacological analysis is being carried out for the confirmation of the presence of any antivenomous substance.

Key Words: Zaire; Snakes; Snake bites; Treatment; Antivenomous plants.

INTRODUCTION

This work was realized in the government project of the "Study of antivenomous plants" initiated by the Centre de Recherche en Sciences Naturelles (CRSN) of Lwiro and sponsored by the Ministry of Higher Education and Scientific Research of the Republic of Zaire. It began in 1979 and has the object to identify and purify the antivenomous substances contained in the traditional plant drugs. Ethnobotanical surveys have been already made and about 109 antivenomous plants used in the Zairean pharmacopoeia were listed (Chifundera, 1987).

The study of antivenomous substances (sera and antidotes with substances of vegetable origin) must be accompanied with the knowledge of the venomous snakes themselves. For this sake, the studies on the identification of the snakes, their distribution, their bioecology and their incidence in the sanitary sector, must be carried out (Heymans, 1973). Of the 152 snake species listed in Zaire, 79 (51.9%) are venomous and only a small number of them have medical importance. The effect of bite has been

known because many reports were published on the nature of venoms and their action on the body. Biochemical studies were also made in several specialized laboratories of America, Europe, Japan and Great Britain (Dekeyser & Derivot, 1960; Boquet, 1970; Brown, 1973). The recent WHO's publication (1981) on venoms gives further information on the characteristics of these complex biological substances.

Systematics and taxonomy of African snakes are now well established by several well-trained herpetologists such as Laurent (1956), De Witte (1962), Bourgeois (1968), Hoge & Hoge (1979), Broadley (1974), Roux-Esteve (1974), Branch (1979) and Roman (1979). According to them, the African snakes are grouped into 8 families consisting of 30 genera and more than 200 species. In Zaire, the ophidiological studies have been carried out for 168 years since they were started in 1819 by Leach, an English naturalist (Laurent, 1965). Since then, about 430 publications have appeared on the classification and the nomenclature of Zairean snakes (Chifundera, 1978). But as little is known about the snake bioecology, we devoted our first study to their reproduction cycles (Chifundera, 1983). Venomous snakes were listed by Bouillon (1965), but the snake bite survey has not yet been well made because epidemiological statistics on the envenomation in Zaire were not available. We have made a lot of effort for collecting the cases of snake bites by visiting hospitals. The publications made over the world on the epidemiology of snake bites do not yet contain the information from Zaire. However, numerous cases of envenomation have been recorded in the sanitary centers scattered all around the country. We have collected many cases which indicate that the snake bites should be considered as a serious problem for the public health.

Examining the treatment cards at some hospitals, we have found that many snake bites exist in Zaire causing death or morbidity. The treatment of envenomation is made by antivenom sera when the victims come to hospitals. But many cases are treated by medicine men who use the traditional plant drugs. There are many medicine men in Zaire; at present they are grouped into an association which is supervised by the Ministry of Health and the Institut de Recherche en Sciences de la Santé (IRSS, Kinshasa).

The inventory of medicinal plants in Zaire was first made in 1908 by a Catholic missionary Willens and was developed in 1939 by Foreami, a Belgian sanitary mission to the Congo (Wildeman et al., 1939). Pharmacological studies of some inventoried plants were made in order to identify the organic substances of biological effects (Staner & Boutique, 1937; Kambu & Bakana, 1984).

In 1947, Burette used the Strychnine, an alkaloid substance, for treating envenomation caused by *Dendroaspis jamesoni*. His treatment indicated the evident action of this alkaloid on the reduction of the systemic symptoms of the bite. The prophylactic action of alkaloids of the Lupinane group was reported also by Perrot (1944) in France. On the other hand, tannins are considered to have a curative action.

In 1973, Zairean government inscribed the use of traditional medicinal plants in its sanitary programme. Since this year, the research on the Zairean pharmaccopoeia has occupied the vital position in the biochemical services. It has been carried out in collaboration with the OAU's STRC (Scientific Technical Research Commission for the traditional medicinal plants) located in Nigeria at the University of Ife (Ile-Ife).

In 1946 and 1947, Grasset of the Switzerland Institute of Hygiene first extracted the

venom from vipers in Zaire (*Bitis gabonica* and *Bitis nasicornis*). His purpose was to prepare the antivenom sera for the military campaigns in Africa. The service of Hygiene of Leopoldville (now Kinshasa) was responsible for this work. From then, dried venoms have been sent to specialized laboratories in France and Germany for preparing the antivenom sera.

In 1979, we started the antivenom programme in which the studies about the venoms and their antidotes are carried out. This programme is comprised of two procedures; the study of the antivenomous plants and the preparation of antivenom sera from hyperimmunized horses.

STUDY AREA

Zaire is a wide country measuring 2,345,409 km^2 and containing 34 millions of inhabitants. It occupies the center of the African Continent. Its climatological condition varies from equatorial and tropical climates in the central and eastern parts to the temperate mountainous climate at the high altitude in the eastern region of Kivu province. Distinct rainy and dry seasons are observed in the tropical area. When it rains, the agricultural activities become intensive, and snake bites are most frequent during this period. The vegetation in Zaire also varies: the forest covers the central equatorial part and the savanna predominates in the southern and northern tropical areas. Rivers, lakes and swamps are numerous (Robert, 1942; Bonnardel, 1973). For this privileged geographical and ecological conditions, Zaire offers a favourable field for the herpetological studies. We observe aquatic, terrestrial, arboreal and burrowing snakes. The socio-economic and cultural life of Zairean people is impregnated by stories, legends and magic formulas utilizing the snake as a principal motif. Flesh of large snakes is eaten by many people and we daily observe snake charmers. A variety of local medicines are used for treating envenomation by snakes.

MATERIAL AND METHODS

I. Materials for Snake Capturing

Snakes are caught by lasso and pincers. Bags serve for the transportation. The hoe, the spade and the machette are used to dig out the snake's hole. The stick and the fork are used for immobilizing the snake. The live snakes are conserved in our serpentarium at Lwiro for producing (milking) the venoms which are used for biochemical investigations.

II. Collection of Venoms

Venoms are obtained from maxillary glands. The fresh venoms are dried overnight on the Calcium Chloride at 37°C. We have now more than 100 g of venom from dif-

ferent snake species. Milking techniques are those utilized by the Butantan Institute of Brazil (Hoge & Hoge, 1979).

III. Snake Inventory

To make an inventory of snakes, it is necessary to make regular field tours which cover large area of varying biotopes. A region is thought to contain snakes if we found in it either dead or live specimens. All captured snakes are scientifically identified at our herpetology laboratory at Lwiro where we have a snake collection of 3,500 specimens. Morphological and zoogeographical criteria are used for the identification of snake specimen (Laurent, 1953, 1956).

IV. Epidemiological Survey

The standard cards used at the Japan Snake Institute (Gunma Prefecture) offered by Dr. Yoshio Sawai, the Director, were sent to the hospitals in Zaire for collecting statistics of snake bites. If we use this prospective method, the number of snake bites may be underestimated since most of the victims are not included in the hospital data. Some people prefer traditional treatment to the modern treatment, or recover without medicament. Retrospective survey is usually necessary in which inhabitants give the number of victims observed in their villages (Carme et al., 1986).

RESULTS

I. The Checklist of Zairean Snakes

The herpetofauna survey made it possible to establish a checklist of all the snakes found in Zaire (Table 1). The family Colubridae contains the largest number of genera (45) and species (97) as shown in Table 2. As we can see from the regional distribution of Zairean snakes (Table 3), the eastern Province of Kivu contains most species (90). The southern Provinces of Kasai contain less species, only 49. The Haut-Zaire Province has 49 genera followed by the Province of Shaba (48) and Kivu (47).

The Colubrids show the largest variety, but the cobras (5 genera and 12 species) and the vipers (3 genera and 13 species) occupy also an important part. The minute-snakes (Leptotyphlopidae) contain less variety (1 genus and 2 species). The mambas and the mole vipers have respectively one genus including several species.

The density of the snakes in Zaire is not yet known. Certain localities contain more individuals or species than other localities. The locality of Kamanyola in the Kivu Province has about 80 *Bitis arietans* per km^2 and Kinsuka near Kinshasa (along the Zaire River) has 10 species within the same area.

Snakes are captured in the forest, savanna and in the aquatic milieu (swamps, lakes and rivers). *Boulengerina* and *Grayia* are aquatic. *Atheris* species live in the mountainous areas and are arboreal vipers. *Bitis nasicornis* is semi-aquatic and *Bitis*

Table 1. Check list of Zairean snakes.

I. Typhlopidae (2 genera, 14 species)

1. Rhinotyphlops caecus WITTE, 1961
2. Rhinotyphlops gracilis STERNFELD, 1910
3. Rhinotyphlops graueri STERNFELD, 1912
4. Rhinotyphlops kibarae WITTE, 1953
5. Rhinotyphlops praeocularis STERNFELD, 1894
6. Rhinotyphlops rufescens CHABANAUD, 1916
7. Rhinotyphlops schlegeli PETERS, 1854
8. Rhinotyphlops sudanensis SCHMIDT, 1923
9. Rhinotyphlops stejnegeri LOVERIDGE, 1931
10. Rhinotyphlops wittei ROUX-ESTEVE, 1974
11. Typhlops angolensis BOCAGE, 1866
12. Typhlops lincelatus JAN, 1861
13. Typhlops punctatus LEACH, 1819
14. Typhlops steinhausi WERNER, 1904

II. Leptotyphlopidae (1 genus, 2 species)

15. Leptotyphlops conjuctus JAN, 1861
16. Leptotyphlops nigricans SCHLEGEL, 1839

III. Boidae (2 genera, 3 species)

17. Calabaria reinhardti SCHLEGEL, 1848
18. Python regius SHAW, 1802
19. Python sebae GMELIN, 1788

IV. Colubridae

A. Aglyphous (27 genera, 54 species)

20. Boaedon fuliginosus BOIE, 1827,
21. Boaedon olivaceus DUMERIL, 1856
22. Boaedon virgatus HALLOWELL, 1854
23. Bothrolycus ater GUNTHER, 1874
24. Bothrophthalmus lineatus PETERS, 1863
25. Chamaelycus christyi BOULENGER, 1919
26. Chamaelycus fasciatus GUNTHER, 1858
27. Chamaelycus parkeri ANGEL, 1934
28. Dasypeltis atra STENFELD, 1912
29. Dasypeltis palmarus LEACH, 1818
30. Dasypeltis scabra LINNE, 1754
31. Dasypeltis fasciata SMITH, 1849
32. Dendrolycus elapoides LAURENT, 1952
33. Duberria lutrix BOULENGER, 1894
34. Gastropyxis smaragdina SCHLEGEL, 1837
35. Gonionotophis brussauxi LAURENT, 1956
36. Grayia caesar GUNTHER, 1863
37. Grayia ornata BOCAGE, 1866
38. Grayia smithi LEACH, 1812
39. Grayia tholloni MOCQUARD, 1897
40. Glypholycus bicolor LAURENT, 1950
41. Hapsidophrys lineatus FISCHER, 1856
42. Helophis schoutedeni WITTE, 1922
43. Hormonotus modestus DUMERIL, BIBRON et DUMERIL, 1854
44. Hydraethiops melanogaster GUNTHER, 1872
45. Limnophis bicolor GUNTHER, 1865
46. Lycodonomorphus leleupi LAURENT, 1950
47. Lycodonomorphus subtaeniatus LAURENT, 1954
48. Lycophidion capensis BOETTGER, 1888
49. Lycophidion irroratum LEACH, 1819
50. Lycophidion laterale HALLOWELL, 1857
51. Lycophidion meleagris BOULENGER, 1893
52. Lycophidion ornatum PARKER, 1936
53. Mehelya capensis SMITH, 1847
54. Mehelya laurenti WITTE, 1959
55. Mehelya poensis SMITH, 1847
56. Mehelya stenophthalamus MOCQUARD, 1887
57. Meizodon coronatus SCHLEGEL, 1837
58. Natriciteres fuliginoides GUNTHER, 1858
59. Natriciteres olivacea PETERS, 1854
60. Natriciteres variegata BROADLEY, 1962
61. Philothamnus angolensis LEACH, 1819
62. Philothamnus hoterodermus HALLOWELL, 1857
63. Philothamnus heterolopidatus GUNTHER, 1863
64. Philothamnus hoplogaster GUNTHER, 1863
65. Philothamnus semivariegatus SMITH, 1840
66. Prosymna ambigua BOCAGE, 1873
67. Prosymna meleagris LOVERIDGE, 1958
68. Pseudaspis cana BOCAGE, 1882
69. Rhamnophis aethiopissa GUNTHER, 1862
70. Rhamnophis batesi BOULENGER, 1908
71. Scaphiophis albopunctatus PETERS, 1870
72. Thrasops flavigularis HALLOWELL, 1852
73. Thrasops jacksoni GUNTHER, 1895

B. Opisthoglyphous (18 genera, 43 species)

74. Amblyodipsas katangensis WITTE et LAURENT, 1942
75. Amblyodipsas polylepis BOCAGE, 1873
76. Amblyodipsas rodhaini,WITTE, 1930
77. Amblyodipsas unicolor REINHARDT, 1843
78. Aparallactus capensis BOULENGER, 1895
79. Aparallactus lunulatus CHABANAUD, 1916
80. Aparallactus modestus GUNTHER, 1897

(Table 1. cont.)

81. Aparallactus moeruensis WITTE et LAURENT, 1943
82. Boiga blandingi HALLOWELL, 1844
83. Boiga pulverulenta FISCHER, 1856
84. Chilorhinophis gerardi BOULENGER, 1913
85. Crotaphopeltis hotamboeia LAURENTI, 1768
86. Dipsadoboa duchesnei BOULENGER, 1901
87. Dipsadoboa elongata LAURENT, 1956
88. Dipsadoboa shrevei LOVERIDGE, 1932
89. Dipsadoboa unicolor GUNTHER, 1858
90. Dispholidus typus SMITH, 1839
91. Dromophis lineatus DUMERIL, BIBRON et DUMERIL, 1854
92. Geodipsas depressiceps WERNER, 1897
93. Hermirhagerrhis nototaenia GUNTHER, 1864
94. Hypoptophis wilsoni BOULENGER, 1908
95. Polemon bocourti MOCQUARD, 1897
96. Polemon christyi BOULENGER, 1903
97. Polemon collaris PETERS, 1881
98. Polemon fulvicollis WITTE et LAURENT, 1943
99. Polemon gabonensis WITTE et LAURENT, 1947
100. Polemon notatus WERNER, 1902
101. Polemon robustus WITTE et LAURENT, 1943
102. Psammophis angolensis BOCAGE, 1872
103. Psammophis jallae PERACCA, 1896
104. Psammophis philippsi HALLOWELL, 1844
105. Psammophis sibilans LINNE, 1754
106. Psammophis subtaeniatus LINNE, 1754
107. Psammophylax tritaeniatus GUNTHER, 1868
108. Psammophylax variabilis GUNTHER, 1893
109. Rhamphiophis acutus GUNTHER, 1888
110. Rhamphiophis oxyrrhynchus REINHARDT, 1843
111. Telescopus semiannulatus SMITH, 1849
112. Thelotornis capensis GUNTHER, 1881
113. Thelotornis kirtlandi HALLOWELL, 1844
114. Xenocalamus bicolor, LAURENT, 1954
115. Xenocalamus mechowi PETERS, 1881
116. Xenocalamus michelli MULLER, 1911

V. Elapidae (5 genera, 12 species)

117. Boulengerina annulata BUCHOLZ et PETERS, 1876
118. Boulengerina christyi BOULENGER, 1904
119. Elapsoidea decosteri LAURENT, 1956
120. Elapsoidea guntheri BOCAGE, 1866
121. Elapsoidea laticincta WERNER, 1919
122. Elapsoidea loveridgei LAURENT, 1956
123. Elapsoidea semiannulata BOCAGE, 1882
124. Naja haje LINNE, 1758
125. Naja melanoleuca HALLOWELL, 1857
126. Naja nigricollis REINHARDT, 1843
127. Paranaja multifasciata WERNER, 1902
128. Pseudohaje goldii BOULENGER, 1895

VI. Dendroaspiidae (1 genus, 3 species)

129. Dendroaspis angusticeps SMITH, 1849
130. Dendroaspis jamesoni TRAILL, 1843
131. Dendroaspis polylepis GUNTHER, 1864

VII. Viperidae (3 genera, 13 species)

132. Atheris hispida LAURENT, 1955
133. Atheris katangensis WITTE, 1953
134. Atheris nitschei TORNIER, 1902
135. Atheris squamigera HALLOWELL, 1854
136. Bitis arietans MERREM, 1820
137. Bitis gabonica DUMERIL et BIBRON, 1854
138. Bitis nasicornis SHAW, 1802
139. Causus bilineatus BOULENGER, 1905
140. Causus defilippi JAN, 1862
141. Causus lichtensteini JAN, 1859
142. Causus maculatus LAURENT, 1964
143. Causus resimus PETERS, 1862
144. Causus rhombeatus LICHTENSTEIN, 1823

VIII. Atractaspiidae (1 genus, 8 species)

145. Atractaspis atterima GUNTHER, 1863
146. Atractaspis boulengeri LAURENT, 1945
147. Atractaspis bibroni GUNTHER, 1868
148. Atractaspis congica PETERS, 1877
149. Atractaspis corpulenta HALLOWELL, 1854
150. Atractaspis irregularis STERNFELD, 1908
151. Atractaspis reticulata BOULENGER, 1901
152. Atractaspis battersbyi WITTE, 1959

Table 2. Snakes of Zaire: Distribution by families, genera and species.

Family	Genus	Species
Typhlopidae	2	14
Leptotyphlopidae	1	2
Boidae	2	3
Colubridae	45	97
Atractaspiidae	1	8
Dendroaspiidae	1	3
Elapidae	5	12
Viperidae	3	13
Total	60	152

Table 3. Regional distribution of Zairean snakes.

Region	Family	Genus	Species
Kivu	8	47	90
Haut-Zaïre	8	49	89
Kinshasa	8	47	89
Shaba	8	48	86
Equateur	8	41	63
Kasai	8	34	49

gabonica is forest-living. *Bitis arietans* is savanna-living. Burrowing snakes such as *Atractaspis* and *Calabaria*, and pythons live in the lowlands of hot regions.

Zaire holds a unique position with regard to snakes of the world. It is known that the origin and the early evolution of snakes took place in tropical Africa and possibly in Southern Asia (Johnson, 1956; Schmidt, 1949; Underwood, 1951). The equatorial forest of the northern Zaire contains some of the most ancient and conservative forms of snakes (Bourgeois, 1968). On the other hand, because of the long time involved, there also exist in Zaire some of the most evolved and specialized snakes in the world. In fact, Zaire is unique in possessing the following specialized species: (1) the only burrowing python in the world, *Calabaria reinhardti;* (2) the only snake that develops a rotatable maxilla and extremely long fangs (so long that they cannot be erected), *Atractaspis*, a fact which resulted in its being wrongly classified as a true viper until 20 years ago; (3) the only true egg-eating snakes, *Dasypeltis*, which are so unique that they have allocated to a subfamily or tribe of their own in past times; (4) the only two venomously dangerous opisthoglyphous colubrids, *Dispholidus typus* and *Thelotornis kirtlandi;* (5) the only aquatic elapid, *Boulengerina*; (6) the only arboreal elapids *Pseudohaje* and *Dendroaspis*; (7) the only fossorial elapids found nowhere except in Australia, *Elapsoidea* and *Paranaja;* (8) the only truly arboreal viper, *Atheris*. In addition to these, Zaire has one of the longest venomous snakes in the world, *Dendroaspis polylepis*, and the largest and heaviest venomous snake, *Bitis gabonica*. It also has the smallest snake in the world, *Leptotyphlops*.

Table 4. Snake bites in Zaire (Data of hospitals).

Year or Period	Cases	Deaths	Percentage (%)
1947	5	—	—
1948–1952	505	1	0.2
1979	4,170	340	8.2
1980	3,700	230	6.2
1981	5,244	750	14.3
1982	1,765	225	12.7
1983	1,530	94	6.1
1984	4,590	409	8.9
1985	3,825	266	7.0
1986	3,442	341	9.9

II. Snake Bites in Zaire

Registration of snake bites in medical institutions in Zaire is not well made Informations concerning the sex and the age of victims, the time of bite and the snake species which has inflicted the bite are sometimes missed. Usually, the number of bites includes all bites caused by any animals (dog, pig and human). In the Manual of International Statistical Classification of Diseases, Injuries and Causes of Death, adopted by many medical institutions in Zaire, no provision exists for a separate classification of snake bite deaths. All data for several years are grouped into the section "Accidents caused by bites and stings of venomous animals and insects, E. 905". It would therefore be impossible to tabulate separately the death from snake bite. Because of these confusions we have voluntarily omitted all the data in which snake bites are not well indicated. However, for reducing these difficulties, we adopted the really observed cases of snake bites and for completing our data, retrospective methods were used. In 1979, all magistrates and local authorities were requested to notify every case of snake bites. Their answers, the well recorded epidemiological data obtained in some hospitals, number of our really observed victims, made it possible to conclude that many snake bites exist in Zaire. In fact, Table 4 shows the number of cases of snake bites in Zaire: it varies from one year to another. For the period from 1979 to 1986, we realize that the number of cases varies between 1,530 and 5,244 which gives an average of 3,533 snake bites per year. For the years before 1979, archives were absent or the snake bites were not separately tabulated. We are sure that the cases reported here underestimate the real situation in Zaire. According to various authors (Carme et al., 1986; Theakston et al., 1981), all epidemiological data are very misrepresentative in Africa, with only 15% being revealed at hospitals. This implies that, in Zaire, about 24,000 snake bites may occur per year.

The death due to snake bites occured not in a few cases but 6.1 to 14.3% per year (average 8%) during the years from 1979 to 1986. In Zaire, the factors of mortality which we have observed are the followings:

(a) the absence of antivenom sera in many hospitals,

(b) the long distance to be covered by the victims to reach the hospital or dispensaries,

(c) the bad practices of urgent treatment; fetishism and traditional drugs are often used without a good effect.

(d) the difficulty to identify the snake,
(e) the lack of protection by clothes or by shoes.

These epidemiological data on snake bites show that the envenomations constitute a serious problem for the public health in Zaire. To solve this problem, we must reduce the factors which contribute to the mortality of the victims. On the other hand, on analyzing these epidemiological data the following questions arose: which snake species have caused the bites which part of the body is injured? who is bitten? where and when is he or she bitten? The followings are the answers.

1. The Species Responsible for Bites

Envenomation results from the presence of numerous dangerous snakes in Zaire. About 79 (51.9% of the total snake species in Zaire) venomous snake species are presently known (Tables 5, 6). Opisthoglyphous colubrids, mambas, cobras and vipers are the most dangerous. Snakes with medical importance are those listed in Table 7.

Table 5. Venomous snakes of Zaire.

Family	Genus	Species
Opisthoglyphous colubrids	18	43
Atractaspiidae	1	8
Dendroaspiidae	1	3
Elapidae	5	12
Viperidae	3	13
Total	28	79

Table 6. Regional distribution of venomous snakes of Zaire.

Region	Family	Genus	Species
Shaba	5	25	46
Kinshasa	5	23	43
Kivu	5	20	42
Haut-Zaïre	5	22	40
Equateur	5	17	27
Kasai	5	16	22
Total	5	28	79

Table 7. Zairean snakes of medical importance.

Biotopes	Category I	Category II	Category III
Forest	*Bitis gabonica* *Bitis nasicornis* *Dendroaspis jamesoni* *Naja melanoleuca*	*Pseudohaje goldii* *Atheris* sp.	*Causus* sp.
Savanna	*Bitis arietans* *Naja melanoleuca* *Naja nigricollis* *Dendroaspis angusticeps* *Dendroaspis polylepis*	*Aractaspis* sp. *Dispholidus typus* *Thelotornis kirtlandi*	*Causus* sp. *Polemon* sp.
Aquatic		*Boulengerina annulata* *Boulengerina christyi*	

They are grouped into three categories according to the WHO's recommendations in 1981:

Category I: Snakes that commonly cause death or serious disability, such as, *Bitis*, *Naja* and *Dendroaspis*.

Category II: Snakes that seldom bite but inflict serious effects such as death or local necrosis: *Pseudohaje goldii*, *Atheris*, *Atractaspis*, *Boulengerina*, *Thelotornis kirtlandi*, and *Dispholidus typus*.

Category III: Snakes that commonly bite but inflict no serious effects: *Causus* and *Polemon*.

In the Kivu Province, we surveyd 1,392 cases of snake bite for the period from 1967 to August 1988 and only in 148 cases the venomous snakes responsible for the bites were identified. The species *Atractaspis irregularis*, *Naja melanoleuca*, *Bitis nasicornis*, *Bitis arietans* and *Bitis gabonica* bite during this period (Table 8).

At Kinshasa, all the snake bite in 1978 were caused by *Boulengerina christyi*, an aquatic cobra living in Zaire River. In the forest of Walikale (Kivu Province), the species usually responsible of causing bite are *Bitis nasicornis* and *Bitis gabonica;* the bites occurred during the period of farming activities. At Lwiro (Kivu), all the cases of bites in 1969 (13 cases), 1979 (1 case), 1981 (1 case). 1983 (2 cases), and 1986 (2 cases) and August 1988 were caused by *Atractaspis irregularis* during the period of weeding and harvesting.

Table 8. Species responsible for snake bites in KivuProvince from 1967 to August 1988.

Snake species	No. of cases
Atractaspis irregularis	54
Naja melanoleuca	40
Bitis nasicornis	26
Bitis arietans	14
Bitis gabonica	13
Crotaphopeltis hotamboeia	1
Undetermined	1,244

Table 9. Period of bites from 1980 to August 1988 in the Kivu Province.

Month	No. of cases
January	18
April	26
May	12
June	11
July	2
August	10
September	53
October	24
December	36
Sub total	192
Undetermined	782
Total	974

There are various factors of envenomation, which indicate why people are bitten. The factors of increasing risk, which contribute to the contact of the victim with the snake are as follows:

(a) the mimetism of the snake: The coloration of the snake merges into the colour of the ground or of the vegetation: *Bitis gabonica, Atheris squamigera, Thelotornis kirtlandi, Causus lichtenseteini.* When someone walks on the snake, he is likely to be bitten,

(b) the climate and the season: In the savanna of Kivu Province many cases of snake bites are observed in the rainy season during the farming activities (Table 9),

(c) the condition of the habitation: The houses cluttered up with woods, stones, holes and branchwoods are the shelters of snakes. Dirt around the houses breeds the rats and their predators, namely snakes,

(d) the profession and the age of victims: Fishermen, shepherds, farmers are the ones who are most frequently bitten. Active population is most exposed to the fatality (Table 10).

2. The Injured Parts of Body

The parts of body often bitten are the feet and the arms. The bite becomes very dangerous when it is inflicted on the upper limbs. Farmers, fishermen and mushroom collectors, are usually bitten their wrist, where as the shepherds are often bitten on the feet.

3. The period of the year when the bites are most frequent

People may be bitten either during the day or night. From 1979 till now, we have ob-

Table 10. Snake bites in the Kivu Province (Records of hospitals and dispensaries: from 1967 to August 1988).

Year	Cases of snake bites			
	Female	Male	Total	Death
1967	-	13	13	-
1969	-	10	10	
1970	-	16	16	-
1973	-	9	9	-
1974	-	8	8	-
1975	-	12	12	6
1977	6	18	24	-
1978	14	86	100	30
1979	6	220	226	6
1980	-	612	612	-
1981	1	252	253	-
1983	-	5	5	1
1985	6	33	39	-
1986	-	53	53	6
1987	-	6	6	-
1988 (Jan.—August)	-	6	6	-
Total	33	1,359	1,392	49

served only three cases in which two girls and one boy were bitten at night. In 1979, the victim, a teen-ager girl of Kiliba (Locality of Uvira, Kivu) was bitten by *Atractaspis irregularis* and her limb was cut off after gas gangrene.

According to our data, snake bites may occur throughout the year but the majority are observed during the agricultural activities. In the savanna of Kivu Province, many accidents are recorded in the rainy season (from January to June and September to December). This period corresponds to the time of farming activities of grubbing and harvesting. From 1980 to 1988 we made a record on the period of bites which shows that 88% of the cases in which the month was determined are situated in the rainy season (Table 9).

4. Localization of Accidents

Accidents were observed in the field, in town and in houses. Generally, bites are most frequent in the bush. But we also recorded 146 bites in Bukavu town from 1979 to 1984, of which one death was noted in 1983 (Table 11). At Kinshasa, capital city of Zaire with three millions of inhabitants, we recorded only 50 cases of snake bites from 1978 to 1985, and no death was observed, this is probably because antivenom sera were immediately utilized for the treatment of envenomations (Table 12).

5. The Age and Sex of Victims

The age and sex of victims were checked for 253 cases out of 5,244 bites in 1981 and we found 3 children (1.2%) and 250 adults (98.8%) were bitten. As to their sex, we observed 11 females (4.35%) and 242 males, (95.65%).

Table 11. Snake bites at Bukavu town from 1979 to 1984.

Year	No. of cases
1979	24
1980	12
1981	72
1982	36
1983	1
1984	1
Total	146

Table 12. Bites at Kinshasa from 1978 to 1985 (Direction of Hygiene, Kinshasa).

Year	Cases of snake bites						Total
	Female			Male			
	Infants	Adults	Total	Infants	Adults	Total	
1978	0	3	3	2	1	3	6
1979	0	5	5	5	5	10	15
1980	1	1	2	0	1	1	3
1981	3	3	6	2	4	6	12
1982	0	0	0	1	0	1	1
1983	0	2	2	0	0	0	2
1984	0	3	3	2	1	3	6
1985	1	0	1	0	4	4	5
Total	5	17	22	12	16	28	50
Percentage (%)			44			56	

In the the Kivu Province, the sex of victims was well determined: from 1967 to August 1988, 33 females (2.37%) and 1,359 males (97.63%) were bitten. Their age was not determined (Table 10).

According to these data, it seems that most of the victims belong to the active population of males.

III. Treatment of Snake Bites

The sanitary purpose is to reduce the incidence of bites which cause mortality and morbidity. Two ways are used in Zaire: the modern and the traditional methods.

1. The Modern Methods

Antivenenes produced from hyperimmunized horses are imported from France (Institut Pasteur de Paris) and from Germany (Boehringwerke). The antivenom sera have a high venom neutralizing power and usually they have polyvalent actions. Zaire imports about 3,500 doses per year equivalent to 150,000 dollars. But, it is very difficult to use these antivenom sera under the present condition because they are expensive and need an adequate equipment for storage under the tropical climate. They are preserved for a duration of three years in Europe, but in hot climate, they cannot be preserved more than three months. Moreover, secondary effects are often observed (blood diseases, serum induced-anaphylaxis) because serum sickness is common after antivenom administration (Brown, 1973). When antivenom serum is not present, incision, suction, amputation and tourniquet are used to reduce the effects of envenomation.

To reduce the importation cost of antivenom sera, Zaire proposes to prepare its own serum. The first attempt to produce the antivonom sera from Zairean snakes was made in 1946 and 1947 by Grasset of the Switzerland Institute of Hygiene (Grasset, 1946, 1947).

2. The Traditional Methods

There are not many hospitals in Zaire and the distance between a dispensary to another is longer than 50 km. If someone is bitten by a snake, he often looks for a traditional treatment. Magic formulas and plant drugs are often used (Chifundera, 1987). The phytotherapy against envenomation is known in Zaire and in many other countries of Africa (Kokwaro, 1976; Kerharo & Adam, 1964; Watt & Breyer-Brandwijk, 1932). Phytochemical screening is being made for testing the biological active substances and the pharmacological analysis is being made for identifying the antivenomous substances.

It has been observed that immunization is used for a protective purpose. In fact, gradual administration of venom can bring the immunization. This is confirmed by the recent discovery of antibodies in the serum of persons previously bitten (Theakston et al., 1981). Great Britain, Japan and Australia are advanced in this research (WHO, 1981).

In Zaire, charmers of snakes are immunized by using the following traditional methods:

(a) Snake fangs are removed and exposed to the sunshine and when the venom is dried, regular pricks are administered weekly to the person to be immunized.
(b) A snake head of which the glands contain venom is calcined in mixture with Irago nyarubasa (*Anthericum* sp.). The ashes are rubbed on the scarification made on each articulation for durable immunization.
(c) Fresh young leaves of sixteen plants (*Funtumia elastica, Amaranthus aspera, Hibiscus cannabinus, Kalanchoe integra, Vernonia conferta, Hugonia platysepala, Spilanthes mauritiana, Bidens pilosa, Oxalis corniculata, Sida rhombifolia, Dyschoriste perrotetii, Desmodium adscendens, Alchornes* sp., *Senecio stuhlmannii, Anthericum elgonense* and *Melothria punctata*) are crushed and mixtured, and their decoction is drunk for durable immunization.

CONCLUSION

Zaire contains 152 species of snakes included in 60 genera and in 8 families. The presence of numerous venomous snakes, about 79 species (51.9%), 28 genera and 5 families, provokes many bites which cause mortality of 6.1 to 14.3% of the bite cases. The epidemiological data given here are underestimates: many cases of bites are not treated at the hospitals because an important number of bitten persons are traditionally treated by local medicine men. Probably 24,000 cases of bites may occur annually in Zaire according to the estimation of many authors (Carme et al., 1986).

Traditional plant drugs are usually used for the treatment of envenomations, but their active principles are not yet known. We hope that our present programme on the phytochemistry of these plants will clarify the pharmacologically effective substances through testing the action of purified plant extracts on snake venoms. However, the antivenom sera are still useful for the treatment of envenomations.

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