

Distribution, abundance and habitat preference of an undescribed species of blind snake (Serpentes: Typhlopidae) on Ant Atoll, Federated States of Micronesia

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ABSTRACT - Twenty-eight specimens of an undescribed species of blind snake (*Ramphotyphlops* sp.) have been recorded from Ant Atoll, Federated States of Micronesia since 1999; 25 were collected and preserved, two were captured and released, and another was observed but not collected. All are from Pasa Island and nearly all were found inside rotting coconut logs. None was observed during a search of 26.9 man-hours among the 11 other islands on the atoll during June and July 2009. Food resources (ants and termites) are abundant on all the islands. If the snake is proven to be confined to Pasa, we suggest that potential predators such as rats, cats and pigs, all of which are widely distributed among the islands, are main factors in limiting its distribution on the atoll. Pasa, along with Wolouna, a tiny isolated islet with little suitable habitat for blind snakes, are the only two islands on the atoll where rats (*Rattus* spp.) are unrecorded. The snake remains unknown outside of Ant Atoll, but possibly differentiated elsewhere and colonised Ant from an unknown source.

OVER 200 species of blind snakes (Typhlopidae) are known worldwide, mainly in the tropics and subtropics (McDiarmid et al., 1999). With the exception of *Ramphotyphlops braminus*, a parthenogenetic species endemic to southern Asia that has been widely introduced throughout the world (often in the root masses of translocated plants), none have been recorded in the Federated States of Micronesia (FSM). This study is an assessment of the habitat, distribution and abundance of a recently discovered and undescribed species of *Ramphotyphlops* known only from Ant Atoll, Pohnpei State, FSM. The study is based largely on our two surveys totalling five days during June-July 2009, together with other unpublished sighting and specimen records. The species is currently being described (Wynn et al., pers. comm.).

Ant Atoll is located approximately 15 km southwest of Pohnpei in the eastern Caroline Islands, in the west central Pacific Ocean (Fig. 1). Twelve islands are distributed along a reef surrounding a large lagoon (74 km²) with a single, deep water channel (Fig. 2). Maximum elevations are only 2.5-3.0 m ASL (U.S. Geological Survey, 1944), the total land area is approximately 1.8 km²,

and Pamuk (0.6 km²) is the largest island. Coconut forest is the main vegetation type, and coconut (*Cocos nucifera*) is the dominant tree on most of the islands (e.g. Fig. 3a). Other common trees include *Artocarpus* sp., *Barringtonia asiatica*, *Guettarda speciosa*, and *Neisosperma oppositifolia*. Thickets of *Scaevola taccada* and *Tournefortia argentea* form a discontinuous band between the forest proper and the beach; rocky beaches predominate on the ocean side and sandy beaches on the lagoon side. The substrate consists of varying amounts of coral sand with decomposed organic matter along with coral rubble and boulders.

Ant Atoll is privately owned and shared by the Nanpei and Hawley families. Currently, there are no settlements on the atoll, but the islands are frequently visited by hunters, fishermen, and snorkeling and diving enthusiasts from Pohnpei. Ayres et al. (1979) reported a radiocarbon date of AD. 800 ± 100 for a charcoal sample from a fire pit at Imwinyap Island and stated that "site distributions on Ant appear to reflect intensive occupation over a substantial period of time". Galipaud (2001, 2004) found evidence of human occupation in the form of pottery radiocarbon-dated to 2,000 years ago.

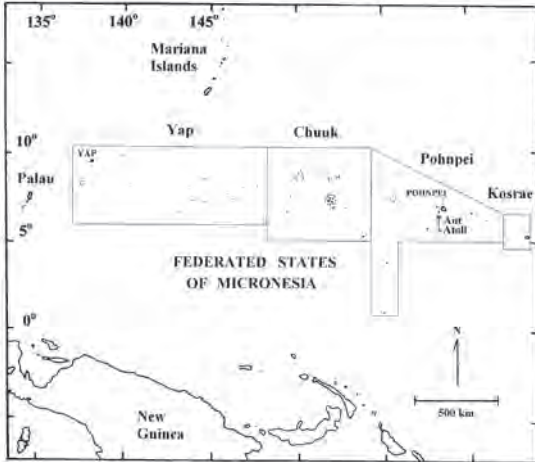


Figure 1. Location of Ant Atoll and the Federated States of Micronesia in the west central Pacific Ocean.

METHODS AND MATERIALS

Searches were conducted on Pasa, Renipiua, and Shikaroi Islands on 5 and 6 June 2009 and on all twelve islands during 16-18 July 2009. We cut open rotten logs and termitaria, turned over large rocks and solid logs, and looked through piles of *Cocos* trash while walking unpredetermined routes along the long axes of the islands. All islands were surveyed from one end to the other with the exception of sampling being limited to three separate sites in the eastern, central and western parts of Nikalap Aru. Search effort was recorded in man-hours calculated as the sum of the search times (in minutes) contributed by each searcher and divided by 60. In June, we received assistance from several students. Two worked together in close proximity to each other during searches on Renipiua and Shikaroi and their times were treated as a single-person effort. Five people worked together loosely in two teams on Pasa during an 85 minute search and their times were treated as a two-person search effort. The July surveys were conducted solely by the authors, synchronously, but independently, and along parallel routes about 20-50 m apart, except on the smallest islands where such separation was not possible.

Place names are from Bryan (1971), a 1:15000 scale map of Ant Atoll produced by Pohnpei State Land Commission in 1985, and verbal contributions by Pohnpeian residents; alternative names for the islands and variations in spelling are numerous.



Figure 2. Map of Ant Atoll, showing location of islands.

Island areas are from Bryan (1971) and are based on measurements made prior to 1946 (see United States Commercial Company, Research Section, 1946). A small island (Wachikichiki, 0.77 ha) shown between Imwinyap and Panshanki in Bryan's map has apparently been merged with Imwinyap. We combined the two island areas, but did not add the small area contributed by the narrow filled-in channel between them.

RESULTS AND DISCUSSION

Number of Specimens Recorded

Eight specimens of the undescribed species of *Ramphotyphlops* were found on Ant Atoll during a search effort totaling 34.8 man-hours over a period of five days in June and July 2009. This included all 12 islands. This brings the total number of snakes recorded from Ant Atoll to 28, all of them from Pasa Island. The first was collected by a coconut crab hunter in 1999. Subsequently, a College of Micronesia Marine Field Studies field trip on 30 August 2008, organised specifically to search for the snakes, resulted in 16 additional specimens. Two others were captured, photographed, and released by Danko Taborosi and Maricruz Sanchez Collazo on 28 March 2009, and one other was observed in a termitarium during a search for coconut crabs in April or May 2007 (D. Manglay, pers. comm.).

Distribution and Ecology

The evidence to date suggests that this species

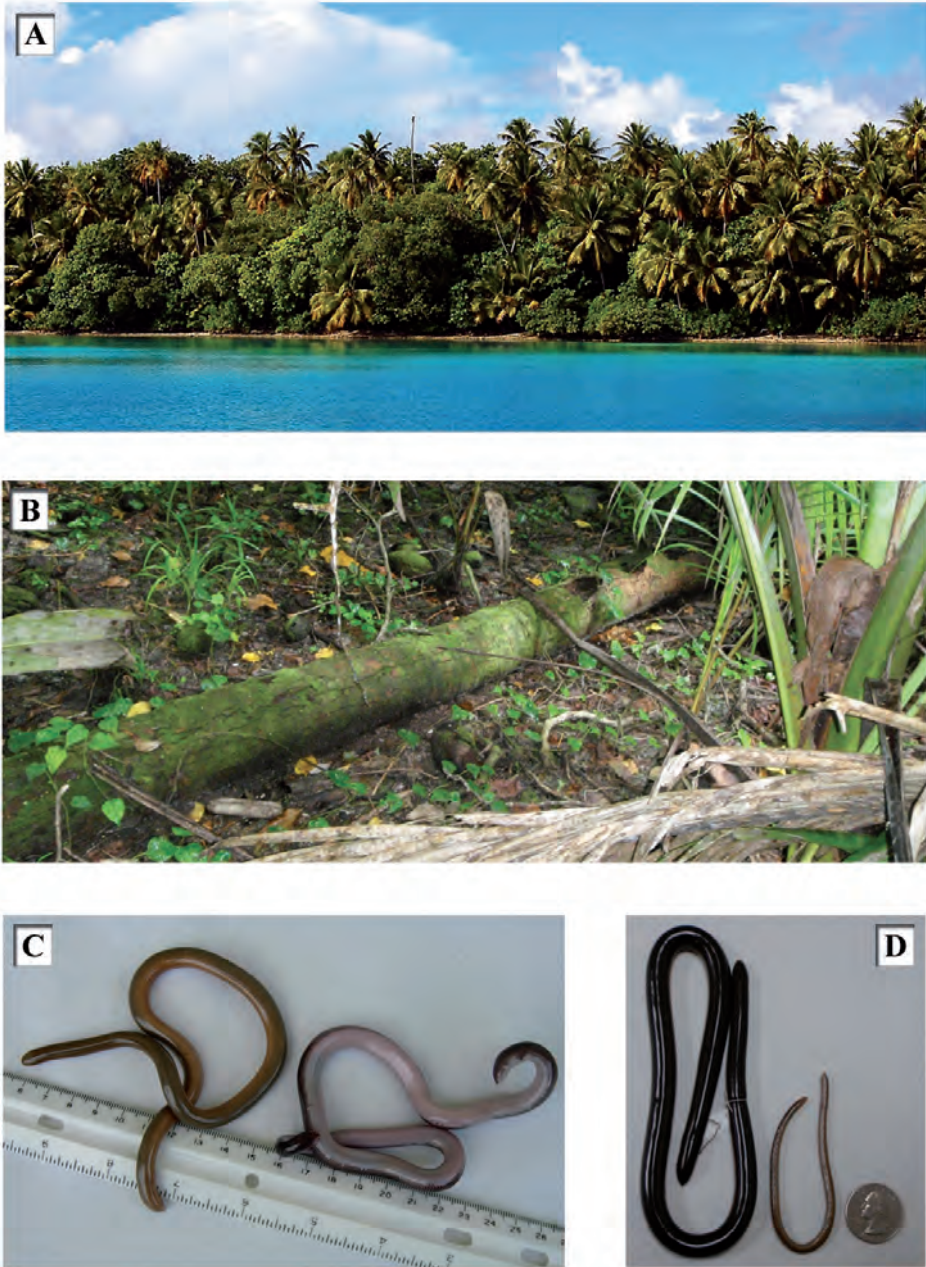


Figure 3. Habitat and habitus of *Ramphotyphlops* sp. on Ant Atoll. A, lagoonside view of Pasa Island [photo courtesy of Danko Taborosi and Maricruz Sanchez Collazo]; B, decayed coconut tree trunk, the preferred habitat of *Ramphotyphlops* sp.; C, living *Ramphotyphlops* sp.; D, preserved specimen of *Ramphotyphlops* sp. (left) and *R. braminus* (right) with U.S. 25-cent coin for size comparison.

is confined to Pasa Island, where our search represented only 22% of the time spent among the 12 islands during the June/July surveys but resulted in 100% of the sightings. All other known sightings of the snake are also from Pasa. However, additional surveys are needed, especially among the larger islands of Nikalap Aru, Imwinyap, and Pamuk, to be able to assess the distribution of *Ramphotyphlops* sp. on the atoll with greater confidence.

Little is known about the ecological requirements of this species that might contribute to its apparently very limited distribution, but lack of food resources is not likely among them. Typhlopoid snakes are fossorial and feed almost exclusively on various stages in the life cycles of ants and termites (e.g. Cogger, 2005; Webb et al., 2006). Both ants and termites are abundant throughout the atoll. We encountered numerous termitaria on all the larger islands and observed ants and termites on all the islands. Clouse (2007) recorded 20 species of ants on Ant Atoll (21 if two species of *Tapinoma* are present) and 72 species on nearby Pohnpei Island.

If the blind snake is restricted to Pasa Island, we

suggest that a combination of factors that include lack of suitable habitat and presence of potential predators may account for its absence elsewhere on the atoll. With the exception of three or four specimens found under decaying plant debris, all snakes were found inside rotted logs, the interiors of which had decayed nearly to the consistency of soil (Fig. 3b). On some of the smaller islands (e.g. Nakkapu, Naron, Shikaroi, and Tolonmurui) we found no more than 1-4 logs to search, compared with 20-50 logs each on the larger islands such as Pasa, Nikalap Aru, Imwinyap, and Pamuk. Additionally, unlike Pasa, which has predominately sandy soil throughout, many of the islands have large areas of coral rock and rubble, which is less hospitable for burrowing snakes.

Pigs (*Sus scrofa*), cats (*Felis catus*) and rats (*Rattus* cf. *tanezumi* and *R. exulans*) are among the potential predators of snakes on Ant Atoll (Table 1). Interestingly, Pasa and Wolouna are the only islands where rats are unrecorded. Wolouna is one of the smallest (1.8 ha) and the most isolated of the islands, and has few coconut trees; Marshall (1957) counted only four or five old trees in the

Island	Area (ha) ^a	Search Effort (hr) ^b	Snakes Observed	Potential Predators		
				Rats ^d	Cats	Pigs
Wolouna	1.81	0.31	-	-	-	-
Pasa	18.64	7.9	8	-	Sa	Se
Nikalap Aru	46.61	5.11	-	+/B/M	+/M	+/M/B
Imwinyap	24.08	2.46	-	B/A	+	+
Panshanki	15.53	2.48	-	B	+ ^e	+
Nakkapu	4.14	0.28	-	B	-	+
Naron	6.21	0.86	-	B	-	+
Remba	1.03	0.21	-	B	-	+
Shikaroi	0.77	1.18	-	B	-	+
Renipiua	4.92	3.35	-	B	-	+
Tolonmurui	1.29	0.26	-	+/B	-	-
Pamuk	60.86	10.43	-	+/B	+/M	+/M

a. From Bryan (1971); see methods for additional information.

b. Calculated as the sum of the search times (in minutes) contributed by each searcher divided by 60.

c. Sources of records: += this study, A = Ayres et al. (1979) [bones found at archeological sites], B = Buden 1996, M = Marshall (1957), Sa = S. Santos (in Buden 1996), Se = Harvey Segal (in Buden 1996) [animals were reported present at least into the 1980s].

d. Records pertain to *Rattus tanezumi*, or *R. exulans*, or both.

e. Tracks observed on the beach.

Table 1. Results of searches for *Ramphotyphlops* sp. on the 12 islands of Ant Atoll during June and July 2009, with records of potential predators.

centre of the island. Dominant trees on Wolouna include *Pisonia grandis*, *Terminalia samoensis*, and *Tournefortia argentea*. During our visit, however, many appeared to be dead possibly from storm damage, and the large number of nesting and roosting seabirds usually present on the island were lacking. The soil is a combination of coral rock, rubble and sand, and it potentially has a large nitrogen component from accumulated guano.

Nikalap Aru would appear to be the most likely island on the atoll to share a population of blind snakes with Pasa. It is one of the largest islands on the atoll, the one nearest to Pasa, and it has extensive areas of sandy soil and large numbers of coconut trees. Also, Nikalap Aru and Pasa are the only two islands located on the eastern side of the deep water passage into the lagoon. However, Nikalap Aru has a large number of potential predators. Rats are especially common throughout the island and feral pigs have uprooted vegetation in many areas, leaving behind overturned rocks and turned over soil. Marshall (1957) recorded rats along with domestic cats, dogs, pigs and chickens on Nikalap Aru during his visit in December 1955, when there was a small village that no longer exists.

Behaviour

The behaviour and activity patterns of *Ramphotyphlops* sp. are unknown, although it tends to occur in small aggregations. Most of our specimens were collected in small groups of 2-4, and with a maximum of eight occurring in a single log. Greene (1997) remarked that large colonies of *Ramphotyphlops braminus* sometimes live in rotting wood, and Ehmann & Bamford (1993) gave examples of aggregation behaviour in two other species of Australian typhlopids, which they believe as being related to mating activity.

Colonisation and Possible Modes of Dispersal

The origin of *Ramphotyphlops* sp. on Ant Atoll is uncertain, but given the young ages of Pacific atolls it is more likely a relatively recent colonist as opposed to an ancient autochthon. During the last glacial maximum, ca 20 ka, when sea level was estimated at about 120 m below present level (e.g. Peltier, 2002), Pacific atolls were broad, steep-sided subaerial limestone plateaus (Dickinson,

2004, 2009). Post-glacial eustatic rise in sea level drowned the platforms by 8-9 ka (Dickinson, in litt.) and reached a highstand 1.6-2.6 m above present level about 4,000 years ago (Dickinson, 2003, 2004, 2009). Transient sand cays may have existed at different times and at different locations throughout the Holocene (Dickinson, 2004, 2009), but it is unlikely that sufficient (if any) habitat would have been available to sustain a population of fossorial snakes during this time of extensive flooding. Ray and Connell (1991) reported that radiocarbon dates of material from supratidal parts of atolls are mostly less than 4,000 years, and Richmond (1993) similarly reported that atoll islands were less than 4,000 years old. Furthermore, Dickinson (2004, 2009) remarked that present day atoll configurations of stable, "pinned" islands have an even more recent timeline of about 1-2 ka, dating from when ambient high tide fell below mid-Holocene low tide level and the emergent palaeoreefs formed a protective barrier forestalling erosion.

Although it is known only from Ant Atoll, *Ramphotyphlops* sp. was possibly more widespread in the past and may have since been extirpated throughout most of its range, leaving a relict population on Ant. Small peripheral or satellite islands may be refugia for species extirpated on the mainland or on adjacent large islands (Perry et al., 1998). Alternatively, *Ramphotyphlops* sp. may still be extant elsewhere, either broadly distributed or in a few disjunct populations, but undiscovered owing to rarity, remote locations, lack of concerted search, or combinations thereof. On geographic grounds, Pohnpei, the nearest high island would be a likely source for the Ant Atoll population. With the exception of *Ramphotyphlops* sp., the terrestrial vertebrate fauna of Ant Atoll is a subset of more broadly distributed species, all of which occur on Pohnpei (Buden, 1996). However, this snake is unknown from Pohnpei, and, given the amount of excavation on the island (farming and construction), its presence is unlikely to have gone unnoticed. The possibility of its presence in the more distant past should not be completely discounted. Whether it arrived by natural dispersal (e.g. drift logs), or by human assistance is also a matter of conjecture. Possibly it was transported

to Ant by early aboriginal colonists from more distant areas via Pohnpei or other islands, or by more recent visitors including those in the wake of European exploration. Pregill (1998) recorded fossils of *R. braminus* in probable pre-cultural strata in the Northern Marianas thus suggesting it is indigenous, though Pregill and Steadman (2009) pointed out that chronology could be skewed if these burrowing snakes penetrate older strata. DNA studies on Pacific populations of *Ramphotyphlops* spp. in progress will likely shed light on the phylogeography of the Ant Atoll population as well as on other disparate populations of typhlopids in the Pacific (Fisher, pers. comm.).

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