

Iguana Times

THE NEWSLETTER OF THE INTERNATIONAL IGUANA SOCIETY, INC.
\$6.00

VOLUME 3, NUMBER 3
OCTOBER 1994



Adult male, Ricord's Iguana, *Cyclura ricordi*.
Photograph: Jeff Wines

ADAPTATIONS TO HERBIVORY IN IGUANINE LIZARDS

JOHN B. IVERSON
DEPARTMENT OF BIOLOGY
EARLHAM COLLEGE
RICHMOND, INDIANA

Introduction

Totally herbivorous lizards are found in three disjunct regions: (1) the New World tropics northward into the Mojave Desert of the SW United States (all the Iguaninae but two species), (2) the Near and Middle East from North Africa to Southwest Asia (spiny tailed agamids *Uromastyx*); and (3) the tropical Far East in the Fiji Islands (the banded iguanas *Brachylophus*), the Philippines and Indonesia (water lizards *Hydrosaurus*), and the Solomon Islands (giant skinks *Corucia*). They are found on islands as well as continents, in predator-filled to nearly predator-free environments, in xeric (most), mesic, and hydric habitats, and they include both oviparous and viviparous (only *Corucia*) forms.

These lizards are generally considered to be unspecialized in comparison to more obviously specialized lizard groups such as the Teiidae, Chamaeleonidae, Varanidae, Anguinae, and Helodermatidae. However, I believe that these herbivorous lizards, in particular the iguanines, are much more specialized than is generally realized.

Perhaps the most unique characteristic of the lizards of the sub-family Iguaninae is their success at herbivorousness. Unfortunately, complete, reliable data on diet and feeding habits for most of the iguanines are not available; most of the published information is only anecdotal, and, in some cases (see below), clearly misleading. Intrigued by my observations that the ground iguana, *Cyclura carinata*, is almost totally herbivorous from hatching through adulthood (a weight range of 15 to 1900 g), I began examining lizard herbivory in terms of diet, feeding habits, feeding strategies, and adaptational correlates (both morphological and physiological). By looking simultaneously at all of these aspects of her-

bivory, I hoped to better understand the mechanisms involved in its evolution in lizards.

Diet

One of the problems inherent to discussions of herbivory lies with the definition of "herbivorous." Many workers have called lizards herbivorous based only on a few records of plant food in their diets. In reality each species probably lies somewhere along a carnivory-omnivory-herbivory continuum, and may even fluctuate along that continuum depending on such factors as season, size or resource availability. For purposes of this discussion I consider as "truly herbivorous" (i.e., on the far right of the continuum) only those species whose diets include essentially only vegetation (whether fruits, flowers, seeds or foliage) throughout the year.

Many species generally called "herbivorous" are probably facultative herbivores at best, and more likely, simple omnivores. Based on the literature and my own dissections of several hundred lizard species, such forms as *Anolis equestris*, *Basiliscus spp.*, *Agama spp.*, *Physignathus leseuri*, *Angolosaurus skoogi*, *Gerrhosaurus spp.*, *Egernia spp.*, *Phymaturus spp.*, *Tiliqua spp.*, *Macroscincus coctei*, and *Trachydosaurus rugosus*, although often termed herbivorous in the literature, are clearly not true herbivores. In fact, by my definition, the only totally herbivorous extant lizards are the iguanines ± 30 species; but see below) among the Iguanidae; the genera *Uromastyx* and *Hydrosaurus* among the Agamidae (ca 17 species); and *Corucia zebrata* in the Scincidae.

I also found no basis for earlier speculations that the iguanines *Amblyrhynchus cristatus*, *Cyclura nubila*, *Iguana*, and *Dipsosaurus dorsalis*,

and the agamid *Uromastix hardwicki* exhibit an ontogenetic shift from carnivory to herbivory. Most of these suggestions were based: (1) on diet information from captive lizards, or (2) on anecdotal field observations. In fact, of all the true herbivores I have dissected, only the iguanine *Ctenosaura similis* showed any indication of an omnivorous juvenile diet. Further field study will be necessary to establish quantitatively the extent of this omnivory by size and season. I thus conclude that an ontogenetic shift from carnivory to herbivory is not usual in lizards truly herbivorous as adults, and further, that the documentation of such a transition (as appears to be the case for *C. similis*) will at best be the very rare exception rather than the rule.

Surprisingly few data are available on the specific diets of most herbivorous lizards. Most of the attention has been directed to species in the American southwest, the desert iguana (*Dipsosaurus dorsalis*) and the chuckwalla (*Sauromalus obesus*), with some consideration given to the Neotropical *Iguana*. Although some authorities provide significant lists of plant foods (21 plant species for *Dipsosaurus dorsalis*; 22 species for *Sauromalus obesus*), most references refer to but a few of the plant species eaten, and rarely categorize them by plant part. Thus the true diversity of diet in these lizards is generally unappreciated. For example, it has recently been shown that *Cyclura carinata* includes at least 58 plant species in its diet; *Cyclura cornuta stejnegeri*, at least 71 species; *Sauromalus varius*, about 60 genera; and *Uromastix acanthinurus*, at least 45 species. These high diversities imply that foraging strategies in these lizards are probably much more complex than generally realized.

Feeding Ecology

Other than Auffenberg's work, studies of the ecological aspects of feeding in herbivorous lizards have received little attention. However, it is known that herbivorous lizards spend the majority of their activity cycle resting, not feeding or foraging as do most carnivorous lizards or mammalian herbivores. It apparently takes very little time to fill the digestive tract, especially in relation to normal total food passage time (96+

hours). Moberly estimated that *Iguana* spends 90% of its time resting, and Beverly Dugan (personal communication) estimated that the same species spent 96% of the day inactive and only 1% feeding. Auffenberg has calculated that *Cyclura carinata* spends only 18% of its daily activity period on a typical summer day actually involved in feeding and/or foraging behavior; and others have commented on the reduced time spent feeding by *Dipsosaurus dorsalis*, *Sauromalus obesus* and *Uromastix acanthinurus*, respectively. Several herbivorous lizard species also inhabit regions temperate enough to necessitate the suspension of activity for the winter months: *Dipsosaurus dorsalis*, *Sauromalus obesus*, and *Uromastix acanthinurus*. Yet although no feces may be produced and the rest of the gastrointestinal tract may be empty, the proximal colon apparently always contains digesta.

Another neglected aspect of the feeding ecology of herbivorous lizards concerns food limitation. Despite the apparent abundance of plant food, availability of food resources may be the primary limiting factor for populations of many iguanine lizard species. For example, in Colombia, Mueller has shown that green iguanas inhabiting strongly seasonal habitats are smaller than those in less seasonal habitats. Similarly, Case has shown that chuckwallas, *Sauromalus obesus*, grow faster and larger in habitats with more diverse and more abundant food resources. Nagy and Case have even documented cessation of reproduction in adult *Sauromalus* in harsh years. *Cyclura carinata* unquestionably grew faster and increased its fecundity in captivity with unlimited food. *Dipsosaurus dorsalis* likewise grew faster with unlimited food in captivity than it did in the field. Insufficient food resources (in quantity and/or quality or availability and/or useability) appear to impose restraints on growth and fecundity in these lizards.

Rand has suggested that food may be limiting to *Iguana iguana* in highly seasonal tropical habitats only during part of the year. During the winter, food resources for *Cyclura carinata* are not only restricted to items more difficult to digest (primarily leaves) and of lower caloric content

than at other times of the year, but environmental temperatures may also physiologically limit the effectiveness (efficiency?) of the lizard's use of those resources which are available. Further, even during times of maximum primary productivity, i.e., times when high quality foods (e.g., fruits) are most abundant, lizards can only eat and assimilate as much as their digestive machinery can process. Because of their low relative metabolic rates and daily fluctuations in body temperatures, this machinery may well limit energy intake even at maximum efficiency. Thus food limitation in individual iguanine lizards (but not populations) may operate via resource useability (or processability) in addition to simple availability. Again we lack the critical ecological and physiological studies to test this hypothesis.

Digestive Physiology

Other physiological aspects of lizard herbivory have received some attention. For example, digestive efficiencies of carnivorous lizards are known to vary typically from 70 to 90% and to exceed significantly those of herbivorous lizards, which normally range from 30 to 70%. But Throckmorton and Hansen, and Sylber, have reported efficiencies high in the carnivore range for the herbivores *Ctenosaura pectinata* fed sweet potato tubers and *Sauromalus varius* fed dandelion flowers, shredded carrot roots and "chick starter." However, those two species, like most herbivorous lizards, probably don't have such easily digestible foods available in nature for most of the year. For example, during at least parts of the year, the herbivorous iguanines *Dipsosaurus dorsalis*, *Cyclura carinata*, and *Iguana iguana* each primarily rely on leaves which are fibrous and presumably difficult to digest. Ingested leaves often pass through the entire gastrointestinal tract of *Cyclura carinata* and *Cyclura cornuta* nearly intact. We badly need data on the relationship of digestive efficiencies to variables such as diet (and age and colon anatomy).

Freeland and Janzen have suggested that the detoxification of plant secondary compounds by herbivores may be metabolically very expensive. Thus herbivorous lizards must either avoid toxic vegetation or expend energy detoxifying plant

compounds. It is therefore not surprising that *Dipsosaurus dorsalis* apparently eats only the flowers of the creosote bush, *Larrea divaricata*, leaving the fruits and leaves. It is noteworthy that *Cyclura cornuta* and *C. carinata* both feed commonly on the fruits and leaves of the manchineel, *Hippomane mancinella*, and the fruits of the poisonwood tree, *Metopium toxiferum*, species which contain strong alkaloids. Specific feeding strategies of herbivorous lizards have not been studied well enough to shed light on the relative importance of plants such as these to lizard nutrition and energetics, but evidence indicates that secondary plant compounds may be among the most important factors determining food preferences in herbivores.

Many aspects of the diet, feeding behavior, and digestive physiology of herbivorous lizards obviously remain to be investigated. The information is especially critical to our understanding of the functional and evolutionary significance of their morphological specializations. Because they number so few among extant lizard species and because their numbers are so rapidly declining it is important that attention be focused on them without delay.

Trophic Adaptations

All true herbivorous lizards, regardless of family, are specialized in that they all share one significant morphological adaptation (and a suite of associated physiological and ecological ones) found in no other living lizards: all have a distinctly enlarged, partitioned colon. All iguanine lizards but *Amblyrhynchus cristatus* possess from one (*Dipsosaurus dorsalis*; Figure 1) to eleven (some *Cyclura cornuta*) transverse valves in the proximal colon (Table 1). Valves are of two kinds, circular (sometimes with sphincter) or semilunar, (Figures 1 and 2) and circular valves (if present) always occur proximally to semilunar valves. Intraspecific variation in the number and type of valves is small, but greater in species with higher modal numbers of valves. There is no significant ontogenetic change in the number or the kind of valves.

The colon of *Amblyrhynchus cristatus* differs from that of other iguanines only in the height of

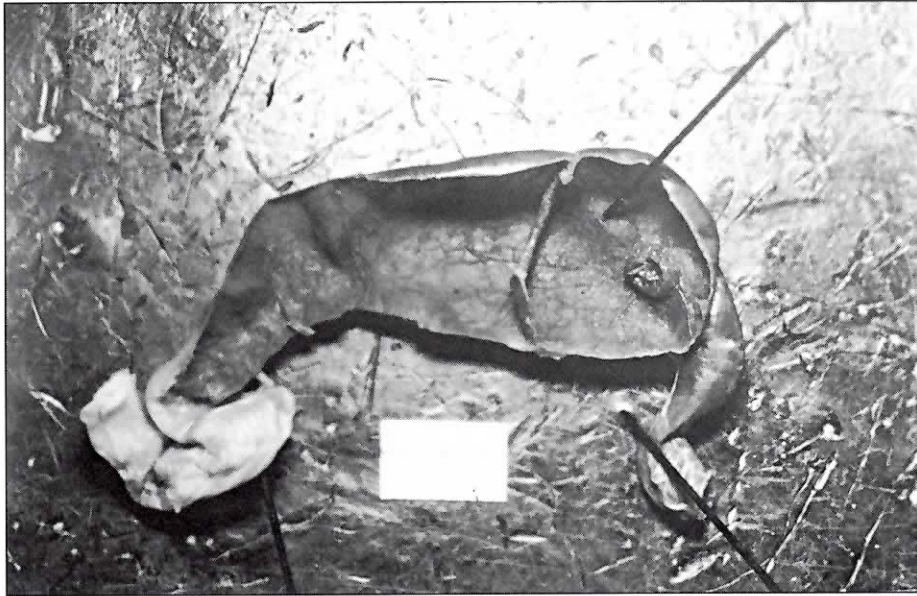


Figure 1.
Ventral view of frontal section through the colon of *Dipsosaurus dorsalis* (UF 40726). Note ileocecal valve and singular circular valve. Anterior to right.

Table 1. Modal Number of Colic Valves in Iguanine Lizards with Sample Sizes Greater than Five

Species	% of Total Sample with Modal Condition	Modal Number CV's	Modal Number SLV's	Species Range
<i>Dipsosaurus dorsalis</i>	100	1	0	SW US/NW Mexico
<i>Ctenosaura clarki</i>	88	1 (0-2)	1 (1-2)	Southern Mexico
<i>Ctenosaura quinquecarinatas</i>	100	1	2	SE Mexico to Nicaragua
<i>Ctenosaura palearis</i>	86	1	2 (1-2)	Guatemala
<i>Ctenosaura similis</i>	95	1 (2-4)	2 or 3	Mexico to Panama
<i>Ctenosaura acanthura</i> and <i>C. pectinata</i>	100	1	3	Mexico
<i>Brachylophus fasciatus</i>	100	0	4	Fiji Islands
<i>Cyclura carinata</i>	93	1	4 (4-5)	Turks & Caicos Islands
<i>Iguana iguana</i>	48	1	6 (3-6)	Mexico to South America West Indies
<i>Cyclura cyclura figginsi</i>	43	4 (2-6)	3 (2-6)	Bahamas
<i>Cyclura cornuta</i>	38	3 (3-4)	6 (5-7)	Hispaniola

Ranges appear in parentheses below modes.

CV = circular valves

SLV = semilunar valves

the valves; the infolded tissue layers involved in them are the same. The valves in all iguanines are formed by the infolding of the mucous membrane, the submucosa, and at least the circular (internal) muscular component of the muscularis externa. The serosa is not involved in the valvular structure. The valves may have evolved as simple infoldings (or creases) along with the medial colic all due to the increased bulk of digesta commensurate with an increasingly herbivorous diet and limited abdominal space. I visualize this process as functionally similar to crease formation when rigid tubing is bent.

The variation in colon valve morphology in the iguanines seems to be of little value in phylogenetic comparisons. For example, modal number of valves varies within the genus *Cyclura* from 5 to 9. In addition, as mentioned above, the colon of *Amblyrhynchus* (with only folds, not complete valves) differs internally from all other iguanines, including *Conolophus* (with 1 circular and 4 semilunar valves) to which it is supposedly most closely related. However, because the number, type and size of valves is so constant within a given iguanine species, colon structure is an important taxonomic adjunct. Colons of unknown species can nearly always be allocated at least to genus, based solely on morphology of that organ. In fact, this level of constancy suggests the existence of an undescribed

iguanine taxon in the West Indies. The colon of *Iguana iguana* from the northern Lesser Antilles differs radically from that of the remainder of the species' range. Four total valves were present in each of three individuals from Montserrat and St. Croix, whereas all other specimens examined by me bore five, six (modal), or seven valves. No other iguanine species exhibits such extensive geographic variation. In light of Lazell's comments on the slightly different pattern and scalation characteristics in the same northern Antilles population, a systematic reappraisal seems warranted.

Perhaps the most intriguing thing about iguanine colic variation is the significant linear relationship between number of valves and mean body size for interspecific comparisons (Figure 3). The larger the species, the more complex is the colon (i.e., the more colic compartments present).

Although not as complexly modified, the colon of *Uromastyx* and *Hydrosaurus* is also partitioned: *Uromastyx* proximally and *Hydrosaurus* distally. In being partitioned, the colon of *Corucia* differs radically from all other skinks I have examined (Figure 4), including species of the closely related genera *Egernia* and *Tiliqua*. Thus a partitioned colon has apparently evolved independently at least three times (once in each of the three families) in the Lacertilia. At least in regard to their gastrointestinal tract anatomy, these



Figure 2.

Ventral view of frontal section through the proximal colon of *Cyclura cornuta* (UF 33554). Note four circular valves (CV's) and seven semilunar valves (SLV's). Anterior to right.

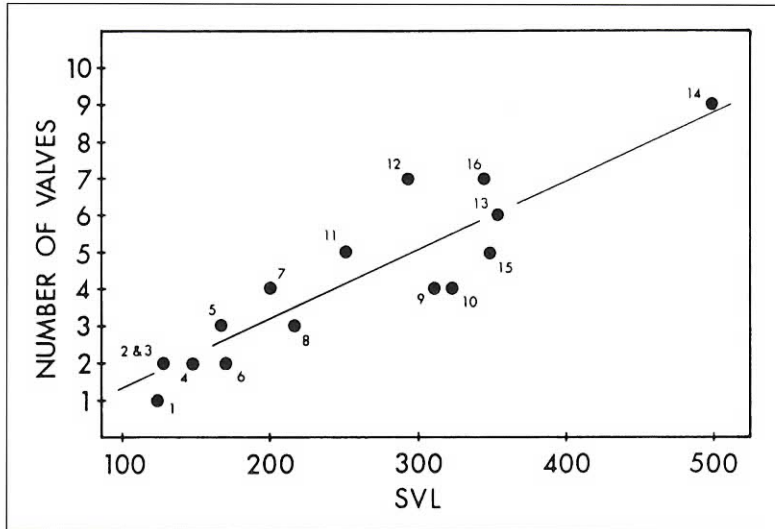


Figure 3. Relationship between modal number of colic valves and body size (mm snout-vent length) for the following iguanine species: *Dipsosaurus dorsalis* (1), *Ctenosaura defensor* (2), *C. quinquecarinatas* (3), *C. clarki* (4), *C. palearis* (5), *Sauromalus obesus* (6), *Brachylophus fasciatus* (7), *Ctenosaura hemilopha* (8), *C. similis* (9), *C. acanthura* (=pectinata) (10), *Cyclura carinata* (11), *C. cyclura* (12), *C. ricordi* (13), *C. cornuta* (14), *Conolophus subcristatus* (15), and *Iguana iguana* (16).

lizards can hardly be considered unspecialized.

Though I have established that all truly herbivorous lizards possess a partitioned colon, I am still uncertain about its functional significance. The partitioned colon surely slows the passage of digesta through the gut, and relative absorptive surface area (for water and nutrients) is certainly increased. But the presence of tremendously dense nematode faunas (and presumably bacterial and protozoan populations) in the normal cecum of all these herbivorous lizards suggests that they provide important microhabitats for colic (cellulytic?) symbionts. For example, McBee and McBee have documented an excess

of 10^{10} bacterial cells or clumps per gram of colic material, and I estimated the population of nematodes in the colon of a single healthy adult *Cyclura carinata* to be in excess of 15,000. Juveniles of *C. carinata* begin accumulating colic nematodes soon after hatching, and worm populations are usually about 100 by age 3 months, continuing to increase with age. These nematodes (families Atractidae and Oxyuridae) have direct life cycles, and eggs are likely ingested during substrate licking, geophagy, or coprophagy—behaviors frequently observed in these lizards. Significantly, these heavy worm burdens are typical of herbiv-



Figure 4. Ventral (right) and dorsal halves of the proximal colon of *Corucia zebrata* (UF 41309). Anterior to top.

orous lizards, whereas such burdens are not found in omnivorous or carnivorous lizards.

The question remains as to just what the relationship is between these organisms and their hosts. Hypothesizing that colic compartmentalization permits the proliferation of nematodes, bacteria, and perhaps protozoa (if by no other means than by reducing the likelihood of egestion due to peristaltic flow of digest), I compared the number of colic nematode species described from each lizard species with the number of colic valves for the 11 best-studied iguanine lizard species (Figure 5). Clearly, increased colic partitioning allows an increase in diversity (and surely abundance) of at least nematodes, and probably bacteria and protozoa as well.

A positive linear correlation is also suggested by a comparison of nematode species richness and mean body length for the ten iguanine species for which data are available. No such relationship for cecal nematodes is identifiable in carnivorous lizards. In fact, larger, carnivorous lizard species often harbor fewer nematode species than smaller lizard species. I would be surprised if colic bacteria and perhaps protozoa did not exhibit these same relationships.

The tremendous nematode densities in healthy lizards suggest they are not parasitic, but rather commensalistic, or perhaps even mutualistic. Potential roles for these nematodes include (1) the simple mixing and mechanical breakdown of vegetation, effectively increasing the surface area of digesta particles; (2) the production of useable waste products (vitamins, cellulase, volatile fatty acids?); and/or (3) the regulation of the composition and/or abundance of colonic microbes (on which some nematodes are known to feed). However, in a study of digestion in the yellow chuckwalla (*Sauromalus varius*), Hansen and Sylber treated their lizards for intestinal worms, assumed none were present, and yet found very high digestibility coefficients for low to mid-fiber diets. This seems to indicate a reduced importance of colonic nematodes, but only if it can be certainly established that the worms were, in fact, eliminated.

The importance of bacteria and protozoa to digestion in other herbivorous organisms (pri-

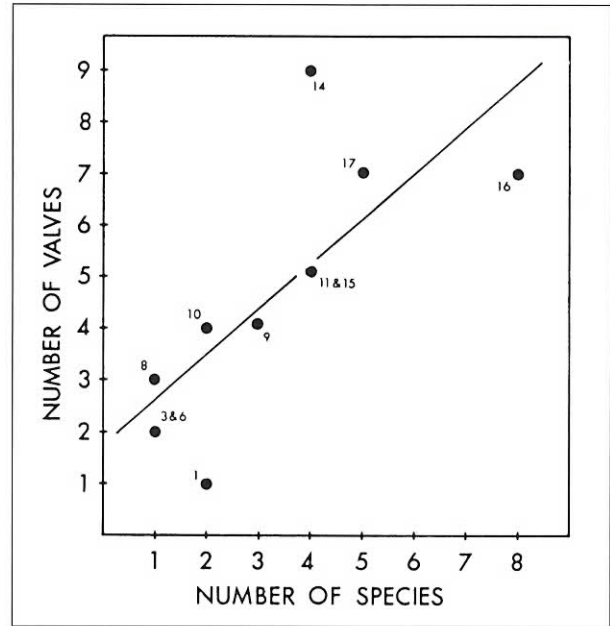


Figure 5. Intestinal nematode species richness versus colic modification (modal number of colic valves) for the 11 best-studied iguanine species. Species are coded as in Figure 3, except *Cyclura nubila* (17).

marily higher vertebrates and insects) is well-established. Their significance in herbivorous reptile digestion should be intuitive, especially since it has recently been established that there is considerable cellulolytic activity in the colon of herbivorous lizards, and also that colic fermentation products (volatile fatty acids) are assimilated by the green iguana, *Iguana iguana* and yellow chuckwalla, *Sauromalus varius* (and even provide at least 15.2% of the daily energy budget in the herbivorous green turtle, *Chelonia mydas*). Thus, hindgut fermentation appears to be very important to the digestive physiology of herbivorous reptiles.

Gastrointestinal tract modification for symbiont culture is also the norm in herbivorous organisms that have previously been studied. Colonic partitioning in herbivorous lizards is thus by no means novel. What is surprising is the lack of attention it has received, especially since it appears to be the one adaptation essential for a lizard's completely herbivorous existence. However, numerous studies now in progress by several investigators are addressing the physiology and biochemistry of herbivory in reptiles.

Body Size

True herbivorous lizards share another obvious character. Excluding the varanids (which are very specialized carnivores), they are the largest extant lizards. This relationship has been frequently mentioned in the literature, and several hypotheses offered to explain the adaptive significance of the correlation between large body size and herbivory. These include the advantage of greater mechanical strength for reducing vegetation for consumption (although there is no mastication); the advantage of reduced predation and competition; the advantage of eating easily obtainable foods of medium to poor quality (i.e., plants) rather than higher quality items (e.g., insects) more energetically costly to obtain (since metabolic rates are relatively lower in large lizards); and the advantage of greater thermal inertia, allowing the maintenance of elevated body temperatures and facilitating the digestion of vegetation. Each of these theories relates selective advantages which no doubt accrue to large, herbivorous lizards, but none appears to fully explain the body size-herbivory relationship in these lizards. I here extend another hypothesis which I think more adequately explains the body size-herbivory correlation and permits speculation on the evolution of these characters in lizards. I believe that the anatomical, physiological, and ecological characteristics of the gastrointestinal tract are the most important determinants, not only of herbivorous capabilities, but also of body size in these lizards.

I have already mentioned here the positive relationship of colic complexity to body size in these lizards, and the presumed benefit of that modified colon to digestion. Previous studies on both lizards and turtles have shown that body size may be significantly related to resource availability. Analogously, I believe that the evolutionary increase in colon complexity has increased resource useability (not necessarily availability!), and thereby energetically permitted increased body size. Thus colon modification (and the diversification and increase in the intestinal flora and fauna), these herbivores have been able to grow to larger sizes, and thus more fully gain other selective advantages, such as reduced predation, metabolic and thermoregulatory benefits.

Discussion

I believe that the iguanines, *Uromastyx*, *Hydrosaurus*, and *Corucia* are much more specialized than generally realized. Each has a relatively large body size and a modified colon with large nematode and microbe populations—a combination of characters unique among the lizards. In addition, although I have not mentioned them, these lizards all possess dentition modified for herbivory and (apparently) nasal salt glands for extrarenal salt secretion. These last two characters are shared by lizards which are not entirely herbivorous, however they nevertheless facilitate an herbivorous existence: teeth for efficient cropping and salt glands for dealing with the increased potassium load.

In summary, the evolution of lizard herbivory probably had its roots in xeric habitats (evidenced by the significant inverse correlation between percentage of lizards exhibiting at least some herbivory and annual rainfall in North American communities). In order to inhabit those areas, lizards would have been faced with: (1) problems of ionic balance (regardless of their diets), and (2) seasonal difficulties in obtaining adequate animal food (probably insects). The evolution of extrarenal nasal salt glands in these lizards would presumably have reduced the osmotic problems, and simultaneously may also have allowed the lizards to utilize small amounts of plant resources during seasonal animal food shortages without being susceptible to additional ionic problems from ingesting potassium rich plant parts. The acquisition by these proto-herbivores of small populations of symbiotic (cellulytic) nematodes and/or bacteria would have even further facilitated the efficient use of ingested vegetation. As the diet of these lizards became more omnivorous, the bulk of the digesta in the gastrointestinal tract would presumably have increased. Among other things, this presumably would have resulted in increased gastrointestinal tract capacity, cramped abdominal space and even medial crimping of intestinal loops where they folded back on themselves. If, as I believe, these crimps (1) slowed the movement of digesta (permitting more time for digestion or absorption), or (2) reduced the likelihood of egestion of gut symbionts by providing

microhabitats for them, selection would have favored their maintenance. Thus evolution of these “protovalves” in conjunction with salt glands and the acquisition of gut symbionts may finally have made it energetically feasible to subsist primarily on vegetation. Both before and (more intensely) after the appearance of these valves, selection would also have been operating on the dentition to permit efficient handling of first an omnivorous, and later an herbivorous diet.

Finally, those species in which the evolution of valves was more rapid, would, because they had more valves and more compartments, also have had more symbionts and hence more efficient food processing. The energy benefit from this apparatus would result in increased body size, the size increase in direct proportion to the efficiency of the gastrointestinal machinery. When measured in terms of number of partitions, this is exactly the relationship that is obtained for the iguanines (Figure 3). Body size increases would, of course, then have imparted additional advantages to these lizards, specifically the ecological, metabolic, and thermoregulatory benefits already mentioned.

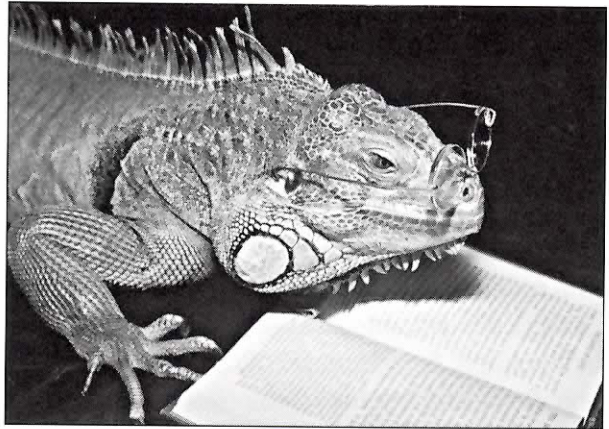


This article is condensed and reprinted with permission from a chapter in the book, *Iguanas of the World: Their Behavior, Ecology, and Conservation*, edited by Gordon Burghardt and A. Stanley Rand, and published in 1982 by Noyes Publications. It has recently been reprinted and is now available from IIS (see ad on this page). Although written for a scientific audience, the editors highly recommend it as an exhaustive source of facts about iguana biology.

NOTICE

Iguana Times staff contacted Reptiles magazine publisher, Phillip Samuelson, after running our news account of smuggled, critically endangered San Salvadore iguanas on the cover of their April, 1994 issue. Samuelson assured us they had no knowledge that the animal was contraband previous to running the photo.

I.I.S. Bookstore



Photograph courtesy of Jayme Gordon

As a service to our members, a limited number of publications will be distributed through the I.I.S. Bookstore. The following publications are now available:

Iguanas of the World: Their Behavior, Ecology and Conservation, Edited by Gordon Burghardt and A. Stanley Rand. 1994. Most complete single iguana book ever written—highly recommended. 472 pp. **\$60.00** (including postage); **\$75.00** (non-members)

New!

The Green Iguana Manual, by Philippe de Vosjoli. 1992. **\$7.00** (including postage); **\$8.75** (non-members)

Guide to the Identification of the Amphibians and Reptiles of the West Indies (Exclusive of Hispaniola), by Albert Schwartz and Robert Henderson. 1985. **\$19.00** (including postage); **\$27.00** (non-members)

Schwarze Leguane, by Gunther Köhler. 1993. **\$19.00** (including postage); **\$24.00** (non-members). Excellent Ctenosaur guide book, photographs, range maps, text in German.

Send check or money order (payable to International Iguana Society) **to:**

I.I.S. Bookstore
Route 3, Box 328
Big Pine Key, FL 33043

HERPETOCULTURE TODAY: ONE PERSON'S THOUGHTS

STAN DRAPER
SALT LAKE CITY, UT

Talking to a friend of mine the other day, he brought up one of the bad changes in recent herpetoculture. Too many people are getting into making money with reptiles and amphibians and not doing it merely for the joy of working with the animals and possibly making a little coin besides. I, for one, count myself among those guilty. Though, hopefully, to a lesser degree than most. The worst of these people do not see their animals as anything other than dollar signs. This, to me, is perverting the art of herpetoculture. It has led to breeding animals to produce new and different colors or hybrids that could or should never exist. It has also brought about the exploitation of natural resources. You can not import thirty-thousand individuals of a single species without causing detriment in one way or another.

One of the most obvious dollar breeders even advertises with the words, "the ultimate investment animal." I am not saying that these people do not take care of the animals. They do have to take care of their "investments." What I am saying is that they do not have these animals because they are unusual, pretty or have interesting behavior. They raise them for the MONEY they can make because the animals are rare, beautiful or have atypical habits.

Another type of perverted "herpetoculturist" is the one who obtains and breeds a new animal for the express purpose of claiming bragging rights. These people go to any length to own a rare animal. If they are successful with the animal and breed it, they immediately publish an article which usually does not contain all of the pertinent or correct information. Not only are they patting themselves on the back, but they also don't want anyone outside their little circle to know the whole and truthful tale behind the acquisition and breeding. Oh what some won't do for their fifteen minutes of fame. I guess you can call me a purist, for I cannot see any reason other than money for

some of the breeding I have seen or heard about over the past ten years or so. Just what is the purpose or reason for "jungle-corns," "reticmese," "mex-pyros," "blizzards," or "blood reds?" Money, money, money and an itsy bit of notoriety. The only things this kind of irresponsible breeding results in are the weakening of the genetics and the corruption of the ethics which should be an integral part of this endeavor called captive breeding, not mix and match.

Another ethics buster is the putrefication of the import business. When somebody imports thirty-thousand individuals of one species, he/she/it is thinking of only one thing and that is their fat wallet. They don't care that probably one-third to one-half of these animals will die within their first year of captivity. They don't care that they are ruining the genetic base of the wild population. They really don't care that they destroy the market for captive breeders. And they really aren't thinking about the future. With this kind of irresponsible, unintelligent money-grubbing, we will all see more unwanted rules and regulations. These are the same types who are under suspicion or indictment for illegal doings in the import business.

Like I said in the beginning, I am guilty to a certain degree. I am in business as a breeder. The couple of things that set me and others like me apart are that we work with the animals because we love what they are and the satisfaction of being able to simulate nature to the point of getting successful breeding and hatching. Oh yes, we do like to make money at it, because what's better than a hobby that pays for itself and a little more. Though I have been at this "business" seriously for about seven years now and have yet to see a profit, I am not about to quit.

Hopefully, we can slow this trend towards "money-grubbing" by encouraging youngsters

continued on page 13

ECOLOGY, STATUS, AND CONSERVATION OF THE UTILA SPINY-TAILED IGUANA *CTENOSAURA BAKERI*

GUNTHER KÖHLER

Ctenosaura bakeri is endemic to Isla de Utila, a small Caribbean island (12.7 km maximum length, 5.2 km maximum width) which belongs to the Islas de la Bahia on the northern coast of Honduras. Until recently, only six specimens have been reported in the literature: two type specimens of Stejneger (1901) and four juvenile specimens collected by Wilson and Hahn in the late sixties (De Querioz, 1990; Wilson and Hahn, 1973). Ecological and reproductive data are nonexistent, and only black and white photos of museum material have been published (Bailey, 1928; Köhler, 1993). In April and May of 1994, I had the opportunity to do systematic and ecological studies of *C. bakeri* on Utila.

The few juveniles collected in this century were "taken on rocks and in grass along beaches..." (Wilson and Meyer, 1973). So we started looking for this species in typical *Ctenosaura* habitats, which we knew to be hot, dry, sunny areas with hiding retreats like rocks, fallen trees, etc. We encountered spiny-tailed iguanas along the beach of Utila, but they all belonged to the common species *C. similis*.

After several unsuccessful days of searching for *C. bakeri*, we did some work with basilisks (*Basiliscus vittatus*) in the mangrove swamp which covers most of the island. Then—unexpectedly—we discovered our first Utila spiny-tailed iguana. It was a large male sitting approximately 10 m high on a branch of a huge tree. We successfully captured this impressive animal and were able to examine it more closely. It measured 295 mm SVL with a total length of 692 mm. That is much more than the previously reported maximum size of 230 mm SVL for this species (De Queiroz, 1990). In the following weeks we discovered more specimens of *C. bakeri* in the mangrove swamp, but none in the hot, dry beach areas. Thus, the habitat of the Utila

spiny-tailed iguana is very extraordinary for a *Ctenosaura* species!

We had the luck to be on Utila during the egg-laying period of *C. bakeri* (May and April), and found that the females migrate to sandy nesting areas close to the beach. Because optimal nesting sites are rare on Utila (most of the island is covered by swamp and forests; the shore is either rocky or covered by mangrove; and there are only undisturbed open sandy areas), the females seem to concentrate at a few sites during egg laying.

Native iguana hunters know these sites and the time of egg-laying, which makes them very effective at capturing gravid females. Only one out of 31 gravid females we examined at a nesting site appeared to be older than two years. This suggests that an alarmingly small percentage of females successfully reproduces. The poor reproductive output of *C. bakeri* on Utila is reflected in the scarcity of juveniles.

In collaboration with Lic. Geovanny Rodriguez and Lic. Roger Cruz from the Cooperacion Hondurena de Desarrollo Forestal (COHDEFOR) I am working on a conservation program for *C. bakeri* and *C. oedirhina*. Our plans are summarized below:

1. Inform the local people about the endangered status of these iguanas to help them realize that the "garrobo de Utila" is a unique animal found on their island only and nowhere else in the world. They will have no more iguanas to hunt in a few years if they continue to kill them as they are doing at present.
2. A ban on hunting during the egg-laying period should be very effective. Due to the high reproductive potential of spiny-tailed iguanas the population should increase within several years. COHDEFOR will ban iguana hunting on Utila for the months of April and May, and on Roatan for the months of May and June.

3. We will conduct research on the reproductive biology and population structure and dynamics of these two species. The more we learn about these species, the more effective our conservation program can be.
4. *C. bakeri* and *C. oedirhina* should be included in Appendix I of CITES to prevent international trade of these species.
5. Each year a group of international scientists and amateur herpetologists as well as technicians from COHDEFOR will be sent to Utila during the egg-laying period of *C. bakeri* to conduct the research on reproductive biology and to help enforce the ban on hunting.

If you have an interest in participating in the conservation program of *C. bakeri*, please contact me for further information.



Acknowledgements

Lic. Geovanny Rodriguez and Lic. Roger Cruz from the Cooperacion Hondurena de Desarrollo Forestal (COHDEFOR) deserve special thanks for the support and permission to do scientific investigations with *Ctenosaura* species in Honduras. I wish to thank Elke Schlagehan, Offenbach, Dirk Braun, Grevenbroich, Tobias Eisenberg, Rodenbach and Dir Rittmann, Hagen, for great field assistance and companionship in Honduras.


Literature Cited

- Bailey, J. W. 1928. A revision of the lizards of the genus *Ctenosaura*. Proc. U.S. Nat. Mus., Washington, D.C. 73(12):1-55.
- De Queiroz, K. 1990. *Ctenosaura bakeri*. SSAR Catalogue of American Amphibians and Reptiles 465:1- 2.
- Kohler, G. 1993. Schwarze Leguane - Freilandbeobachtungen, Pflege und Zucht. - Hanau (Verlag G. Kohler). 126 S.
- Stejneger, L. 1901. On a new species of spiny-tailed iguana from Utila Island, Honduras. Proc. U.S. Natl. Mus. 23(1217):467-468.
- Wilson, L. D. and D. E. Hahn. 1973. The herpetofauna of the isles de la Bahia, Honduras. Bull. Florida State Mus., Biol. Sci. 17(2):93-150.

Herpetoculture Today...

continued from page 11

and oldsters alike who keep "herps," to keep at it just for the enjoyment of seeing our fellow creatures at their finest. Give anybody and everybody a pat on the back for a successful breeding of any animal, not just the expensive or rare ones. If we can get even one more herpetoculturist started by helping them obtain their first starter animal by either giving it to them or letting them make payments or allowing them to work it off, the whole hobby will benefit. Once we get them started, then all it will take is a little guidance and encouragement to hopefully keep them on the right track.

Just one person's thoughts. 

Reprinted with permission from *Intermontanus* 3(5):33-34 (1994).

THANK YOU

Classic Pet Supply of Warren, Michigan recently made a \$75.00 donation to The International Iguana Society. They raised the donation from entry fees for their **1st Annual Iguana Contest**.

Fifty iguana owners entered their pets in the contest, which was judged by a local veterinarian, in six categories: Longest Iguana, Shortest Iguana, Largest Throat Fan, Tallest Spikes, Greenest in Color, and the Grand Prize category of Best Looking. Prizes included various iguana care supplies and the Grand Prize was a \$100.00 Gift Certificate to Classic Pet Supply.

The International Iguana Society would like to thank Classic Pet Supply for their generous donation...we look forward to news of the 2nd Annual Iguana Contest!

BOOK REVIEW

GORDON H. RODDA

This excellent book review is reprinted with permission from Herpetological Review 25(2):85-87 (1994). Although it was critically written for a scientific audience, and legitimately points out a number of shortcomings, most iguana owners nevertheless will find sufficient useful information to make purchase of the book worthwhile.

Iguanas: A Guide to Their Biology and Captive Care, by Fredric L. Frye, B.Sc., D.V.M., M.Sc., CBiol, FIBiol, Fellow, Royal Society of Medicine, and Wendy Townsend. 1993. Krieger Publishing Company, Krieger Drive, Malabar, Florida, 32950, USA. ISBN 0-89464-695-8, 145 pp. US \$28.50.

Of late, iguanas have captured the imagination of the pet buying public. Trade in live iguanas has increased at least tenfold over the last decade and the green iguana (*Iguana iguana*) now ranks behind only the red-eared slider (*Trachemys scripta*) among wild terrestrial vertebrates in international commerce. No wild bird or mammal species is traded in numbers of this magnitude (A. Gaski, pers. comm.). About 90% of the more than 300,000 iguanas marketed each year are destined for the US (Fig.1). What effect this trade has on wild stocks of iguanas is unknown. Perhaps the demand for iguanas would be lessened if survivorship of the captives was prolonged through knowledgeable caretaking. Frye and Townsend have produced a handbook on care of captive iguanas.

Despite the title, this book will not appeal to biologists. This is a book for pet owners. The first twelve pages describe the biology of wild and captive iguanas. Fifty pages of husbandry suggestions follow, augmented by thirty pages of descriptions of diseases that warrant the attention of a veterinarian. The concluding chapter consists of endearing anecdotes about the junior author's personal menagerie.

There are several valuable features of this handbook. The menu lists will be useful for all iguana owners. The lesson on how to grow sprouts in jars could be new information for some

readers. Townsend's anecdotes about the difficulties she has had maintaining strongly territorial animals in her home drives the message home in a singularly effective manner. The layout and binding are pleasant.

Although the book is liberally endowed with Townsend's beautiful if occasionally fanciful drawings of a diversity of iguanines, the focus is narrower. Thirty-four of the thirty-six photographs are of *Iguana iguana*, as is virtually all of the text. For example, the statement, "Six or eight weeks prior to and during courtship, male iguanas acquire bright gold or orange coloring over much of the body, as well as a whitened head," describes only *Iguana iguana*—and should be restricted to selected populations of that species (Rodda, 1992). The emphasis on green iguanas is appropriate from a conservation standpoint, as few of the other iguanines have wild populations capable of withstanding commercial exploitation (Burghardt and Rand, 1982). Unfortunately, concern for this problem is never stated, other than the recognition that several species are "not available in the pet trade."

A potential strength of this book is that the two authors provide very different perspectives. Unfortunately, little was done to integrate their efforts. For example, on at least two occasions virtually identical paragraphs appear within a few pages. The transition between authors is jarring, as the folksy familiarity of Townsend's prose contrasts with the stiff and disjointed jargon of Frye's contributions.

A pet owner is likely to find much of Frye's writing inscrutable. For example, Frye uses a contrasting font to highlight the importance of the obscure phrase "amphigonia retardata," when most readers would be satisfied with calling it sperm storage. Frye doesn't seem to have reached a decision as to his target audience. For example, he gives dosages of a prescription drug for treatment of herpes, a disease that the pet owner is incapable of diagnosing, but coyly refuses to give information

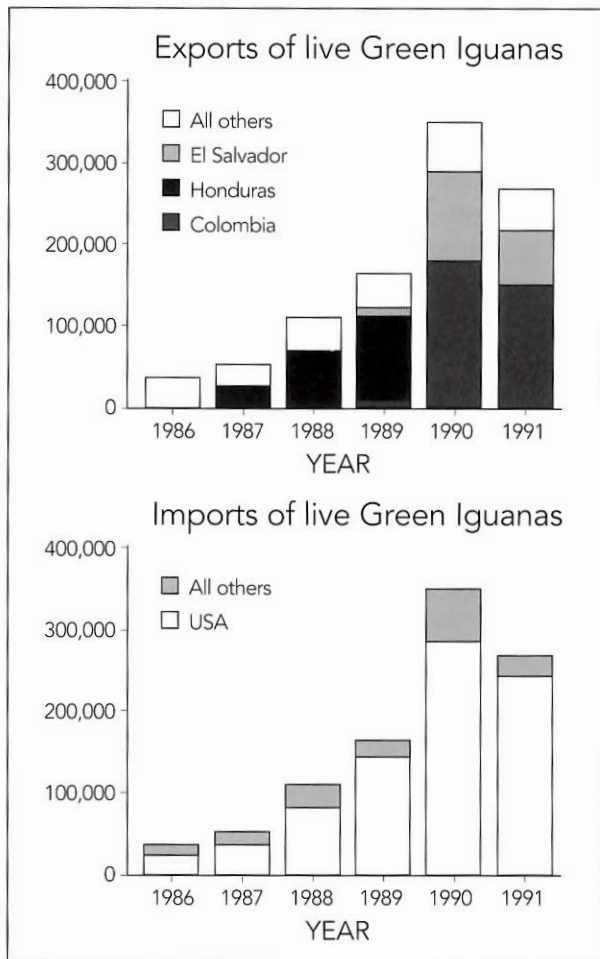


Figure 1. World Conservation Monitoring Centre and CITES Secretariat statistics for international trade in *Iguana iguana*. Data for 1991 and 1992 are incomplete at this time, but indicate further increases in exports from Colombia and imports into the U.S.

on the appropriate dose of kapectate to use for iguanas with diarrhea, a readily diagnosable ailment (usually corrected through diet, however).

It appears that neither authors nor editors concerned themselves with the details of manuscript preparation. Within the taxonomic index over half of the scientific names are not italicized, whereas others, even those in the same genus, are. The text refers to Fig. 3 for a view of femoral pores, but these structures do not appear in either Fig. 3 or Fig. 4. I sought help from the index, but information in figures is not indexed. Eventually I stumbled across the pores in Fig. 7. Egg dimensions are captioned as being in cm, but the values given (e.g., 40 x 80) must be in mm. In a throwback to Wynne-Edwards (1962), Frye informs us that "Territoriality... serves to pre-

serve each species in its most vigorous state." We are informed that "tall cages must have more than one door... Fig. 11," but there is only one door in Fig. 11. Some of the photos (e.g., Figs. 12a, 12b) are pointless, some are too poorly reproduced to detect the item of interest (Fig. 14b), and others are redundant (there are five color photographs to show that regrown tails may be imperfect). Photographs of females mutilated by frustrated territorial males (Figs. 20a, 20b) are labeled as if such mutilation were normal. For a list of toxic plants, the reader is referred to Table 3, which is the list of preferred foods. Some iguanas do well on "toxic" foods (Auffenberg, 1982), a consideration omitted from this work.

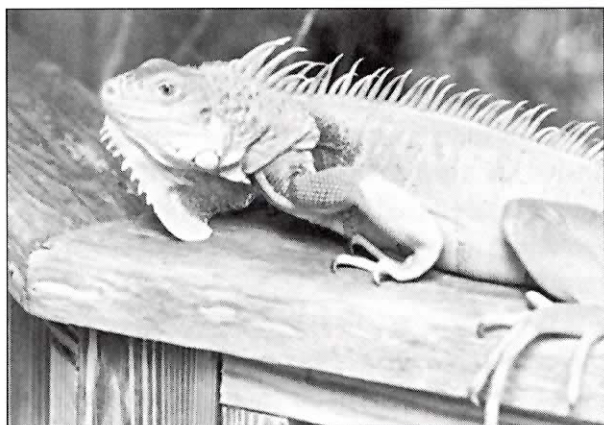
There is a conspicuous lack of scholarship in the tabulation of data. For example, the table intended to summarize what is known about egg development cites a few anecdotal captive observations for *Iguana iguana*, but neglects a number of significant captive studies (Bagh, 1962; Braunwalder, 1979, and references therein; Enderlein, 1963), including several that are in the recommended readings (Miller, 1987; Putz, 1982; Van Aperen, 1969). More significantly, the authors completely overlook all data from systematic studies of *Iguana iguana* egg development (e.g., Bock et al., 1989; Licht and Moberly, 1965; Muller, 1972; Phillips et al., 1990; Rand, 1968, 1972; Rand and Dugan, 1980; Ricklefs and Cullen, 1973; Swanson, 1950; Werner, 1988; Werner and Miller, 1984). One of the table sources, Boylan (1963), does not appear in the literature cited (it is a personal communication cited in another work).

The authors appear insensitive to the unnaturalness of some behaviors seen in captivity. For example, on the basis of captive anecdotes they assure us that iguanas themselves consider homosexual behavior normal. I don't know what opinions iguanas have on the subject, but homosexual mounting is transitory and rare in wild green iguanas (Dugan, 1982; Rodda, 1992).

I was annoyed by the incessant promotion of business for veterinarians. Frye overly enthuses about the "cadre of well trained veterinarians" who have an "armamentarium of highly effective" treatments that are available for whatever

ails an iguana. The pet owner needs to know when an ailment is serious enough to require professional care, but not all veterinarians are well equipped to deal with exotic pets, and it is arguable that “any unusual lump, or bump, swelling, discoloration, or ‘sore’ ” requires professional veterinary attention. Frye spends most of a page warning readers that untreated flatulence may kill their iguana. He warns that if post-ovipositional females are “depressed” they should be taken to a veterinarian at once. (Post ovipositional females are probably more in need of a good meal, as they may not have eaten for several weeks or months.) He warns readers that “overly large, misshapen, or decomposed eggs with normal shells, infection, or low blood calcium levels are conditions which require immediate veterinary care.” I do not know how a pet owner is expected to identify these conditions in the gravid female, nor is any guidance offered.

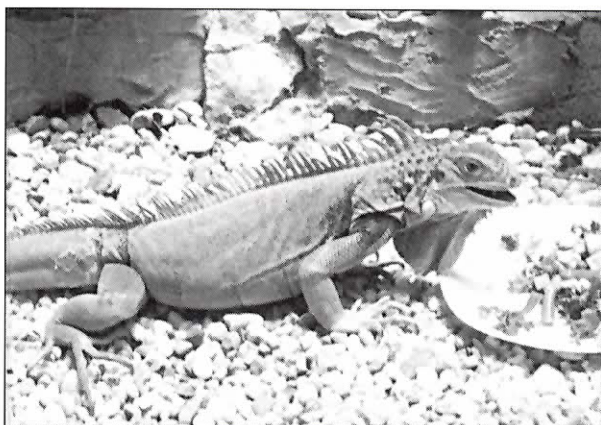
The book provides a valuable service through the numerous color photographs of iguanas with metabolic bone disease. These photographs will no doubt motivate readers to supply their pet with a nutritional diet. The authors include numerous warnings about the importance of appropriate calcium phosphorus ratios. Unfortunately, they fail to specify what ratio is needed. Their generally useful dietary advice is offset by their inclusion of the grossly erroneous myth that juvenile green iguanas are carnivorous. Although carrion feeding has been observed once in adult green iguanas (Loftin and Tyson, 1965), and a single anecdote has been published of a juvenile eating



Free ranging Florida Keys green iguana, *Iguana iguana*.
Photograph: R.W. Ehrig

a caterpillar in the wild (Hirth, 1963), all other data from wild green iguanas indicates that they are herbivorous at all sizes (Barbour, 1932; Iverson, 1980, 1982; Rand et al., 1990; Troyer, 1982, 1984; Van Devender, 1982). Frye and Townsend’s Table 2 notwithstanding, insects, arachnids, and eggs are not usual food items for green iguanas. This book makes the controversial declaration that digestive tracts of baby iguanas must be inoculated with unspecified microorganisms, but no information is given as to how this might be accomplished. Elsewhere they specify that coprophagy should be discouraged.

Among the more difficult problems presented to the keeper of pet iguanas is that of reproduction. In my experience, the reproductive cycles of captives are often poorly synchronized, with hormonally excited males attempting to mate or fight with cage mates that are not in breeding condition. This problem is not discussed, nor are any suggestions given for providing the captives with a synchronizing environment. The authors state that females cease feeding 2-3.5 months after copulation. This may be an artifact of reproductive asynchrony; wild iguanas in the llanos of Venezuela cease feeding coincident with copulation (Rodda, 1992). Natural reproduction is erroneously characterized in a variety of other ways as well. For example, they state that iguana males mark their females with femoral pore secretions. They may in some areas, but this has not been observed in wild green iguanas (Dugan, 1982; Rodda, 1992). Contrary to the information given, some iguanines are reported to guard nests (Wiewandt, 1982). The authors state that significant embryonic growth does not occur in the several months during which oviducal eggs are retained in iguanas; Licht and Moberly (1965) observed limb buds and a functioning heart at oviposition in *Iguana*. The authors ambiguously state that maturity occurs at age 2 or 3 years depending on whether the iguanas were raised in captivity (which is which?). The available data for wild green iguanas (Zug and Rand, 1987) exhibit a mode of five years. The book makes the perhaps ghoulish comment that females “should be healthy and possess excellent flesh” prior to mating. This strikes me like those yellow “child in



Free ranging Florida Keys green iguana, *Iguana iguana*.
Photograph: R.W. Ehrig

car” warning labels seen in some cars driven in the U.S. Does this mean a pet owner should not strive to take care of their charges at other times?

While the care recommendations given in this book are generally sound, there are a few that should be refined. For example, there are redundant warnings that pet iguanas may harbor malaria, but the authors fail to note that iguana malarias are not among the malarias that affect humans and are not transmissible to humans. The advice to force feed an iguana if it fails to eat after two weeks must be tempered by the recognition that newly hatched individuals, breeding males, and gravid females normally fail to eat. Newly acquired individuals may need to be maintained in opaque cages for them to begin feeding (Troyer, pers. comm.). There are repeated warnings that cages must be sprayed or animals given water to drink. Pet owners should not become alarmed if their pets fail to drink standing water. Wild green iguanas have been seen to drink only when they are not feeding during the breeding season (Rodda, 1992). However, captive iguanas typically suffer from insufficient humidity; spraying the animals and their cages is a useful but often incomplete cure for this problem. The directions given in this book with regard to humidity are unreasonable. On the one hand they recommend including powerful ventilation fans on cages; on the other they specify 85-95% humidity for tropical iguanas. In my experience, maintaining 85-95% humidity in cages in typical modern houses is simply impossible even if the ventilation is omitted. Furthermore, if such a high humidity level is attained, mold and pathogens will propagate

uncontrollably. The alfalfa pellet substrate that they recommend will rapidly absorb moisture and become unusable in a high humidity environment.

The book’s final chapter by Townsend is a delight to read, even if the hijinks reported (e.g., sleeping with “Goober” and “Peanut,” smuggling iguanas aboard commercial aircraft in socks pinned to undergarments) provide unfortunate role models. Townsend indicates a willingness to assume that iguanas are capable of assuming human roles: “As [a hatchling] is beginning to get used to the human face, in his eyes, the expression of fear is almost completely replaced by what one might call wonder.” Perhaps, but if this leads to animal welfare requirements for daily clean sheets and a mint on their pillow, we will have erred.

Remarkably enough, for a book oozing with affection for iguanas, no effort is made to promote the welfare of wild iguanas. The epilogue vaguely promises that keeping iguanas will somehow help save the rain forest. It will do so only if the display of captives results in effort or at least funds being channeled to rain forest preservation activities. Showing off a pet may simply generate more demand for sales of wild animals. The authors include an appendix listing herpetoculture organizations, but they fail to promote iguana conservation in any meaningful way. Many island iguanines are desperately in need of help. Responsible pet owners will want to support the conservation activities of groups like The Nature Conservancy’s International Program or the International Iguana Society. Pet stores and iguana owners should be encouraged to tithe a percentage of their earnings to such efforts.

If you are looking for a book on the biology of iguanas there is yet no volume to surpass Burghardt and Rand (1982). If you are looking for a book on the pet trade in iguanas, it remains to be written. If you are looking for a guide to care of green iguanas, pick up Beltz (1989) or de Vosjoli (1992). These booklets provide more authoritative information in a more comprehensible form, at a fraction of the price.

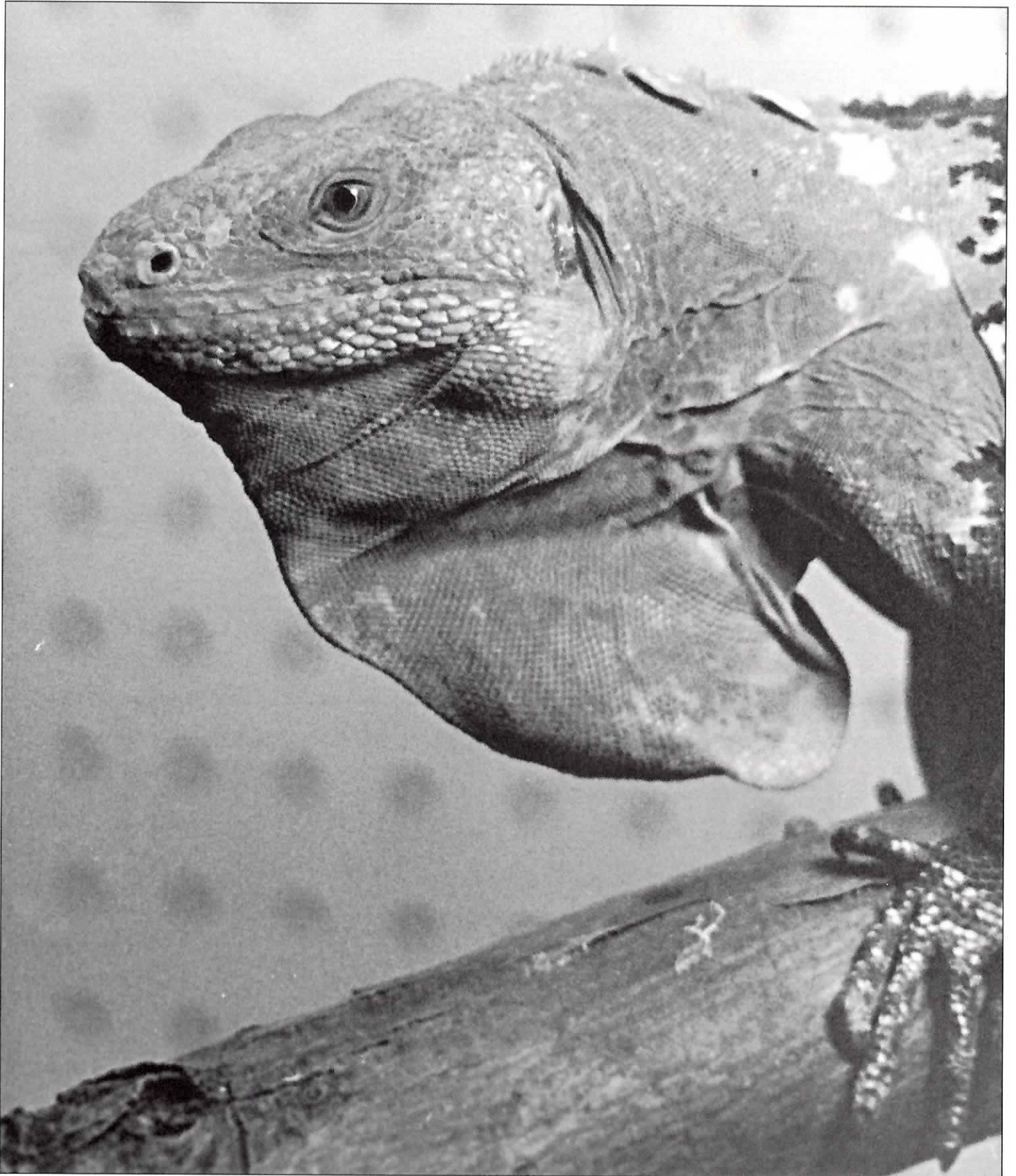
Acknowledgments.—J. R. Caldwell (World Conservation Monitoring Centre) and CITES Secretariat provided the data shown in Fig. 1. A. Gaski of TRAFFIC, USA, and W. M. Osborn and R. Tannen of the U.S. Fish and Wildlife Service provided insights into international trade in iguanas. P. Medica supplied valuable references. R.J. Rondeau, T. Fritts, S. Skagen, and A. S. Rand suggested improvements to the manuscript.

Literature Cited

- Auffenberg, W. 1982. Feeding strategy of the Caicos ground iguana, *Cyclura carinata*. In G. M. Burghardt and A. S. Rand (Eds.), *Iguanas of the World: Their Behavior, Ecology, and Conservation*, pp. 84-116. Noyes Publ., Park Ridge, New Jersey.
- Barbour, T. 1932. About iguanas. *Copeia* 1932:97.
- Beltz, E. (Ed). 1989. *Care in Captivity: Husbandry Techniques for Amphibians and Reptiles*. Chicago Herpetol. Soc., Chicago, Illinois. 88 pp.
- Bock, B. C., A. S. Rand and G. M. Burghardt. 1989. Nesting season movements of female green iguanas (*Iguana iguana*) in Panama. *Copeia* 1989:214-216.
- Braunwalder, M. E. 1979. Über eine erfolgreiche Zeitigung von Eiern des Grünen Leguans, *Iguana i. iguana*, und die damit verbundene Problematik (Reptilia: Sauria: Iguanidae). *Salamandra* 15:185-210.
- Burghardt, G. M. and A. S. Rand (Eds). 1982. *Iguanas of the World: Their Behavior, Ecology, and Conservation*. Noyes Publ., Park Ridge, New Jersey. 473 pp.
- De Vosjoli, P. 1992. *The Green Iguana Manual*. The Herpetocultural Library Series, Advanced Vivarium Systems, Lakeside, California. 71 pp.
- Dugan, B. A. 1982. The mating behavior of the green iguana, *Iguana iguana*. In G. M. Burghardt and A. S. Rand (Eds.), *Iguanas of the World: Their Behavior, Ecology, and Conservation*, pp. 320-341. Noyes Publ., Park Ridge, New Jersey.
- Enderlein, R. 1963. Freilandhaltung und Zucht des Grünen Leguans, *Iguana iguana*, in Schweden. *Zool. Gart.*, N. F.(Leipzig) 28:1-7.
- Hirth, H. F. 1963. Some aspects of the natural history of *Iguana iguana* on a tropical strand. *Ecology* 44:613-615.
- Iverson, J. B. 1980. Colic modifications in iguanine lizards. *J. Morphol.* 163:79-93.
- Iverson, J. B. 1982. Adaptations to herbivory in iguanine lizards. In G. M. Burghardt and A. S. Rand (Eds.), *Iguanas of the World: Their Behavior, Ecology, and Conservation*, pp. 60-76. Noyes Publ., Park Ridge, New Jersey.
- Licht, P. and W. R. Moberly. 1965. Thermal requirements of embryonic development in the tropical lizard *Iguana iguana*. *Copeia* 1965:515-517.
- Loftin, H. and E. T. Tyson. 1965. Iguanas as carrion eaters. *Copeia* 1965:515.
- Miller, T. J. 1987. Artificial incubation of eggs of the green iguana (*Iguana iguana*). *Zoo Biol.* 6:225-236.
- Muller, H. 1972. Okologische und ethologische Studien an *Iguana iguana* L. (Reptilia: Iguanidae) in Kolumbien. *Zoologische Beiträge N. F.*18:109-131.
- Phillips, J. A., A. Garel, G. C. Packard and M. J. Packard. 1990. Influence of moisture and temperature on eggs and embryos of green iguanas (*Iguana iguana*). *Herpetologica* 46:238-245.
- Putz, R. 1982. Erfahrungen bei der Haltung und Zucht des Grünen Leguans *Iguana iguana iguana*. *Herpetofauna* 20:21-25.
- Rand, A. S. 1968. A nesting aggregation of iguanas. *Copeia* 1968:552-561.
- Rand, A. S. 1972. The temperatures of iguana nests and their relation to incubation optima and to nesting sites and season. *Herpetologica* 28:252-253.
- Rand, A. S. and B. Dugan. 1980. Iguana egg mortality within the nest. *Copeia* 1980:531-534.
- Rand, A. S., B. A. Dugan, H. Monteza and D. Vianda. 1990. The diet of a generalized folivore: *Iguana iguana* in Panama. *J. Herpetol.* 24:211-214.
- Ricklefs, R. E. and J. Cullen. 1973. Embryonic growth of the green iguana *Iguana iguana*. *Copeia* 1973:296-305.
- Rodda, G. H. 1992. The mating behavior of *Iguana iguana*. *Smithson. Contr. Zool.* (534):1-40.
- Swanson, P. L. 1950. The iguana, *Iguana iguana iguana* (L.). *Herpetologica* 6:187-193.
- Troyer, K. 1982. Transfer of fermentative microbes between generations in a herbivorous lizard. *Science* 216:540-542.
- Troyer, K. 1984. Diet selection and digestion in *Iguana iguana*: the importance of age and nutrient requirements. *Oecologia* 61:201-207.
- Van Aperen, W. 1969. Notes on the artificial hatching of iguana eggs *Iguana iguana* at Melbourne Zoo. *Intl. Zoo Yrbk.* 9:44-45.
- Van Devender, R. W. 1982. Growth and ecology of spiny-tailed and green iguanas in Costa Rica, with comments on the evolution of herbivory and large body size. In G. M. Burghardt and A. S. Rand (Eds.), *Iguanas of the World: Their Behavior, Ecology, and Conservation*, pp.162-182. Noyes Publ., Park Ridge, New Jersey.
- Von Bagh, S. 1962. Die Zucht des grünen Leguans, *Iguana iguana* in hohon Norden. *Aquar. Terrar. Z. (Stuttgart)* 15(8):244-247.
- Werner, D. I. 1988. The effect of varying water potential on body weight, yolk and fat bodies in neonate green iguanas. *Copeia* 1988:406-411.
- Werner, D. I. and T. J. Miller. 1984. Artificial nests for female green iguanas. *Herpetol. Rev.* 15:57-58.
- Wiewandt, T. A. 1982. Evolution of nesting patterns in iguanine lizards. In G. M. Burghardt and A. S. Rand (Eds.), *Iguanas of the World: Their Behavior, Ecology, and Conservation*, pp. 119-141. Noyes Publ., Park Ridge, N. J.
- Wynne-Edwards, V. C. 1962. *Animal Dispersion in Relation to Social Behaviour*. Oliver and Boyd, Edinburgh. 653 pp.
- Zug, G. R. and A. S. Rand. 1987. Estimation of age in nesting female *Iguana iguana*: testing skeletochronology in a tropical lizard. *Amphibia-Reptilia* 8:237-250.

Gordon H. Rodda
National Biological Survey
4512 McMurry Ave.
Fort Collins, Colorado 80525, USA.

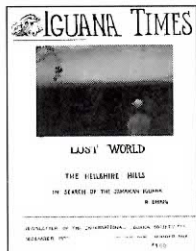
IN AN UPCOMING ISSUE...



Adult *Ctenosaura palearis*, male, SVL of 32cm. Photography: Bruce Elfström

Iguana Times Back Issues

MEMBERS ONLY: For a limited time, the International Iguana Society is making back issues of *Iguana Times* available to all current IIS members. Quantities may be limited, so act now!

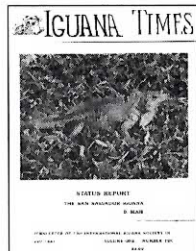


Volume 1, Number 1
December 1990

Articles Featured:

In Search of the Jamaican Rock Iguana; Trees and Shrubs of the Hellshire Hills, Jamaica; Iguana Newsbriefs; The Impact of Feral Cats and Dogs on Populations of the West Indian Rock Iguana, *Cyclura carinata* (Part 1). **Rare original issue with color photograph on front cover! A classic – don't miss it – quantities are limited!**

\$5.00
(while supplies last)



Volume 1, Number 2
May 1991

Articles Featured:

What are We?; News of the Society; The Impact of Feral Cats and Dogs on Populations of the West Indian Rock Iguana, *Cyclura carinata* (Conclusion); Jamaican Initiative; Iguana Newsbriefs; Letters to the Editor

\$5.00
(while supplies last)

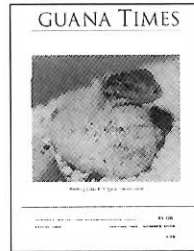


Volume 1, Number 3
November 1991

Articles Featured:

Mona Island Slaughter; Adventure on North Andros; Sex and the Single Saurian; Cayman Update; The Captive Husbandry and Propagation of the Cuban rock iguana, *Cyclura nubiila*: Part 1. Captive Environment; In search of the Mystery Iguana; Iguana Newsbriefs; News of the Society

\$5.00
(while supplies last)

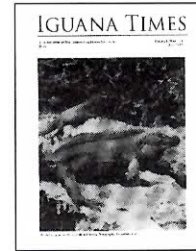


Volume 1, Number 4
March 1992

Articles Featured:

The Cayman Island Rock Iguana, *Cyclura nubiila caymanensis*; Growth of the Green Iguana, *Iguana iguana*, in the First 18 months of Life in Captivity; A Visit with Iguanas of the Galapagos Islands; Iguana Newsbriefs; A Note on Captive Maintenance of *Cyclura nubiila*; The Captive Husbandry and Propagation of the Cuban rock iguana, *Cyclura nubiila*: Part 2. Captive Environment in a Temperate Climate

\$5.00
(while supplies last)

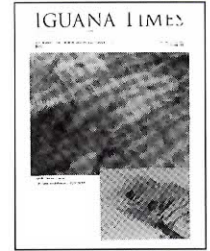


Volume 1, Number 5
June 1992

Articles Featured:

A Cay by Any Other Name; The Captive Husbandry and Propagation of the Cuban rock iguana, *Cyclura nubiila*: Part 1. Diet and Feeding; The Vegetation of a Bahamian Cay Inhabited by a Population of Rock Iguanas; Allan's Cays Signs; Allan's Cays Expedition; Salmonellosis: Will it Pose a Problem for Iguana Husbandry?

\$6.00
(while supplies last)



Volume 1, Number 6
October 1992

Articles Featured:

The Trouble with 'Lewis'; Booby or Bust!; French Andros Iguanas; Iguana Rescue Group; A Good Way to Spend a Hurricane; *Cyclura collei* Update; DNA Study Results; Mayaguez Cuban Iguanas; Iguana Newsbriefs; Lizard Letters.

\$6.00
(while supplies last)



Volume 2, Number 1
January 1993

Articles Featured:

Fiji Banded Iguanas; Roatan Island Spiny-tailed Iguana; Salmonellosis in Reptiles; The Captive Husbandry and Propagation of the Cuban rock iguana, *Cyclura nubiila*: Part 4. Breeding; Iguana Rescue Group Update; Lizard Letters; Iguana Newsbriefs; News of the Society

\$6.00
(while supplies last)



Volume 2, Number 2
May 1993

Articles Featured:

The Mating Behavior of *Iguana iguana* (Part 1); A Visit with Mao; News of the Society; Albert Schwartz; Iguana Newsbriefs

\$6.00
(while supplies last)

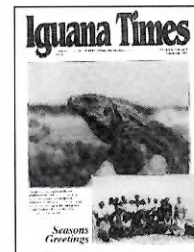


Volume 2, Number 3
August 1993

Articles Featured:

The Mating Behavior of *Iguana iguana* (Part 1); The Captive Husbandry and Propagation of the Cuban rock iguana, *Cyclura nubiila*: Part 5. Raising Hatchlings; Iguana Rescue Group Update; First Breeding of Rhinoceros Iguana, *Cyclura cornuta*, at the National Zoo; Iguana Newsbriefs

\$6.00
(while supplies last)



Volume 2, Number 4
December 1993

Articles Featured:

Evolution of Nesting Patterns in Iguanine Lizards; Iguanas as Pets?; News of the Society; Iguana Newsbriefs

\$6.00
(while supplies last)



Volume 3, Number 1
March 1994

Articles Featured:

Herpetoculture and Conservation; Smuggling... Bahamian Iguanas; Cesarean Section in a *Cyclura*; Full Spectrum Lighting; Respiratory Diseases in Iguanas; Lizard Letters; Iguana Newsbriefs; Treasurer's Report

First full color covers!
\$6.00
(while supplies last)

TO ORDER:

Send check or money order payable to: International Iguana Society
Route 3, Box 128
Big Pine Key, FL 33043.

Please add \$1.00 S&H for single issues, and \$2.00 S&H for 2 or more issues.

THE OFFICIAL INTERNATIONAL IGUANA SOCIETY T-SHIRT



\$12 plus \$2 for postage & handling (\$1 P&H for each additional shirt)

Sizes available in Small, Medium, Large, and X-Large.

Send check or money order to:
International Iguana Society, Inc.
Route 3, Box 328
Big Pine Key, FL 33043

NEWS OF THE SOCIETY

International Iguana Society, Inc.
Treasurer's Report
January 1, 1994—September 30, 1994

Cash Balance as of September 30, 1994:

1. Florida Account	12,754.69
2. Tennessee Account	1,000.00
Total Cash Balance	13,754.69
Total Period Revenue	11,360.76
Total Period Disbursements	9,571.56
Excess of Revenues Over Expenditures	1,789.20

Cash Revenues:

1. Membership Dues & Goods Sold	11,204.13
2. Interest Earned on Florida Account	156.63
Total Cash Revenues	11,360.76

Cash Disbursements:

1. Iguana Times	
a. Printing	4,300.97
b. Postage	1,670.04
c. Mailing Supplies	118.74
Total	6,089.75

2. Office Expense	
a. Telephone	654.92

3. Advertising & Promotion	
a. Reptile & Amphibian Magazine	10.00
b. Florida Herpetological Society Expo	160.00
Total	170.00

4. Annual Conference	
a. Board Member Transportation	864.00
b. Bahia Honda State Park Pavillion	32.10
c. Printing of Ballots & Itinerary	22.41
Total	918.51

5. Conservation Assistance	
a. San Salvador Project	400.00

6. Cost of Goods Sold	
a. IIS Tee Shirts	747.90
b. Books	451.00
Total	1,198.90

7. Bank Debits	
a. Foreign Currency Exchange Deficit	24.86
b. Florida Account-Conversion Fee to Interest Type	10.37
c. Non-Collectable Funds	43.00
Total	78.23

8. Florida State Incorporation Renewal Fee	61.25
Total Disbursements	9,571.56

Cash Balance as of January 1, 1994 11,965.49
Excess of Revenues over Expenditures
for Period 1,789.20
Cash Balance as of September 30, 1994 13,754.69

Reported by David M. Ehrlich, DVM, Treasurer

IGUANA NEWSBRIEFS

IIS ACCOMPLISHMENTS

On 2 August, 1994, the International Iguana Society, Inc. became four years old as an organization. Below is a list of our accomplishments as an international conservation and educational herpetological non-profit organization.

- ✂ Published thirteen issues of "Iguana Times"
- ✂ Important early support for the Jamaican iguana program and the Jamaican iguana conference
- ✂ Design, construction and installation of informational signs in the Allan's Cays, Bahamas on behalf of the Allan's Cay iguanas, *Cyclura cyclura inornata*
- ✂ Vegetation studies on thirteen Bahamian Islands that support endangered iguana populations
- ✂ Field survey of *Cyclura cyclura figginsi* population in the Exumas
- ✂ Important help in initiating DNA study of Grand Cayman blue iguana, *Cyclura nubila lewisi*
- ✂ Initiated first field study of *Cyclura rileyi nuchalis*
- ✂ Assistance to long-term study of *Cyclura rileyi rileyi*
- ✂ Over 7,000 free iguana care sheets distributed
- ✂ Over 1,100 telephone inquires handled

SALMONELLOSIS IN IGUANAS ON RISE

Dr. David Ackerman of New York State Department of Health, reports increases in incidence of Salmonella in pet iguanas. Between 500-1000 cases have been documented in New York state. With the importation of 750,000 live green iguanas into the USA in 1993 (USFWS), and the squalid conditions they are often kept in, this is unfortunately not very surprising.

THIRD IGUANA CAUGHT IN HAWAII IN 1994

A three foot long iguana was caught in Iao Valley on Maui and is being evicted from the state.

It dove into a pool at Kepaniwai Heritage Gardens, while police, Maui Parks and State Department of Land and Natural Resources officers tried to capture it. It was grabbed when it surfaced for air.

The iguana is being held at the Honolulu Zoo and eventually will be sent to Utah.

People who voluntarily hand over an illegal bird or animal are granted amnesty from penalties imposed by state quarantine laws, which prohibit bringing in alien species.

This is the third iguana captured by state officials this year.

Source: Irene Theofanis

NEW RESTRICTIONS IN GALAPAGOS

As a result of international publicity because of recent fires and endangered tortoise poaching, new restrictions have been put in place on the Galapagos. Ecuador announced the restrictions in late September because of concerns of over-fishing and large numbers of tourists coming to the ecologically sensitive islands.

President Sixto Duran-Ballen suspended the issuing of new licenses for tourist operations and facilities on the remote group of rocky islands 600 miles west of Ecuador. An ecological impact assessment of the effects tourism has on the islands is being prepared. Over 49,000 tourists a year visit the islands with water and electrical power in increasing short supply.

The Galapagos Islands are home to the worlds only marine iguanas and endangered land iguanas. Giant tortoises and other endangered animals are under pressure from tourists and new residents with little respect for the unique natural resources.

Source: Miami Herald Wire Service

NEW CTENOSAURA SPECIES DISCOVERED!

IIS member, Gunther Köhler and Konrad Klemmer, discovered a new species of *Ctenosaura* during a six week excursion to Honduras in April and May 1994. Five species of spiny-tail iguanas were previously known to occur in Honduras, *Ctenosaura bakeri*, *oedirhina*, *palearis*, *quinquecarinata*, and *similis*. The new species has been described as *Ctenosaura flavidorsalis*. Additional information will be reported in future issues.

IIS AT EXPO

IIS was represented at the 1994 National Reptile Breeders Expo. Deborah Neufeld, Jan Truse, and Sandy Hart did an excellent job. Over 22 new members joined IIS or were renewed. The expo was well attended with 6,000 people present.

NEGATIVE NOTE: Only two rhino iguanas were on sale at the 1993 expo. This year several dozen were available; unfortunately most appeared to be smuggled animals (see *I.T. Vol.3, No.2*). It is disturbing to see this situation in a species that has been protected for over 14 years. Hopefully this situation will be corrected at future expos.

Iguana Times Copyright ©1994 by **The International Iguana Society, Inc.**, Route 3, Box 328, Big Pine Key, FL 33043. The contents of *Iguana Times* may be reproduced for inclusion in the newsletters of other herpetological societies, provided the material is reproduced without change and with appropriate credits, and a copy of the publication is sent to The International Iguana Society. There are occasional exceptions to this policy.

Statement of Purpose

The International Iguana Society, Inc. operates as a non-profit, international organization dedicated to the preservation of the biological diversity of iguanas through habitat preservation, active conservation, research, captive breeding and the dissemination of information.

Subscription Information

The Iguana Times, the newsletter of the society, is distributed quarterly to members and member organizations. Additional copies are available at a cost of \$6.00 including postage. Annual dues for The International Iguana Society are \$25.00 for individuals, \$30.00 for foreign memberships, and \$35.00 for organizations, which receive double copies of the newsletter.

Write to:

The International Iguana Society, Inc.
Department of Biology
Southern College
Collegedale, TN 37315

Solicitations

Members of the I.I.S. are encouraged to contribute articles for publication in the *Iguana Times*, following a format like that shown in the most recent issue of the newsletter. Articles can deal with any aspect of iguana biology, ecology, behavior, husbandry, systematics, etc.

Manuscripts must be typed, DOUBLE-SPACED, with wide margins, on 8½" x 11" paper, or may also be submitted on disk (3.5" or 5.25"). We support most word processing applications in both PC and Macintosh formats. Please include file name, software name & version number on the disk, and a hard copy printout of your file. Include your address and telephone number on the manuscript.

Members are also welcome to submit letters to the Editor for publication in future issues of the newsletter. Authors of one page or more of print are entitled to three copies of the issue in which their article appears.

The Editors

Advertising policy of Iguana Times

We advertise only non-living products (except feeder insects). All products have been examined and been found to be high quality and fairly priced. Contact I.I.S., Department of Biology, Southern College, Collegedale, TN 37315, for more information.

I.I.S. 1994 Board of Directors

Robert W. Ehrig

President
Big Pine Key, FL

William Hayes, PhD

Vice President
Southern College
Collegedale, TN

David Ehrlich, DVM

Treasurer
Grassy Key, FL

Thomas A. Wiewandt, PhD

Tucson, AZ

Richard R. Montanucci, PhD

Clemson University
Clemson, SC

John B. Iverson, PhD

Earlham College
Richmond, IN

Michael Ripca

Leaping Lizards Graphic Design
Drexel Hill, PA

I.I.S. 1994 Advisory Board

Gordon M. Burghardt, PhD

University of Tennessee
Knoxville, TN

Howard E. Lawler

Arizona Sonora Desert Museum
Tucson, AZ

Richard Moyroud

Gemini Botanical Garden
Manalapan, FL

Ross Burnaman

Secretary
Tallahassee, FL

Julian Duval

Indianapolis Zoo
Indianapolis, IN

Iguana Times Staff

William Hayes, PhD

Editor-in-chief
Collegedale, TN

Robert W. Ehrig

Managing Editor
Big Pine Key, FL

Michael and Janet Ripca

Production Coordinators and Associate Editors
Leaping Lizards Graphic Design
Drexel Hill, PA

John B. Iverson, PhD

Feature Writer
Richmond, IN

Caroline Jones

Editorial Assistant
Chattanooga, TN

Marcie Ehrig

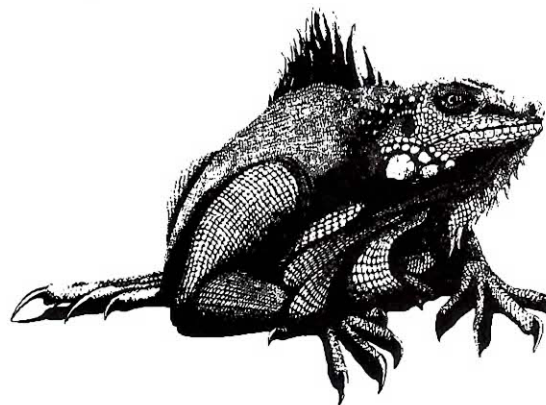
Administrative Assistant
Big Pine Key, FL

Carol Ann Barb

Baltimore, MD
Manuscript Keyboarding

The College Press

Printer
Collegedale, TN





Utila Isle Spiny-tail Iguana, *Ctenosaura bakeri*, male, Utila Island, Bay of Honduras, Honduras. Photograph: Gunther Köhler (see story on page 12)