Two case reports of local envenoming by the Spotted grass snake, Psammophylax rhombeatus (Linnæus, 1758) (Serpentes, Psammophiidae)

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ABSTRACT

Two cases of bites by a South African psammophiid snake, *Psammophylax rhombeatus*, are described and analyzed. These are the first detailed reports of local envenoming by a *Psammophylax* spp. While handling a wild-collected 1 m *P. rhombeatus*, the snake inflicted a protracted bite proximal to the metacarpophalangeal joint of digit #5, left hand of a 24-year-old male amateur herpetologist. Local edema persisted for three days, but no pain or other signs or symptoms including non-specific autonomic effects (e.g. headache, nausea) occurred. In a second case, a 28-year-old male herpetologist-photographer was repositioning a 0.58 m female *P. rhombeatus* in order to photograph the snake and her egg clutch, when the snake bit the metacarpophalangeal joint of digit #5, left hand, and briefly advanced its jaws. The bite caused mild local pain, progressive edema of the left hand, and arthralgia; resolution required almost 1 week. Bites from non-front-fanged snakes such as these by *P. rhombeatus* are uncommonly reported in comparison with those described for front-fanged snakes (e.g. Viperidae, Elapidae). Therefore, documentation of bites even with minimal effects provides information essential for the construction of an accurate medical risk profile for these less-known species.

Keywords:

Non-front fanged snake;

Colubroid;

Psammophiidae;

Envenoming;

Snake bites;

Psammophylax rhombeatus;

Spotted grass snake;

Rhombic Skaapsteker

1. Introduction

Grass Snakes or 'Skaapstekers' (genus *Psammophylax* Fitzinger, 1843) are terrestrial Central, South and East African non-front-fanged colubroid snakes (NFFCs) with low-pressure venom glands (or, 'Duvernoy glands') (Taub, 1967; Heymans, 1977; McKinstry, 1983). Sub-equal maxillary teeth are followed after a diastema by a pair of slightly enlarged, grooved posterior maxillary teeth. The venom of studied species is reportedly quite viscous, and has been compared with glycerin (FitzSimons, 1921).

Six species are recognized in the genus *Psammophylax* (Table 1). They feed on small vertebrates including fishes (Broadley, 1977; Branch, 1988; Shine et al., 2006; Cottone & Bauer, 2010; Chippaux & Jackson, 2019; Keates et al., 2019; Wilkey, 2019). They are unusual among snakes by variably engaging in parental care (Shine et al., 2006). Their common name 'Skaapsteker' has an Afrikaans origin related to their presumed habit of biting sheep (literally: ‘sheep stabber’), a belief that unfortunately leads some ranchers to kill these snakes on sight (Tyrone Ping, personal observations). However, cape cobras (*Naja nivea* (Linnæus, 1758), Elapidae) are probably responsible for most of the stock losses that are blamed on relatively harmless *Psammophylax* (FitzSimons, 1921; Alexander & Marais, 2007), although some authors have considered puff adders, *Bitis arietans* Merrem, 1820 (Viperidae), more likely culprits (Elstob in Chippaux & Jackson, 2019).

Early workers, most prominently, Frei (1910), Andrews (1912) and FitzSimons (1912) contemplated whether *Psammophylax* spp. were venomous. Based on experiments with fowl reportedly bitten by *Trimerorhinus rhombeatus* (most likely *P. rhombeatus*; *Trimerorhinus* A. Smith, 1847 is a junior synonym of *Psammophylax*.), FitzSimons (1921: 488) considered the possibility that this species could be as dangerous as the Boomslang (*Dispholidus typus* (A. Smith, 1828)) and its venom more potent than that of elapid species of notable medical importance (e.g., cobras, *Naja* spp. and mambas, *Dendroaspis* spp.). However, Phisalix (1922) reported delayed lethal effects in a small sampling of rodents and chicken bitten by specimens of two *Psammophylax* species from South Africa.

Christensen (1955: 2) later commented that *Trimerorhinus tritaeniatus* possess “potent venom”. Alexander and Marais (2007) stated that the venom of *Psammophylax* spp. has no medical relevance. Spawls et al. (2018) suggested that the venom of *Psammophylax* spp. is “fairly toxic”, but little is injected when a bite is delivered to a human, and thus no serious symptoms have been recorded. Wilkey (2019) considered the two species of *Psammophylax* present in Malawi and reported that their venom is mild and may cause local swelling and some mild pain. However, Spawls and Branch (2020) noted that *P. tritaeniatus* reportedly have “toxic venom” with that of *P. rhombeatus* having “potent” neurotoxicity. Nonetheless, they concluded that no medically significant effects from a *Psammophylax* bite have so far been recorded. Likewise, FitzSimons and Smith (1958) noted the absence of any reported serious case of human envenomation from *Trimerorhinus* (now *Psammophylax*), and opined that all published cases are dubious. Consistent with the latter impression, Chapman (1968) described the effects observed in three cases of bites by *Psammophylax* spp. in Natal, and indicated that these consisted of “a slight local reaction of bruising and swelling, one with a rigor”. Branch (1982) reported similar signs and symptoms following a bite from an East Cape *P. rhombeatus*. However, these reports are described second hand and it is not clear if formal medical review was ever conducted within a reasonable timeframe after the bites.

Warrell (1995: 460) noted that *P. tritaeniatus* bites were associated with non-specific systemic symptoms such as nausea, headache and rigors. Warrell (2010) later opined that *Psammophylax* is probably capable of mild envenomations that cause only local pain, mild swelling and lymphangitis, and emphasized the absence of any reported serious bites. Kuch and Mebs (2002, 167-168) quoted FitzSimons (1910) apparently referring to a case of human envenomation from *P. rhombeatus* that reportedly included “giddiness, lassitude, cold clammy skin, cold sweat on the forehead, a little swelling at the site of the fang punctures, with discolouration of the surrounding tissue”.

The previously reported cases were also reviewed by Minton (1990), and later, Weinstein et al. (2011) evaluated them and assigned these with a low-quality evidence rating (C/D). This rating indicated limitations noted in these reports including lack of formal medical review and/or detailed information/documentation about the species assigned responsibility for the bite(s). Therefore, there are no detailed descriptions of bites by *Psammophylax* spp., or first-hand reports that have documented their medical effects.

While performing field work and photography, two of the authors were bitten by specimens *P. rhombeatus* and developed effects consistent with local envenoming. We report here on these two first-hand cases of bites by *P. rhombeatus*, present the details of these bites and their reported effects.

2. Case reports

Case 1

While performing a herpetological field survey on September 30 2004 near the Sterkfontein dam (Orange Free State) in South Africa (28°27'N, 29°01'E) in the morning around 1000-1100 hrs, one of us (JR; 24 yr old male, amateur herpetologist, with no significant medical history, no current medications or known allergies) was bitten by an approximately 1± m (total length) *P. rhombeatus* (gender undetermined) (Fig. 1). The victim was previously (2002) bitten by a Brazilian lancehead, *Bothrops moojeni* Hoge, 1966 (Viperidae, Crotalinae) and severely envenomed (progressive edema and consumptive coagulopathy); he was treated with six vials of Bothrofav® (Sanofi-Pasteur, Lyon, France; a monovalent $F(ab')_2$ antivenom against venom of the fer-de-lance or Martinique lancehead, *Bothrops lanceolatus* Bonnaterre, 1790; this antivenom has no clinically proven paraspecificity for *B. moojeni* venom).

The *P. rhombeatus* was discovered under a piece of pottery (pipe) in a humid habitat that had recently burned (2-3 months prior) and was beginning to reestablish floral growth. The snake was captured without difficulty, and was kept for several minutes in order to photograph the specimen. While handling the snake, the victim momentarily loosened his grip, and was promptly bitten proximal to the metacarpophalangeal joint of the digit #5, left hand. The snake maintained a firm grip for approximately 10-15 secs while it implanted the enlarged posterior maxillary teeth into the victim's hand. Once manually disengaged from the bite site, two symmetrical puncture marks consistent with the enlarged posterior maxillary teeth, as well as small blood drops produced by several of the anterior teeth were observed (Fig. 2). The local, proportional bleeding stopped after several minutes. There was no first aid applied, and the wound was not disinfected. Several minutes post-bite, edema and erythema were first noted around the bite site. Within about seven hours post-bite, the edema involved the whole hand; moving the hand and fingers was not painful, but there was a nearly complete limitation of flexion and extension; manual dexterity was significantly affected (e.g., handling silverware was very difficult). Subsequently, the local edema of the bitten hand remained unchanged for three days and resolved on only the fourth day post-bite. The pain was estimated as 1/10 (using the verbal pain 0 to 10 with 10 being 'unbearable' pain) during the bite, but there was no pain (0/10), even when moving the hand and fingers. The victim described the most persistent effect as marked digital stiffness noted especially with attempted flexion of the fingers. Ecchymosis was absent and there were no other symptoms or signs including non-specific complaints such as headache and/or nausea. Complete resolution was observed within 4 days.

Case 2

A 28-yr-old male herpetologist/professional photographer with no significant medical history or allergies was investigating the herpetofauna at Glen Austen Gauteng, South Africa (25.975536°N, 28.169737°E) at 1120 hrs on October 18 2014 when he encountered an approximately 600 mm (total length) female *P. rhombeatus*, that was coiled around a recently deposited egg clutch (Fig. 3A). The snake was gently moved in order to photograph the eggs, together with the specimen. As the snake was handled, it inflicted a bite delivered to the medial-dorsal surface of the thumb, left hand, that initially consisted of contact with only the anterior maxillary and mandibular teeth; however, the snake began to advance its jaws and the victim sensed being punctured by both of the enlarged posterior maxillary teeth (Fig. 3B). The snake was firmly attached and resisted removal by the victim; it was gently coaxed to release by manually manipulating its head and had remained attached for approximately 45 seconds. The victim noted that immediately after detachment of the snake, the wounds immediately bled and continued bleeding for an estimated 2-3 minutes; the victim opined that the wounds bled a bit disproportionally in relation to the lacerations and punctures comprising the wound site. There was no attempted first-aid or interventions for the bite. For several hours post-bite, the victim only noted a “slight burning sensation”, but approximately 7 hours later the victim reported being awakened by his partner who stated that she felt “heat radiating” from his hand. The victim noted local moderate edema that involved the entire left hand; the edema mildly inhibited digit flexion/extension and the skin was notably warm ("hot to touch"). The victim reported a mild "throbbing-type pain" ranked 2/10 ("very mild, but pulsating, making it uncomfortable particularly when trying to sleep"), and did not ingest any analgesics or any other medications/substances. The edema was still present and moderately inhibited manual dexterity 36 hours post-bite (Figs 4A, 4B), and persisted for almost 1 week. Stiffness was present in the all of the metacarpophalangeal joints and digits of the left hand, but this completely subsided after approximately 4 days. Thereafter, the signs and symptoms fully resolved without any sequelae. The victim reported several previous asymptomatic and uneventful brief bites from several species of non-front-fanged snakes including *Psammophylax* (also, the psammophiids, short-snouted grass snake, *Psammophis brevirostris* Peters, 1881; cross-marked grass snake, *Psammophis crucifer* (Daudin, 1803), and the colubrine colubrid, marbled tree snake, *Dipsadoboa aulica* (Günther, 1864)); there was no history of any envenoming from any front-fanged species, and no history of having received antivenom. The victim has many years of experience photographing reptiles in the field often requiring close contact with many species of reptiles.

3. Discussion

The victims in these cases received firm bites with some jaw advancement from adult *P. rhombeatus*. Although the snakes were attached for <1 min, both victims developed mild-moderate signs and symptoms consisting of significant local edema with some local progression and minimal pain at the bite site. These resolved without sequelae in four to seven days (respectively, victims #1 and #2). Notably, both victims experienced similar clinical evolution of edema and local pain. The victims did not receive formal medical review and this limits the evidence quality (Level C/D, following the evidence rankings by Weinstein et al. (2011). However, careful observations were recorded and accurately correlated with images taken in chronological order, thus providing precise records of the effects of the bites.

Observations of *Psammophylax* spp. have suggested that these snakes rarely attempt to bite unless roughly handled (FitzSimons, 1921). Our own observations (FG, TP) suggest that some *P. rhombeatus* specimens are quick to bite when handled, as was also reported by Branch (1988). However, the effects of the bites described here may indicate that an especially prolonged bite by a large adult specimen might produce more significant local envenoming. Spawls and Branch (2020) commented that *P. rhombeatus*, "has a potent neurotoxic venom, but no adverse symptoms ever recorded from a bite", while Bates (1996) referring to *Psammophylax* venom and that of several other NFFC stated, "…is comparatively weak and bites usually result in only localized swelling and pain similar to that caused by a bee sting". Perceived venom neurotoxicity of *Psammophylax* is probably based on the previously outlined experiments by Phisalix (1922), FitzSimons (1921), and the comments by Christensen (1955). However, there is so far no biomedical evidence of neurotoxins in any *Psammophylax* venom, nor any clinical evidence of neurotoxicity from their bites, although as noted here, detailed reports about their venom and bites are absent in the literature. Therefore, there is insufficient documentation to firmly characterize the clinical syndrome that may be caused by prolonged bites by *Psammophylax*. Additionally, 3-finger-fold neurotoxins are common in many NFFCs including other psammophiids (Lumsden et al., 2007; Jackson et al., 2019; Modahl and Mackessy, 2019), and these may occur in *Psammophylax* venoms, but could have prey specificity (e.g., lizards). We decline speculation about the venom components that may have caused the effects that developed in the victims described here. Several venom components probably contribute to this e.g., snake venom metalloproteases; however, victim hypersensitivity may also play a role in the acute effects of some NFFC bites such as these (Weinstein et al., 2011). The minimal pain associated with the rapidly progressive edema suggests the specific investigation of this whenever possible e.g., laboratory evaluation of inflammatory cellular subsets and immunoglobulins. For example, Th2-related markers, including the interleukins (IL) and C-motif chemokines (CCL): IL-5, IL-13, IL-10, IL-31, CCL13, CCL18, and many others, are prominently expressed in lesions manifested in acute atopic dermatitis (Malik et al., 2017).

Management of bites by *Psammophylax* spp. is governed by the severity of the victim's distress; simple wounds and local effects can be managed with meticulous wound care, while progressive edema, persistent pain, bleeding and greater distress suggestive of systemic effects should be promptly reviewed by a physician whenever possible. There is no antivenom for bites by *Psammophylax* spp. and no antivenom of any kind should be given because: it subjects the patient to unnecessary risks; it would be ineffective, and in any case is not clinically indicated. There is also no evidence supporting the administration of parenteral steroids, or antihistamines for treatment of bites by NFFC, nor for antibiotic prophylaxis unless there has been interference with the wound (e.g., incorrect first-aid, application of local remedies, etc.), environmental contamination, or shows signs of early necrosis (Weinstein et al., 2011; Weinstein, 2017).

Further studies of the venoms of *Psammophylax* spp. are desirable, and formal reports of any bites inflicted by these snakes can further document their medical effects and clinical management.

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Table 1

A brief inventory of *Psammophylax* spp. and related species.

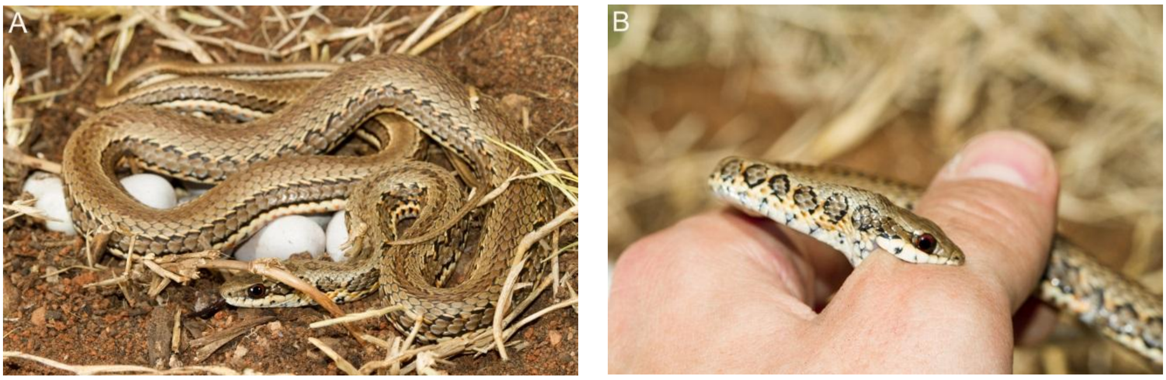
Valid name	Common names	Previous name(s); subspecies	Distribution	Reference(s)
Psammophylax kellyi Conradie, Keates & Edwards in Keates, Conradie, Greenbaum & Edwards, 2019	Tanzanian Grass Snake, Tanzanian Skaapsteker	*Psammophylax multisquamis* [pro parte]; [no recognized subspecies]	Mount Meru, N Tanzania	Keates et al., 2019
Psammophylax multisquamis (Loveridge, 1932)	Kenyan Grass Snake, Kenyan Striped Skaapsteker	*Trimerorhinus tritaeniatus multisquamis*, *Psammophylax tritaeniatus multisquamis*, *Psammophis variabilis multisquamis* ; [no recognized subspecies]	Ethiopia, Kenya, N Tanzania, N Rwanda	Branch, 2005; Spawls et al., 2018; Chippaux & Jackson, 2019
Psammophylax ocellatus (Bocage, 1873)	Angolan Grass Snake, Angolan Skaapsteker	*Psammophylax rhombeatus ocellatus* [pro parte]; [no recognized subspecies]	SW Angola, ?NW Namibia	Branch et al., 2019; Keates et al., 2019
Psammophylax rhombeatus (Linnæus, 1758)	Spotted Grass Snake, Spotted Skaapsteker, Rhombic Skaapsteker	*Coluber rhombeatus*, *Trimerorhinus rhombeatus*, *Psammophylax rhombeatus ocellatus* [pro parte]; [no recognized subspecies]	S Namibia, Rep. of South Africa, Lesotho, Swaziland, SW Angola	Phisalix, 1922; Branch, 1988; Alexander & Marais, 2007; Chippaux & Jackson, 2019; Spawls & Branch, 2020
Psammophylax tritaeniatus (Günther, 1868)	Striped Grass Snake, Striped Skaapsteker, Three-lined Grass Snake	*Trimerorhinus tritaeniatus*, *T. tritæniatus*, Rhagerrhis *tritaeniatus*, *Rhagerhis tritaeniata*; [recognized subspecies: *P. t. tritaeniatus*, *P. t. subniger*]	NE Namibia, N Botswana, Zimbabwe, NE Rep. of South Africa, Angola, S Tanzania, Zambia, Malawi, S Dem. Rep. Congo, Zambia, Mozambique	Phisalix, 1922; Branch, 1988, 2005; Alexander & Marais, 2007; Spawls et al., 2018; Chippaux & Jackson, 2019; Wilkey, 2019; Spawls & Branch, 2020
Psammophylax variabilis Günther, 1893	Grey-bellied Grass Snake, Grey-bellied Skaapsteker	*Trimerorhinus tritaeniatus* [pro parte], *Trimerorhinus tritaeniatus. variabilis*; [recognized subspecies: *P.v.variabilis*, *P.v. vanoyei*]	N Botswana, Dem. Rep. Congo, Tanzania, Burundi, Rwanda, Uganda, Kenya, Ethiopia, Malawi, Zambia, Mozambique, Namibia	Branch, 1988; Alexander & Marais, 2007; Spawls et al., 2018 ; Chippaux & Jackson, 2019; Wilkey, 2019
Kladirostratus acutus (Günther, 1888)	Striped Beaked Snake, Beaked Skaapsteker	*Psammophis acutus*; *Psammophylax acutus*; *Rhamphiophis acutus*; [recognized subspecies : *K. a. acutus*, *K. a. jappi*]	Angola, NW/W Zambia, S Dem. Rep. Congo, W Tanzania, N Malawi, N Rwanda	Keates et al., 2019
Kladirostratus togoensis (Matschie, 1893)	Northern Sharp-nosed Skaapsteker	*Psammophis togoensis*; *Rhamphiophis togoensi*; *Rhamphiophis acutus garambensis*; *Psammophylax acutus togoensis*; *Psammophlylax togoensis*; [no recognized subspecies]	Ghana, Togo, Nigeria, Cameroon, Central Afr. Rep., N Dem. Rep. Congo, Uganda	Keates et al., 2019

Figure legends

Figure 1. The Spotted Grass Snake or Rhombic Skaapsteker (*Psammophylax rhombeatus*) that inflicted the bite (Case #1). The snake was approximately 1 m total length; gender is unknown.

Figure 2. The left hand shortly after having been bitten by *Psammophylax rhombeatus* (Case #1). The snake remained attached for approximately 10-15 seconds, but did not advance its jaws. The bite produced symmetrical punctures that corresponded with the enlarged posterior maxillary teeth; only scant bleeding was noted. Note the early edema proximal to the metacarpophalangeal joint.

Figures 3A, B. (A) The Spotted Grass Snake or Rhombic Skaapsteker (*Psammophylax rhombeatus*) that inflicted the bite (Case #2). The snake (female) was approximately 580 mm total length, and was found coiled around her clutch of recently deposited eggs. The snake inflicted the bite when she was re-positioned in order to take photographs (image courtesy of Tyrone Ping). (B) The *Psammophylax rhombeatus* specimen shown in Fig. 3A, inflicting the bite on the medial-dorsal surface of the left thumb, victim #2. The wound reportedly bled "freely", but bleeding ceased within approximately 2 minutes. The victim reported that the subsequent local edema was accompanied only by mild throbbing pain, but rendered sleep difficult (image courtesy of Tyrone Ping).



Figures 4A, B. Persistent local effects, left hand 36 hrs after bite by *Psammophylax rhombeatus* on medial-dorsal surface of left thumb (Case #2). The snake remained attached for approximately 45 seconds and briefly advanced its jaws. The bite caused progressive local edema that eventually involved the entire hand and caused functional limitations of digital flexion and extension; only mild local pain was noted. Note the significant local edema of the thenar eminence in Panel B (images courtesy of Tyrone Ping).