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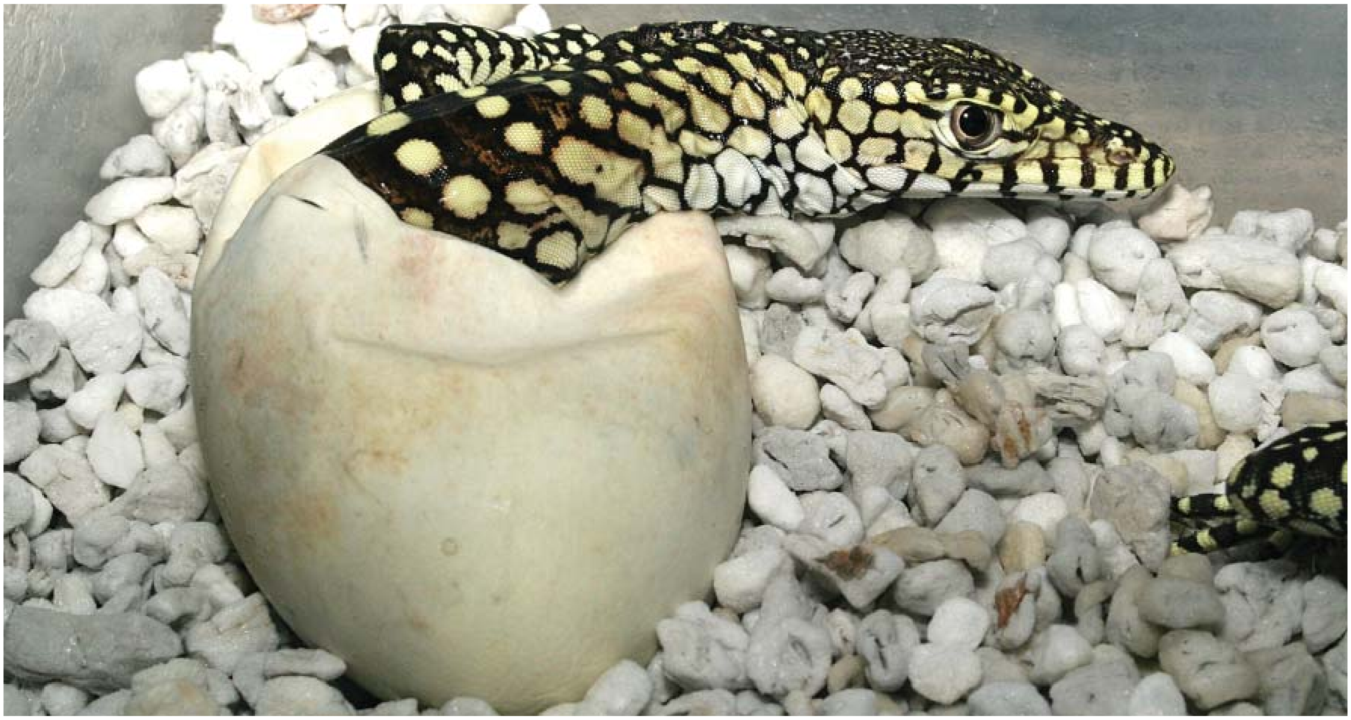
INTERNATIONAL VARANID INTEREST GROUP

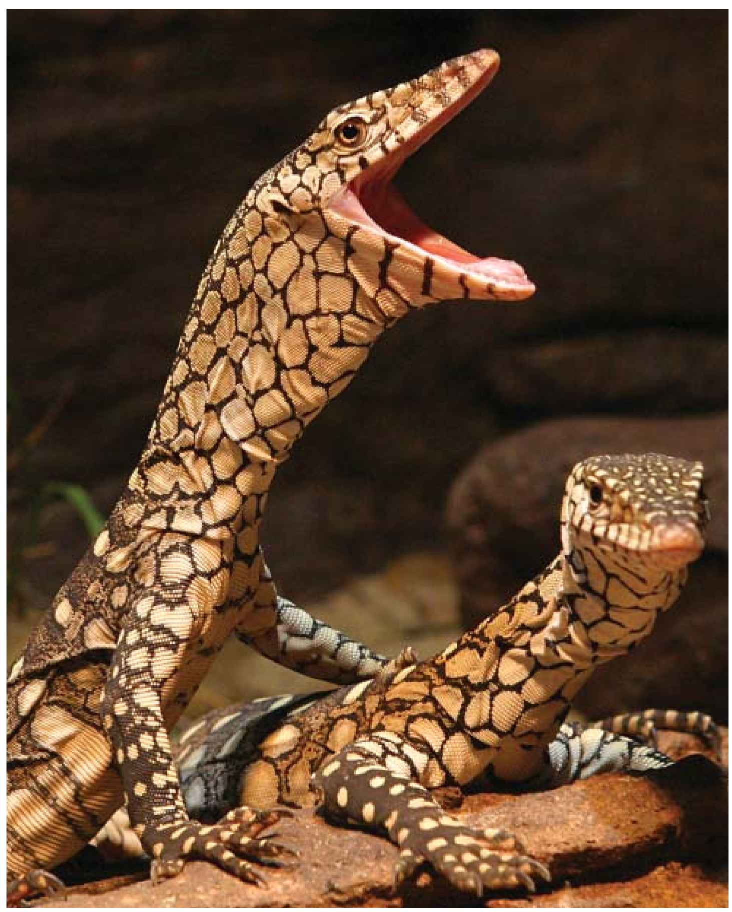
www.varanidae.org

The International Varanid Interest Group is a volunteer-based organization established to advance varanid research, conservation, and husbandry, and to promote scientific literacy among varanid enthusiasts. Membership to the IVIG is free, and open to anyone with an interest in monitor lizards and the advancement of varanid research. Membership includes subscription to *Biawak*, a quarterly journal of varanid biology and husbandry, and is available online through the IVIG website.

On the Cover: *Varanus giganteus*

The *Varanus giganteus* depicted on the cover and inset of this issue were hatched by Sydney Wildlife World in August and September 2007 after approximately 250 days of incubation. The eggs, totaling 17, were from two separate clutches laid by the same female. Most of the juveniles have been sent to numerous other zoological institutions around Australia.
Photographs by **David Kirshner**.





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Varanus salvator. Salang Village, Tioman Island, Malaysia. 2007.
Photograph by **Holland Risley** hollandrisley@yahoo.co.uk

EDITOR'S NOTE

An emerging threat to varanid herpetoculture...

Although long-contested by animal rights groups such as PETA, the keeping of reptiles and amphibians by private hobbyists has recently come under fire by many local and national governments worldwide. With an ever-surmounting body of evidence demonstrating the negative effects caused by the international reptile and amphibian trade on local and regional environments, the growing number of unwanted pet reptiles in rescue shelters, and an increase in the frequency of pet reptile-related injuries, it is inevitable that many local and national governments will seek to enact legislation to restrict or prohibit the keeping of reptiles and amphibians by the general public, if they have not done so already.

Recently, the United States Fish and Wildlife Service (USFWS) has requested information from the reptile-keeping community on the biology and herpetoculture of boids of the genera *Boa*, *Python* and *Eunectes*, for possible addition to the list of injurious wildlife governed by the Lacey Act. Much of this initiative is in response to the establishment of large constrictors in southern Florida, and their inherent threat to local ecosystems. Although it should be stressed that this is not a legislative proposal, but a review of available information on the three genera, if legislation is proposed and passed, the importation and inter-state trade of taxa placed on the list would become prohibited. As a result of this recent initiative, thousands of snake hobbyists and breeders have united to cooperate with the USFWS by providing information in hopes of preventing any future legislation from being proposed which could affect their ability to keep boids privately.

Although the current initiative focuses exclusively on three genera of boids, it would be realistic to assume that similar actions may be taken for *Varanus* as well, given a similar ecological scenario involving

Copulating *Varanus salvadorii*. Chester Zoo. October 2007.
Photograph by **Becki Scott** http://www.beckiscott.co.uk/

the establishment and dispersal of the Nile monitor (*Varanus niloticus*) in southwestern Florida. Varanid keepers should acknowledge this daunting possibility, and begin thinking about potential legislation and it's ramifications if enacted.

Private varanid hobbyists have contributed an incredible amount of information to the study of monitor lizards over the past several decades. Much has, and still can be learned about varanid biology through careful observation, data collection, and reproduction of specimens maintained in captivity. Although it is undeniable that there are many problems presently associated with the international reptile trade which require fixing, it would be unfortunate if the ability to keep and study monitor lizards by private hobbyists became jeopardized.

In an attempt to develop a unified position representing the majority of private varanid hobbyists in the event that similar "informational initiatives" or proposed legislation involving varanid lizards should arise in the future, the International Varanid Interest Group would like to hear what its members have to say about this controversial subject matter, particularly:

- Should any reptile hobbyist, regardless of age, knowledge, experience, or resources be permitted to purchase and keep monitor lizards in captivity?
- Could a permit system similar to those used in Australia to regulate the keeping of reptiles and amphibians be an appropriate alternative to prohibiting the trade of monitor lizards altogether?
- Would placing smaller importation quotas on frequently-imported and "problematic" varanid species such as *V. niloticus* help remedy the current situation involving the release of unwanted pet monitor lizards?

Please submit your thoughts, opinions and criticisms via email to odatriad@yahoo.com .

Varanus gouldii. Woody Point, Bundjalung National Park, NSW. December 2007.
Photograph by **Michael Barritt** and **Karen May** Michael.Barritt@nt.gov.au

NEWS NOTES

Ugandans turn to varanid lizard blood for AIDS cure

The White-throated monitor lizard (*Varanus albigularis*), known locally in Yumbe district, northwestern Uganda as *Lepe*, has seen much recent attention from AIDS patients in search of a cure. People living with the HIV/AIDS virus in Yumbe district have been reported to be injecting themselves with the blood of *V. albigularis*, which natives believe to be a cure for the virus. According to reports, this practice has spread to several other rural sub-counties, and more Yumbe residents are discontinuing anti-retroviral therapy to pursue this treatment.

As a result of these anectodal curative claims, *Varanus albigularis* is reported to have become an expensive item in the Ugandan black market, with reports of individuals selling for more than $175 US.

Komodo Dragon parthenogen hatches at Sedgwick County Zoo

The Sedgwick County Zoo in Wichita, Kansas recently became the first US zoo to successfully hatch out parthenogenic Komodo dragon (*Varanus komodoensis*) offspring according to a recent press release. Although previously documented in *V. komodoensis* at the London and Chester Zoos, this event represents the third reported case of parthenogenesis in varanid lizards; the other case involving *V. panoptes*.

According to the press release, one of two adult female *V. komodoensis* maintained at the zoo laid a clutch of 17 eggs between 19 and 20 May 2007. Two eggs were incubated to further document parthenogenesis in *V. komodoensis*, of which one hatched on 31 January 2008. The hatchling measured ca. 43 cm and 104 g. As of this writing, the remaining egg awaits hatching.

Varanus melinus hatch at Wildlife Conservation Society's Bronx Zoo

Quince monitors, native to the Sula Islands of Indonesia, were first described only a decade ago. Soon after they were known to science, the Department of Herpetology at the Wildlife Conservation Society's (WCS) Bronx Zoo headquarters acquired a group of these animals with the goal of starting a captive breeding program. For several years of effort by Bronx Zoo keepers, a fertile clutch of eggs was finally collected. After incubating at the World of Reptiles Nursery for the past six months seven beautiful hatchlings recently emerged. This is only the second successful breeding of Quince monitors in the United States and the first time scientists were able to collect critical breeding and incubation data for this species.

Photograph by **Julie Larsen Maher/WCS**

Curator of Herpetology Jennifer Pramuk commented on this occasion, "This is the latest in a long history of breeding accomplishments for our department and we are quite excited. We have the meticulous, collaborative work of our zookeepers to thank for this success. Because this has important relevance for international captive conservation efforts, our keepers are being encouraged to publish their protocols and breeding data. Protocols refined at the Bronx Zoo may help other institutions breed the Quince monitor and other related species.” After the animals hatched in the Department’s Nursery incubators, a thorough neonatal exam was performed on them.

Quince monitors are carnivorous throughout their lives. The hatchlings are approximately 9 inches (23 cm) in total length and as adults may achieve a total length of 47 inches (120 cm). The conservation status of this species is likely vulnerable due to habitat loss and collection for the pet trade. Some of these Quince monitors hatched at the Bronx Zoo will be sent to other accredited Association of American Zoos & Aquarium (AZA) institutions that have reptile conservation programs of their own.

-Modified from a WCS press release

Groupement d’ Etude des Varanidés (GEV)

The Groupement d’Etude des Varanidés (GEV) is a French varanid association created in November 2007 by varanid enthusiasts. The primary objective of the GEV is to create and maintain a database for the study of behavior and reproduction of varanid lizards in captivity. With this database, the GEV seeks to ameliorate the management and reproduction of varanids in captivity.

The GEV has also set up captive breeding programs intended for gathering information on the biology and husbandry of monitor lizards. Programs currently exist for several species, including *Varanus gilleni, V. timorensis, V. exanthematicus* and *V. tristis orientalis*. The GEV shall publish an annual report documenting all observations and results collected through these programs.

In addition to studying captive varanid lizards, the GEV seeks to assist in varanid conservation through monetary contributions obtained from the sale of merchandise bearing the GEV logo.

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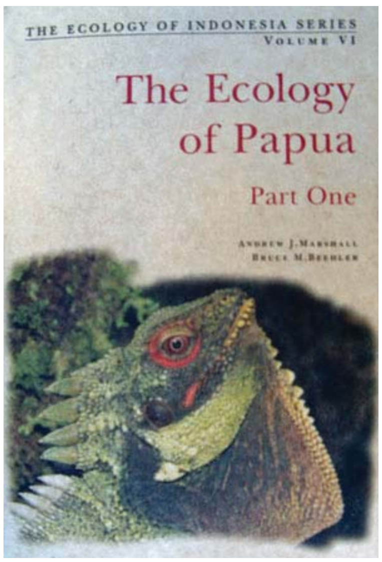
Biawak. 2008. 2(1): 8-9

The Ecology of Papua

ANDREW J. MARSHALL and BRUCE M. BEEHLER (eds.)
Periplus Editions, Singapore. 2007.
Part 1- 749 pp. Hardcover ISBN: 0-7946-0393-9
Part 2- 768 pp. Hardcover ISBN: 0-7946-0483-7

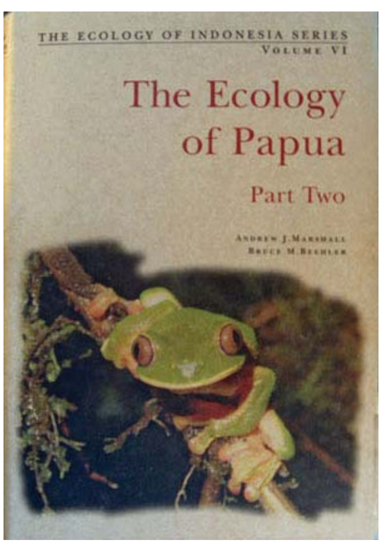


New Guinea is the largest tropical island in the world. Papua, as the western half of the island is now called (formerly Irian Jaya), is the largest (416,000 km²) region of Indonesia (three times the size of Java).

The Ecology of Papua is a two-volume work that is the culmination of a series of books entitled *The Ecology of Indonesia*. The current work totals 1517 pages in two parts (volumes), and represents contributions of 76 authors.

The first section is an introduction to Papua, including a complete history of biological exploration. We learn that the Spanish were the first European explorers to visit the region. The name 'Papua' originates from the log of Ferdinand Magellan who passed by the island in 1521 on his premier circumnavigation of the globe. In 1545 Ynigo Ortiz de Retes landed on the north coast. On seeing the native Papuans for the first time, he is purported to have said, "They look just like the Africans I saw in Guinea." And so he named this new land "Nueva Guinea" – New Guinea.

The second section treats the physical environment. In ch. 2.1 Dan Polhemus gives us a very lucid summary of the geologic history of New Guinea. Although part of the Australian continent, New Guinea has been on the leading edge of the tectonic plate as it moved north colliding with various other plates and terranes over the past 150 million years. As each of those bits of land was added to New Guinea they brought with them their own unique biota. The result is today's complex of high biodiversity and high rates of local endemism. The chapter on climate explains how Papua is one of the wettest places on earth, with some locales receiving over 7000 mm of rain annually.



The third section is a comprehensive survey of the flora of Papua, with chapters on each major plant group. The number of vascular plant species in Papua is still unknown, but estimated to be 20,000 to 25,000. There are probably 2800 species of orchids alone. The fourth section focuses on Papuan fauna. New Guinea has been famous for its birds since the days of Magellan. With 578 species, it has 6% of the world species. New Guinea is also noted for its frog diversity with 282 species and counting (5-6 new species added each year). In chapter 4.6 Allen Allison of the Bishop Museum presents a survey of the herpetofauna of Papua. 28% of the reptiles and amphibians are found nowhere else except in Papua, and 61% are endemic to New Guinea.

Chapter 4.7 is about the monitor lizards of Papua. There are 12 species of the genus *Varanus* in Papua, making it one of the most richly endowed monitor areas of the world. The eastern half of the island (Papua New Guinea) has just 8 species. Kai and Devi Philipp give a brief summary of what is known of the natural history of each of these species. Although the species are familiar to us from the pet trade, their life in nature remains virtually unknown. Throughout these volumes it is emphasized that Papua remains one of the wildest places left on earth, with much of its biota poorly known or even unknown to science.

Part Two (second volume) begins with a review of each of Papua's natural ecosystems. Nine terrestrial ecosystems are recognized, each treated by a separate chapter. The varanids inhabit chiefly the lowland evergreen rainforest. This ecosystem covers half the land surface of Papua. Its tree diversity rivals similar sized parts of the Amazon rainforest, with 1500-2000 tree species in 80 different genera. In Papua, it has been long subject to fire during the droughts brought on by El Niño events. There is evidence of these fires going back 33,000 years, about the time of the first major human settlement of New Guinea.

The remainder of part 2 is dedicated to conservation issues. Human modification of the environment began about 9000 years ago with the advent of agriculture, mostly in the intermontane valleys. The human population of Papua is still relatively small; with about 4 individuals per km^2 (Java has 800/km^2), with some areas like the Foja Mountains apparently completely uninhabited. Papua's environment is under growing threat from outside pressures to exploit its expansive forests and to develop large plantations of oil palm for biofuels. These threats are especially being felt in the lowland rainforest, the habitat of most of the island's monitor lizards. Part Two concludes with a series of appendices, which include a glossary of botanical terms and checklists of each vertebrate fauna group for Papua. Among these is a checklist of the 130 frog species, 15 turtles, 2 crocodiles, 141 lizards, and 83 snakes.

Some book reviewers concentrate on finding as many typographical errors and other minutiae as they can to criticize, probably because they lack the background to understand the material of the book itself. I noted a few typos, of course, as occur in any first edition. But they are of no real consequence.

I have two criticisms of this work. It lacks a gazetteer. What with the geographical names changing every time the political scene changed, every place or feature has more than one name. Add to that in this case, you have a work by multiple authors each choosing their favorite name, sometimes with alternatives given, sometimes not. For example, the chief mountain range of Papua seems to have been called variously the Charles Louis Mountains, the Central Range, the Merauke (or Maoke) Mountains, and the Sudirman Range. The large western peninsula is sometimes called Vogelkop and sometimes Doberai.

My second criticism is of some of the photographs. There are 72 color illustrations in part two, which are generally satisfactory. They include some representative herps, but no monitors. Most chapters are well illustrated with black-and- white photos. Many of these unfortunately appear to have been scanned into the printing process directly from color without being put through a gray-scale process. The result is varying shades of black with almost no contrast resolution.

The two volumes are aimed at a readership of students of conservation, environmental workers, and academic researchers. However, anyone with a fascination for New Guinea will find much to enjoy and enlighten them in this work.

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ARTICLES

Introductory note. – The following article is a previously unpublished manuscript by Dennis King (1942-2002). It was slated to appear together with King and Rhodes (1982, Sex ratio and breeding season of *Varanus acanthurus*, Copeia 1982:784-787), but for some reason did not. Ruth Allen King has kindly consented to publication in *Biawak*, and provided a copy of Dennis's manuscript and data sheets. I have reconstructed the lost Fig. 1 from the original data and corrected a few typographical errors, but the manuscript is otherwise unchanged.

This is the most detailed dietary analysis available for *V. acanthurus*. The specimens examined here overlap partially with those analyzed by Losos and Greene (1988, Biol. J. Linn. Soc. 35:379-407) and James, Losos and King (1992, J. Herp. 26:128-136), and are included in a summary by Dryden (2005, Varanoid Lizards of the World, pp. 298-307); thus, the data in these four contributions should be viewed as complementary, but not strictly additive.

Samuel S. Sweet

Biawak. 2008. 2(1): 11-17

The Diet and Foraging Strategy of *Varanus acanthurus*

DENNIS KING
[*deceased*]

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Bougainvillea Avenue, Forrestfield,
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Abstract - The diet of 127 *Varanus acanthurus*, as revealed by stomach contents, consisted mainly of invertebrates (principally Orthoptera, Coleoptera and Dictyoptera) and lizards. There was no apparent relationship between predator and prey size within the sample but larger individuals tended to eat more food items than did smaller ones. These findings are consistent with predictions on the diet of intensive foragers. No seasonality in feeding activity of *V. acanthurus* could be demonstrated.

Although there are numerous references to the diet and foraging strategy of varanid lizards (Pianka 1973, Pough 1973, Regal 1978) there have been few studies of their diet based on the examination of the contents of substantial numbers of stomachs (King and Green 1979). Varanids are active carnivores and intensive foragers (Pianka 1973, Regal 1978, King and Green 1979, Auffenberg 1981) which have been reported as feeding "primarily upon the eggs and young of vertebrates and the adults of smaller species" (Pianka 1973), although a number of species are known to eat large numbers of invertebrates (Pianka 1969a, 1970b, 1971, 1982, Cisse 1972, King and Green 1979, Greene 1980).

The relationship between predator and prey size in lizards has been discussed by Pianka (1969b and 1982) who stated as a generalization that small lizards or species tend to take smaller prey than larger individuals or species. Pough (1973) suggested that insect-sized prey would not be an energetically efficient diet for large carnivorous lizards; Pianka (1968a) pointed out, however, that *V. eremeus*, which forages widely, could not afford to pass by large insects because of the uncertainty of finding and capturing larger prey. Griffiths (1980) predicted that predators which use a strategy of foraging widely would feed mainly on small prey.

The stomach contents of a large sample of preserved specimens of the medium-sized Ridge-tailed Monitor (*Varanus acanthurus*) in several Australian museums were examined to establish what they eat and to determine whether or not their diet was consistent with the predator-prey size relationship discussed above.

Materials and Methods

Specimens examined are held in the reptile collections of the Northern Territory Museum, Western Australian Museum and Queensland Museum. The stomachs (n = 201) were removed and individual prey items in those containing food (n = 127) were identified to species, where possible, for vertebrates and to the level of order for invertebrates. The longest dimension of each relatively intact prey item was measured with vernier calipers and the item was ascribed to a category of "target-size" using templates based on the area it would present to a predator (Webb et al 1982). The templates used differed in shape, but each had the same surface area as others of that category. The linear dimensions of each category are double those of the previous one, and thus each target size area increases by a factor of 4 over the previous one. The surface area of Target Size 4 is 4.0 sq cm (Webb et al 1982). Snout vent length and head length of each monitor were measured with calipers, and a regression of snout-vent length on head length was calculated from specimens which were not twisted or contorted ($r^2 = 0.95$) so that head length could be used as the standard measure of lizard size (HL = 0.12241 SV + 8.20134 for males and 0.11154 SV + 8.45319 for females).

Results

The majority of the items found in the stomach contents were invertebrates (Table 1), with grasshoppers, beetles and cockroaches comprising almost 2/3 of the total number of food items (Table 1). Grasshoppers occurred in 50% of stomachs and made up 17% of food items. The largest items in the diet were lizards (agamids, gekkonids and scincids) but these occurred in only 14.5% of stomachs containing food and constituted only 7% of all food items (Table 1). All lizards eaten fell into target-sizes of TS 5 to TS 7. Other prey items were found infrequently and then only in small numbers (Table 1). Plant material occurred in 15% of the stomachs, but as it all consisted of mature leaves, it did not appear to have been selected as food, and was presumably accidentally ingested when capturing or eating prey.

Table 1. Food items in stomachs of 127 *Varanus acanthurus*.

Item	No. of stomachs	% Occurrence	Total minimum # of items	% of total items
Grasshoppers (Orthoptera)	63	50	134	44
Beetles (Coleoptera)	29	24	53	17
Unidentified Insects	25	20	27	9
Lizards (Agamidae, Scincidae,Gekkonidae)	18	14.5	23	7
Cockroaches (Dictyoptera-Blattaria)	16	13	17	6
Egg cases (Orthoptera)	8	6.5	10	3
Spiders (Arachnida)	8	6.5	9	3
Slaters (Isopoda)	4	3.2	9	3
Caterpillars (Lepidoptera)	5	4	6	2
Cicadas (Hemiptera)	3	2.4	5	2
Snails (Mollusca)	3	2.4	3	1
Stick Insects (Dictyoptera-Mantodea)	2	1.6	2	trace
Centipedes	2	1.6	2	trace
Ant lion (Myrmeleonydiae)	1	0.8	1	trace
Robber fly (Diptera)	1	0.8	1	trace
Cricket (Orthoptera)	1	0.8	1	trace
Mantispid (Neuroptera)	1	0.8	1	trace
Tick (Acarina)	1	0.8	1	trace
Bone fragment	1	0.8	1	trace
Unidentified carrion	1	0.8	1	trace
Plant material	19	15+	?	?

Table 2. Target sizes of prey eaten by different size classes of *V. acanthurus*.

	Head length (mm) 15.0-19.9		Head length (mm) 20.0-24.9		Head length (mm) 25.0-29.9		Head length (mm) 30.0 +	
Target Size	No. of Items	% of Items	No. of Items	% of Items	No. of Items	% of Items	No. of Items	% of Items
2	0	0	3	6	0	0	0	0
3	0	0	6	12	8	13	3	4
4	5	50	19	38	22	33	37	45
5	4	40	26	32	29	45	41	49
6	1	10	4	8	6	9	0	2
7	0	0	2	4	0	0	0	0
Total	10		50		65		83	

There was no significant relationship between size of *V. acanthurus* and the size of food items eaten. In lizards with HLs from 15.0 - 19.9 mm, the mean greatest dimension of prey items was 2.39 mm ± 0.49 (range 1.0 - 5.9, n = 10) and the values for other size classes were:
20.0 - 24.9 mm, X = 2.52 ± 0.36 (0.4 - 14.0, n = 50),
25.0 - 29.9 mm, X = 2.25 ± 0.19 (0.5 - 9.7, n = 65),
and >30.0 mm, X = 2.05 ± 0.12 (0.6 - 7.5, n = 83).
There was also no relationship between size class of the lizards and target-size of their prey (Table 2). The majority of items (70 - 94%) eaten by all classes were in TS 4 and TS 5 and lizards in the largest size class had eaten the fewest items in TS 6 and TS 7 (Table 2).

The relationship between lizard size and the number of reasonably intact prey items found in them is shown in Figure 1. The slope of the regression line (0.12) is significant ($p = 0.028$) despite the low regression coefficient ($r^2 = 0.062$). All lizards which contained five or more prey items had head lengths >25.0 mm.

A high percentage of stomachs collected in each month contained food items (Table 3), an indication that in most areas *V. acanthurus* probably feeds during all months of the year.

Table 3. Percentage of stomachs of *V. acanthurus* which contained food, by month of collection.

Month	No. of stomachs examined	Stomachs containing food	% stomachs containing food
JAN	10	4	40
FEB	14	9	64
MAR	9	5	55
APR	22	18	82
MAY	25	13	52
JUN	18	7	39
JUL	16	10	63
AUG	24	10	42
SEPT	17	11	65
OCT	20	16	80
NOV	3	3	100
DEC	23	17	74
Total	201*	123*	

* Contents of 4 additional stomachs, for which no month of collection was recorded, were also examined

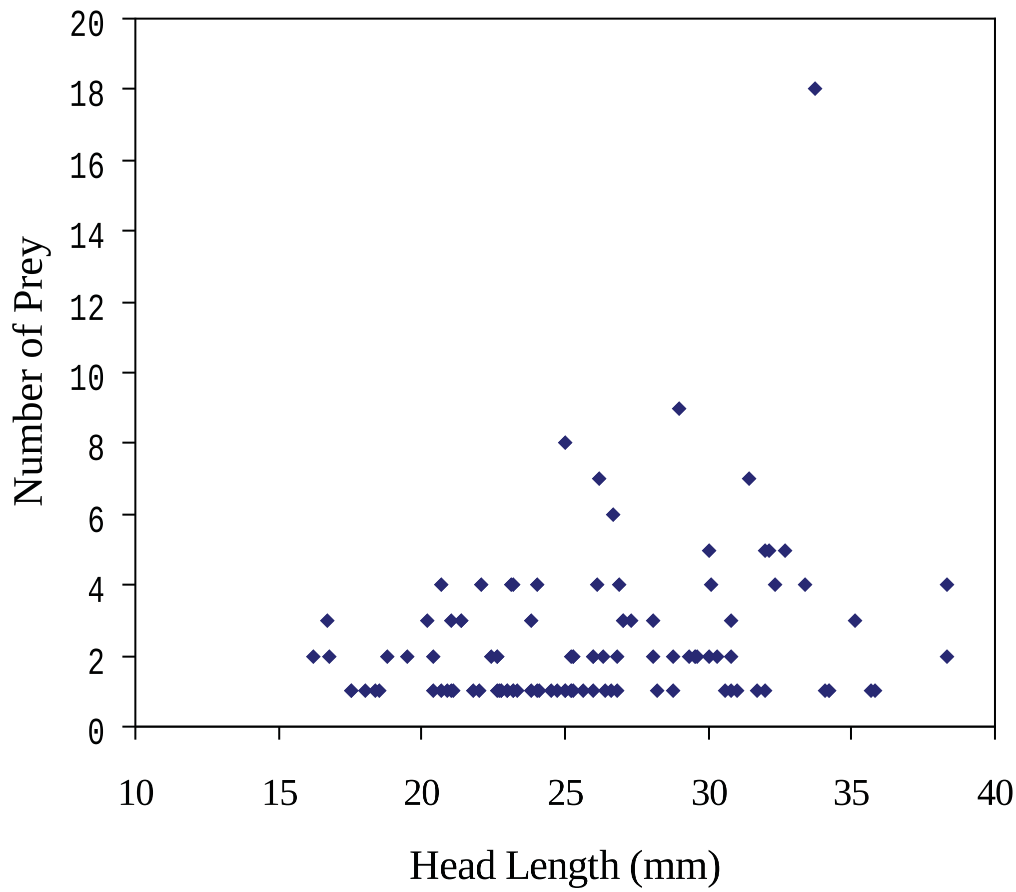

Figure 1. Relationship of head-length to number of prey items found in *V. acanthurus* [the 18 items record includes 17 beetles plus grasshopper fragments].

Discussion

The diet of *V. acanthurus* consists mainly of insects and lizards, as stated by Bustard (1970) and Cogger (1975), and is similar to that of other small and medium-sized species of Australian varanids (Pianka 1968, 1969a, 1970a, b, 1971, King and Green 1979). Varanids have morphological (Rieppel and Labhardt, 1979) and behavioural (Loop 1974) adaptations which enable them to feed on large prey, and large species such as *V. komodoensis* (Auffenberg 1981) and *V. giganteus* (King et al., unpubl. data) appear to feed mainly on large vertebrates. Nevertheless, the majority of food items eaten by *V. acanthurus* were invertebrates (Table 1) as has been reported for other small and medium-sized varanids (Pianka 1968, 1970b, 1971, Cisse 1972, Greene 1980). Despite having a low frequency of occurrence in the diet of *V. acanthurus*, lizards represented a large percentage of the total volume of food consumed.

Although a relationship between size of a predator and of its prey has been shown in other species of lizards (Pianka 1969b, Auffenberg 1978, 1981) no such relationship was apparent in *V. acanthurus* (Table 2). However, as stated by Pianka (1968), it may well be energetically inefficient for a lizard which forages widely to ignore large insects when they are encountered, given the uncertainty of finding larger vertebrate prey. Most *V. acanthurus* are smaller than the 300 g Pough (1973) gives as the upper limit at which eating insects would be efficient; however, medium-sized species of varanids which are above that upper limit do eat considerable amounts of invertebrates (Cisse 1972, King and Green 1979, Greene 1980).

Perhaps the diet of varanid lizards should be viewed in the same way as that recently suggested for crocodiles, in that while the maximum size of prey eaten increases with size of the predator, the ability to eat small prey is maintained, and the size of prey most commonly eaten may change only marginally with increased body size (Webb et al. 1982).

Varanid lizards generally forage over considerable distances (Pianka 1968, 1970a, 1971, 1982, Green and King 1978, Auffenberg 1978, 1981, Regal 1978) and aspects of their anatomy and physiology are well suited to a wide-foraging strategy. They have well-developed olfactory and visual systems (Auffenberg 1978, 1981), a high aerobic scope and capacity for rapidly repaying oxygen debt (Bennett 1972), and show evidence of remembering potential food sources (Auffenberg 1978, 1981). The major energetic cost for intensive foragers is in searching, and the consequent low handling cost predicts that they should, to a large extent, feed upon small prey (Griffiths 1980), retaining flexibility and a relative generality of diet (Pianka 1978, Regal 1978). The optimal strategy for such predators is that they should eat essentially all the palatable food they encounter (Pianka 1978). Pianka (1982, Table 6), in a comparison of 6 species of Australian varanid lizards in the arid zone, has recently shown that although prey size tends to increase with the size of the species of predators, even the largest species examined still ate substantial numbers of small prey items. In addition over half of the prey items eaten by *V. gouldii*, which was the largest species for which he provided dietary data, were less than 1.1 cc. It appears that while varanid lizards may seek large prey items, they also take small prey when they are encountered. The irregular seasonal conditions and unreliability of the availability of large prey in the arid and semi-arid regions of Australia may frequently result in several species of varanid lizards relying heavily on invertebrates as their main prey. Large invertebrates may thus form the major portion of the diet of many varanid lizards in these regions for prolonged periods.

Stomach contents of larger lizards tended to contain more food items than did those of smaller individuals (Fig. 1).

The high percentages of *V. acanthurus* stomachs containing food during each month (Table 3) indicate that there is no annual period of inactivity characterising the species throughout its range, despite the pronounced seasonality in reproductive condition (King and Rhodes, 1982).

Varanus acanthurus seems to be a species which is an opportunist feeder, which forages widely, and is active throughout the year. Its diet contains a wide range of food items and the majority of these are invertebrates.

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Varanus indicus and its Presence on the Mariana Islands: Natural Geographic Distribution vs. Introduction

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Introduction

The presence of *Varanus indicus* on the Mariana Islands has been most often regarded as a recent introduction and not a part of its natural geographic distribution. The introduction of reptile species, particularly *V. indicus* by the Germans before World War I and later by the Japanese on many Pacific islands, has been speculated and documented respectively (Uchida, 1969); however, there is evidence to suggest that its presence in the Mariana Islands, specifically on Guam, is from natural dispersal rather than a product of human introduction.

It is suggested here that introduction of *V. indicus* in Micronesia, to include the Marianas Islands and Guam, pre-dates European presence in the region (Brown, 1956; Lever, 2003) and that it was introduced by Polynesian colonists. Lever (2003), cites both Rodda & Fritts (1992b), which does not shed light on the subject, and McCoid (1993), which was speculation on what he wrote rather than what he actually stated in writing. However, strong linguistic evidence exists that *V. indicus* did exist before there was a European presence in the region; there is a Chamorro (native language of the people of the Marianas) word for monitor lizard, which is '*Hilitai*'. This suggests that *V. indicus* was either present before the Chamorros arrived or they brought it with them. The Spanish presence on Guam and the Mariana Islands dates back to 1565. New words incorporated into the vocabulary of the Chamorro people after the arrival of the Spanish came from the Spanish or later from the Tagolog language. The only Pacific location where there is a European name for a monitor is on Condore Island, off the coast of Vietnam, which is '*Iguana*' (Bayless, 2004), from what the Spanish were calling them; '*Iguana*' typically refers to any large lizard. German, Japanese and English appear to have had no influence over the Chamorro language and there is no '*Waran*' from the German or '*Dai Tokage*' or '*Ootokage*', from the Japanese in reference to monitor lizards. If *V. indicus* was introduced at all, it would have been over 400 years ago.

Consideration of Introduction by Polynesian Colonists

What reason would there have been for the Polynesian colonists to have introduced *V. indicus*? This is a question that needs to be answered if introduction by Polynesian colonists is to be fully accepted. The Japanese purportedly introduced *V. indicus* to some Pacific islands in order to control the rat population (Uchida, 1969), even though there is no direct documentation or evidence of introduction.

Why would the Polynesian colonists want or need to control a rat infestation that probably did not exist at the time? Since most rat infestations have come about through colonization and it is widely held that *Rattus exulans* was introduced by Polynesian colonists as a food source (Matisoo-Smith et al. 1999), it is unlikely that Polynesian colonists would have introduced *V. indicus* for the reason of controlling rats. *Varanus indicus* is diurnal and *Rattus* is nocturnal; therefore, they would have little interaction with each

Figure 1. Strong linguistic evidence suggests the existence of *Varanus indicus* in the Mariana Islands is either a product of natural dispersal or an introduced presence of over four centuries.
Photograph by **Joe Sablan**.

other to include a predator/prey relationship. Due to the fact that *Varanus* consume a large amount of prey with comparatively little meat to offer in return, along with the fact that they prey on other small domestic animals used for human food, such as chickens, which were commonly brought along by Polynesian colonists throughout the Pacific, and their eggs, resulting in *V. indicus* becoming a pest species, it is highly unlikely that they would have been introduced as a food source. Not only is *V. indicus* considered a pest in modern times by peoples of the Pacific Islands (Ulchida, 1969), but they would have been considered as such in the past as a competitor of limited food resources, such as crabs, which are highly prized by people of Pacific islands, birds, their eggs, fish and the rats that they may have introduced to eat. One of the only possible reasons that they may have been taken along purposely by Polynesian colonists is that they are able to survive long periods without food (Sweet pers. com.); however, there is no evidence, at least in the Mariana Islands, of Polynesian colonists consuming monitor lizards, as there exists evidence of eating birds. Although it is highly unlikely that they would have been introduced by Polynesian colonists for the aforementioned reason, it is not at all impossible and as such, can not be completely dismissed. Man continues even today, with all the knowledge we have acquired, to cause ecological disasters by introducing invasive species for all the wrong reasons, e.g. the introduction of *Bufo marinus* in Australia as a failed biological control agent.

Vogt & Williams (2004) stated that it appears that *V. indicus* were probably transported by the early Chamorros (Polynesian colonists that settled in Micronesia) in canoes either intentionally or accidentally; however, there is no supporting evidence other than the lack of fossil remains in pre-human deposits.

It is highly unlikely that the early Chamorros would not have noticed monitor lizards aboard the small canoes and if they were intentionally introduced by the Chamorros, there is again the question, why the Chamorros would have brought them along.

Consideration of Introduction by Europeans or Japanese

There is no record of the Spanish introducing *V. indicus* over the 334 years that they ruled over Guam or the over two centuries that they actually had an active presence in Guam, the Mariana Islands or any of the other islands in the surrounding area. Guam was an important resupply point and stop for Spanish ships going to the Philippines from South America and from the Philippines to South America. Spanish ships did not travel through areas where *V. indicus* was present before or after their transit through Guam, which makes introduction by the Spanish (whether intentional or inadvertent) highly unlikely, if not historically impossible. There is a record of them being seen on Tinian by Don Filipe de la Corte in the mid-1800s (de la Corte, 1875; Lever, 2003). In 1874, Giacomo Doria reported *Monitor chlorostigma*, synonym of *V. indicus* (Mertens, 1942), in Palau, also in Micronesia, to the southwest of the Mariana Islands, in the Caroline Islands. This would predate any of the other claims of them being introduced later by the Germans or Japanese (Fisher, 1948; Marshall, 1975).

At the end of the 19th century, Guam became a possession of the United States. The rest of the Mariana Islands were sold to Germany and during World War I were taken by Japan. Both Germany and Japan had purportedly brought *V. indicus* to Pacific islands and it is suggested that they may have died out and have been reintroduced (Lever, 2003). Although it is suggested that introductions were made and their presence could have been augmented, it appears highly unlikely that they had become extinct for any length of time in the Mariana Islands since the Chamorro and Micronesian words for *V. indicus* would have disappeared from the vocabulary of their respective languages over centuries or even a generation of non-use. Again,

Figure 2. *Varanus indicus* on Saipan. The population on Saipan was described as *V. tsukamotoi* by Kashida in 1929; later, this taxon was placed as a synonym of *V. indicus* by Mertens in 1942. Photograph by **Peter Bonser**.

it was reported in the mid-1800s on Tinian by de la Corte. There is also a description of a monitor lizard on Saipan (Kishida, 1929), which he described as a new species, *V. tsukamotoi*, which has been placed in synonomy with *V. indicus* (Mertens, 1942), the only monitor lizard found on Saipan. No records exist that monitors were introduced by the Japanese to Saipan.

Archeological Evidence

Archeological evidence neither supports prehistoric presence nor discounts natural presence of *V. indicus* on Guam or elsewhere in the Mariana Islands. Pregill (1988) reported archeological evidence of *V. indicus* on Rota. He states in the abstract that they were found in historic sites, but did not conclude whether they were introduced in historic times, introduced in prehistoric times, or native. He does describe them as introduced in the abstract, but they were only found at two sites, in historic layers. Pregill reports charring of avian bones found in his excavations, which shows that they were cooked and consumed, because they were charred (Pregill, 1998), but does not report charring on the bones of *V. indicus* nor have there been any bones found in cultural sites, which could be seen as more evidence that they were not introduced by the early Chamorros as a food source, since their bones would have been disposed of in cultural sites, as were the avian bones. Surely, if the Chamorros brought them to the Mariana Islands as a food source and ate them, monitor bones would have been found in cultural sites, in the same sites where bones of other animals eaten were discarded, such as the charred avian bones.

Geological Evidence

When one looks at the history and plate movements of Asia and the Pacific, one sees that the Caroline and Mariana Islands were too far separated from Asia (Hall, 2002) and far away from the Thorne-Green Line for anything except a fairly recent arrival of *V. indicus* by natural means to be possible. The Thorne-Green Line represents a major cut off point in the natural distribution of many plant and animal species between near Oceania in close proximity to Asia to the west and remote Oceania to the east. If *V. indicus* did naturally disperse to the Mariana Islands, it would have first established itself in southern Micronesia, which is part of the Caroline Plate. No monitor lizards are known to have existed east of the Throne-Green line until recent times in the earth's history.

Considerations of Natural Dispersal of Geographical Distribution

Dispersal across vast bodies of water is not unknown in *Varanus*; the *V. salvator* Complex has an extensive range across large bodies of water that were not ever part of the land bridges that existed from mainland Southeast Asia to Borneo and have radiated to such far away localities as islands of the Lesser Sundas, off the coast of Sulawesi and throughout the Philippine archipelago. Because the *V. indicus* Complex appears to have found its niche on islands/costal regions and its several species are known to have dispersed, increasing their natural geographic distribution to a great number of islands in the seas of Indonesia and the Pacific Ocean, it is logical that they could have dispersed to the Mariana Islands as well; it is much more logical than an introduction by Polynesian colonists for which no strong reasoning exists. Recently, it has also been suggested that the presence of *V. indicus* in the Mariana Islands is possibly due to dispersal based on the aforementioned reasoning (Sweet & Pianka, 2007). Physiologically, *V. indicus* is well suited for dispersal across large bodies of salt water and to distant island chains; *V. indicus* is one of only two species of *Varanus*, the other being *V. semiremex*, that possess salt-excreting nasal glands, which

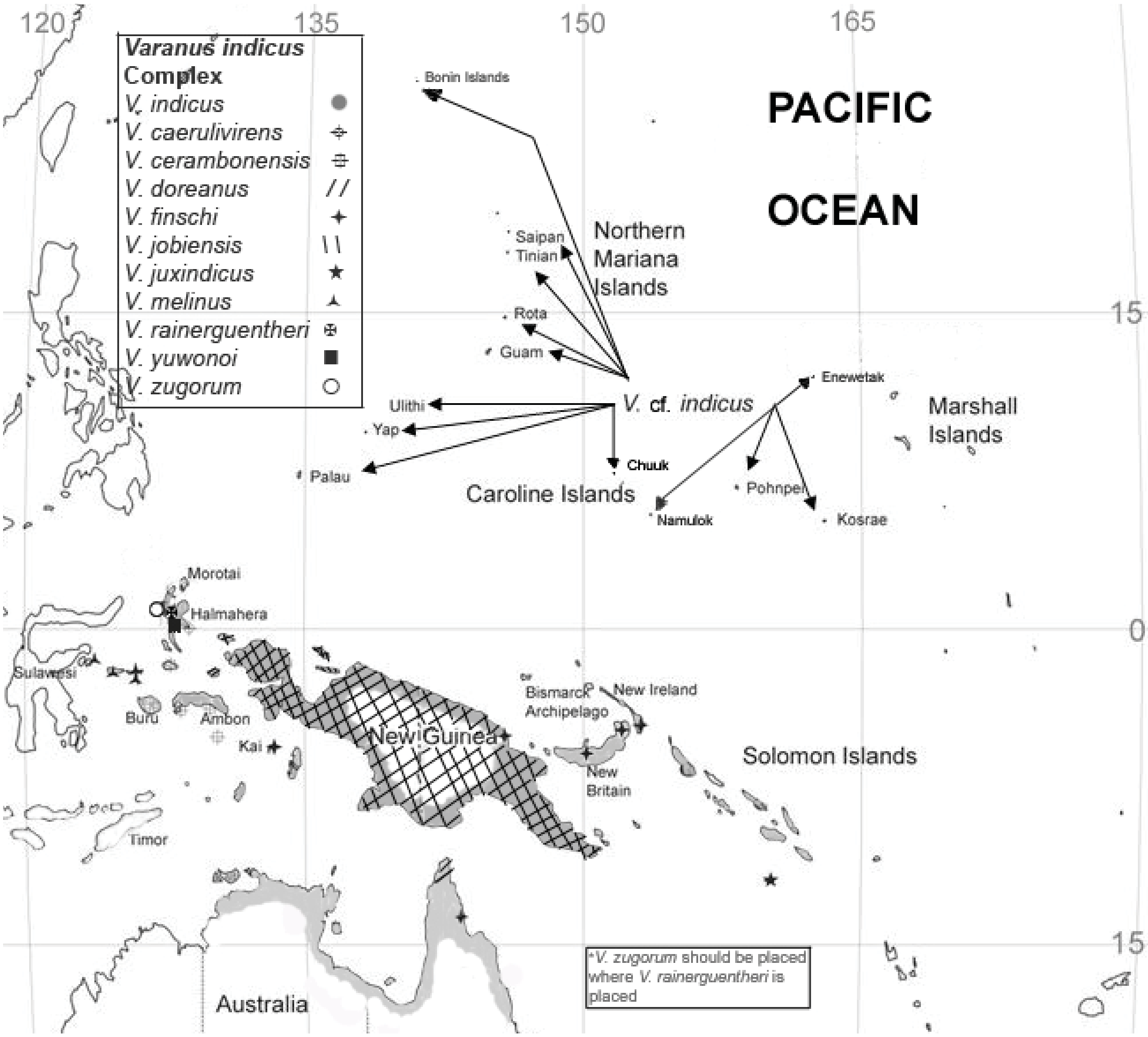

Figure 3. Distribution map of the *Varanus indicus* Complex, showing an almost continuous geographic distribution. *Varanus doreanus* and *V. jobiensis* do not occur at elevations above 1500 m. Modified from species accounts of the *V. indicus* Complex (see references) in E.R. Pianka and D.R. King , Varanoid Lizards of the World (2004), Ziegler et al. (2007), Mertens (1942), Davis (1999), Bayless (2004) & Sweet (pers. comm.)

enable them to survive in saltwater conditions and to consume marine prey (Dunson, 1974).

If one looks at the present distribution of the *V. indicus* Complex, one sees a rather continuous geographic distribution from the eastern Indonesian archipelago to the Mariana Islands, which is more of a pattern of natural dispersal of a geographical distribution rather than introduction. The Mariana Islands represent the furthest extent of its range with the exception of the Bonin Islands and therefore, most likely, among the most recent locations that it has established itself.

Since evidence is lacking that *V. indicus* was present in prehistoric times and that there is no logical reason that Polynesian colonists would have introduced this species, another possibility is that it had dispersed to the Pacific islands in historic times. In one of the few areas there is evidence that they may have been introduced, on Falalap Islet, Ifaluk Atoll in the Caroline Islands ca. 1939, they spread to and established themselves on the other islets of Ifaluk Atoll within 20 years (Uchida, 1969), showing just how rapid this species can expand their range, in this case through suspected introduction. Even in this case, introduction is suspected; there is no actual documentation of or witness to introduction. Although this atoll does not represent much distance across open water in comparison to dispersal to another island chain, one can imagine what could be accomplished in centuries or millennia.

Farrell (1991) states that *V. indicus* arrived in the Mariana Islands before any human presence; however, there is no supporting evidence present. The archeological evidence found (Pregill, 1998) does not support Farrell's claims and findings in Guam have not been published and are believed to be inconclusive. Farrell (1991) represents the only published past claim that *V. indicus* was not introduced.

Figure 4. Large adult *V. indicus* in Guam. *Varanus indicus* has salt-excreting glands which enable it to live in saltwater environments and eat marine prey, making it among the most capable *Varanus* spp. to disperse over extensive saltwater obstacles. Photograph by **Joe Sablan**.

Conclusions

All the evidence points to the presence of *V. indicus* in Guam and the Mariana Islands to be either natural dispersal or that they were introduced prior to any Western or Japanese presence. This has yet to be completely resolved in the future one way or the other through archeological evidence. If introduction is considered, the question as to why they were introduced must be answered. It is clear that they were not introduced to control rat populations, which probably did not exist before colonization or as a food source since no evidence of bones have been found in cultural sites, where other bones of consumed animals were discarded. Without archeological evidence of prehistoric presence, one must consider that natural dispersal expanding the geographical distribution could have possibly occurred during the historical period.

There were sightings of monitor lizards in the Mariana Islands and surrounding islands long before any known or suspected recent era introductions were made by the Germans or Japanese. They purportedly did make introductions, which may have established them in areas they would not have lived otherwise or possibly augmented local existing populations, but there is no documentation or evidence of introductions.

The geographical distribution of the *V. indicus* Complex is nearly continuous and dispersal, as well as allopatric speciation has occurred widely over a vast area and across large bodies of water, which has also occurred in the *V. salvator* Complex. *Varanus indicus* has not only shown the ability to rapidly extend its range, it is physiologically suited to do so by possessing salt-excreting glands giving it the ability to live in saltwater conditions for extended periods of time. Future morphological and molecular analysis of those monitors in the Caroline, Mariana and Bonin Islands may give valuable insight into whether or not they are different and may show whether or not they are naturally occurring, by showing morphological variation from distant populations and molecular similarities to adjacent populations or introduced, by showing molecular similarities to populations of origin.

Figure 5. *Varanus indicus* in Guam, Mariana Islands. Photograph by **Joe Sablan**.

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The Monitor Lizards of Camiguin Island, Northern Philippines

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Abstract - A short survey study was undertaken in February 2005 on Camiguin Island of the Babuyan group, northern Philippines to confirm earlier reports of the presence of a fruit-eating monitor lizard and a possible distinct taxon of the Asian water monitor lizard *Varanus salvator* complex on the island. After conducting brief visits to three sites and interviews with local residents, no evidence of a fruit-eating monitor lizard was found. Examination of a water monitor lizard captured by a local resident indicates that it is not distinct from *V. marmoratus*.

Introduction

Monitor lizard species that are mainly fruit-eating are known to occur only in the Philippines. They are *Varanus olivaceus* (Vulnerable – IUCN, 2007), which has been recorded in Polillo, Southern Luzon and Catanduanes, and the recently described *V. mabitang*, which occurs on Panay (Gaulke and Curio, 2001). Field studies indicate that fruits of the *Pandanus* palm are an important food item for all known populations (Auffenberg, 1988; Bennett, 2000; Gaulke and Curio, 2001). More recently, there has been photographic evidence of the occurrence of a frugivorous varanid in the Northern Sierra Madre Natural Park in northern Luzon (M. Van Weerd, pers. comm.). The true distribution of these lizards is only beginning to be understood. Their existence has been largely unnoticed because they are difficult to see or study in the wild and they are commonly mistaken for their meat-eating relatives belonging to the *V. salvator* complex.

In 2004 a team of researchers who were conducting a census of vertebrate wildlife in the Babuyan group of islands in the northern tip of the Philippines reported to have found evidence of the presence of a fruit-eating monitor lizard on Camiguin Island (Oliveros et al. 2004). The supposed evidence included: (a) the observation of clumps of *Pandanus* seeds that were believed to be fecal matter from a fruit-eating monitor lizard; (b) the clustering of *Pandanus* trees along ridges and hilltops, which on Polillo Island is hypothesized to be due to the dispersal of its seeds by *V. olivaceus* through its feces; and (c) information from local residents supporting the presence of a fruit-eating monitor lizard on Camiguin. However, no sighting of this lizard was made, nor a specimen, collected during their survey.

Another varanid lizard from Camiguin is also of particular interest because a specimen belonging to the Asian water monitor lizard *V. salvator* complex (see recent revision in Koch et al. 2007) from this island appears to represent a distinct form (R. Brown, pers. comm., cited in Anon., 2002).

In February 2005 a brief survey was conducted on Camiguin to verify the presence of a fruit-eating monitor lizard on the island and to determine the identity of the local population of water monitor lizards. The results of this study are presented in this report.

Methods

Camiguin Island (N 18° 56' E 121° 55') is a volcanic island situated 40-50 km north of Luzon (see Figure 1). It occupies an area of only 166 km^2, but it rises as high as 828m above sea level. Camiguin is characterized by steep forested hills overlain with clay, ricefields in small river floodplains and a volcanic cone (Mt Camiguin) in the south. Its population of almost 4,000 people is concentrated in three main settlement areas: Balatubat and Naguilian along the island's southwestern cove; and Minabel on the northwestern coast.

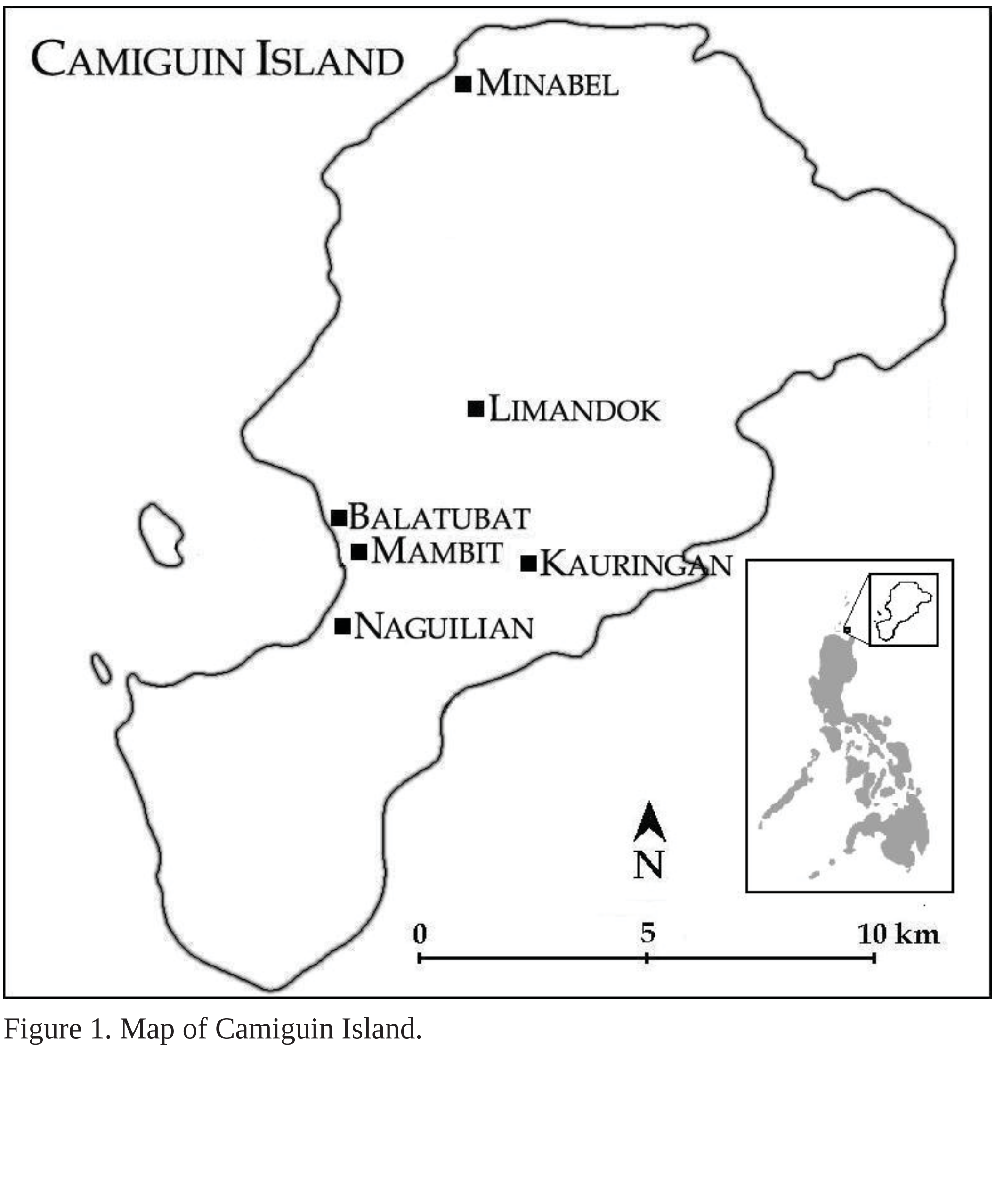

Figure 1. Map of Camiguin Island.

Interviews of local residents were conducted to determine local knowledge of monitor lizard species on the island. A total of fifteen respondents from two barangays on the island – Balatubat and Naguilian – were interviewed using standard questionnaires. Fourteen out of the fifteen respondents relied on rice farming as their main source of livelihood. Slash and burn farming (14 respondents) and fishing (10 respondents) were frequent supplemental sources of income. Four respondents were hunters.

It was presumed that if a large lizard was regularly feeding on *Pandanus* fruits distributions of *Pandanus* seedlings would be similar to those found in other places occupied by similar lizards (i.e. high concentrations of plants on ridges with clumps of seedlings uphill of any prospective parent plant). On this basis it has been possible to identify areas inhabited by *V. olivaceus* on Polillo Island. It was further presumed that other similarities in the diet of the Camiguin animal and *V. olivaceus* would make it possible to identify important food trees quickly, and that these trees could be monitored with infra-red triggered camera traps.

Reconnaissance trips were made to three sites: Limandok, Kauringan and Mambit. Limandok was visited on 20-21 February 2005; Kauringan on 22-24 February; and Mambit on 25 February 2005. During these trips, the team: (a) searched for families of trees that are known to be used by other frugivorous monitor lizards; and (b) investigated other evidence such as the presence of fecal matter, unusual clumps of fruiting trees and cracked shells of land mollusks. At Limandok, an infra-red triggered still camera trap was installed on a *panglumboyin* (local name) tree where more than 800 scratch marks that were made by a monitor lizard were observed on its trunk. The trap was open for approximately 125 hours.

At the Kauringan site, where the team found *Pandanus* trees occurring along hilltops and ridges, the distribution density of adult *Pandanus* plants was mapped following Bennett (in preparation). The distance of plants along the transect and their perpendicular distance to the transect were recorded. Trees were classed as "adult" if they bore a trunk, in which case their height from the ground and their number of crowns were also noted Furthermore, when juvenile plants formed a discreet group, they were considered to form a "clump." A clump's position was measured from its approximate geometric center and the number of juvenile plants in the clump ("clump size") was counted. Four transects on two peaks were

Figure 2. *Panglumboyin* tree where a camera trap was installed.
Photograph by Daniel Bennett.

mapped, one near the peak of Nagtapulan (671 m) and three at the peak of Mt. Mapula-pula (~ 660 m).

From results of the reconnaissance trips and interviews with local residents, previous evidence of the existence of a fruit-eating monitor lizard on the island was cast in doubt (see later text) and thus a proposed exhaustive survey of fecal material was not undertaken.

A live water monitor lizard captured by a local hunter was examined. Biometric measurements, scale counts and photos of the live animal were taken.

Results

Local knowledge of monitor lizards

Six (6) out of the 15 respondents interviewed said there are two kinds of monitor lizard on Camiguin Island. One, which they call "*banyas*," the commonly used term for water monitor lizards by Ilocano speakers, is flesh-eating and occasionally preys on their domesticated chicks. The other, which they call "*lupi*," is arboreal and fruit-eating. The nine (9) other respondents know only of the *banyas*.

Those respondents purportedly familiar with the *lupi* said it differs from the *banyas* by having a shorter snout, a shorter tail, a more bulky body, a pure brown dorsal color and a dirty white ventral color. This description is consistent among the six respondents. Furthermore, according to these people, the *lupi* feeds on fruits of trees they call *camarig*, *sidae*, *panglumboyin*, *anibong* and *aru-e* (all local names), none of which were in fruit during the study. Nobody claimed that the lizard ate *Pandanus* fruit, contradicting previous reports in 2004. When trees are not fruiting, the *lupi* feeds on grubs, they added. However, the respondents' knowledge of the *lupi*'s diet was ambivalent as none of them has either seen the animal eat fruit or seen its feces or its gut contents.

There were only two accounts of captures and one sighting of the *lupi* in the living memory of respondents interviewed. One lizard was reported to have been captured near Nagtapulan in 2003 by a hunter and three were captured on the hills adjacent to the ricefields of Taneg by another hunter in the 1970's. In the first case, the lizard was eaten but the hunter did not notice anything unusual about its taste, gut contents or intestines. In areas where *V. olivaceus* is known to occur, people hunt and eat it in preference to the water monitor lizard since it is commonly reported to have healthier, better-tasting and better-smelling meat (M. Rosaros, pers. comm.).

According to respondents monitor lizard meat is a delicacy, preferably served with alcoholic drinks, as in other parts of the country. Aside from being a delicacy monitor lizards are also hunted in Camiguin for their bile, which supposedly has the ability to cure stomachaches, body pains and convulsions in children. Lizard skin was reportedly sold a decade ago to merchants from Luzon. Local residents harbor no fondness of monitor lizards, which are considered pests and bearers of bad tidings and whose name in the local language used as a verb "*agbanyas*" means "to betray."

Five of the six respondents who claimed knowledge of the *lupi* were not born on Camiguin Island; they came to Camiguin as migrants from northern Luzon. According to these migrants, they know of the *lupi* because it also occurs in the Marag Valley in Cagayan province, Luzon, from where they originated. There have been no reports of fruit-eating monitor lizards from this area but documented evidence has been collected from as far north of Luzon as San Mariano, Isabela province, where local people call them *batitawa*. While these respondents' previous knowledge of the *lupi* from Luzon (assuming the *lupi* is frugivorous) and the secretive behavior of fruit-eating monitor lizards could explain why they are aware of this kind of animal and natives of Camiguin are not, it is also possible that this pre-conception could also have led them to mistake the common water monitor lizard, which is also known to climb trees occasionally, for a fruit-eating monitor lizard.

Site Observations

At Limandok, a tree locally referred to as *panglumboyin* near the Mamolo-molo trail was observed with more than 800 scratch marks that were certainly made by a *Varanus* lizard based on their length and position on the trunk. However, the camera trap that was installed near this tree recorded only a *Spenomorphus* skink. Inside a dead *anibong* tree (*Caryota rhumphiana*) near the Lipit trail, grubs of rhinoceros beetles (family Scarabaeidae) were found. *Pandanus* trees were observed on hilltops and ridges near this site in 2004 (C. Española, pers. comm.) but the location of these trees was not found during the two-day visit to the site. The site where an old clump of *Pandanus* seeds was found on a previous occasion was not visited. Land mollusks were abundant at Limandok and empty cracked shells were common on the forest floor.

At Kauringan, a high density of *Pandanus* trees was observed on the ridges of Mts. Nagtapulan and Mapula-pula. The *Pandanus* fruits available on Camiguin (probably a form of *P. tectorius*) are approximately 2.5 times larger than the fruit of *P. radicans* (Table 1) which commonly occurs in habitats on Polillo, Luzon, Catanduanes and Panay and supports fruit-eating lizards (Auffenberg 1988, personal observations).

Table 1. Dimension of *Pandanus* fruits

	Camiguin (n=45) *Pandanus sp.*	Polillo *Pandanus radicans*
Length	48 mm (± 6.3)	30.1 mm
Width	27.8 mm (± 2.8)	20.2 mm
Mass	16.1 g (± 5.2)	5.6 g

A typical transect from Mt. Mapula-pula yielded a mean density of 0.17 adult *Pandanus* per m^2. Detailed examination of 1,250 m^2 of hill ridges and cursory inspections throughout fieldwork did not identify any clumps of immature plants uphill of a prospective parent.

The *Pandanus* cluster collected in 2004 in Kauringan was taken from beneath an exposed root mass. A visit to the site yielded a similar cluster in exactly the same position. The position, size and condition of the seeds made it very doubtful that they represented the feces of a lizard and strongly suggested a rodent cache. Such caches have been reported for many forest rodents but have not been observed for *Rattus everetti* on Polillo,.

At Mambit, no *Pandanus* trees nor other evidence indicating the presence of a fruit-eating monitor lizard were observed.

In all three sites visited, no fecal matter suspected to come from a large monitor lizard was found. Clumps of *Caryota* palm seeds and seedlings were commonly found but they were likely to have been dispersed by civet cats (*Paradoxurus hermaphroditus*). *Caryota* fruit are important in the diet of these mammals and fresh civet cat droppings that contain palm seeds were commonly seen in the forest floor. Although the team found several trees with scratch marks, there is no evidence that they were not made by the water monitor lizard.

Appendix 1 lists tree genera that are important for *V. olivaceus* in Polillo Island. Their presence or absence on Camiguin is indicated. Other than Pinanga, very few trees were fruiting during the survey.

Varanus salvator of Camiguin

An adult female water monitor lizard (Figure 3) was captured by a resident of Brgy. Balatubat, Camiguin on 27 February 2005. The following measurements, scale counts and observations of the animal were made: Snout to vent length: 438 mm; Tail length: 718 mm; Total length: 1156 mm; Head length: 84 mm; Head height: 21 mm; Head width: 33 mm; Femur length: 7.3 mm; Tibia length: 64 mm; Girth: 195 mm. Number of supraoculars: 7; Number of mid-body scale rows: 140; Number of ventral scale rows: 87.

The nuchal scales were of equal size to the occipital scales, identifying the lizard as *V. marmoratus* rather than a member of the nominate race. The midbody and ventral scale row counts are within the established range of *V. marmoratus* (137-181 and 80-95 respectively (Mertens, 1942; Gaulke and Horn, 2004)) and no characteristic of this specimen suggest that it differs from the typical form of *V. marmoratus*.

Figure 3. *Varanus marmoratus* of Camiguin Island.
Photograph by Mark Anthony P. Reyes.

Discussion

This study found no evidence of a fruit-eating monitor lizard on Camiguin. *Pandanus* are very abundant in some habitats, but no clumps of immature plants were found uphill of possible parent trees and their dispersal on hill ridges appears to be due to rodent activity. The *Pandanus* species found on Camiguin appears to be the coastal species *P. tectorius*. It has restricted distribution in the forest and much larger fruits than those recorded in the diet of *V. olivaceus*. Known animal dispersal agents *of P. tectorius* include bats, crabs rodents and people. On Camiguin rats regularly cache *Pandanus* seeds under tangles of roots , and similar caching activity has been observed during short visits to areas bordering Sierra Madre National Park in northern Luzon, but no rat caches have ever been seen during six years investigations on Polillo Island, Camiguin remains an important area for conservation of reptiles. The little information known about its reptilian fauna already suggests that the island is a small center of endemism. The Camiguin Wolf Snake *Lycodon bibonius* is known only from the island (Ota and Ross, 1994). Recent surveys have led to the discovery of new endemic forms including a species of gecko (H. Ota and R. Crombie, unpublished data), a species of flying lizard and a species of frog (R. Brown, CO, unpublished data) that are currently being described. It would be desirable to implement a management plan to conserve the island's wildlife and natural habitats. The development and implementation of such a plan will greatly benefit from the cooperation of local government officials, government agencies, non-government organizations and members of the local community.

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Appendix 1

Genera that are known to be eaten by frugivorous monitors elsewhere are listed below with their abundance and distribution on Camiguin Island.

Pinanga species - very common, widespread. Similar to *Pinanga insignis* but with fruits that turn from green to yellow and purplish-black when ripe. All *Pinanga* seen were low (individuals over 3m high were rare). *Pinanga* is important in the diet of *V. olivaceus* on Polillo and *V. mabitang* on Panay but was not recorded by Auffenberg (1988) in Caramoan Peninsula or Catanduanes. The seeds were frequently observed in feces of civet cats (*Paradoxurus hermaphroditus*).

Caryota rhumphiana. - common, widespread. Important seasonally in the diet of *V. olivaceus* on Luzon and Polillo. Trees observed on Camiguin appeared identical to the variety on Polillo. Frequently observed in the feces of *Paradoxurus*. The hollow stumps of dead trees are often used for shelter and basking by both water monitor lizards and *V. olivaceus*. One examined on Camiguin Norte contained beetle larvae, a gecko (*Crytdactylus* sp) and a crab. No trees in fruit were observed although it was evident from *Paradoxurus* feces that fruit must have been available. A number of flowering trees were observed.

Pandanus - common, patchy distribution. Two species belonging to the genus were seen. One grows as a shrub or occasionally as a vine. The trunks are very thin and trees have multiple small crowns. The fruits of this species were not observed. The other species grows as a small tree and is discussed in the text. No trees with scratches were observed.

Canarium vrieseanum – rare. The only member of this important genus observed on the island. No trees with scratches were observed.

Grewia – absent. A tree with abundant and distinctive fruits that are of great importance in the diets of many animals for a few weeks in early summer on Luzon and Polillo. Local people did not recognize our description of it and it is probably absent from Camiguin Norte.

Gnetum – absent? Gymnosperms growing as trees or vines that are important in the diet of *V. olivaceus* on Polillo.

Figure 4. *Pandanus* fruit taken from the hilltops of Camiguin Norte.
Photograph by Daniel Bennett.

Figure 5. Fruit of the *Pinanga* palm, which is common on Camiguin Norte.
Photograph by Daniel Bennett.

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Observed Predation on a Suckermouth Catfish (*Hypostomus plecostomus*) by a Water Monitor (*Varanus salvator*) in Bellanwila-Attidiya Sanctuary

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The water monitor, *Varanus salvator* (Laurenti, 1768), known locally in Sinhala as "Kabara Goya", is the largest lizard species in Sri Lanka (De Silva, 2006). The water monitor is diurnal, and widely distributed throughout southeast Asia (Das, 2001; Deraniyagala, 1953; De Silva, 1996), where it is usually found in aquatic habitats such as swamps, ditches, streams, reservoirs, ponds, and mangroves.

The water monitor is categorized as a scavenger which mainly feeds on animal carcasses (Daniel, 2002). It also actively predates on animals such as reptiles, fishes, small mammals, birds and their eggs (Deraniyagala, 1953; De Silva, 1996). Here we report an unusual feeding habit of *V. salvator*, in which an individual was observed preying on an invasive Suckermouth catfish, *Hypostomus plecostomus* (Linnaeus, 1758). This fish was accidentally introduced to Sri Lanka and is considered a threat to native fishes as well as a nuisance to local fishermen (Gunawardena, 2001).

Observations were made on 24 October 2005 in Bellanwila-Attidiya Sanctuary (altitude: 5 m; 6^0 51` N, $79^0$ 53`E) in Colombo district of Western Province, Sri Lanka. A mature male water monitor (ca. 2 m in total length) was observed from a distance of ca. 3 m from 1448 to 1534 h. No disturbances were made while observing the monitor. The monitor emerged slowly from the nearby Katu Ela marsh with a Suckermouth catfish (ca. 50 cm in length) in its mouth (Figure. 1) which was half-dead (probably a by-catch of a local fisherman). The monitor then took nearly 46 min to swallow the fish (Figure. 2), afterwards slowly retreating back to the marsh.

The Suckermouth catfish is covered with thick armor plates and has many spiny fins which make it an unlikely prey candidate for *V. salvator*. In 2005, we observed a Spot-billed Pelican *Pelecanus philippensis* attempting to feed on a fully grown *H. plecostomus* at Bellanwila-Attidiya area. The Pelican was unable to swallow the fish because of its erected spiny fins, which injured the throat pouch of the bird. Additional observations of predation attempts on this fish by *V. salvator* (Henkanaththegedara, pers. comm.) suggest that this may represent a common occurrence, and is worthy of documentation

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Figure 1**.** *Varanus salvator* with captured *Hypostomus plecostomus* in Bellanwila-Attidiya Sanctuary.

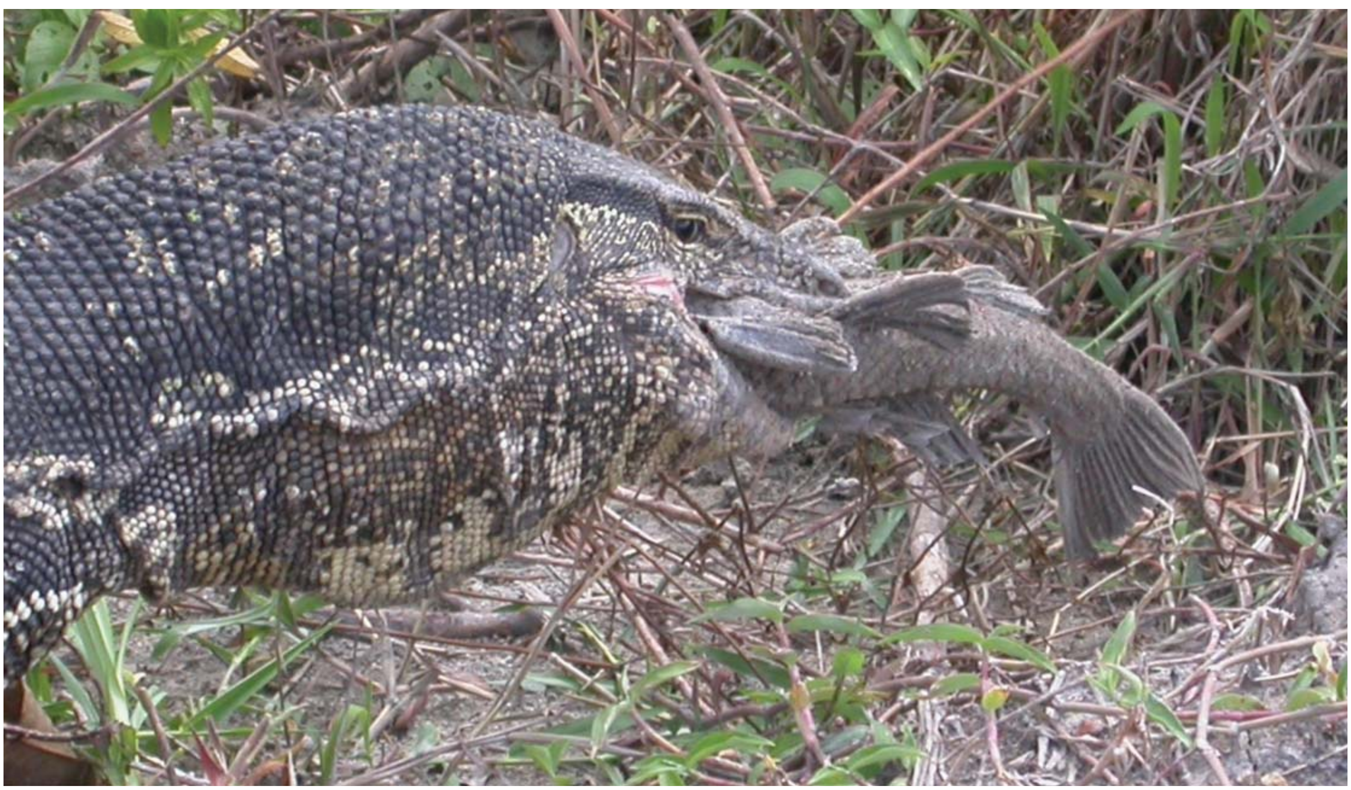

Figure 2. *V. salvator* swallowing *H. plecostomus* in Bellanwila-Attidiya Sanctuary.

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HUSBANDRY NOTES

VARANUS ACANTHURUS ACANTHURUS (Ridge-tailed Monitor). REPRODUCTION

Three unsexed, three-week old *Varanus acanthurus acanthurus* were acquired from a reptile dealer on 29 July 2006. The dealer was uncertain if the monitors originated from different breeders, therefore it is possible that the three individuals may be siblings.

On 27 April 2007, at slightly less than 10 months in age, one of the monitors was seen mounting and copulating with a smaller individual. Copulations continued intermittently for four days, with the male alternating usage of its hemipenes. The male was also observed copulating with the second cage-mate on 30 April 2007. All copulation ceased on 1 May 2007.

On 16 May 2007, the female which was first seen copulating with the male appeared noticeably thinner and had dirt encrusted on its face. Four eggs were discovered buried in the moist dirt substrate at a depth of ca. 30.5 cm and a temperature of 30 °C. Gestation was estimated to be 19-21 days from the first day of copulation.

This first clutch of eggs, set up for incubation in sealed plastic containers inside a Hovabator™ (*GQF Manufacturing*, *Georgia*, *USA*) incubator, failed on 7 August 2007. One egg ruptured on inspection from outside of the incubator (looking through the plastic window), and upon inspecting the ruptured egg, the three remaining eggs ruptured as the incubator was vented. It is assumed that the eggs were too turgid and had received insufficient gas exchange from weekly venting. Upon opening the eggs, nearly fully-developed live embryos were discovered. These eggs were left to incubate, but died shortly after.

A second clutch consisting of 6 eggs was laid by the same female on 18 June 2007, just 34 days after the first clutch. Copulation was not witnessed, but likely occurred shortly after oviposition of the first clutch. Measures were taken to provide drier conditions with a greater constant gas exchange by using polyethylene "Gladwrap" sheeting over the egg containers. The eggs were also moved to a larger-volume incubator which was vented every few days.

On 28 September 2007, one of the five remaining eggs (one failed and decayed early in incubation) dented and hatched. Another three eggs hatched on 30 September. Incubation took 102 to 104 days at an incubation temperature of 30 °C in a medium consisting of a 1:1 mixture of water to perlite by weight. It is presumed that the added gas exchange achieved by using polyethylene sheeting, and a drier incubation

Figure 1. *Varanus acanthurus acanthurus* hatching.

Figure 2. Newly-emerged hatchlings.

medium allowed for the eggs to hatch successfully. The remaining egg pipped, but failed to hatch, with the neonate perishing in the egg. .

All hatchlings were very similar in size. One individual was measured from the clutch; it measured 6.5 cm SVL and 15 cm in total length and weighed between 5 and 6 g. All hatchlings had begun to feed by four days.

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Deceased specimens of the *Varanus prasinus* Complex for morphometric analyses

Formalin-fixed and frozen specimens of adult male and female *Varanus beccarii*, *V. boehmei*, *V. bogerti*, *V. kordensis*, *V. macraei*, *V. prasinus*, and *V. reisingeri* are sought on temporary or permanent loan for use in non-destructive morphometric analyses. Specimens must have undamaged skulls and complete tails. Locality data is not needed, therefore deceased pet trade animals and those from zoological collections are preferred. Unfortunately due to CITES limitations, only specimens presently within the United States are eligible.

All shipping costs will be paid, as well as costs for any preservation materials required. If able to furnish specimens, or would like additional information, or instructions on how to preserve recently-deceased specimens, please contact:

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ERRATA

Biawak, Volume 1, No. 2, pages 96-97, “Recent Publications”. All references from Horn et al.’s (2007) Advances in Monitor Research III are incorrectly cited. The correct citations are as follows:

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INSTRUCTIONS FOR AUTHORS

General Information

Biawak is a peer-reviewed quarterly journal which publishes original articles and notes which pertain to the biology and captive husbandry of monitor lizards, as well as book reviews, historical and ethno-zoological accounts, veterinary reports, innovative techniques, bibliographies, commentaries, and digests of current varanid research. Papers are of a semi-technical to non-technical nature.

Academics, researchers, zoo personnel, students, private breeders, keepers, hobbyists and enthusiasts from all nations are encouraged to contribute. Papers which discuss biology or captive husbandry should focus exclusively on observations and results, rather than personal persuasions. Opinionated papers should instead be submitted as either commentary or letters to the editor. Assistance with manuscript preparation is available upon request.

All contributing authors must attest that manuscripts and material submitted to *Biawak* are original and have not been published or submitted elsewhere. Submission of a paper to *Biawak* implies that the authors concede to the open-access distribution of the manuscript, including all content contained therein.

Submission Categories

Full Length Articles
Full length articles are typically greater than 500 words, but have no limits on length. Photographs, line drawings, and tables are encouraged as long as they compliment the article.

> ***Full Length Natural History Articles-*** A broad range of topics which pertain to varanid biology and natural history are accepted, including, but not limited to habitat preference, behavior, reproduction, diet, predation, and activity.

> ***Full Length Captive Husbandry Articles-*** A broad range of topics which pertain to the captive husbandry of monitors lizards are accepted. Acceptable topics may include, but are not limited to captive reproduction, maintenance, behavior, diet, activity, acclimation, and incubation.

> ***Full Length Review Articles-*** Review articles may cover a variety of topics which pertain to wild or captive monitor lizards. Articles must use previously published works to support the discussion of a particular subject or topic.

Shorter Communications
Brief accounts typically report on single observations or occurrences. They may be as brief as a single paragraph, as long as they accurately and descriptively describe the nature of the observation. When observing behaviors, human interference should be avoided or kept to a minimum.

> ***Natural History Notes-*** A broad range of topics which pertain to wild monitor lizards are accepted. Examples may include, but are not limited to behavior, reproduction, diet, predation, and aggression. Details such as date, time of day, location, habitat type, sex, and size of the animal/s observed are important and should be noted when possible.

Geographic Distribution Notes- Reports which document the geographical occurrence of *Varanus* species are accepted. Accounts need not be range extensions, but must report precise locality data, and when possible, latitudinal and longitudinal coordinates should be given. Notes should include the date, time of day, a description of the habitat, and a description of the animal/s behavior at the time of observation.

Captive Husbandry Notes- A broad range of topics which pertain to the captive husbandry of monitor lizards are accepted. Examples may include, but are not limited to behavior, diet, reproduction, and aggression. A brief description of the husbandry and conditions offered may be necessary to accurately describe the nature of the observation.

Additional Topics

Book Reviews- Reviews of *Varanus*-related books are accepted. Reviews should critique and evaluate the book on many different aspects, including scientific merit, organization, and presentation.

Historical Accounts- Articles which report on the history of *Varanus* maintained in zoological institutions, or the contributions to varanid biology or husbandry made by single individuals are accepted. Additional historical subjects may also be accepted.

Ethno-Zoological Accounts- Articles which report on culural traditions, practices, or beliefs which involve varanid lizards are accepted. Additional topics such as listings of indigenous names for varanid lizards are also accepted.

Veterinary Reports- A broad range of topics pertaining to varanid veterinary medicine and surgery are accepted. Topics may include, but are not limited to diagnoses, treatments, preventative medicine, innovative veterinary techniques, and necropsies.

Techniques- Articles which describe new and innovative techniques in the fields of captive husbandry and field research are accepted. Articles should elaborate on the reason for development of the technique, a detailed description of the technique, and a discussion of the results received from utilizing the new technique. Diagrams and photographs which compliment the text are encouraged.

Bibliographies- Compiled varanid bibliographies are accepted. Due to the volume of varanid literature, bibliographies must be limited to a particular topic (e.g. Reproduction), species complex (e.g. *Varanus indicus* complex), or species in their scope of coverage.

Translations- Numerous research papers and popular articles written on varanid lizards have been published in languages other than English. Translations of non-English articles are accepted and encouraged, and need not be the original author of the work.

Commentaries/Letters to the Editor- Opinionated letters from readers are accepted. Letters may be formal or informal, and may discuss any topic, issue, or controversy pertaining to the study of wild or captive monitor lizards. Letters may be heavily opinionated, and are thus not to be presented as fact.

Current Research/Recent Publications- Researchers are encouraged to submit abstracs of current research or recently published works. Recent publications may include books, journal articles, magazine articles, and newsletter/bulletin articles.

Requests for Research Assistance- Varanid researchers are encouraged to place requests for research assistance. Requests may include, but are not limited to funding, graduate students, volunteers, research technicians, specimens, tissue samples, literature, and travel/lodging accommodations.

Style and Format

All submissions are to be in English, using U.S. spelling and grammar conventions. If English is not the primary language, assistance in preparing the manuscript is available. Manuscripts are accepted electronically (Microsoft Word [.doc] or Rich Text Format [.rtf] files) as email attachments. If contributors are unable to submit manuscripts electronically, hard copies may be submitted instead. The entire manuscript should be double spaced, including literature cited. Abstracts are welcomed for full-length articles over 500 words.

Figures

- Photographs, images, diagrams, tables and line drawings are encouraged, and accepted as .jpg or .gif files. Physical copies are also accepted if electronic submission is not possible.
- Standard photographic submissions should not be less than 1600 x 1200 pixels (2 megapixels), and submissions for cover photos should exceed 2500 x 3200 pixels (8.5 megapixels).
- Tables are to be submitted as editable Excel files, not as pictures
- Each table should be submitted on a separate page, not within the text, and be double spaced throughout

Units of Measurement *All measurements should follow the International System of Units (SI)

- Time: 0900 h and 24 h; 15 min; 45 s
- Temperature: 28 °C
- Length/Distance: 2.2 cm; 3 m; 18 km
- Mass: 3.2 g; 5.1 kg

Format

- Articles and notes should be written in the third person narrative when possible. e.g.,

“Four adult males were captured...”

Instead of:

“I captured four adult males...”

- A period should be followed by a single space
- Do not boldface any portion of the text
- Use italics for Latin names, addresses on title page, and product manufacturers. Do not italicize any other words.
- Do not use professional titles for individuals mentioned in the text or acknowledgements, e.g., Dr., Prof., Mr., Mrs., etc.
- Products mentioned within the text should also cite the manufacturer and their location within parentheses. e.g.,

  "..... A Pro-Mist ® misting system *(Pro Products: Mahopac, New York, USA)* was used to achieve adequate humidity levels and..."

Citation of Literature

- Ensure that spelling, dates, and sources are correct.
- In the text, references are cited with surnames.
  - Reference with one author: (Pianka, 1969)
  - Reference with two authors: (Wicker and Eidenmüller, 1995)
  - Reference with multiple authors: (Enge et al., 2004)
- Organize references chronologically within a series, separated by a semi-colon. e.g., (Pianka, 1969; Bayless, 2002; Ibrahim, 2002)
- Literature Cited is to be arranged alphabetically.
- Examples of proper literature citation formats:

For an article appearing in a journal, magazine, or other serial publication:

Gaulke, M., V.A. Altenbach, A. Demegillo and U. Struck. 2005. On the distribution and biology of *Varanus mabitang*. Silliman Journal. 46: 89-117.

For a book:

Auffenberg, W. 1988. Gray's Monitor Lizard. University Presses of Florida. Gainesville, Florida.

For a chapter within a book:

Sweet, S.S. 2004. *Varanus glauerti*. In E.R. Pianka and D.R. King, Varanoid Lizards of the World, pp. 366-372. Indiana University Press, Bloomington, Indiana.

For an article found on a website:

Böhme, W. 2003. Checklist Of The Living Monitor Lizards Of The World (Family Varanidae): http///www.cites.org/common/cop/12/ESF12i-06A.pdf. Checklist of CITES Species Compiled by UNEP-WCMC, Convention on International Trade in Endangered Species of Wild Fauna and Flora (Last accessed 31.01.06).

For further information regarding proper citation of references, and acceptable reference material, please consult the editor.

Full-Length Articles

Full-length articles published in *Biawak* report on varanid biology or captive husbandry, and should include a title, the author's name, the author's address and/or email address, the text, acknowledgements, literature cited, and appendices (if applicable).

- ***Title-*** this should briefly summarize the scope of the article. The title should be centered at the top of the page s. e.g.,

Notes on the Biology of *Varanus*

- ***Author's Name and Address-*** The author's name should be centered below the title and should include all capital letters. The author's address is centered beneath the author's name and should be italicized. The email address is centered beneath the address. e.g.,

AUTHOR'S NAME
Author's address
Author's email address

- ***Text-*** Full-length manuscripts should include subheadings, and may include: introduction, materials and methods, results, and discussion.

- ***Acknowledgements-*** Individuals which assisted in the study or preparation of the manuscript are acknowledged here. e.g.,

"The author would like to thank ___ for their assistance in the field; ___ for providing access to specimens and ___ for review of this manuscript..."

- ***Literature Cited-*** All references mentioned in the text must be listed in the Literature Cited.

- ***Appendices-*** All charts, tables, and graphs are placed in the appendices after the Literature Cited.

Shorter Communications

For brief accounts, important details to note may include location, date, time of day, habitat type, sex, size and age of the animal(s) observed, and a description of the behavior or occurrence observed. For captive husbandry notes, important details to note may include the origin of the animal(s), duration in captivity, date, time of day, sex, size and age of the animal(s) observed, and a description of the behavior or occurrence observed. Brief natural notes should include a title, text, literature cited, the author's name and the author's address and/or email address.

- ***Title-*** The title in this section should include the scientific name (in capitalized italics), common name (in parentheses), and a keyword or phrase which best describes the location or nature of the account (all capital letters). e.g., *VARANUS VARIUS* (Lace Monitor). CAPTIVE NESTING BEHAVIOR

- ***Text-*** No subheadings are required for shorter accounts. Content should report on specific observations and findings.

- ***Literature Cited-*** All references mentioned in the text must be listed in the Literature Cited.

- ***Author's Name and Address-*** The author's name (capitalized letters) should be centered below the Literature Cited. The author's address is centered beneath the author's name and should be italicized. The email address is centered beneath the address.

Book Reviews

Submissions should include the title of the book, the author's name, the author's address, the date of publication, number of pages, publisher, city of publication, the text, the reviewer's name and the reviewer's address. e.g.,

Varanoid Lizards of the World
Eric R. Pianka and Dennis R. King (eds.)
Indiana University Press. Bloomington, Indiana. 2005
Hardcover. 588 pp.
ISBN: 0-25334366-6

Text of review

Reviewed by: REVIEWER'S NAME
Reviewer's address
Reviewer's email address

Additional Information

For additional information regarding format, content, submissions, or authoring guidelines, please consult back issues of *Biawak* for reference, or contact the editor.