Herpetological Review, 2003, 34(3), 307–312.

Colubrid Snakebite: A Public Health Problem in Brazil

MARIA DA GRAÇA SALOMÃO
Laboratório de Herpetologia, Instituto Butantan – Av. Vital Brasil, 1500 Butantã, São Paulo, 05503-900, SP – Brazil
and
CEPPE, Centro de Pós-Graduação, Pesquisa e Extensão, UnG-Universidade Guarulhos, SP – Brazil
e-mail: mgsalomao@hotmail.com

ARACY BRAULE PINTO ALBOLEA
Laboratório de Herpetologia, Instituto Butantan – Av. Vital Brasil, 1500 Butantã, São Paulo, 05503-900, SP – Brazil

SELMA MARIA ALMEIDA SANTOS
Laboratório de Herpetologia, Instituto Butantan – Av. Vital Brasil, 1500 Butantã, São Paulo, 05503-900, SP – Brazil
and
FMVZ-USP – Departamento Cirurgia - Anatomia, Faculdade de Medicina Veterinária e Zootecnia da Universidade de São Paulo, SP – Brazil

Whereas bites by viperid and elapid snakes have long been recognized as an important public health problem in Brazil (Ministério da Saúde. Fundação Nacional da Saúde 1998), bites by other snakes have received much less attention. Nonetheless, reports of symptomatic bites by supposedly non-venomous snakes in Brazil have appeared throughout this century (Martins 1916; Penteado 1918; Vital Brazil and Vellard 1926). Interest in colubrid bites increased after the herpetologists Karl Patterson Schmidt and Robert Mertens were killed by African snakes in the genera *Dispholidus* and *Thelotornis*, respectively (Nahas et al. 1976).

Symptomatic bites by colubrid snakes were reviewed by Minton (1990). Since then, additional species of colubrid snakes have been reported to cause symptomatic bites. These include several life-threatening bites to infants by *Boiga irregularis* (Fritts et al. 1990, 1994), and two serious bites by *Hydrodynastes gigas*, resulting in repeated episodes of collapse and paralysis in one case (Manning et al. 1999) and a "permanently disfigured" arm in another (Stevens 2000).

Apart from *Dispholidus* and *Thelotornis*, *Rhabdophis tigrinus* (Mittleman and Goris 1974; Zotz et al. 1991) has also caused fatal bites, and more recently, a fatal bite by *Philodryas olfersii* was reported (Fowler and Salomão 1994; Salomão and Di-Bernardo 1995). Controversies about the capacity of some colubrids, such as the South American *Tachymenis peruviana*, to kill humans remain. Lema (1978a) reported a case of fatal bite by *T. peruviana*, citing Vellard (1955). However, Vellard (1955) did not mention symptoms in humans, but only discussed the potent effects of *T. peruviana* venom in animal experiments. Serious bite symptoms by this species have been described by Schenone and Reyes (1965). Finally, *Boiga forsteni* is also suspected to have caused fatal bites in Sri Lanka (Fritts and McCoid 1999).

During the 1980s and 1990s certain colubrids thought to possess toxic saliva or venom (see Kochva 1987 for considerations on this matter) were identified (Hill and Mackessy 2000; McKinstry 1978, 1983; Minton 1990; Spawls and Branch 1995), based on the histological observation of their Duvernoy's glands, carried out by Taub (1967), Kochva and Gans (1970), Gabe and Saint-Girons (1971), and the descriptions of clinical manifestations in patients bitten by these snakes. Minton (1990) listed, summarized, and divided these symptoms into two basic categories: systemic poisoning associated with coagulopathy and those that presented local effects.

In Brazil, the number of reports on bites from "non-venomous" snakes has increased considerably and snakebites by "harmless" snakes are now considered a problem of public health. Among all the snakebites registered in the State of São Paulo (Fan and Cardoso 1995) and those caused by crotaline snakes in the city of Uberlândia, State of Minas Gerais (Silveira and Nishioka 1995), approximately 40% did not develop symptoms of envenomation, possibly because the snake was nonvenomous or, if it was venomous, the skin was not deeply punctured or no venom was injected (so called "dry bite") (Albolea 1999; Albolea and Salomão 1998; Ministério da Saúde. Fundação Nacional da Saúde 1998; Santos-Costa et al. 2000).

Examples of snakes which have caused human envenomations with serious clinical manifestations are the opisthoglyphous species *Phalotris lemniscatus* (= *Elapomorphus bilineatus* according to Ferrarezzi [1993]) (Lema 1978b); *Philodryas olfersii* and *P. patagoniensis* (Araújo and Santos 1997; Brito and Carvalho 2000; Campbell and Lamar 1989; Fowler and Salomão 1994; Nickerson and Henderson 1976; Nishioka and Silveira 1994; Salomão and Di-Bernardo 1995; Silva and Buononato 1983/84), *Clelia clelia plumbea* (Pinto et al. 1991) and the aglyphous *Liophis miliaris* (Santos-Costa and Di-Bernardo 1997) and *Helicops modestus* (Albolea and Salomão 1998; Albolea et al. 2000).

This paper is a report on bites caused by snakes other than pitvipers and coral snakes. It includes the frequency of snakebite per year, the identification of the snake species implicated, the profile of victims (age and sex) and clinical manifestations, as an aid in evaluation and prevention of this problem in Brazil.

The Hospital Vital Brazil (HVB), Instituto Butantan, São Paulo, provides free treatment for patients bitten by snakes. Some patients still possessed the snake (live or dead) which caused the snakebite, therefore an immediate identification could be done,

helping doctors make decisions about the use of antivenom. Snakes would then be deposited in the museum collection of the Laboratório de Herpetologia, Instituto Butantan, which contains only snakes responsible for biting humans and subsequent hospitalization of these patients. Data concerning information about the snake, the patient, and the snakebite itself are recorded by the museum and in HVB reports for each patient. A survey of the specimens, museum data, and medical reports allowed us to collect detailed information on the most common snakes involved, patient profiles, and most frequent symptoms. We emphasize that most snakebite victims at HVB come from the state of São Paulo and our conclusions may not apply to other states in Brazil. However, registers from the state of São Paulo are the most complete data sets in Brazil, being used by health authorities as a national reference because a lack of information on this subject from other states.

Hospital Vital Brazil started its activities in 1946. However, routine registration of snake species began only in 1959. Since then, HVB admitted a total of 6048 snakebite victims in which the offending snake accompanied the patient and was available for identification (Table 1). Of these, 4083 were inflicted by elapid and viperid snakes, 42 were inflicted by snakes of the families Anomalepididae, Boidae, and Leptotyphlopidae, and 1923 were caused by snakes in the family Colubridae (Table 2). Among the colubrids, the largest number of snakebites was caused by the genera *Helicops*, *Philodryas*, and *Liophis* (Table 3).

We found that male patients predominated in 11 of the 16 genera investigated. Snakes belonging to five genera—*Tomodon*, *Tropidodryas* ($\chi^2 = 4000$, $P = 0.045$, d.f. = 1), *Liotyphlops*, *Erythrolamprus* ($\chi^2 = 11560$, $P < 0.001$, d.f. = 1), and *Apostolepis* ($\chi^2 = 36000$, $P < 0.001$, d.f. = 1)—bit significantly more female patients.

TABLE 1. Frequency of snakebites registered at Hospital Vital Brazil, Instituto Butantan.

Year	Viperids and Elapids		Others		Total	
	N	%	N	%	N	%
1959	52	64.2	29	35.8	81	1.34
1960	64	68.1	30	31.9	94	1.55
1961	72	69.2	32	30.8	104	1.72
1962	66	61.1	42	38.9	108	1.79
1963	81	68.6	37	31.4	118	1.95
1964	76	70.4	32	29.6	108	1.79
1965	77	72.6	29	27.4	106	1.75
1966	65	60.7	42	39.3	107	1.77
1967	103	64.8	56	35.2	159	2.63
1968	89	60.5	58	39.5	147	2.43
1969	87	66.4	44	33.6	131	2.17
1970	97	74.6	33	25.4	130	2.15
1971	104	68.4	48	31.6	152	2.51
1972	88	59.8	59	40.2	147	2.43
1973	80	64.5	44	35.5	124	2.05
1974	97	68.8	44	31.2	141	2.33
1975	106	65.4	56	34.6	162	2.68
1976	82	62.6	49	37.4	131	2.17
1977	91	62.3	55	37.7	146	2.41
1978	109	61.2	69	38.8	178	2.94
1979	134	64.1	76	35.9	209	3.46
1980	126	65.9	65	34.1	191	3.16
1981	119	65.7	62	34.3	181	2.99
1982	150	69.8	65	30.2	215	3.55
1983	156	70.6	65	29.4	221	3.65
1984	173	72.1	67	27.9	240	3.97
1985	235	71.6	93	28.4	328	5.42
1986	233	70.0	100	30.0	333	5.51
1987	179	71.3	72	28.7	251	4.17
1988	148	68.5	68	31.5	216	3.57
1989	130	74.5	40	23.5	170	2.81
1990	88	66.1	45	33.9	133	2.20
1991	83	72.8	31	27.2	114	1.88
1992	50	59.5	34	40.5	84	1.39
1993	87	73.7	31	26.3	118	1.95
1994	50	66.7	25	33.3	75	1.24
1995	65	67.7	31	32.3	96	1.59
1996	51	61.4	32	38.6	83	1.37
1997	40	64.5	22	35.5	62	1.03
1998	52	68.4	24	31.6	76	1.26
1999	48	62.3	29	37.7	77	1.27
Total	**4083**		**1965**		**6048**	**100.0**

Patients between 0 and 40 years of age were the main victims of colubrid bites, particularly of *Helicops* ($\chi^2 = 23.604$, $P < 0.0001$, d.f. = 1) and *Philodryas* ($\chi^2 = 10.071$, $P < 0.0015$, d.f. = 1). Snakes belonging to the genera *Xenodon*, *Liophis*, *Philodryas*, *Atractus*, *Chironius*, *Waglerophis*, *Helicops,* and *Thamnodynastes* bit more patients between 15 and 40 years old. Children under 14 years old were the main victims of *Liotyphlops*, *Mastigodryas*, *Tropidodryas*, *Oxyrhopus*, *Waglerophis*, and *Helicops* (Table 4). Hands, arms, feet, and legs were the most frequently bitten parts of the body. Snakes of the genera *Atractus*, *Mastigodryas*, *Philodryas*, *Thamnodynastes,* and *Xenodon* bit hands and arms 60.0% of the time, whereas species of the genera *Helicops* ($\chi^2 = 5.22$, $P = 0.0223$, d.f. = 1), *Liotyphlops*, *Tropidodryas*, *Apostolepis,* and *Waglerophis* bit feet and legs more often. The high frequency of *Helicops* bites on feet and legs must be a consequence of the aquatic habits of these snakes, associated with the fact that people do not use protection to walk in the water, especially when fishing. Bites to the trunk were reported for *Erythrolamprus*, *Tomodon*, *Apostolepis,*

and *Tropidodryas*. Most of these bites to the middle of the body occurred when the victim was either in bed or having a bath (Table 5).

The main clinical manifestations exhibited by patients (Table 6) were abrasions (sometimes with bruising) and local pain, followed by local hemorrhage from teeth punctures, swelling, and erythema. Other less significant symptoms included: stinging sensation, local numbness, general discomfort, hyperemia, local paleness, local itching, and sweating. Ecchymoses and gum hemorrhage occurred only in patients bitten by *Philodryas* (Table 7).

Recently (September 2000) a herpetologist from Instituto Butantan was bitten by *Liophis poecilogyrus* on his left fourth digit and thereafter exhibited local effects such as intense pain (particularly throbbing), swelling, local hemorrhage, lack of sensitivity, and local decrease of temperature. These symptoms lasted for three hours (C. A. Falcetti, pers. comm.).

Some of these manifestations are very similar to those exhibited by patients bitten by pitvipers, and this may confuse inexperienced doctors. An example of this is the case of a man, 53 years

TABLE 2. Percentage of snakebites among different families of snakes at Hospital Vital Brazil from 1959 to 1999.

Family	Number of snakebites	(%)
Viperidae	4050	66.96
Colubridae	1923	31.80
Elapidae	33	0.55
Anomalepididae	28	0.46
Boidae	13	0.21
Leptotyphlopidae	01	0.02
Total	6048	100.00

TABLE 3. Percentage of snakebites by genera at Hospital Vital Brazil from 1959 to 1999.

Family	Genus	N	%
Anomalepididae	*Liotyphlops*	28	1.42
Boidae	*Boa*	11	0.56
	Epicrates	1	0.05
	Eunectes	1	0.05
Colubridae	*Helicops*	427	21.73
	Philodryas	397	20.20
	Liophis	258	13.13
	Oxyrhopus	167	8.50
	Thamnodynastes	142	7.23
	Waglerophis	122	6.21
	Chironius	81	4.12
	Xenodon	75	3.82
	Sibynomorphus	74	3.77
	Tomodon	51	2.60
	Atractus	29	1.48
	Mastigodryas	27	1.37
	Apostolepis	14	0.71
	Tropidodryas	13	0.66
	Erythrolamprus	10	0.51
	Tantilla	10	0.51
	Simophis	5	0.25
	Pseudoboa	4	0.20
	Spilotes	4	0.20
	Clelia	3	0.15
	Taeniophalus	3	0.15
	Sordellina	2	0.10
	Gomesophis	2	0.10
	Echinanthera	1	0.05
	Hidrodynastes	1	0.05
	Imantodes	1	0.05
Leptotyphlopidae	*Leptotyphlops*	1	0.05
	Total	1965	100.00

TABLE 4. Percentage of snakebites by genus among patient age groups at Hospital Vital Brazil from 1959 to 1999.

	Age of patients		
Genus	0–14	15–40	Over 40
Helicops	42.4	47.0	10.6
Philodryas	27.3	54.5	18.2
Liophis	31.5	58.0	10.5
Oxyrhopus	50.0	25.0	25.0
Thamnodynastes	36.4	45.5	18.1
Waglerophis	50.0	50.0	0
Chironius	28.6	50.0	21.4
Sibynomorphus	40.0	20.0	40.0
Tomodon	40.0	40.0	20.0
Xenodon	16.7	83.3	0
Atractus	16.7	50.0	33.3
Liotyphlops	66.7	0	33.3
Mastigodryas	60.0	20.0	20.0
Apostolepis	40.0	40.0	20.0
Tropidodryas	60.0	20.0	20.0
Erythrolamprus	33.4	33.3	33.3

TABLE 5. Percentage of snakebites to different parts of the body by genus at Hospital Vital Brazil from 1959 to 1999.

Genus	Trunk	Hand and arm	Foot and leg
Helicops	0	30.8	69.2
Philodryas	0	60.0	40.0
Liophis	0	42.4	57.6
Oxyrhopus	0	50.0	50.0
Thamnodynastes	0	53.3	46.7
Waglerophis	0	40.0	60.0
Chironius	0	42.9	57.1
Sibynomorphus	0	60.0	40.0
Tomodon	20.0	40.0	40.0
Xenodon	0	60.0	40.0
Atractus	0	60.0	40.0
Liotyphlops	0	14.3	85.7
Mastigodryas	0	60.0	40.0
Apostolepis	16.6	16.7	66.7
Tropidodryas	16.7	0	83.3
Erythrolamprus	33.3	33.3	33.4

TABLE 6. Percentage of pathologies presented by patients bitten by mildly venomous snakes admitted to Hospital Vital Brazil from 1959 to 1999.

Pathology	%
Abrasions	30.67
Local pain	28.09
Local hemorrhage	13.40
Swelling	10.05
Erythema	8.25
Discomfort	4.90
Stinging sensation	1.28
Ecchymosis	0.77
Numbness	0.77
Gum hemorrhage	0.52
Hyperemia	0.52
Local paleness	0.26
Local itching	0.26
Sweating	0.26

old (HVB number 73386) bitten by *Helicops*, who was admitted to the hospital and received four vials of bothropic antivenom, because of coagulopathy. Bothropic antivenom was also given to a patient (HVB number 48575), bitten by *Liophis miliaris*, who presented serious symptoms of hemorrhage. On another occasion a 17-year-old boy was admitted with all the symptoms of *Bothrops* envenomation. However, he claimed he had been bitten by a green snake with brown head, which unfortunately he had not managed to catch. When a *Philodryas olfersii* was shown to him, he identified it immediately, which avoided the administration of bothropic antivenom (G. Puorto, pers. comm.).

Colubrids produce the greatest number of bites in relation to their abundance in neotropical regions, compared to other families (Cadle and Greene 1993; Ferrarezzi 1994; McDowell 1987; Vanzolini 1986). In India 80% of reported snake bite cases are caused by "mildly venomous" snakes, particularly a common water snake (*Cerberus rhynchops*) (Saha and Hati 1998). Aquatic snakes of the genus *Helicops* caused most snakebites registered in the state of Rio Grande do Sul, in southern Brazil (Costa 1997). A possible explanation for this is the defensive behavior exhibited by species of *Helicops* (Cei 1993) when compared to species of other genera. Bites to the feet and legs are more frequent because farm workers often do not wear shoes. A similar situation has been found regarding colubrid bites reported by Minton (1996), Costa (1997), and Saha and Hati (1998). Snakebites involving *Helicops* and *Liophis* occurred predominantly near or in the water, where snakes are difficult to see because of cryptic coloration. Snakes of other genera such as *Waglerophis*, *Chironius*, *Apostolepis*, *Tropidodryas*, and *Tomodon* can also have a cryptic color pattern, thus increasing the probability of bites. This is because people typically touch or step on them without realizing their presence. Alternately, brightly patterned species might inflict more bites because of their attractiveness and increased liklihood of being handled. This seems to be the case with species of *Philodryas*, *Apostolepis*, and *Erythrolamprus*, as many patients admitted they were bitten when attempting to capture snakes.

Blind snakes (*Liotyphlops*) have not been reported to bite humans. Data presented here show that children were most frequently involved in these encounters (66.7%), probably because they play on the ground, digging up soil and often have bare feet (part of the body most affected—85.7%). Many parents indicated that the child was playing with the snake. This shows a close correlation between the fossorial habits of this snake, and the situation in which the encounter occurred. However, despite the number of cases (N = 28), the medical reports of these patients described only abrasions and local pain.

Local hemorrhage is one of the most common pathologies produced by snake venom. Proteolytic activity at various levels, high phospholipase A (2) activity, phosphodiesterase and acetylcho-

TABLE 7. Distribution of main clinical manifestations (%), shown by patients admitted to Hospital Vital Brazil, Instituto Butantan, among the different genera of mildly venomous snakes. (SS – stinging sensation; LP – local pain; N – numbness; SL – swelling; EC – ecchymosis; ER – erythema; A - abrasions; GD – general discomfort; GH – gum hemorrhage; HY – hyperemia; HE – local hemorrhage; PL – local paleness; LI – local itching; SW – sweating).

Genus	SS	LP	N	SL	EC	ER	A	GD	GH	HY	HE	PL	LI	SW
Helicops		30.5		10.6		1.2	41.2	5.9			10.6			
Philodryas	2.7	19.3	2.0	14.7	2.0	13.3	20.7	7.3	1.3		16.0	0.7		
Liophis		32.6		4.4		6.5	39.1	6.5			8.7		2.2	
Oxyrhopus	16.7	16.7		16.7		16.6	33.3							
Thamnodynastes		21.4		7.1		7.1	42.9				14.3			7.2
Waglerophis		55.6					22.2				22.2			
Chironius		37.5		6.2			43.8				12.5			
Sibynomorphus		50.0					25.0				25.0			
Tomodon		40.0					60.0				16.7			
Xenodon		41.7		8.3		8.3	25.0							
Atractus		50.0					50.0							
Liotyphlops		57.1		14.3			28.6				22.2			
Mastigodryas		11.1				22.2	44.5							
Apostolepis		28.6		14.3		28.5	14.3			14.3	33.3			
Tropidodryas		55.6					11.1							
Erythrolamprus		33.3				16.7	33.3				16.7			

linesterase activities, have been found in the "venom" (Duvernoy's secretion) of twelve species of colubrid snakes (Hill and Mackessy 2000). Bioassays using mice (18–22 g) have shown that the species *Apostolepis dimidiata*, *Phalotris lemniscatus*, *Elapomorphus quinquilineatus*, *Erythrolamprus aesculapii*, *Thamnodynastes strigilis*, and *Liophis miliaris* have highly hemorrhagic "venoms" (M. G. Salomão, pers. obs.). Such reactions in mice were similar or more intense than those resulting from *Philodryas olfersii*, whose Duvernoy's secretion causes quantitatively more hemorrhaging than the venom of many species of *Bothrops* (Assakura et al. 1992; Salomão 1991). Local hemorrhage is normally a consequence of skin perforation combined with venom effects. *Philodryas* is an exception because bites cause significant systemic coagulopathy such as gum hemorrhage.

Experiments using the saliva of *Helicops* (0.0725 mg dried venom/g mice) killed mice in 10 minutes, with the mice exhibiting spasms and distension of posterior legs. When tested on fish (4–6 g), their usual prey, it caused a decrease of opercular beatings and general immobilization for about 30 minutes, followed by death (Albolea 1999; Albolea et al. 2000). Paralysis was also observed when extract of the Duvernoy's glands of *Sibynomorphus neuwiedi* (Laporta-Ferreira 1985) and of *S. mikani* (Salomão and Laporta-Ferreira 1994) were used on snails and slugs, respectively.

Other symptoms, such as general discomfort (e.g., headache, nausea, dizziness) and sweating may be a consequence of psychological effects of encountering a snake. These results show a relationship between the effects of venom on prey and certain symptoms present in victims of bites from "mildly venomous" species. Moreover, additional laboratory studies should be undertaken to determine if other snake species, presently considered nonvenomous, might have "venoms" of medical significance to humans (Nishioka and Silveira 1994).

Our results have documented the potential danger of certain Brazilian colubrid snakes to humans. Several taxa, in particular *Philodryas olfersii* and at least some species of *Phalotris* and *Apostolepis*, and possibly *Hydrodynastes gigas*, can cause potentially life-threatening illness. The adjective "harmless" should be abandoned when referring to colubrids. We suggest the designation of "mildly venomous" (Minton 1990) to refer to those snakes which are known to produce toxic symptoms and recommend the use of "non-venomous" exclusively for those species which lack Duvernoy's glands. Moreover, we feel people should be advised not to handle snakes unnecessarily, mainly because the effects of the "venom" of many species are completely unknown and even those species, such as boids, which do not inject toxic saliva may cause serious injuries (see Duarte et al. 2000 for details on attacks by boids). Campaigns such as those carried out in Instituto Butantan to teach people about the importance of snakes in the environment, despite their potential danger to humans, should be encouraged and implemented in other states. Training for doctors and nurses for immediate snake identification should be reinstituted; such training would minimize unnecessary administration of antivenom, and consequently, antivenom side effects (see Nishioka and Silveira 1994 for more examples). Studies on natural history should focus on epidemiological aspects of colubrid species to better understand their behavior, consequences of interaction with people, and thereby reducing risks of snakebite to the public. Finally, the idea of preparing a specific antivenom for some colubrid snakes, as suggested by Lema (1978a, b) and Salomão (1991) should be considered on the basis of its cost/benefit ratio, despite the logistic difficulties of venom extraction from colubrid snakes (Salomão et al. 1990).

Acknowledgments.—We thank Wolfgang Wüster for discussions and revision of the manuscript, and donation of reprints on this subject. We also thank David Hardy, Sr. and Emmett Blankenship for reviewing several drafts of the ms. Finally, we thank Francisco do Carmo Costa for help with final revision of the ms.

Literature Cited

Albolea, A. B. P. 1999. Padrões de atividade em serpentes não peçonhentas de interesse médico *Helicops modestus* (Colubridae: Xenodontinae) e *Liophis miliaris* (Colubridae: Xenodontinae) e sua relação com a Epidemiologia. Master's thesis, Universidade Guarulhos-CEPPE-UnG. Guarulhos, SP. 70 pp.

———, and M. G. Salomão. 1998. Ocorrência de acidentes ofídicos causados por serpentes não peçonhentas no estado de São Paulo. 9° Encontro de Biólogos do CRB – 1 (SP, MT, MS). Livro de Resumos: 61 Campo Grande, Mato Grosso do Sul.

———, ———, and S. M. Almeida-Santos. 2000. Why do non-poisonous snakes cause snakebites? Toxicon 38:567–568.

Araújo, M. E., and A. C. M. C. A. Santos. 1997. Cases of human envenoming caused by *Philodryas olfersii* and *Philodryas patagoniensis* (Serpentes: Colubridae). Rev. Soc. Bras. Med. Trop. 30:517–519.

Assakura, M. T., M. G. Salomão, G. Puorto, and F. R. Mandelbaum. 1992. Hemorrhagic, fibrinogenolitic and edema-forming activities of the venom of the colubrid snake *Philodryas olfersii* (green snake). Toxicon 30:427–438.

Brito, M. A., and M. A. Carvalho. 2000. Perfil dos acidentes ofídicos na Amazônia Matogrossense. XXIII Congresso Brasileiro de Zoologia. UFMT/IB 13 a 18 de fevereiro/2000. Livro de Resumos: DI 049: 744. Cuiabá, Mato Grosso.

Cadle, J. E., and H. W. Greene. 1993. Phylogenetic patterns, biogeography, and the ecological structure of neotropical snake assemblages. *In* R. E. Ricklefs and D. Schluter (eds.), Species Diversity in Ecological Communities—Historical and Geographical Perspectives, pp. 281–293. University of Chicago Press, Chicago, Illinois.

Campbell, J. A., and W. W. Lamar. 1989. The Venomous Reptiles of Latin America. Comstock Publishing Associates, Ithaca, New York. 425 pp.

Cei, J. M. 1993. Reptiles del noroeste, nordeste y este de la Argentina. Herpetofauna de las selvas subtropicales, Puna y Pampas. Museo Regionale di Scienze Naturali - Torino. 949 pp.

Costa, M. C. S. 1997. Estudos de aspectos epidemiológicos, do quadro clínico e tratamento de acidentes ofídicos em pacientes atendidos no Hospital Municipal de Pronto Socorro de Porto Alegre, RS, com caracterização taxonômica dos agentes etiológicos. Master's thesis, Pontifícia Universidade Católica do Rio Grande do Sul. Porto Alegre, RS. 75 pp.

Duarte, M. R., S. M. Almeida-Santos, and J. L. Cardoso. 2000. An attack on a human by a green anaconda (*Eunectes murinus*). Bull. Chicago Herpetol. Soc. 35:164.

Fan, H. W., and J. L. Cardoso, 1995. Clinical toxicology of snake bites in South America. *In* J. Meier and J. White (eds.), Handbook of Clinical Toxicology of Animal Venoms and Poisons, pp. 667–688. CRS Press, London.

Ferrarezzi, H. 1993. Nota sobre o gênero *Phalotris* com a revisão do grupo *Nasutus* e descriçãode três novas espécies (Serpentes, Colubridae, Xenodontini). Memórias do Instituto Butantan 55 suplemento 1:21–38.

———. 1994. Uma sinopse dos gêneros e classificação das serpentes

(Squamata). II. Família Colubridae. Herpetol. Bras. 1:81–91.

Fowler, I. R., and M. G. Salomão. 1994. Activity patterns in the colubrid snake genus *Philodryas* and their relationship to reproduction and snakebite. Bull. Chicago Herp. Soc. 29:229–232.

Fritts, T. H., and M. J. McCoid. 1999. The threat to humans from snakebite by snakes of the genus *Boiga* based on data from Guam and other areas. *In* G. H. Rodda, Y. Sawai, D. Chiszar, and H. Tanaka (eds.), Problem Snake Management. The Habu and the Brown Tree Snake, pp. 116–127. Comstock Publishing Associates, Ithaca, New York.

———, ———, and R. L. Haddock. 1990. Risks to infants from bites of the brown tree snake (*Boiga irregularis*). Am. J. Trop. Med. Hyg. 42:607–611.

———, ———, and ———. 1994. Symptoms and circumstances associated with bites by the brown tree snake (Colubridae: *Boiga irregularis*) on Guam. J. Herpetol. 28:27–33.

Gabe, M., and H. Saint-Girons. 1971. Histologie comparee des glandes salivaires du vestibule buccal chez les lezards et les serpents et evolution de la fonction venimeuse. Tox. Anim. Plant Origin 1:65–68.

Hill, R. E., and S. P. Mackessy. 2000. Characterization of venom (Duvernoy's secretion) from twelve species of colubrid snakes and partial sequence of four venom proteins. Toxicon 38:1663–1687.

Kochva, E. 1987. The origin of snakes and evolution of the venom apparatus. Toxicon 25:65–106.

———, and C. Gans. 1970. Salivary glands of snakes. Clin. Tox. 3:363–387.

Laporta-Ferreira, I. L. 1985. Fisioecologia de serpente moluscófaga *Sibynomorphus neuwiedi*. Ph.D. dissertation, Inst. Biociências Universidade de São Paulo-USP. São Paulo, SP. Brazil. 93 pp.

Lema, T. 1978a. Cobras não venenosas que matam. Natureza em Revista 4:38–46.

———. 1978b. Relato de um envenenamento por uma cobra não venenosa. Natureza em Revista 4:62–62.

Manning, B., M. Galbo, and G. Klapman. 1999. First report of a symptomatic South American false water cobra envenomation. J. Toxicol. – Clin. Tox. 37:613.

Martins, N. 1916. Estudo das Opisthoglyfas brasileiras e o seu veneno. Ph.D. dissertation Faculdade de Medicina do Rio de Janeiro. 112 pp.

McDowell, S. B. 1987. Systematics. *In* S. A. Seigel, J. T. Collins and S. S. Novak (eds.), Snakes: Ecology and Evolutionary Biology, pp. 3–50. MacMillan Publ. Comp., New York.

McKinstry, D. M. 1978. Review: Evidence of toxic saliva in some colubrid snakes of the United States. Toxicon 16:523–534.

———. 1983. Morphologic evidence of toxic saliva in colubrid snakes: a checklist of world genera. Herpetol. Rev. 14:12–15.

Ministério da Saúde. Fundação Nacional da Saúde. 1998. Manual de Diagnóstico e Tratamento de Acidentes por Animais Peçonhentos. Brasília: 1 Zoonoses. 131 pp.

Minton, S. A. 1990. Venomous bites by nonvenomous snakes: an annotated bibliography of colubrid envenomation. J. Wild. Med. 1:119–127.

———. 1996. Are there any nonvenomous snakes? An update on colubrid envenoming. Adv. Herpetoculture 1:127–134.

Mittleman, M. B., and R. C. Goris. 1974. Envenomation from the bite of the Japanese colubrid snake, *Rhabdophis tigrinus* (Boie). Herpetologica 30:113–119.

Nahas, L., A. S. Kamiguti, A. R. Hoge, and R. C. Goris. 1976. Characterization of the coagulant activity in the venom of aglyphous *Rhabdophis tigrinus* snake. *In* A. Ohsaka, K. Hayashi and Y. Sawai (eds), Animal, Plant and Microbial Toxins, Vol. 1. pp. 159–170. Plenum Press, New York.

Nickerson, M. A., and R. W. Henderson. 1976. A case of envenomation by the South American colubrid *Philodryas olfersii*. Herpetologica 32:197–198.

Nishioka, S. A., and P. V. Silveira. 1994. *Philodryas patagoniensis* bite and local envenoming. Rev. Inst. Med. Trop. São Paulo 36:279–281.

Penteado, D. C. 1918. Estudos histológicos das glandulas da cabeça dos ophidios brasileiros. Mem. Inst. Butantan 1:27.

Pinto, R. N. L., N. J. Da Silva Jr., and S. D. Aird. 1991. Human envenomation by the South American opisthoglyph *Clelia clelia plumbea* (Wied). Toxicon 29:1512–1516.

Saha, P. K., and A. K. Hati. 1998. A comparative study on some epidemiological aspects of non-poisonous and poisonous snake bite cases. The Snake 28:59–61.

Salomão, E. L., and M. Di-Bernardo. 1995. *Philodryas olfersii*: Uma cobra comum que mata, caso registrado na área da oitava Delegacia Regional de Saúde. Arq. Soc. Bras. Zool./Sorocaba, 14/15/16:21.

Salomão, M. G. 1991. Estrutura e secreção das glândulas de Duvernoy de *Sibynomorphus mikani* (Colubridae, Dipsadinae) e *Philodryas olfersii* (Colubridae, Xenodontinae), e das glândulas de veneno de *Bothrops jararaca* (Viperidae, Crotalinae) e *Micrurus frontalis* (Elapidae, Elapinae) e a influência dos estados de alimentação e jejum. PhD dissertation, Inst. Biociênc. Universidade de São Paulo- USP. São Paulo, SP. 122 pp.

———, and I. L. Laporta-Ferreira. 1994. The role of secretions from the supralabial, infralabial, and Duvernoy's glands of the slug-eating snake *Sibynomorphus mikani* (Colubridae: Dipsadinae) in the immobilization of molluscan prey. J. Herpetol. 28:369–371.

———, G. Puorto, M. F. D. Furtado, and P. Sawaya. 1990. *Philodryas olfersii*: Morphological, histochemical studies of Duvernoy's glands. Venom extraction. Mem. Inst. Butantan 52 (Suplemento):69.

Santos-Costa, M. C., and M. Di-Bernardo. 1997. Envenenamento humano por serpente aglifodonte *Liophis miliaris* (Linnaeus, 1758). 2° Encontro Nacional de Acidentes com Animais Peçonhentos. Livro de Resumos:47. Porto Alegre, Rio Grande do Sul. Brazil.

Santos-Costa, M. C., A. B. Outeiral, and F. M. D'agostini. 2000. Epidemiologia, Sintomatologia e Tratamento de Acidentes Humanos por Serpentes Não Peçonhentas. XXIII Congresso Brasileiro de Zoologia. UFMT/IB 13 a 18 de fevereiro/2000. Livro de Resumos: RE 070:527. Cuiabá, Mato Grosso, Brazil.

Schenone, H., and H. Reyes. 1965. Animales ponzonosos de Chile. Bol. Chil. Parasitol. 20:104–108.

Silva, M. V., and M. A. Buononato. 1983/84. Relato clínico de envenenamento humano por *Philodryas olfersii*. Mem. Inst. Butantan. 47/48:121–126.

Silveira, P. V. P., and S. A. Nishioka. 1995. Venomous snake bite without clinical envenoming ("dry bite"). A neglected problem in Brazil. Trop. Geogr. Med. 47:82–85.

Spawls, S., and B. Branch. 1995. The dangerous snakes of Africa. Oriental Press, Dubai. 192 pp.

Stevens, K. 2000. Brief notes on the captive care of the false water cobra (*Cyclagras gigas*, Dumeril, Bibron and Dumeril 1854). The Herptile 25:94–97.

Taub, A. M. 1967. Comparative histological studies on Duvernoy's gland of colubrid snakes. Bull. Amer. Mus. Nat. Hist. 138:1–50.

Vanzolini, P. E. 1986. Paleoclimas e especiação em animais da América do Sul tropical. Assoc. Bras. Est. Quat. Publ. Avulsa 1:1–35.

Vellard, J. 1955. Propriétés venimeuses de *Tachymenis peruviana* Wiegm. Folia Biologica Andina, Pars II – Zoologica 1:1–14.

Vital Brazil, and J. Vellard. 1926. Contribuição ao estudo das glândulas das serpentes aglyphas. Mem. Inst. Butantan, Tomo III:301–322.

Zotz, R. B., D. Mebs, H. Hirche and D. Paar. 1991. Hemostatic changes due to the venom gland extract of the red-necked keelback snake (*Rhabdophis subminiatus*). Toxicon 29:1501–1508.