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Micropechis ikaheka (Elapidae) in Papua, Indonesia: A Study of Diet and Cannibalism

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Introduction

Snakes are primary predators in many terrestrial, aquatic, and marine communities. As predators, the lives of wild snakes are therefore closely related to feeding ecology. Feeding ecology is related not only to food availability but also to the body sizes of the predators and prey (Cundall and Greene, 2000). Studying the diet of a snake species is critical to our knowledge of the ecology of the snake at individual, population and community levels. Ecological studies of snake diets are also very important for a better understanding of the relationships between snakes and other organisms in the ecosystem (Su et al., 2005).

The New Guinea small-eyed snake, *Micropechis ikaheka* (Lesson 1830), is one of the most venomous terrestrial snakes of continental New Guinea, occuring from lowland wetlands and plantations to mid-montane rainforests up to c.1,500 m asl (Slater, 1968; Hudson, 1988; O'Shea, 1996). This species may be active both by night and day (Slater, 1956), but is primarily nocturnal (O'Shea, 1994a; O'Shea, 1996; Krey and Farajallah, 2013). It is a secretive, semi-fossorial species that inhabits leaf-litter, loose soil or piles of decaying vegetation, discarded rubbish from cocoa, coconut or palm oil industries, holes in fallen palm trees, under tree buttresses, and in rocky crevices (Hudson, 1988; O'Shea, 1994b; O'Shea, 1996; Krey and Farajallah, 2013).

Micropechis ikaheka exhibits a very generalized diet (Shine and Keogh, 1996), comprising lizards, snakes, frogs, and small mammals. Some specific dietary items have been reported, including the New Guinea ground boa *Candoia aspera* (O'Shea, 1994a), and skinks *Sphenomorphus jobiensis* (McDowell, 1984; Shine and Keogh, 1996) and *S. simus* (Krey, 2009).

O'Shea (1994b) reported cannibalism in the species, in captivity. He described a small female predated by a larger female. This case of cannibalism, in a group of freshly-caught snakes destined for venom research, demonstrates a feeding behaviour that may also occur in wild populations. Small-eyed snakes are elapids, a family of snakes well documented as exhibiting ophiophagic traits (Greene, 1976; Shine, 1977; Green, 1984; Sokolov, 2003; O'Shea, 2004a; O'Shea & Williams, 2009), although cannibalism is reported less frequently (Curtis, 1952; Shine, 1977; Greene, 1984; Firmage and Shine, 1996).

The authors had the unique opportunity to study the dietary preferences of *M. ikaheka* and provide the first report on the diet of this species from the western half of the great sub-continental island of New Guinea, the largest tropical island in the world. This paper focuses on diet and cannibalism in *M. ikaheka* from Papua (Indonesian New Guinea), based primarily on preserved specimens in LZU and MZB.

Methods

We examined 17 available specimens of *Micropechis ikaheka* in the collections of Zoology Laboratory, Papua University (LZU) in Manokwari, West Papua. In addition, we also examined five specimen of *M. ikaheka*

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in the collections of Zoology Bogoriense Museum (MZB) in Cibinong, West Java. All specimens were dissected along the ventral side and their sexes were determined. We opened all of abdomens to check for prey. All prey items found were immediately removed for identification. We were not able to identify some of the prey at the species level but only to prey type. A stereoscopic microscope with opticlab was used for fish and frog identification, while reptilian and mammalian identification was based on direct observation. Skinks identifications were either confirmed or reidentified by Dr. Glenn Shea, University of Sydney, NSW, Australia. Locality data, snout-vent length (SVL) and tail length (TL) values were recorded for all snakes containing prey. The number and condition of the prey, the direction of ingestion, and the final location of prey items in the gastrointestinal tract (GI), were also recorded. We considered the stomach as the upper gastrointestinal tract (UGI) and the intestines and colon as the lower gastrointestinal tract (LGI) following the categories of Hamilton et al. (2012).

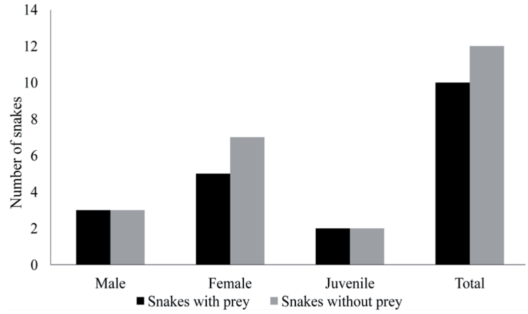

Figure 1. Identified prey items of adult male, female and juvenile *M. ikaheka.*

Result and Discussion

Of the 22 *M. ikaheka* examined, ten (45.45%) contained identifiable prey items (Table 1). Mean snout-vent length (SVL) (mean ±SD) and mean tail length (TL) of the eight adult specimens (3 ♂♂ and 5 ♀♀) containing prey were 1152.3±36.5 mm (range 1117-1190), 162.3±13.5 mm (range 148-175), and 1139.4±305.7 mm (range 740-1541), 166.8±34.3 mm (range 130-202), respectively. Identified prey items for adult male, female, and unsexed juvenile *M. ikaheka* are listed in Table 1 and numbers of snakes with prey versus without prey are presented in Fig. 1.

Based on our analysis, *M. ikaheka* appears to be a generalist vertebrate predator, predating amphibians, fish, reptiles, and mammals. Prey primarily comprises reptiles (61.5% of all prey items), followed by mammals and fish (both 15.4%), and amphibians (7.7%). We identified three reptilian families: lizards (Scincidae) being the dominant prey items (75% of all reptile prey items), with snakes (Elapidae: *M. ikaheka*

Table 1. Identifiable prey items from gastrointestinal tract (GI) of *M. ikaheka*. The number of prey items (N) is also given. For mammals, which were heavily digested, N is based on clumps of hair.

Accession	Locality	Sex	Prey Type	Prey Item	N	GI
MZB-2371	Jamursbamedi	♀	*M. ikaheka*	Body without head	1	UGI & LGI
SJR 07803	Salawati Is.	♂	*Dendrelaphis* sp.	Body without head	1	UGI & LGI
SJR 07721	Batanta Is.	♂	Scincidae	Tail	1	LGI
SJR 08048	Batanta Is.	♂	*Sphenomorphus simus* *S. muelleri*	Whole body Whole body	1 1	UGI UGI
SJR 08092	Sentani Lake	♀	Scincidae	Tail	1	LGI
LZU 29	Manokwari	♀	*S. solomonis*	Whole body	1	UGI
LZU 30	Bintuni	♀	Mammals	Hair	1	LGI
LZU 32	Manokwari	♀	Mammals	Hair	1	LGI
LZU 47	Yapen Is.	Juv.	Fish	Part of body	2	LGI
			Frogs	Bone with muscle	1	LGI
2012/BT/001	Cyclop Mts.	Juv.	Scincidae	Tail	1	LGI

and Colubridae: *Dendrelaphis* sp.) accounting for the remaining 25%. That skinks were the dominant (46.2%) prey items for *M. ikaheka* was also reported by Shine and Keogh (1996) who recorded an even higher percentage of skinks (66.7%; Table 2) in the gut contents of 42 snakes. Skinks may therefore be the most important prey type. The presence of hair permitted identifications of prey as mammals and both hindlimb and forelimb bones as frogs but it was not possible to obtain species identifications for these prey items. Similarly it was not possible to identify fish remains to species as only a few scales and bones remained (Fig. 2).

Snakes ingest their prey whole, the result being that it may take longer for them to digest the meal (Mattison, 1986). Whereas mammals chew and masticate food, to break it up and initiate the digestive processes with saliva, this facility is unavailable to snakes. Although some cytotoxic venom components may achieve similar effects when injected into prey, speeding up the digestive process, these components are not present in the venom of *M. ikaheka* which is primarily neurotoxic, myotoxin, and to a lesser degree haemolytic and procoagulent, in its composition and effects (Geh, et al 1996; Warrell, et al 1996).

Only prey located, at least in part, in the UGI could be identified to genus or species, prey from the LGI was too well digested to identify beyond prey type. Prey items were most frequently located in the LGI (61.5%) rather than the UGI (23.1%) and least frequently in both the UGI and LGI (15.4%), i.e. elongate prey items such as snakes. Intact prey items in the UGI were identified as *Sphenomorphus muelleri, S. simus* and *S. solomonis*. Only the heads of both ingested snakes, *M. ikaheka* and *Dendrelaphis* sp., were digested in the LGI tract, making identification easy, although head patterning plays an important part in differentiating between *Dendrelaphis* species so it was not possible to go beyond the generic level with that specimen. In addition, our conjecture is that due to the increased regulation of pH in the gastrointestinal tract (LGI) of snakes, most prey had been digested only a few days before the

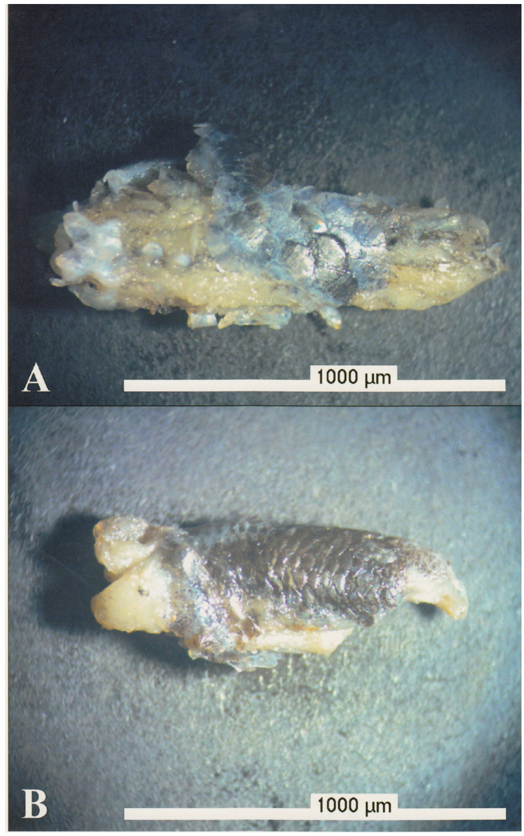

Figure 2. Prey items identified as freshwater fish, eaten by a juvenile of *M. ikaheka* from Yapen Island. Both prey (A and B) are from the LGI tract, ingested head first. Photos by Keliopas Krey using a stereoscopic microscope with opticlab (Magnification x=0.8; scale marker=1000µm).

Table 2. Comparison of prey items identified from gastrointestinal tract of *M. ikaheka* in this study and in Shine and Keogh (1966).

Prey Type	Present Study	Shine & Keogh (1996)
Frogs	1	1
Scincidae	3	4
Sphenomorphus spp.		3
S. jobiensis		2
S. simus	1	
S. muelleri	1	
S. solomonis	1	
Tiliqua sp.		1
Snakes		2
Micropechis ikaheka	1	
Dendrelaphis sp.	1	
Mammals	2	2
Fish	2	

Figure 3. A juvenile *M. ikaheka* (length from tail to upper body without head: 400 mm) from the gastrointestinal tract of an adult (see Table 1, MZB-2371). Photos by Keliopas Krey.

predators were caught. Several studies have shown that ingestion of food triggers the rapid production of gastric hydrochloric acid in snakes and lowers the gastric pH, both important factors in the mechanism of digestion (Bessler and Secor, 2012).

It is frequently reported that snakes swallow their prey head first (Loop & Bailey, 1972; Klein & Loop, 1975; Greene, 1976; Glaudas et al., 2008; Lin and Tu, 2008; Hamilton et al., 2012), because this allows for the smoother passage of prey down the throat by reducing the likelihood of snagging of the scales, limbs or fins against the inside of the mouth or throat. In our sample the direction of ingestion was head first (100%) for all reptilian, frogs and fish items, easily determined from the position of the adpressed limbs and fins. The treesnake, *Dendrelaphis* sp., (TTL, minus head: 1180 mm) was also swallowed head first and occupied a large proportion of the digestive tract of an adult *M. ikaheka* (SJR 07803), extending from the oesophagus to the LGI. We were unable to determine the direction of ingestion of mammals in the gastrointestinal tract (LGI).

Prey selection may reflect variance in capture abilities rather than active selection (Houston and Shine, 1993). It is probable that *M. ikaheka* preys primarily on skinks because of their great abundance and availability in the semi-fossorial and terrestrial microhabitats inhabited by *M. ikaheka* (Krey pers. obs.) and they may be easier to captured than any other terrestrial vertebrate (frogs, snakes, mammals).

The New Guinea small-eyed snake, *M. ikaheka,*was reported to exhibit cannibalism in captivity (O'Shea, 1994b). Our study provides the first case of cannibalism in a wild *M. ikaheka*, based on a juvenile *M. ikaheka* (Fig. 3) found in the gastrointestinal tract of an adult female. Approximately 120 mm of the body of the smaller specimen (SVL: 320 mm; TL: 59 mm) had been ingested head first (Fig. 4A,B) by a larger specimen (SVL: 630 mm; TL: 130 mm) (Krey, pers. obs.). The incident took place in the afternoon on November 2010, at Manokwari, West Papua Province (GPS coordinates: 00^{0}52.599'S; 134^{0}05.192' E).

An adult *M. ikaheka* was also found consuming an eel, (in Indonesian, *sidat*) by two MZB researchers, at Waina Creek (GPS coordinates: -5.37488333, 134.53888333), on 6th December 2013, on Warialau Island, North Aru Archipelago, Maluku Province, Indonesia. The eel was

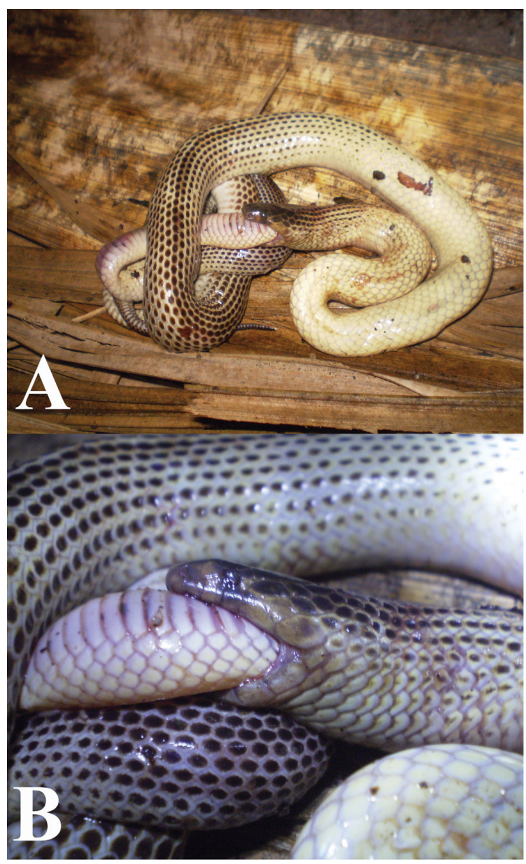

Figure 4. The cannibalism of *M. ikaheka* at Manokwari, West Papua Province. The direction of ingestion is head first (A and B). Photos by Keliopas Krey.

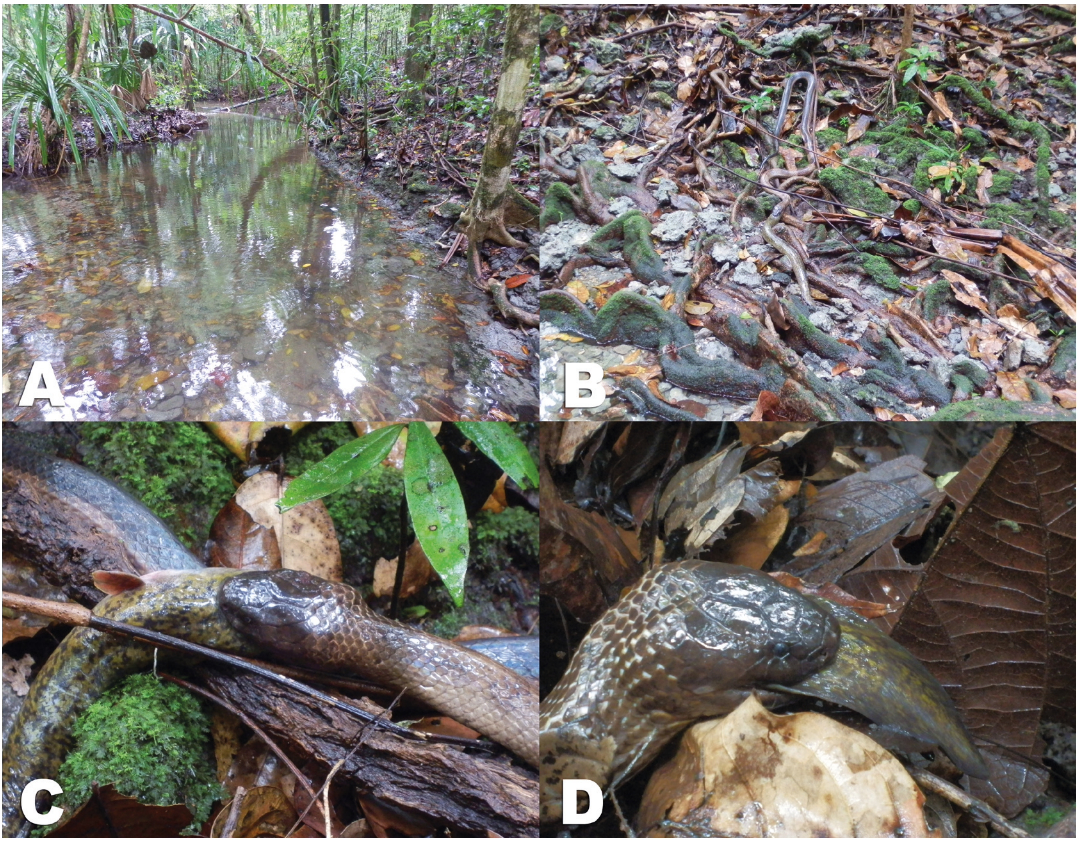

Figure 5. *M. ikaheka* found ingesting an eel, *Anguilla* sp, at Warialau Island, North Aru. Rainforest, the habitat of the eel and *M. ikaheka* (A). The eel was captured in the water and pulled out to the creek bank (B). The direction of ingestion is head first (C). Most of the eel's body has been swallowed (D). All photos by D. Wowor.

captured by the snake at 15.58 local time, and the snake was observed approximately 1.0 m from the water edge. The eel was identified as *Anguilla* sp. (Fig. 5) based on the general morphology (D.Wowor, pers. com., one of the observers). The size of both *M. ikaheka* and the *Anguilla* sp. were not recorded. However, Wowor believes the snake to be >1.0 m TTL, while the eel was approximately 1/3rd that length. Neither specimen was collected and could therefore not be included in the analyses of this study.

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