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**AN APPROACH TO SMALL ANIMAL ECOLOGICAL STUDIES, AND THEIR RELEVANCE TO REPTILE HUSBANDRY**

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# An Approach to Small Animal Ecological Studies, and their Relevance to Reptile Husbandry

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## ABSTRACT

Care of captive reptiles, particularly wild-caught ones, is often unsatisfactory, especially with respect to cage environment and behaviour. Thorough understanding of each species' biology, ecology and behaviour can do much to minimize health and welfare problems arising from inappropriate husbandry practices. An approach to ecological studies on small vertebrates is outlined and its relevance to reptile husbandry, tested over half a century of clinical practice, is illustrated through synopses of a field study and three clinical cases.

## KEYWORDS:

Reptiles; small animal ecology; husbandry; captive care; behaviour; rehabilitation.

## INTRODUCTION

In the course of biological investigations spanning five decades, the dichotomy between the activities of field ecologists, taxonomists and museum curators on the one hand, and of veterinarians, reptile keepers, and wildlife rehabilitators on the other, has often struck me very forcibly. I believe that most, if not all, of those activities relating to the care of wildlife in captivity should as far as possible be firmly based upon a thorough knowledge and understanding of each species' biology and natural history. I have therefore tried, in this note, to integrate suggestions for an approach to studying small animal ecology with some of the more important fundamental principles of captive animal husbandry. Comprehensive reviews of these subjects, and treatment in more detail at higher levels, have been excluded as not strictly germane to the approach to, or purposes of, the present discussion.

My special interest in biomedical matters lies with reptiles and amphibians, and that may be apparent in what follows; but I hope that this brief account may be judged useful by those whose interests lie with birds, mammals, and perhaps also with fishes and at least some invertebrate groups.

The relevance of field ecology (the reason for this term will be explained shortly) to small animal husbandry and medicine becomes immediately apparent if – and only if! – Rudolph Virchow's profound (and seemingly simple) dictum is borne in mind: that disease is life under modified conditions (Virchow, 1858).

Any wild animal held in confinement is immediately in a foreign and generally hostile (or at least maladaptive) environment and is, in a very real sense, diseased. This condition may not manifest itself as organic disease initially, but the animal is under severe psychological stress that will soon become a psychiatric disorder if the animal is not restored to a more natural environment. There is all too often a curious blindness to the fact that wild animals are just as susceptible to mental and emotional disorders as are humans, and that these can – and usually do – manifest themselves, in time, as physiological disturbances that may terminate in organic disease unless normal psychological and physiological conditions are restored.

## SOME ASPECTS OF REPTILE HUSBANDRY IN SOUTHERN AFRICA, 1960 – 1990

A brief survey of selected aspects of the natural history of disease in reptiles, based on some fifty years of first-hand observations, may provide an illuminating, if somewhat unsavory, insight into my central thesis – that a thorough understanding of the biology of any given species of animal is an essential prerequisite for keeping it successfully in captivity. Without such knowledge (and, what is more important, without proper understanding), it is better not to keep the animal in captivity at all. Such knowledge and understanding can only be attained by carefully planned field studies designed to address the central questions of animal biology.

The following account is based on experiences in southern Africa from the 1960s to 2019, and should be read as such; the situation in Europe and America over the same period of time may have been rather different.

The life expectancy of reptiles held in the few Snake Parks in southern Africa in the 1950s and 1960s could generally be measured in months; those in private collections tended to live somewhat longer, but usually not much longer. The clinical picture was almost invariably that of hyperactivity or of catatonia; refusing to take food voluntarily (force-feeding was almost invariably traumatic); wasting and emaciation; and a marked susceptibility to Types I and II necrotising stomatitis (infectious stomatitis (Frye, 1991), mouth-rot, or canker) which invariably ended in death. Other diseases were by no means uncommon, and were undoubtedly associated with a severely compromised immune system. At this time literature on reptiles and amphibians was virtually non-existent apart from papers, principally on taxonomy, in the scholarly journals. Field studies on individuals and natural populations were almost unknown, and reptile keepers had little or no biological knowledge or understanding worth speaking of, regarding the animals in their care.

By 1967 I was able, on the basis of both field studies on wild reptiles and a great many post-mortems on captives in a snake park, to describe the nature of necrotic stomatitis in captive-stressed reptiles and its causes (including environmental and psychological stress), and to outline a treatment that took into account what might be termed biological and environmental pathology (Lambiris, 1967).

It was only in the latter half of the 1970s that an interest in the lower vertebrates really started to develop, and the number of amateur herpetologists with a serious interest in the subject in this part of the world grew from just a tiny handful to some two hundred, many working in relative isolation. This period saw a marked improvement in the housing and care of captive reptiles, and a marked decrease in morbidity and mortality rates. This meant a significant reduction in both the number of post-mortems that I was able to do, and in the range of disorders found at autopsy.

The situation remained more or less unchanged during the 1980s, but nevertheless amateur herpetologists were exchanging information at an unprecedented rate and husbandry practices started to improve considerably. One important consequence was the relatively sudden successes in captive breeding, something that had been notably unsuccessful in the past. Another significant consequence was the marked decline in the incidence of necrotic stomatitis, which was due at least in part to improved husbandry practices and a better understanding of reptile behaviour.

In the early 1990s, two major events occurred. Firstly, in South Africa the almost absolute ban on importing exotic species was lifted; and secondly, there was a flood of information in the form of both printed media and the Internet. These were not unmixed blessings. Some of the information available in books, magazines, the Internet, and other sources is good. Some of it is even very good. Much, however, is sheer rubbish and is reflected all too clearly in the considerable number of reptiles and amphibians that are still referred to me, the owners having acted in good faith but in pure ignorance of what they were doing to their beloved pets.

## ECOLOGY AND DISEASE

Let us return to this matter of “field ecology”, mentioned earlier. It has become apparent over the last two decades that something interesting is happening with captive reptiles.

One can easily distinguish between a wild-caught reptile brought in for treatment, and another individual of the same species that has come from a long line of captive-bred progeny. The wild animal clearly regards the terrarium as a strange and hostile environment, and tries to respond appropriately, but without success – there is no escape, and it develops first psychological, then physiological, and eventually organic disorders that require urgent intervention. The product of long captive-breeding programmes may be morphologically indistinguishable from its wild congener, but it is an altogether different animal psychologically, ecologically and behaviourally. To it, the terrarium is not a hostile environment; it has become a natural one. This is probably one of the reasons why captive breeding programmes, after a long history of catastrophic difficulties, eventually started to succeed quite well. We are really looking at "field ecology" versus "captive ecology", and this is by no means an unimportant distinction, especially if reintroduction is an objective.

Some species have obviously adapted well to captive conditions, especially among the Colubrids (in the broad sense of the term). Some species, though, which have always been notoriously difficult to keep in captivity, still remain problematic and it is not altogether surprising that the same kind of clinical picture that was so prevalent in the 1960s and 1970s still presents very frequently in these species. Whenever I have been able to help the latter patients, it has invariably been by being able to give the owner very precise and specific details about the captive environment drawn from detailed field knowledge of that particular species' biology, behaviour and ecology *in nature*. In those instances where I lack such knowledge, clinical management has tended to be less effective. It is not altogether surprising that a sudden recurrence in the last three or four years of necrotic stomatitis, a condition which I had only seen infrequently since the mid-1990s, is associated with wild-caught reptiles and those kept in 1960s conditions of housing and owners' knowledge.

Successful animal husbandry would seem, therefore, to be predicated upon to rather different concepts of ecology – field ecology, relating to wild animals and to wild animals held in captivity (hopefully only temporarily, for purposes of treatment and rehabilitation prior to return to the wild); and captive animal ecology, relating to the products of many generations of captive breeding and which would find the natural environment almost as hostile as their wild congeners would find a cage or a terrarium.

Nevertheless, it would probably take far longer to produce truly domesticated reptiles than a few decades, and I feel that a sound knowledge and understanding of the field ecology of any species is essential to its proper care in captivity as any other aspect of husbandry and welfare. It may be worth mentioning that in southern Africa, at least, many people involved with the rehabilitation of birds and mammals often seem to display a similar lack of understanding of the biology of the animals in their care. It is surely no coincidence that the legendary successes, such as the late Viv Wilson at Chipangali in Zimbabwe, have invariably been really sound field biologists of wide experience, great learning, and deep understanding. There are few veterinarians in southern Africa who have any real interest in reptile medicine, and most of those are not formally trained herpetologists. There are virtually none with an interest in amphibian medicine, and none that I know who have any sound knowledge of amphibian biology.

## AN APPROACH TO STUDIES IN SMALL ANIMAL ECOLOGY

It is with this background in mind, then, that I put forward the following outline for studies in small animal ecology in the hope that it will be of as much benefit to captive animals (via their owners and veterinary clinicians) as it has been to ecologists and taxonomists. This outline, which might be judged a useful starting point for research into small terrestrial vertebrates, is in no small measure due to the late Rudyerd Boulton, who for many years taught and guided me in the principles of biological fieldwork, and to whom I owe so much. It is confined for practical purposes to terrestrial (including amphibious) vertebrates; and addresses those investigations that can best, or only, be carried out in the field. It should be borne in mind that such investigations often require little more

than a note-book; the ability to ask good questions; the ability to observe and record accurately, thoroughly and completely; considerable patience; a pair of binoculars and a few simple meteorological instruments – a maximum and minimum thermometer, a laboratory thermometer, a rain gauge, and a hygrometer.

All good research is necessarily dependent on asking a good question to start with. A good question is one that elicits a good answer, and the latter is determined by the context in which the question was initially asked. (A good answer is one that elicits information specifically required for a particular purpose; or in the world of research, it may identify previously unrecognised ignorance, thereby indicating and defining further lines of investigation.) Either too narrow or too broad a view can lead to wrong or fallacious conclusions and interpretations. It is probably better to work from the particular to the general, given a hypothesis within the frame of which relevant facts can be sought.

The reader is not expected to become thoroughly acquainted with more than a few score of species at most – that would take many years of fieldwork. If, however, each reader is encouraged to study a few local species in depth, then the resulting pooled and shared knowledge gained within a short period (say ten years or so) could contribute very significantly to improved husbandry and clinical practices.

## BASIC RESEARCH

The approach to basic field research on small animals should address certain fundamental issues. Of these, the most important are:

**Identification and classification of the animal under investigation.**

This is an absolutely essential first step. It is by no means unusual to discover, after a study has been completed and published, that the data were based on a population wrongly identified, or that the population under investigation actually comprised two morphologically very similar, but nevertheless biologically and behaviourally different, species. In either case, interpretation of the data is almost certain to be invalidated.

Identification is especially critical when dealing with a polytypic species, one with two or more subspecies, for differences at the subspecies level are more likely to be biological than morphological, and the consequences of misinterpretation of data due to misidentifications are likely to be even more serious. If necessary, voucher specimens should be collected and submitted to a competent authority in the investigator's own country, after first getting his consent to undertake identifications and advice on how to collect, preserve, document and send specimens in compliance with the relevant legislation.

**Distribution of the animal under investigation.**

A knowledge of the geographic distribution of the species under investigation is essential, for a widely distributed taxon may well be found in habitats differing, at least to some extent, with respect to vegetation, geology and soil types, rainfall, temperature regimes, and other characteristics. This is especially important at the subspecies level, where geographic separation is a key issue.

**Observation of the animal in the field.**

Field ecology is, as noted above, a matter of asking appropriate questions and seeking answers to them that can be synthesized into a well integrated understanding of the observed species' biology. Although this paper focusses on reptiles, the principles outlined here can be applied to all terrestrial vertebrates (including amphibians). The list of questions given here is by no means exhaustive, but does include those that I think are highly relevant to the keepers of captive animals and to people involved in their veterinary care and rehabilitation. It may seem initially that some of these questions are rather academic, but on reflection they will all be seen as crucial to a proper, well-

informed, successful approach to captive animal welfare and husbandry as they are to the general biologist.

- What is the animal's preferred habitat?
- What ecological niche does it occupy? Define the niche carefully and thoroughly.
- Does it occupy the same niche at all ages and in all seasons?
- If not, what alternate niches are used, when, and why?
- Is the animal associated with a particular plant community?
- Is it associated with a particular kind of soil?
- Is it associated with a particular kind of rock or geological, geomorphological or topographical formation?
- Is it associated with a particular kind or water body, e.g. stream, river or other kind of channel, pond, dam, pan, etc.; and if so, is it seasonal or perennial?
- What are the climatic conditions that control the animal's geographic distribution?
- What are the microclimatic conditions which control the animal's ecological distribution?
- What are the biotic factors that control the animal's geographic and ecological distributions?
- Does the animal breed throughout the year, or does it become sexually active only at certain seasons or cycles?
- If reproduction is seasonal or cyclic, what are the environmental and biotic factors that initiate mate attraction, mating, nesting, oviposition or birthing, and other reproductive activities?
- What is the gestation (viviparous or ovoviviparous species) or incubation (oviparous species) period?
- How many young are born, or hatched, in a litter or clutch?
- In the case of eggs hatching, what factors determine the time of hatching?
- Is any form of parental care evident? If so, what is its nature?
- How long is the period of parental care, if present?
- What is the degree of perinatal mortality, and how is it related to litter or clutch size?
- What is the average life expectancy of a normal healthy animal in the wild?
- Is gonad development seasonal?
- What plant or animal species form the principal components of its food?
- Is there any evidence of selective feeding or predation? If so, specify the nature of the selectivity.
- Is selectivity constant throughout the year, or intermittent?
- What are the triggering or determining factors, and to what aspect of the animal's biology are they related?
- Can stomach and intestinal contents be identified in the laboratory?
- How often does the animal eat?
- How does the animal find and obtain or capture its food?
- Are there preferred foraging or feeding sites? If so, what is their nature, and how are they related to the animal's feeding behaviour patterns and strategies?
- How is food recognised, and how is it obtained or captured?
- What evidence of food and feeding habits can be obtained by examination of faeces, kill remains, middens, etc.?
- How are population numbers kept in control? (Predation? Territorial availability? Intra- and inter-specific competition? Food availability and quality? Disease epidemics? Environmental disturbances? Other factors?)
- To what endo- and exoparasites, and to what commensals, is the animal a host?
- Are parasites actively pathogenic? If so, is pathogenicity constant or episodic? If episodic, what factors precipitate it?

- Are individuals, or the population as a whole, prone to episodic outbreaks of disease? If so, what kinds of disease, and what are the factors influencing epidemiology?
- Is the animal diurnal, crepuscular or nocturnal in habits and activities?
- Where, when and how does it sleep?
- Does it use a permanent shelter, a temporary or transitory one, or none at all?
- Does it build a nest, burrow, or other kind of refuge or shelter? And if so for what purpose(s)?
- Of what materials, and manner of construction, is the shelter made, and where is it sited?
- Is the nest, burrow or other kind of shelter shared with other members of the same species? (Same sex or opposite sex? Random or constant association of individuals? Continuous, discontinuous, seasonal association?)
- Is the nest, burrow or other shelter shared with other species, either vertebrate or invertebrate? If so what is the relationship between them? (No observable interaction? Occasional or regular predator-prey interaction? Other kinds of relationship?)
- Do both male and female share in the care of the young? (Neither? Only one? [specify which])
- For how long does the parent (or parents) care for the young, and in what way?
- What factors influence duration, nature and termination of parental care?
- What are the relationships between young and adults (a) within a family unit and (b) within the population as a whole? Do the young live together with adults, or is there segregation? If there is segregation, what is the nature of the segregation, what are the causative factors, and what factors trigger movement into the adult community, and when?
- What is the composition of aggregations larger than the immediate family?
- Are these aggregations segregated by sex, age, season; or are they associations of family parties?
- Are there commensal relationships with other species?
- What are the predators upon the species being studied? Which are the principal predators, and which are secondary or lesser predators?
- How does the animal conceal, protect or defend itself, or escape from, predators or other enemies?
- How does the animal define its territory?
- What are its home range, feeding range, mating area, oviposition or birthing site, midden areas, and other identifiable sites of specific activities, and how are they influenced by environmental factors?
- How does the animal communicate with conspecifics and with other species, e.g. predators or other kinds of animal?
- Is communication vocal, behavioural, chemical, or mechanical? Does it change from one purpose to another?
- What mate recognition and isolation mechanisms are there, and how do they operate?
- How, when and where does mating take place?
- What environmental, biological, and ecological factors influence or determine mating behaviour and activities?
- Is the animal migratory, vagile, subject to local movement, or sedentary? What are the determining factors in each case?
- What is the nature of overall population dynamics, with respect to total numbers; percentages of males and females; neonates or hatchlings, juveniles and adults; birth, recruitment and mortality rates?
- What cyclic patterns of change (e.g. increase and decrease in numbers or proportions) are there, what is their nature, and what factors cause them?

## ECOLOGICAL APPROACH TO SMALL ANIMAL HUSBANDRY

To the above questions, which are essentially those for the naturalist, I append a much shorter starting list for keepers of captive animals, veterinarians, and rehabilitators. It will soon be apparent that these are really rather general starting points for much longer series of more specific questions that might be formulated for more detailed field studies on particular species, and are by no means definitive; they are simply suggestions that each reader should expand upon individually, according to knowledge and opportunity.

**For studies on natural populations:**

- How dependent upon, and how sensitive is the animal to small but highly specific environmental variables (e.g., humidity, air flow, air or water temperatures, photoperiod, light intensity and wavelengths)?
- What essential environmental and biological factors cannot be replicated under captive conditions?
- To what extent do constraints upon normal behaviour and activity patterns of wild animals, imposed by captive conditions, affect physical, physiological, behavioural, and psychological well being in captive animals?

**For studies on captive individual animals and captive populations:**

- What is normal behaviour of each species in the wild? How does the behaviour of captive individuals differ, and in what respects? (These are the two most important questions to ask, and the most challenging ones to answer. Each actually stands for a multiplicity of subsidiary questions, but together these two key questions go back to Virchow's dictum, stated at the beginning of the article.)
- What factors stimulate or inhibit gametogenesis, and therefore reproductive viability? (One could consider, among many other factors, temperature regimes; photoperiod; general and specific nutritional requirements.)
- What factors stimulate or inhibit mating behaviour and activities?
- What factors influence oviposition and post-ovipositional history in oviparous species? (The vast majority of amphibians, most reptiles, birds.)
- What behavioural changes can be demonstrated in long lines of captive-bred individuals of any given species, compared with wild individuals of the same species?
- What biological changes (as reflected by, for example, environmental requirements) can be demonstrated in long lines of captive-bred individuals of any given species, compared with wild individuals of the same species?
- What physical, behavioural, and physiological changes can be demonstrated in long lines of captive-bred individuals of any given species, compared with wild individuals of the same species?
- Are tolerance factors and lethal extremes with respect to temperature, water requirements, foods, etc., altered in captive-bred animals compared with those of wild conspecifics?

## AN ILLUSTRATIVE FIELD STUDY

The following notes are drawn from my medium-term (fifteen years) study of a group of reptiles occupying a small rock outcrop on the northeastern shoreline of Lake Chivero, Zimbabwe. The study site is small, barely 10 x 15 metres, and is set in Miombo (*Brachystegia/Julbernardia*) woodland and *Hyparrhenia* grassland, on yellow or yellow-brown sandy quartz soils with flat granite outcrops and on which lie scattered boulders of moderate size. (Fig. 1.) Within the study site is a cluster of five boulders on granite bedrock, two separated from the other three, and all within an area of 3 x 3 metres. The two boulders have an Acacia tree growing between them; the group of three boulders, nearby, are partly shaded by another nearby tree.

**Figure. 1. This site contained twenty distinct microhabitat types, each an ecosystem in its own right, exploited by the snake, lizard and chelonian species found there, of which those mentioned in the text are only a part. The highly specific niche separations and resource partitionings of these reptiles within so small an area exemplify the importance of sound knowledge and understanding any species' ecology in determining the real requirements of captive reptiles, and of good husbandry practice.**

Amongst other reptiles, this small subsection is home to the following lizards: Rainbow Skink, *Trachylepis quinquetaeniata margaritifer* (Peters, 1858); Variegated Skink, *Trachylepis varia* (Peters, 1867); Sundevall's Skink, *Mochlus sundevallii* (A. Smith, 1848); Wahlberg's Snake-eyed Skink, *Panaspis wahlbergii* (A. Smith, 1849); Ground Agama, *Agama armata* Peters, 1854; Kirk's Agama, *Agama kirkii* Boulenger, 1885; Tree Agama, *Acanthocerus atricollis* (A. Smith, 1849); Cape Rough-scaled Lizard, *Ichnotropis capensis* (A. Smith, 1838); Peters' Rough-scaled Lizard, *Ichnotropis squamulosa* Peters, 1854; Flat Rock Lizard, *Platysaurus intermedius subniger* Broadley, 1962; and, in the sandy soils adjoining the bedrock, Percival's Legless Skink, *Acontias percivali occidentalis* FitzSimons, 1941.

To the casual observer, these eleven taxa occupy the same habitat (open wooded grassland on rocky and sandy soils), and he might well be inclined to keep captives together in one large terrarium or, possibly, different taxa in separate terraria but furnished in much the same way. Either approach will very likely be unsatisfactory, for the casual observer will fail to take into account those aspects of niche separation and resource partitioning that allows so many taxa to co-exist successfully in such close proximity to one another.

The Rainbow Skink, the Kirk's Agama and the Flat Rock Lizard all exploit rock crevices for shelter, but have very different requirements in this respect.

The Flat Rock Lizard utilises very narrow horizontal crevices, just wide enough to accommodate its very flattened body, under exfoliated slabs lying on the bare bed-rock; the crevices so exploited must be extensive enough to shelter groups of fifteen or more individuals, and to allow adults and

juveniles to live apart. Adult males are very territorial and each requires a relatively large area. Females and juveniles of both sexes (which have the same colours and markings as adult females) tend to be more gregarious and to require smaller territories. Two eggs are laid in a deep crevice in which damp leaf litter has accumulated; several females may exploit the same crevice, which is usually not the one exploited by adults for shelter, for oviposition.

The Rainbow Skink and Kirk's Agama occupy rather wider crevices between or in the boulders. The former tends to be found in lower and more horizontally or only somewhat obliquely orientated crevices; the latter in more vertically and somewhat more open crevices, near the tops of the boulders. Rainbow Skinks require crevices large enough to accommodate some seven or eight adults; juveniles tend to occupy separate crevices. The eggs (6-10) are laid in crevices warmed by the sun and kept humid by accumulated leaf litter. Kirk's Agamas tend to be more or less solitary or to live in pairs. Their eggs are laid either in the ground or under an exfoliated rock slab.

The Flat Rock Lizard feeds principally on invertebrates living in the rock crevices, or just outside them. The Rainbow Skink feeds principally on invertebrates on open rock, or in the shelter of rocky overhangs or foliage. Kirk's Agama feeds only on ants moving over the uppermost, fully exposed, portions of the boulders.

The Variegated Skink lives in leaf litter on stony or rocky ground, or around tree bases, dashing into the open to seize small invertebrate prey. The Snake-eyed Skink also lives in leaf litter around stones and rocks, and under fallen rotting branches, but feeds almost entirely on small invertebrates living in the leaf litter, not in the open.

The Ground Agama lives, as its name implies, on open sandy ground between the rock outcrops and boulders, generally where there is rather sparse grass cover, and living in short burrows. The Tree Agama is strictly arboreal in the wild, though in urban areas it may occasionally be found sunning itself on brick walls. Within this study area, all three species of Agama feed principally on two species of ant. While they share the same resource, there is a clearly defined partitioning – the Ground Agama takes its prey only on open ground; the Kirk's Agama takes the same prey only on the upper parts of the boulders; and the Tree Agama will take the ants only when they are on the tree trunks.

Percival's Legless Skink is strictly fossorial and spends almost all its time in burrows; it may rarely be encountered when turning over large stones partly buried in the ground. This effectively avoids competition for niches and resources with the other lizards in the study site, but its specialised biology immediately raises problems with respect to captive housing and husbandry.

The two species of Sand Lizard are a particularly intriguing example of the need for careful field study. Morphologically, they resemble one another very closely, and their biology is almost identical. They exploit the same niches and resources, and yet they may be – as they are here – completely sympatric. How, then, do they manage to co-exist? The answer is deceptively simple. They are both very short-lived, with life spans of less than one year. When Peters' Rough-scaled Lizard is present as an adult, exploiting adult resources common to both species, the Cape Rough-scaled Lizard exists either as eggs or as juveniles, exploiting juvenile resources common to both species.

Peters' Rough-scaled Lizard mates and lays eggs in April to May; the eggs hatch in October and November (the long incubation period is due to the intervening winter months) and the hatchlings, which mature in some four to five months (quite rapidly, because of the warm summer temperatures), die off in July to September. The Cape Rough-scaled Lizard mates and lays eggs between October and December, and the eggs hatch in February and March (a short incubation period at the end of summer). The hatchlings mature in seven to eight months (because of low winter temperatures) and the adults die between December and February.

These very brief summaries of a few selected aspects (a tiny fraction of what I observed in the course of this investigation) may serve to highlight the complexities underlying the proper housing and care of captive animals, and to demonstrate why I feel that a sound knowledge of the field biology of any species of animal that is to be kept in captivity is essential for any person who is

responsible in any way for the care of that animal while in captivity. Some species are highly adaptable generalists with respect to their environment and biology, while others are highly conservative specialists. The former are more likely to do well in captivity, or at least not show any grossly abnormal behaviour or physiology, whereas the latter will almost certainly fail to thrive in captivity.

## THREE ILLUSTRATIVE CLINICAL CASE HISTORIES

### Case 1

Three Jameson's Green Mambas, *Dendroaspis jamesoni kaimosae* Loveridge, 1936, presented in the terminal stages of starvation. The snakes were wild-caught and were stated to be in good health when acquired. From the very beginning they refused to eat, and when seen they had not taken food for six months.

My examination found that the snakes were emaciated, dehydrated, very weak, and completely unresponsive to their surroundings and to being handled. Husbandry history revealed that the three snakes were housed together in a large glass tank in the owner's living room. This was furnished only with some bare branches, a water bowl and a hide box on the floor of the tank that was almost never used. A full physical examination elicited nothing of note apart from starvation and dehydration. Behavioural assessment indicated profound stress and a fugal state.

Diagnosis: Severe stress consequent on unalleviated and inescapable environmental deprivation, leading to life-threatening feeding and other behavioural disorders.

Treatment: I advised the owner to immediately place each snake in a terrarium of appropriate size, furnished with branches bearing dense foliage and with more appropriate water containers and shelters above ground level. The cages were to be arranged so that no one snake could see the other two, and that none could see the owner moving around the house. Natural photoperiods were to be ensured at all times.

One snake died the day after the consultation, but the other two responded very well to the changes, and within a few weeks were plump, relaxed, and in far better physical and psychological condition.

This case illustrates very clearly both the biological responses of an animal forced into an inappropriate and threatening environment from which there could be no escape, and the consequences of the owner's ignorance of the biological and behavioural requirements of an East African mamba whose habitat, behaviour and general ecology differ very markedly indeed from the Green Mamba, *Dendroaspis angusticeps* (A. Smith, 1849), in eastern South Africa. In this instance, the owner's extrapolating from a relatively familiar local species to an altogether unfamiliar closely related, but nevertheless very different, species led to disaster. It is also worth emphasizing the often-ignored links between taxonomy, ecology and biomedical fields. Amongst other things, *Dendroaspis jamesoni kaimosae* is immediately distinguishable from the (usually) uniformly green *D. angusticeps* by its boldly black-edged head shields and body scales anteriorly, and blackish tail. To the taxonomist, these are useful diagnostic characters. To the ecologist, they immediately suggest important differences in microhabitat, one aspect of which appears to be tied in with camouflage in different kinds of foliage. To the keeper of captive snakes, they should – but often do not – indicate a great deal about the different kinds of cage furnishings in general, and of basking and shelters specifically, that should be provided for the two species.

### Case 2

Wild-caught Dwarf Horned Adders, *Bitis rubida* Branch, 1977, from a semi-desert locality in the Northern Cape, dying inexplicably some weeks after capture. In each case, the snake showed signs of difficulty in breathing for some three or four days prior to death, suggesting a respiratory tract disorder.

On my examination of living Adders, nothing of clinical significance was found. The snakes were well nourished, in excellent physical condition, and their behaviour was within the bounds of normal for healthy wild animals.

The owner is well informed on the biology of this species, which he has studied quite intensively in the field, and the snakes are housed in terraria that closely approximate the natural environment in all-important respects. I was initially at a loss to explain the deaths of some snakes but not others, until he mentioned that the survivors were held in a different room from those that died. Careful questioning elicited the fact that the snakes that died differed in only one respect from those that did not – they were housed in a room fitted with an air conditioner. This one factor was enough to tilt the balance between survival and death. When the snakes were removed from the air-conditioned room, there were no more deaths.

Although it was difficult to judge from what the owner said during consultation, the possible cause of death was most likely low-frequency vibrations from the air conditioner, something convincingly established in several other cases elsewhere. It was not possible to decide, on the available information, whether differences in temperature and relative humidity in the two rooms played any part in the deaths or not; but I have, in my records, other instances where inappropriate temperature and humidity regimens were lethal factors.

This case illustrates rather well the points that species with highly specialized biology have equally highly specialized environmental requirements; and that no aspect, irrespective of how trivial it may seem to the keeper, can be safely ignored.

**Case 3**

A six-month-old Red-eared Slider, *Trachemys scripta elegans* (Wied-Neuwied, 1839), presenting with a suspected lower respiratory tract infection, first noticed two or three days before. The patient had been, to the owner's belief, in good health previously but was not eating well and was small for his age.

On examination, the alert and responsive terrapin showed flaring of the marginal shields, especially posteriorly, and the head appeared to be somewhat enlarged, and the eyes rather protuberant, but with normal eyelids. There was no evidence of kyphosis or scoliosis, nor of deformities of the long bones of the limbs, and the shell was well ossified. The nares and oropharynx were clear of mucus, but there was a tendency to elevate the head with extended neck, and occasional "gaping". On auscultation and percussion the lung fields and coelomic cavity were hyper-resonant. Further questioning elicited the fact that the terrapin could not submerge properly when in the water.

Although the differential diagnosis included possible pneumonia and a gastro-intestinal disorder as well as nutritional secondary hyperparathyroidism, there were anomalies suggesting that crucial information was lacking.

The answer was immediately apparent from a description of the terrapin's housing, obtained early in the interview. He was initially kept in a deep aquarium without provision of basking areas or any opportunity of emerging from the water and fed only crickets, mealworms and chicken liver. More recently a small tub containing potting mix and planted with Bromeliads and *Echeveria* had been placed in the water, and his owner noted an immediate tendency to try to crawl into the tub and burrow into the substratum, without realizing the significance of this behaviour – that the tub was an inadequate first step towards the kind of environment that the terrapin needed.

Treatment in this case was simple. I gave the owner detailed information about the size and set-up of an aquaterrarium appropriate for this species, and about a better-balanced diet – namely, a variety of plant and animal foods, appropriate for feeding upon on both land (mealworms and other insects, earthworms, chopped vegetables) and in the water (aquatic plants, small fishes, aquatic invertebrates).

After he had transferred the terrapin into a larger aquarium with shallower water, a gravel and sand bottom, haul-out and basking areas of clean sand, land and water shelter areas, and some terrestrial vegetation in as well as aquatic plants, and provided more diverse, better balanced foods, the owner reported dramatic changes in feeding and general behaviour within twenty-four hours, and the complete disappearance of the symptoms of respiratory tract infection and of inability to submerge within three days.

Although the owner is an intelligent and generally well-educated person with a keen interest in reptiles, he clearly had a complete misapprehension of the behaviour, biology and environmental requirements of his terrapin, resulting in problems that could have been very much more severe had he not sought advice promptly.

## CONCLUSION

I have attempted to emphasise the importance of ecological field studies in understanding the natural history of animals for biologists in general, irrespective of where their primary interests may lie; and for those concerned with the most effective care of captive terrestrial vertebrates in their charge, whether they be keepers and breeders, wildlife rehabilitators, or veterinarians. Although my own concern has been principally with amphibians and reptiles I am convinced, by working with ecologists and rehabilitators interested in other groups, that the general approach outlined here may be judged useful in their own disciplines too.

## ACKNOWLEDGEMENTS

The paucity of References is no oversight. The list of questions in the first part of this note are my own, which occurred to me in the course of field studies, when it became very apparent how little I actually knew. The field studies, bioveterinary questions, and clinical notes were also independent of published references.

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