

THE SNAKES COLLECTION FROM PAPUA, INDONESIA WITH NOTES ON ANALYSIS OF STOMACH CONTENT

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ABSTRACT

A complete list of snake species found in Papua is essential for the conservation and management of these species in the future. This study provides a basic overview of the snake's specimens deposited in the Laboratorium Zoology UNIPA (LZU) at Manokwari, West Papua Province during at last 15 years. In addition, these data are compared with specimens from the Muzeum Zoologicum Bogoriense (MZB) at Cibinong, West Java. We recorded 30 species of snakes from LZU (36.1%), and 43 species from MZB (51.8%), of the 83 species reported by Allison (2007). Clearly much more collecting effort needs to be focused on Papua, as less than 50% of the known species have voucher specimens in a museum. Of the species on collection, *Morelia viridis* is the only protected species on Papua, while *Lycodon aulicus* is the only alien species. We also conducted a through investigation of prey content for each species using preserved stomach contents. We dissected a total of 93 specimens. Twenty-nine percent of the specimens contained prey items. We discovered four categories of prey items, whole body, body parts, shell, and hair. The prey items belonged to the following four classes of animals: Reptiles (56%), Amphibians (16%), Mammals (19%), and Osteichtyes (9%).

ABSTRAK

Daftar spesies ular yang ditemukan di Papua sangat penting untuk konservasi dan pengelolaan pada masa depan. Penelitian ini bertujuan untuk menyediakan informasi dasar terkini tentang koleksi ular yang tersimpan di Laboratorium Zoologi UNIPA (LZU) di Manokwari selama 15 tahun terakhir. Selain itu, seluruh data-data ini diperbandingkan dengan koleksi spesimen Muzeum Zoologicum Bogoriense (MZB) Cibinong, Jawa Barat. Seluruhnya tercatat ular sebanyak 30 spesies asal LZU (36.1%), dan 43 spesies asal MZB (51.8%), dari 83 spesies yang dilaporkan oleh Allison (2007). Upaya pengumpulan lebih banyak jelas perlu difokuskan di Papua, karena kurang dari 50% spesies yang diketahui merupakan spesimen pemberian pada museum. Dari keseluruhan koleksi ular, *Morelia viridis* satu-satunya spesies lindungan asal Papua, sedangkan satu-satunya spesies asing yaitu *Lycodon aulicus*. Kami juga melakukan penelitian melalui isi mangsa terhadap setiap spesies menggunakan isi lambung yang diawetkan. Seluruhnya item mangsa adalah hewan terdiri dari: Reptil (56%), Amfibi (16%), Mamalia (19%), dan Ikan bertulang keras (9%).

Keywords: Specimens, Prey, Muzeum, New Guinea, Papua

INTRODUCTION

New Guinea is the second large island in the world after the Greenland, and Papua is the first largest island in Indonesia, encompassing 416.129 km². Papua is the western half of the mainland island of New Guinea, while the other half in the east is Papua New Guinea which form as vast landmasses with teresterials ecosystems, as well as an array of endemic species (Beehler, 2007). The habitat mostly consists of tropical rainforest, providing ample opportunity for a

diverse set of species to flourish.

Papuan snakes are widespread across the mainland as well as small of satellite islands (Waigeo, Batanta, Misool, Biak, and Numfor). Eighty-three species of snakes have been recorded on Papua (Allison 2007), consisting of three percent of the worlds 2700 species (Taylor & O'Shea, 2004). These eighty-three species are classified into seven families, including Acrochordidae (file snakes), Boidae (boids), Colubridae (tree snakes, water snakes and ground snakes), Cyndrophiiidae (asian pipe snakes), Elapidae (front-fanged snakes), Pythonidae (pythons), and Typhlopidae (burrowing snakes). Within these families, *Cylindrophis aruensis* (Cyndrophiiidae,) is an endemic species from the Aru Islands (McDowell, 1975; O'Shea, 1996; Allison, 2007). Five of the seven families except Boidae and Cyndrophiiidae were represented in Australia whereas six families except Boidae occurred in Southeast Asia. Most families appear to have had a long history in the Indo-Australian region (Allison, 2007).

Snakes have an important role in nature, especially in the food chain. In Java, for example, snakes function as predators for controlling rat pests that often attack rice plants. Even so, humans tend not to like snakes so the role of these animals is not as big as they should be (Whitten *et al.*, 1999). However, so far there has been no information about predatory snakes in Papua. Some reports indicated that a group of elapid snakes may be the main predators of other snake species in New Guinea (Shine & Keogh 1996; O'Shea 1994a), even more than that, they are cannibals (O'Shea 1994b; Krey *et al.*, 2015). Snakes in Papua New Guinea region prey on lizards, snakes, frogs, insects, small mammals and other prey (O'Shea, 1996; O'Shea, 1994a; Krey *et al.*, 2015), but there is no data on Papuan snakes diet except *Micropechis ikaheka* predating amphibians, fish, reptiles, and mammals (Krey *et al.*, 2015).

The snake specimens at LZU provide a series of data to study their eating habits and food preferences. The study also carried out quantitative analysis of food preferences in species, and recorded the number of species that had been stored at the LZU and MZB.

Measuring biodiversity is one of the first

steps toward better conservation practices (Knight *et al.*, 2008). Here we present number of Papuan snakes at Laboratorium Zoology UNIPA (LZU) in Manokwari, West Papua, and the Museum Zoologicum Bogoriense (MZB) in Cibinong, West Java. We also present the results of examining the stomach contents of all snakes in the LZU collection.

MATERIALS AND METHOD

Specimen Collection

Field trips have been conducted regularly between the years of 2002 and 2016. Collection has been made at all habitat types present, and at elevations up to 2.500 m ASL. Snakes were captured by snake hook or hand and preserved using 10% formalin, then stored in 70% ethanol. All Papuan snake specimens were stored in the Laboratory Zoological UNIPA (LZU) in Manokwari, West Papua. In addition, data were also obtained from the collection of the Zoology Bogorienze Muzeum (MZB) in Cibinong, West Java.

Diet Analysis

We dissected a total of 93 snake's specimen of LZU collection. We opened the whole abdomen to ensure the retrieval of all prey items. We record the location of the prey item (stomach, intestine), and the number and condition of prey items. Due to process of digestion and degradation, we were not able to identify many of the prey item except to Class. Categorization and identification of prey taxa was based on Menzies (1975) for frogs, Brown (1991) for lizards, Rooij (1917) and O'Shea (1996) for snakes, Kimura and Matsuura (2003), and Allen (2000) for Osteichtyes, Menzies and Dennis (1979) for mammals.

RESULTS

The Species and Specimen Collection of Snake

Established 15 years ago for the sake of education and research, the University of Papua (UNIPA) continues to make improvements and developments in various fields (Tabel 1 and Figure 1). These data of snake diversity counts from various collecting trips within Papua beneficial to support the study of biology, ecology, evolution and natural history.

Table 1. Data collection of snakes at LZU and MZB. Note: 1- Manokwari; 2- Bintuni; 3- Raja Ampat; 4- Yapen Island; 5- Waropen; 6- Biak Numfor Island; 7- Jayapura; 8- Mimika; 9- Jayawijaya; 10- Merauke; 11- Fakfak; 12- Mamberamo; 13- Tambrau, 14- Kaimana

Famili & Species	Number of collection		The Origin of LZU Specimen														
	LZU	MZB	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>e</i>	<i>f</i>	<i>g</i>	<i>h</i>	<i>i</i>	<i>j</i>	<i>k</i>	<i>l</i>	<i>m</i>	<i>n</i>	<i>o</i>	<i>p</i>	<i>q</i>	
Acrochordidae																	
<i>Acrochordus arafurae</i>	2	2															2
Boidae																	
<i>Candoia aspera</i>	1	17								1							
<i>Candoia carinata</i>	1	13								1							
Colubridae																	
<i>Boiga irregularis</i>	10	30	8					1				1					1
<i>Cerberus rynchops</i>	0	1															
<i>Dendrelaphis calligaster</i>	6	25	3						1	1		1					
<i>Dendrelaphis punctulatus</i>	1	5										1					
<i>Dendrelaphis formosus</i>	0	2															
<i>Pseudoferania polylepis</i>	0	1															
<i>Fordonia leucobalia</i>	0	1															
<i>Lycodon aulicus</i>	1	0								1							
<i>Stegonotus cucullatus</i>	11	5	4	1	1		2	2	1								
<i>Stegonotus diehli</i>	4	4							1		2		1				
<i>Stegonotus modestus</i>	2	2						1	1								
<i>Stegonotus parvus</i>	0	7															
<i>Stegonotus</i> sp. 1	1	0										1					
<i>Stegonotus</i> sp. 2	1	0							1								
<i>Tropidonophis doriae</i>	3	2									1			1	1		
<i>Tropidonophis elongatus</i>	0	2															
<i>Tropidonophis mairii</i>	3	5	1	1									1				
<i>Tropidonophis multiscutellatus</i>	3	5		1							1	1					
<i>Tropidonophis statisticus</i>	3	1								2		1					
<i>Tropidonophis mcdowelli</i>	1	0							1								
<i>Tropidonophis picturatus</i>	1	6	1														
Elapidae																	
- Elapinae																	
<i>Acanthophis praelongus</i>	2	17							1			1					
<i>Acanthophis antarcticus</i>	1	0	1														
<i>Aspidomorphus schlegelii</i>	3	3	2						1								
<i>Aspidomorphus muelleri</i>	2	13	2														
<i>Demansia vestigiata</i>	0	6															
<i>Furina tristis</i>	2	0															
<i>Micropechis ikaheka</i>	14	17	2	2	4	1	1			1						2	1
<i>Pseudechis australis</i>	0	2															
<i>Pseudechis papuanus</i>	0	2															
<i>Toxicocalamus loriae</i>	0	1															
<i>Toxicocalamus preussi</i>	1	8							1								
<i>Toxicocalamus preussi</i>	1	8							1								
<i>Toxicocalamus stanleyanus</i>	0	2															
- Laticaudinae																	
<i>Laticauda colubrine</i>	2	4	2														
<i>Laticauda laticaudata</i>	0	1															
- Hydrophiinae																	
<i>Aipysurus laevis</i>	0	1															
<i>Pelamis platurus</i>	0	1															
Pythonidae																	
<i>Liasis papuanus</i>	1	0						1									
<i>Morelia viridis</i>	3	6	3														
<i>Bothrochilus albertisii</i>	8	6	7							1							
<i>Simalia amethystina</i>	0	6															
<i>Simalia boeleni</i>	0	1															
<i>Morelia spilota harrisoni</i>	0	2															
<i>Liasis fuscus</i>	0	1															
Typhlopidae																	
<i>Indotyphlops braminus</i>	1	2											1				
Total of species:	30	41	12	4	2	1	3	9	9	3	3	9	1	1	1	1	3
Total of specimen:	97	238	36	6	5	1	4	10	10	4	3	10	1	1	2	4	

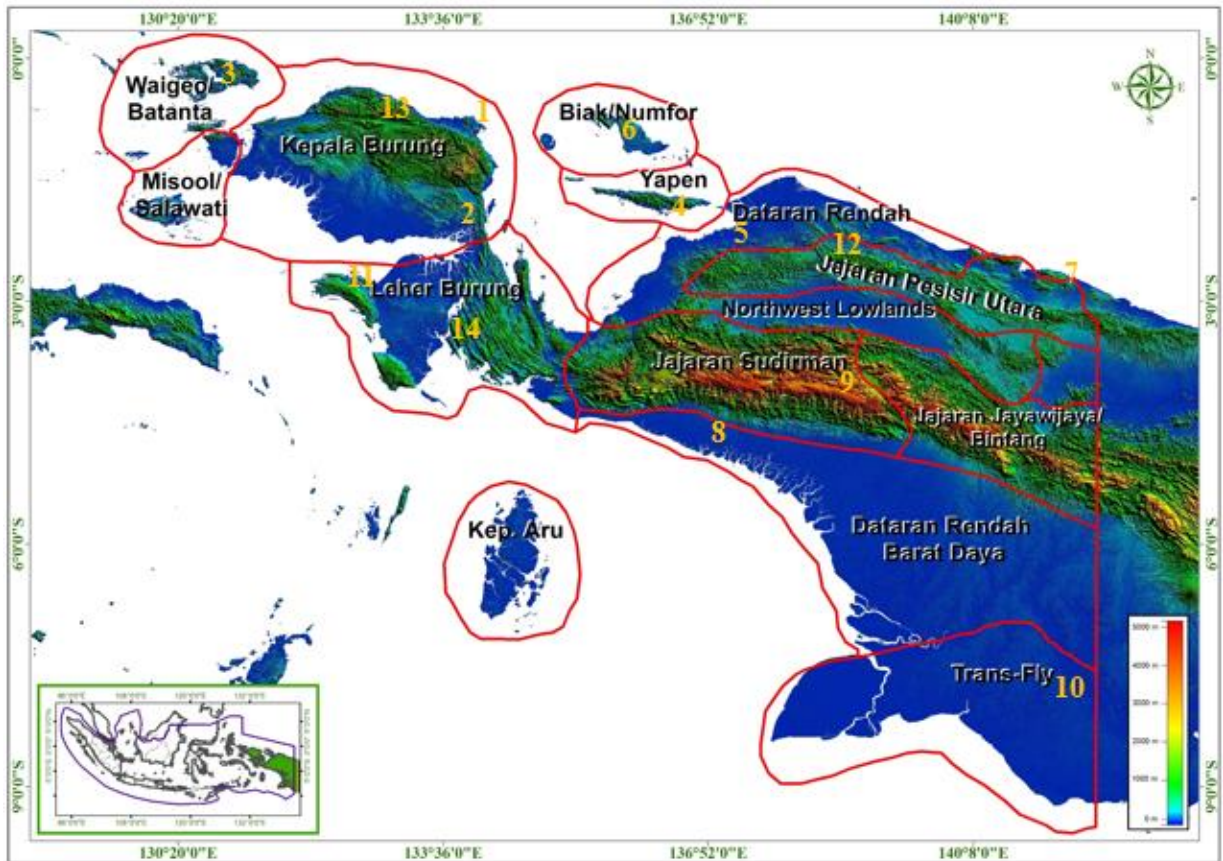


Figure 1. Zoogeographical distribution of snakes in Papua based on LZU specimens

A total of 97 specimens of snakes from Papua were stored in LZU, including 30 species from six families. Though a positive start in understanding Papuan snakes, this collection is still much smaller than that of MZB. Of the 5.451 snakes in the MZB collection, 259 are from Papua, consisting of 43 species from six families (Table 1). The LZU collection originates from a variety of places in mainland of Papua such as Manokwari, Jayapura, Merauke, Bintuni, Mimika, Jayawijaya, Waropen, Mamberamo, Fakfak, Kaimana and some satellites islands like Biak, Numfor, Waigeo, Batanta, and Yapen. Snake species in Papua that have been recorded include species of snakes that live on land, in freshwater and marine areas. Some species have even been recorded from Papua, but have not been found in Papua New Guinea (O'Shea, 1996).

Snake Diet

While a total of 93 snake specimens from LZU

were dissected, only 27 (29.03 %) specimens contained prey items (Table 2). There were at least four categories of prey items, namely whole body, body parts, shells, and hair. Our data show that there are 32 types of prey, which are grouped into four classes: Reptiles, Amphibians, Mammals, and true bony fish or Osteichthyes. Reptiles may be the most important selected prey type with total 56 % (Figure 2). It is assume that many terrestrials snakes in Papua preys primarily on scincid lizards, snakes as well as the eggs of reptiles. Reptiles, especially lizard very abundance and availability in the ground habitats inhabited by snake (Krey obs.) and they may be easier to captured than any other terrestrial vertebrate. The presence of hair or scales represented for mammals or reptiles, hard shells for reptile eggs (Figure 3), parts of the scales and limbs for lizards, and body parts for fish.

Table 2. Prey items found in the digestive tract of snake specimens in LZU. N: number of specimens

Snakes Species	N	Prey Type	Prey Item	Number
<i>Acanthophis antarcticus</i>	1	Reptilia		
		Scincidae	Part of body	4
		<i>Sphenomorphus</i> sp.	Whole body	1
		Amphibia		
<i>Acanthophis praelongus</i>	1	Microhylidae		
		<i>Xenorhina</i> sp.	Part of body	1
<i>Boiga irregularis</i>	1	Reptilia		
<i>Dendrelaphis punctulatus</i>	1	Scincidae	Part of body	1
<i>Dendrelaphis calligaster</i>	1	<i>Pogonomys</i> group	Part of body	1
<i>Furina tristis</i>	1	Scincidae	Part of body	1
<i>Laticauda colubrina</i>	2	Pisces		
		Muraenidae	Part of body	1
<i>Bothrochilus albertisii</i>	2	<i>Gymnothorax</i> sp.	Part of body	1
		Mammals		
		<i>Melomys</i> sp.	Part of body	1
<i>Morelia viridis</i>	1	<i>Pogonomys</i> group	Part of body	1
<i>Micropechis ikaheca</i>	7	Mammals	Hair	1
<i>Stegonotus cucullatus</i>	2	Reptilia		
		Sauria		
		Scincidae	Part of body	2
		<i>Sphenomorphus simus</i>	Whole body	1
		<i>S. muelleri</i>	Whole body	1
		<i>Eugongylus rufescens</i>	Part of body	1
		Serpentes		
<i>Dendrelaphis</i> sp.	Part of body	1		
<i>Stegonotus diehli</i>	1	Mammalia	Hair	2
<i>Stegonotus</i> sp.	1	Reptilia (eggs)	Shells	2
<i>Tropidonophis doriae</i>	1	Reptilia (eggs)	Shells	3
<i>Tropidonophis mairii</i>	2	Reptilia (eggs)	Shells	3
		Amphibia		
		Hylidae		
<i>Tropidonophis multiscutellatus</i>	2	<i>Litoria infrafronata</i>	Part of body	1
		Pisces		
		Clariidae		
<i>Tropidonophis mairii</i>	2	<i>Clarias bathracus</i>	Whole body	4
		Amphibia		
		Ranidae	Part of body	1
		Amphibia		
<i>Tropidonophis multiscutellatus</i>	2	Hylidae	Whole body	1
		Amphibia		
		Tadpoles	Whole body	4
Total	27			43

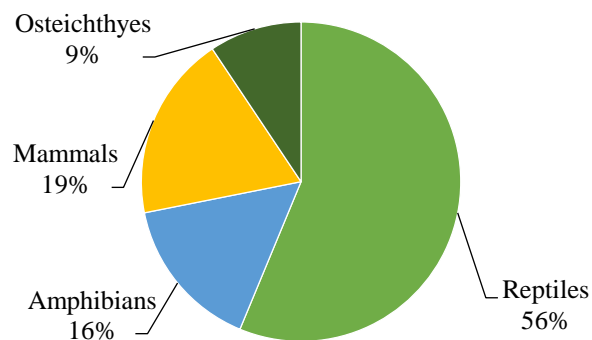


Figure 2. Percentage of four prey classes. The largest class was Reptilia

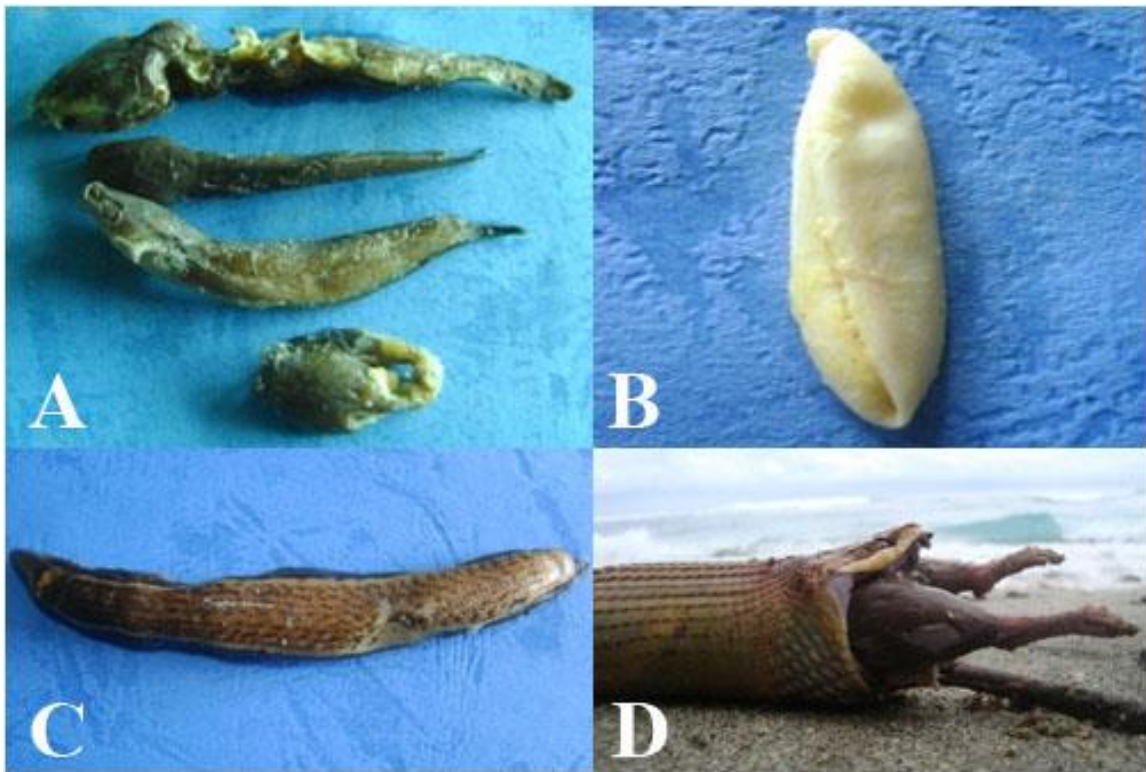


Figure 3. Some view of the prey items ingestion by snakes in Papua. A freshwater fish, *Clarias bathrachus*, eat by a *Tropidonophis mairii* from Merauke (A). The shells of reptiles eggs found in the gastrointestinal tract of *Stegonotus cuculatus* (B). Whole body of *Sphenomorphus muelleri* was found on the gastrointestinal tract of *Micropechis ikaheca* from Batanta Island (C). A *Pogonomys* group was captured and ingestion from head first by *Boiga irregularis* (D). Photo by Denisa Taran (A, B, C) and Hendrik Burwos (D).

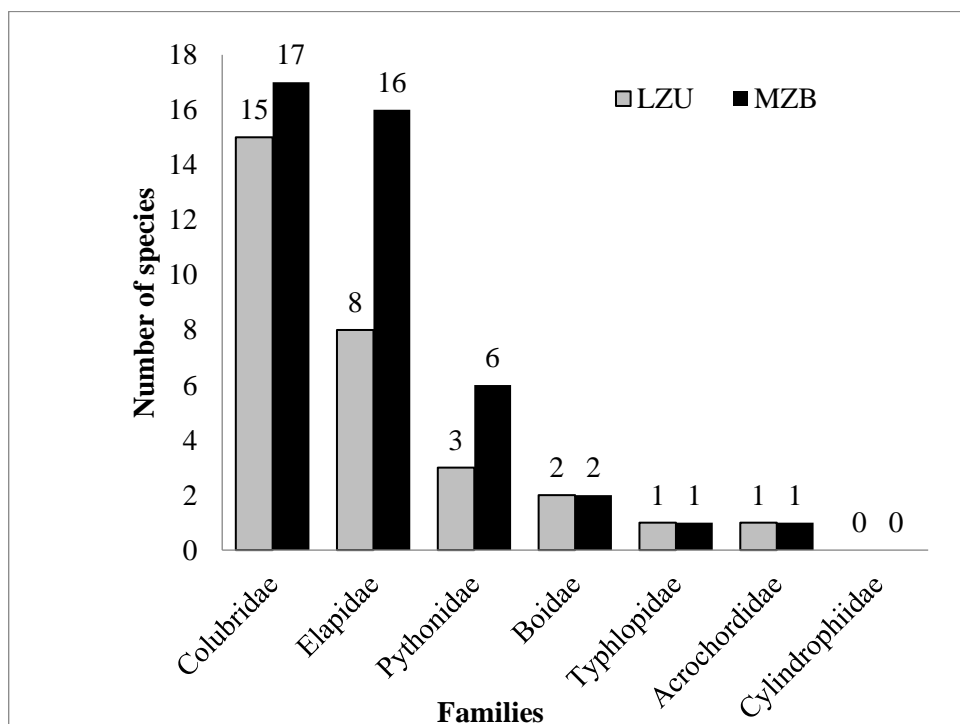


Figure 4. Numbers comparison of specimen collection of snakes at LZU (present study) and MZB (2014). Includes Cylindrophiiidae although the species of this family are not stored in LZU and MZB.

DISCUSSION

Snake Species Comparison from Papuan Biogeographic Region

The list of snake species in LZU (present study) and MZB (2014) is much shorter compared with Allison (2007), which was compiled based on the literature and specimen collections from around the world. All the collected species of snakes in LZU and MZB (Table 3) reach 35 % and 48 % of the total reported by Allison (2007). The collected specimens of Papuan snakes in LZU today will probably continue to grow in line with the increased research and collection in the future.

Table 3. Snake species comparison from Papuan biogeographic region

Taxon	LZU (Present Study)	Allison (2007)	MZB (2014)
Acrochordidae	1	2	1
Boidae	2	2	2
Colubridae	15	28	17
Cylindrophiidae	0	1	0
Elapidae	8	34	14
Pythonidae	3	6	6
Typhlopidae	1	10	1
Total of species	30	83	41
Total of genera	17	41	23
Total of families	6	7	6

There is no collection of the Cylindrophiidae, *Cylindrophis aruensis*, in the MZB and LZU until now. *C. aruensis* is known to be endemic to the Aru Islands (McDowell, 1975), mostly nocturnal and feed on invertebrates and small vertebrates (Allison, 2007). There were 17 and 15 species of colubrid in MZB and LZU collections respectively (Figure 4). Colubrids occupy a diversity of habitats which quite common even in the surrounding residential areas. They are also most often found by accident within the home or plantation, and even in the attic of the home. Colubrid is the largest group in New Guinea, with 34 species from 11 genera (Allison, 2007). This is higher than Australia which has only 10 species (O'Shea, 1996).

The only introduced species of snake collected in the LZU is a colubrid, *Lycodon aulicus* (SVL: 42.9 cm). This non-venomous snake was found in early 2005 near Sentani Airport at Jayapura by Burhan Tjaturadi, a Papuan senior herpetologist. Until now there is

no information about life history and potential threat of the *Lycodon* to native biotas in their new home, Papua. However, we suspect this species have been unintentionally transported by humans by aircraft. Two specimens of the invasive species have been collected from Sentani (Jayapura), Papua province in early 2005 (Tjaturadi *et al.*, 2007). So far at least four specimens of these colubrid have been found by accident near the residential areas around Sentani Lake (including around Sentani Airport), and Waena (Tjaturadi, personal communication). *L. aulicus* has been found to inhabit other Asian regions such as the Philippines, India, China, Burma and other Asian regions to Sumatra, Java, Sulawesi, including several other small islands in the Sunda region like Wetar, Flores, Timor and Alor (Rooij, 1917; McKay, 2006).

Snake Diets

All snakes are carnivores, unlike other reptiles that feed on nectar, fruit, and leaves (Donoghue, 2006). Moreover, *Micropechis ikaheca* has been reported as a cannibal (O'Shea, 1994b), as well as to prey on other snakes such as *Dendrelaphis* sp. All items in the diet of snakes that were found in this study were a body or body parts of animals, including reptile shell which showed that all members of this sub-order in Papua are true carnivores. Eggs were considered as the eggs of reptiles based on the severity, not broken, and the folds as well as the size (Hamilton *et al.*, 2012; Gardner & Mendelson, 2003). The finding of hair in the digestive tract of *Morelia viridis*, *Bothrochilus albertisii*, and *B. irregularis* indicate that they play a role in population regulation of rat, naturally. This is an important focus regarding the preservation of habitats and snakes, let them live freely in their habitat.

Our data (Table 2) indicated that egg shells were only a prey item of adult *Stegonotus* spp. However, they also eat small frogs, lizards, snakes, small mammals and possibly invertebrates, but primarily reptile eggs (O'Shea, 1996). The diet significant proportion of *Stegonotus cucullatus* in north Queensland, Australia, were reptile eggs (Trembath *et al.*, 2009). Snakes in general consume far fewer bird

eggs compared to reptile eggs (Queiroz & Rodriguez - Robles 2006). The data collected by Queiroz and Rodriguez-Robles showed 45 species of snakes prey on Squamata eggs and only 16 species prey on bird eggs. Scarcity of snakes that eat bird eggs may be caused by the difficulty swallowing since sometimes the eggs are too hard and large to swallow.

In the wild, *Stegonotus* is often observed in bushes, under a pile of coconut husk and among litter which also is home to other reptile groups. Although terrestrial in nature, *Stegonotus* is often spotted in the bush about 1-2 meters above ground level so they can reach bird eggs of that height range. *Stegonotus* is a group of terrestrial snakes, but sometimes it can become fosorial or arboreal species to find prey (O'Shea, 1996).

Traditional Utilization of snakes by the Papuans and Implication to Conservation

Snakes are feared by humans, and many find them uninteresting. This fact also causes these animals far away from research place. As we known, all snakes are definitely the reptiles that always evoke positive and negative responses. Snakes have been present in folklore, mythology, religious, medicine, and used also as the pet trade (Funk, 2006), which probably has contributed to or evoked negative responses to people in all over the world.

In Papua, snakes have traditionally been associated with evil and sin. Consequently, most Papuans are still afraid with all snakes or any thing appearing like a snake. Spontaneous reactions usually occur when they see a snake and



Figure 5. Python and Boa from Papua, a potential exploitation. (A) White-Lipped Python, *Bothrochilus albertisii*, (B). The only species protected species of Papuan snake under Indonesia Government Regulation No. P.20 2018, Green Tree Python, *Morelia viridis* from Foja Mt. Mamberamo basin. (C). New Guinea Ground Boa, *Candoia aspera* from Kuala Kencana, Timika, (D) Pasific Ground and Tree Boas, *Candoia carinata* from Haya, Mamberamo. Photo by Keliopas Krey.

without thinking about whether it's venomous or not, people do not hesitate to kill them. Based on the our interviews with Papuan local people, snakes are always at the top of their list of the most feared animals in Papua until now. The local community and even parents often remind each other not to enter and destroy the forest because there are "big and dangerous" snakes. It's funny but we understand this fact as a wisdom as well as benefits for forests conservation in Papua.

Although feared, there is some interesting information about the traditional utilization of snakes by the Papuans. In Papua New Guinea, snakes are used for food, fun, traditional medicine, and also for financial gain (O'Shea, 1996). Some of the indigenous people in Papua eat *B. albertisii* and *Morelia viridis*, also used the body parts of snakes for traditional medicine. For example, indiginous people from Arfak Manokwari extracted *M. ikaheca* to the oil and than use it as a liniment to treat a swelling muscle (Krey obs.). The people in a number of place in vogelkop region catch some species of snakes directly from the wild and sell to people who order for traders. Sometime they sleep in the woods to hunt some snakes such as *Bothrochilus albertisii*, *Candoia aspera*, *Candoia carinata*, and *Morelia viridis* (Figure 5).

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