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Local envenoming by the Schokari sand racer, *Psammophis schokari* Forskål, 1775 (Serpentes, Psammophiidae) and a brief review of reported bites by sand racers (*Psammophis* spp.)

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1 **Local envenoming by the Schokari sand racer, *Psammophis***
2 ***schokari* Forskål, 1775 (Serpentes, Psammophiidae) and a brief**
3 **review of reported bites by sand racers (*Psammophis* spp.)**

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22 ABSTRACT

23 A recent case of a bite by a psammophiid snake, *Psammophis schokari*, is described and analyzed. This is
24 the first report of local envenoming by this species. The 1 m long *P. schokari* inflicted a protracted bite on
25 the third digit, right hand of the male 59 year-old victim who developed mild, but locally progressive
26 edema and persistent pain; full resolution required almost three months. All documented cases of bites by
27 snakes of the genus *Psammophis* are briefly reviewed and discussed. Finally, we encourage the use of a
28 standardized method to describe the observed symptoms of bites by non-front-fanged colubroid snakes
29 (NFFCs). Such bites are rare compared to those described for front-fanged snakes (e.g. Viperidae,
30 Elapidae). Published data are still often comprised of anecdote or second-hand information. Whenever
31 possible, formal medical evaluation of victims bitten by NFFCs should be performed in order to establish a
32 medical risk and management profile for each species.

33

34 Keywords:

35 Non-front fanged snake; Colubroid; Psammophiidae; Envenomation; Snake bites; *Psammophis* spp.;

36 Sand snakes

37

38 **1. Introduction**

39

40 *Psammophis* H. Boie in Fitzinger, 1826 is a genus of mainly
41 African non-front-fanged colubroid snakes (NFFCs) with low-
42 pressure venom glands (or, ‘Duvernoy glands’); studied species have
43 enlarged, grooved posterior maxillary teeth associated with the glands.
44 Previously assigned as a subfamily (Psammophiinae) of the family

45 Lamprophiidae, recent robust evidence supported elevation of the
46 group to the family Psammophiidae (Kelly et al., 2008). Only a few
47 species are found outside Africa (Arabian Peninsula, Middle East and
48 Asiatic continent including some Indonesian islands). Bites by these
49 snakes are not uncommon, but rarely cause medically significant
50 effects, and although most species are abundant and common, there
51 are scarce published reports that document the medical effects of their
52 bites. Weinstein et al. (2011) reviewed reported bites by *Psammophis*
53 spp., and described several new cases. Previously published cases only
54 involved 4 of 35 known species and all described mild local effects
55 (FitzSimons, 1962; Isemonger, 1955; Broadley and Cock, 1975;
56 Spawls, 1979; Branch, 1982, 1998; Minton, 1990; Senter, 1998;
57 Weinstein, 2017). **Table 1** summarises the documented effects of bites
58 inflicted by *Psammophis* spp.

59
60 *Psammophis* spp. effectively use venom to subjugate their prey;
61 captive specimens often accept rodents (Steehouder, 2015; SA
62 Weinstein, personal observations), but many species feed on other
63 squamate reptiles (Spawls et al., 2002; Broadley et al., 2003; SA
64 Weinstein, personal observations). Probable specificity of some
65 venom toxins for squamate reptile prey is suggested by the rapid
66 effects observed in a captive *Psammophis leithi* Günther, 1869
67 (Pakistani sand racer) that succumbed 6 minutes after having been
68 bitten on its head by a slightly larger *Psammophis schokari* Forskål,
69 1775 (Mertens, 1953: pp. 196). Some *Psammophis* spp. feed on highly

70 venomous front-fanged snakes; a field collected 140 cm *Psammophis*
71 *mossambicus* Peters, 1882 (olive whip snake or sand racer)
72 regurgitated a 67 cm juvenile black mamba (*Dendroaspis polylepis*
73 Günther, 1864; Elapidae) (Broadley et al., 2003).

74

75 Bites by snakes of the genus *Psammophis* are popularly
76 considered medically insignificant (Simbotwe, 1982). Currently, there
77 is no clinical information that supports common speculation of the
78 hypothetically more serious effects of bites from large specimens of
79 *Psammophis* spp. (Weinstein et al., 2013; Weinstein, 2017). Most
80 published bite cases are based on observations made by non-medically
81 qualified authors because the victims experienced only mild, transient
82 effects and did not have formal medical review. The problems
83 associated with the subjectivity and somatosensory issues of reported
84 snakebites lacking formal medical review have been discussed in
85 detail (Weinstein et al., 2011, 2014).

86

87 *Psammophis* spp. often attempt to bite when handled and most
88 reported symptomatic bites include protracted contact in which the
89 snake remained attached for one minute or more. Reported bites most
90 commonly feature uncomplicated lacerations and multiple transiently
91 bleeding puncture wounds. There are also some reliably reported
92 anecdotal cases consistent with these reported effects that lack detail
93 sufficient for evidence-based analyses. It should be noted that in
94 several anecdotally reported cases, the identification of the species

95 assigned responsibility for the reported bite was not verified. Doubt
96 persists about a few of the identified cases since the systematics of the
97 genus *Psammophis* remain unsettled and there is fairly regular
98 description of new species, sometimes with broad geographic
99 distribution areas (e.g. Hughes and Wade, 2002; Böhme et al., 2019;
100 Trape et al., 2019; Parrinha, 2020). Also, although non-specific
101 symptoms such as nausea have occasionally been reported, there is so
102 far no documented evidence of systemic effects of envenoming after
103 bites by any *Psammophis* spp.

104

105 One of us (FG) was recently bitten by a *P. schokari* during field
106 work and we report here details of the bite. To our knowledge, this is
107 the first described bite by a *P. schokari*.

108

109 **2. Case report and Discussion**

110

111 While performing a herpetological field survey on 12/2/2020
112 near the town of Mirbat, Dhofar, Oman (16°59'N, 54°41'E), one of us
113 (FG; 83 kg, 59 yrs old male, amateur herpetologist, with no significant
114 medical history, no current medications or known allergies, never
115 previously bitten by any snake) was bitten by an approximately 1 m
116 (total length) *P. schokari* (gender undetermined). The animal was
117 captured in an area composed of open sandy substrate, rocks and a
118 few scattered low bushes (Fig. 1). At around 1100 hrs. on a sunny day,
119 the snake was observed moving with head erect and a small agamid

120 lizard in its mouth. Once captured, it released the prey which could
121 not be collected for identification or to check if it was envenomed. At
122 the time of its capture, the snake inflicted some glancing bites without
123 any sustained attachment; this is a relatively frequent defensive
124 behavior of this species especially when restrained.

125

126 In order to facilitate photographing the specimen, the snake was
127 placed in a box; however, the snake rapidly emerged and inflicted a
128 firm bite on the proximal phalanx digit #3, right hand (Fig. 2A).
129 Efforts to manually remove the snake were not successful, and it
130 remained attached for approximately 30 seconds without advancement
131 of the jaws after which it spontaneously released its jaws. Once
132 disengaged from the bite site, small blood droplets were noted from
133 two symmetrical puncture marks consistent with the enlarged
134 posterior maxillary teeth, as well as smaller punctures produced by
135 several of the anterior teeth. There was no first aid applied, and the
136 wound was only irrigated with a small volume of clean water. After an
137 hour, mild local edema was noted in the affected digit. The next
138 morning, at approximately 24 hrs post-bite, the local edema of the
139 bitten finger had progressed to mildly involve the
140 metacarpophalangeal joints (MCPs) of the fourth and second digits,
141 but without frank edema of these respective digits (Fig. 2). The edema
142 remained unchanged, but persisted for the next four days. There was
143 only slight erythema at the bite site and only mild local pain; there

144 was no ecchymosis. The mobility of the bitten finger was not
145 significantly impaired. However, the edema minimally limited range
146 of motion and manipulation of heavy objects. Other than edema, only
147 a moderate pruritus was noted around the bite site. Because of limited
148 access to medical facilities and the relatively mild effects of the bite,
149 the victim did not seek formal medical review; no medication of any
150 kind was taken. On the day following the bite, incidental sun exposure
151 of the bite site caused an annoying burning sensation; this was
152 accentuated with the mildly progressive edema involving the fourth
153 and second MCPs. The edema completely resolved after four days
154 post-bite. Nearly three months after the bite, some discomfort
155 persisted at the bite site that was exacerbated by flexion movements of
156 the affected finger (Fig. 2C).

157

158 This is the first reported bite by a *P. schokari*. The victim
159 experienced mild local effects similar to those reported after bites
160 from several congeners (Table 1). However, two other psammophiids,
161 the rufous beaked snake (*Rhamphiophis oxyrhynchus* (Reinhardt,
162 1843)), and the Montpellier snake (*Malpolon monspessulanus*
163 (Hermann, 1804)) have inflicted medically significant envenoming.
164 The former produced severe pain and progressive local edema
165 (Weinstein et al., 2014), while the latter is so far the only NFFCs that
166 has caused medically verified neurotoxicity (cranial nerve palsies)
167 (Pommier and de Haro, 2009). A novel neurotoxin ('rufoxin') was

168 isolated from *R. oxyrhynchus* venom (Lumsden et al., 2007), but most
169 psammophiid venoms remain so far unstudied. However, analytical
170 gel electrophoresis (SDS-PAGE, sodium dodecyl sulphate
171 polyacrylamide gel electrophoresis) of *P. schokari* venom revealed the
172 presence of P-III snake venom metalloproteinases (SVMP), cysteine-
173 rich secretory proteins (CRISPs), and several low molecular mass
174 components consistent with 3-finger-fold toxins (Modahl and
175 Mackessy, 2019). Although most reported bites by *Psammophis* spp.
176 have to date been limited to mild local effects, it is certainly possible
177 that a prolonged bite could cause more medically significant effects.
178 Also, the reported clinical effects are consistent with manifestations
179 caused by venom components and possibly local hypersensitivity.
180 Type 1 hypersensitivity including primary anaphylaxis (without prior
181 sensitization) has been reported after serious envenomings by several
182 front-fanged colubroids including: the Israeli or oasis burrowing asp
183 (*Atractaspis engaddensis* Haas, 1950, Lamprophiidae,
184 Atractaspidinae), European viper (*Vipera berus* (Linnæus, 1758),
185 Viperidae, Viperinae), and the Palestine viper (*Daboia palaestinae*
186 (Werner, 1938), Viperidae, Viperinae) [Chajek et al., 1974; Reimers et
187 al., 2000; Weinstein, 2017; Weinstein and Warrell, 2019]; it also
188 probably has occurred after bites by several taxa of NFFCs including
189 the Western hognose snake (*Heterodon nasicus* Baird & Girard, 1852,
190 Colubridae, Dipsadinae) and others (Weinstein and Keyler, 2009;
191 Weinstein et al., 2011, 2013; Weinstein, 2017). Any bite causing
192 distress and/or significant observed effects such as persistent bleeding,

193 progressive edema and/or any suggestion of systemic insult (e.g.
194 evidence of cranial nerve palsies, etc.) should whenever possible
195 receive prompt, formal medical review. A methodical approach to and
196 management of patients presenting with NFFCs bites has been
197 described in detail (Weinstein et al., 2011; Weinstein, 2017). Formal
198 medical review can also result in higher quality evaluation of bites
199 from any given taxon and thus facilitate construction of an evidence-
200 supported medical risk and clinical management profile for each
201 species.

202

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330 medical significance. *Toxicon*, 69, 103–113.

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Figure legends

336

337 Figure 1.

338 The Schokari sand racer (*Psammophis schokari*) that inflicted the bite.

339 The snake was approximately 1 m total length; gender is unknown.

340



341

342

343

344 Figure 2.

345 *Psammophis schokari* inflicting the reported bite on the medial aspect
346 of the proximal phalanx digit #3, right hand (Panel A). The snake
347 remained attached for approximately 30 seconds, but did not advance
348 its jaws. The bite produced symmetrical punctures that corresponded
349 with the enlarged maxillary teeth; only scant bleeding was noted. Mild
350 pain and edema developed one hour after the bite (Panel B). However,
351 it progressed locally and involved the index and ring fingers; the
352 effects persisted for 4 days. The appearance of the hand just over two
353 months after the bite (Panel C); the effects were not fully resolved
354 until almost 3 months after the bite.

355

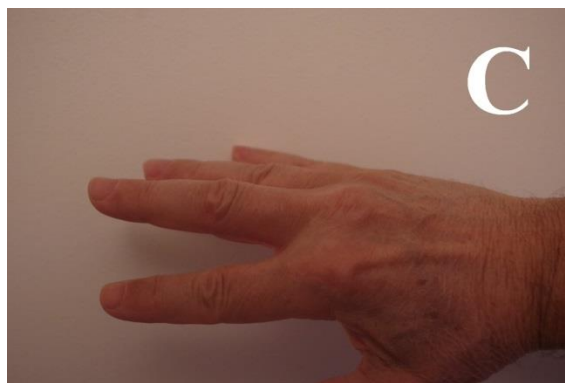


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359

360 Legend of Table 1

361

362 Table 1. Documented bites by sand snakes or sand racers,

363 *Psammophis spp.**

364

Table 1. Documented bites by sand snakes or sand racers,
*Psammophis spp.**

Species [number of documented cases]	Reported Effects ¹	Level of Evidence ²	Comments	Reference
Two-striped sand racer, <i>Psammophis biseriatus</i> Peters, 1881 [n=1]	Ed, Ecc, P (mild-moderate), Lymp	C/D	Probable mild Lymp without formal clinical verification.	Spawls (1979), Weinstein et al. (2011)
Phillip's whip or sand snake, <i>P. phillipsii</i> Hallowell, 1844 [n=4]	Ed, Ery, P (mild)	C/D	One reported bite (FitzSimons, 1962) may involve a different <i>Psammophis</i> spp.	FitzSimons (1962); Broadley and Cock (1975); Branch (1982, 1998); Senter (1998); Weinstein et al. (2011)
Speckled sand racer, <i>P. punctulatus</i> A.M.C. Duméril, Bibron & A.H.A. Duméril, 1854 [n=1]	Bl, P (mild)	C/D	Effects limited to transiently bleeding puncture wounds with mild pain. Bite was brief without prolonged attachment.	Weinstein et al. (2011)
Striped sand snake, <i>P. sibilans</i> Linnæus, 1758 [n=2]	Bl, Ed, P (mild - moderate), Pr	C	Bl brief and minimal. Ed locally progressive in one case (30 yr old male with history several NFFC bites) that involved prolonged attachment to right index finger. P was persistent with edema x 1 week. Signs also consistent with local hypersensitivity (e.g. Pr persistent for 2 days with slight maculopapular	This report (SAW, previously unpublished)

			dermatitis).	
Schokari sand racer, <i>P. schokari</i> Forskål, 1775 [n=1]	Ed, Ery, P (mild, persistent), Pr	C/D	Locally progressive Ed. P was mild, but persisted for 4 days. Some evidence of local hypersensitivity with mild local envenoming (see text).	This report
<p>^aTable includes only published or personally reviewed bites that have sufficient detail for reasonable risk assessment. Second-hand or anecdotally reported cases are not included. After Weinstein et al. (2011, 2013).</p> <p>^bAbbreviations: Bl - local bleeding; Ecc - local ecchymosis; Ed - local edema; Ery - local erythema; Lymp - lymphadenopathy; P - pain; Pr - local pruritus.</p> <p>^cQuality of evidence stratification is after the Strength of Recommendation Taxonomy (Ebell et al., 2004) as modified by Weinstein et al. (2011): C - case report prepared/interpreted by non medically qualified author and/or contains limited clinical information/absence of formal medical review (even if case was prepared by medically qualified author). Absence of verified identification of the species assigned responsibility for the bite can also ; D- published report contains description of significant symptomology/signs without qualified clinical verification at time of bite and/or supporting clinical details, investigations, etc.; report based on second-hand or anecdotal account. Mixed evidence quality is presented as a combination ranking e.g. C/D that reflects features of both evidence levels (see Weinstein et al. [2011] for further information about specific evidence level criteria).</p>				