

Future Directions in Reptile Medical Education

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ABSTRACT

Reptile medicine has emerged as a specialty area within the broader field of zoological medicine. It encompasses the medical needs of approximately 7,500 vertebrate species. This vertebrate class is highly diversified, having biological and medical peculiarities that differ both between and within major groups. Historically, veterinarians who have become recognized specialists with reptiles have had limited formal training in their medical management. The pet reptile trade is a multi-million-dollar business, and the popularity of reptiles as pets has resulted in a need for more veterinarians with training in their medical management. While few private practices have high volumes of reptile cases, many small-animal practices will have the opportunity to see a significant number of reptiles on an annual basis. Most practitioners with reptile medical expertise have merged their experiences as reptile pet owners with the principles of veterinary medicine taught in veterinary college. Several North American veterinary colleges have reptile medicine courses, and most have didactic and clinical courses in exotic and zoo animal medicine that include lectures and practical experience. Most accredited zoological medicine residency training programs include training in reptile medicine. The case load and interest in reptile medicine will probably never be sufficient to lead the average veterinary college to develop much more than what is currently offered. Consequently, those few colleges having more extensive course offerings, both didactic and clinical, will serve as educational centers for this discipline. Future Web-based teaching programs in reptile medicine will allow students nationally and internationally to have access to instructional material that can be continually updated.

INTRODUCTION

The class Reptilia represents a large and diverse group of vertebrates, including some 7,500 species of the orders Chelonia (tortoises and turtles), Crocodilia (alligators, caiman, crocodiles, gharial), Rhynchocephalia (tuataras), and Squamata (lizards, amphisbaenids, and snakes). While many are relatively small and benign (the majority of lizards are under 30 g in adult body weight), others, such as the largest crocodilians and those that are venomous, are a challenge to evaluate safely. Prior to the 1980s, veterinarians with expertise to work with these animals were few and far between. Likewise, until the early 1980s, courses with lectures in reptile medicine were offered in only a small number of veterinary colleges in North America. In the 1970s, zoological medicine slowly emerged as a recognized specialty area, and others such as avian medicine and reptile medicine eventually followed. When these fields first emerged, they were seen as peripheral components of the veterinary profession. A critical mass of veterinarians was needed to bring recognition to their respective fields, both within and outside academia. In certain ways, the proliferation of captive breeding and sale of pet reptiles resulted in a desire on the part of many of the young owners of these animals to seek a livelihood whereby their hobby could be merged with a profession. For some, veterinary medicine was an ideal choice. With a new young crop of veterinary students entering our profession and desiring more information about reptiles, there was a need to provide pertinent information. And it came in the form of scientific articles, books, sessions at national veterinary meetings such as the North American Veterinary Conference, specialty meetings on exotic animal medicine, and new courses in veterinary

colleges as faculty were hired who could teach these courses.

In order to understand the future of reptile medicine, it is important to understand its past. This past is tied to keeping reptiles in captivity and with the development of modern herpetoculture. The breeding of captive reptiles for the pet trade triggered a need for skilled and trained veterinarians who could diagnose and treat their health problems. And who could be better than those veterinarians who had kept these animals since childhood and were involved in their captive breeding? This article will therefore begin with a brief history of reptiles in captivity, followed by the development of the reptile pet trade and then by a look at current reptile pet ownership. A summary of current curricula in reptile medicine in veterinary colleges in North America is presented, along with training programs, current needs, and job opportunities. Finally, emerging responsibilities and perceived future needs are discussed.

HISTORICAL PERSPECTIVES

Reptile medicine is an outcome of the health care needs of reptiles kept as pets, displayed and used for educational and conservation programs in zoological parks and aquariums, used for captive breeding and sale in the pet trade, and used in research. A brief overview of the history of captive reptiles is therefore necessary to understand the development of this discipline. Detailed reviews are found in Coote,¹ Murphy,² and Kisling.³ The earliest records of captive reptiles (cobras and crocodiles) come from the pictographs and hieroglyphs at the Saqqara cemetery near Memphis in Egypt, which dates to approximately 2500 BC.¹ At this time, pharaohs used their power and money to fund

expeditions to collect these animals for private menageries. The first known zoo to keep reptiles was founded by Ptolemy I of Egypt (323–285 BC). By the second century BC, wealthy Romans were keeping private collections of animals, including snakes. In Rome, extensive animal-holding facilities called “vivaria” were constructed; the word “vivarium” persists today, referring to an enclosure for keeping, raising, or observing animals. In 1793, Europe’s first classical zoological park, the Jardin des Plantes of the Musée d’Histoire Naturelle, was established in Paris. It was in this zoo that the first observation of pythons incubating their eggs was made.

In England, Henry I established the first recorded Royal Menagerie at Woodstock around AD 1100. In 1252 this collection was transferred to the Tower of London. In 1835, most of the Royal Menagerie’s animal collection was transferred to other facilities, including the newly formed Zoological Society of London. In June 1849 the London Zoo opened the world’s first known specialist reptile house. Until 1903 London Zoo keepers were allowed to trade in surplus animals to the general public, which became an important source of reptiles to a growing number of amateur British herpetoculturalists. In 1897, the best known of these, the Reverend Gregory Climensen Bateman, published his several decades of experience of keeping reptiles and amphibians in his book *The Vivarium*.⁴ This, the first herpetoculture book in English, provides a fascinating insight into the care and availability of species during the reign of England’s Queen Victoria (1837–1901).

In the seventeenth and eighteenth centuries, the Dutch East India Company was the main supplier of reptiles and other exotic livestock into Europe through the port at Amsterdam, where they constructed special holding facilities. The Exeter Exchange, which was established in the 1770s and lasted until 1829, was a famous indoor menagerie in London. It was actually an early shopping mall or arcade, housing a variety of retail shops and market stalls. The 1860s were a boom period for the supply and sale of wild animals in zoological gardens across Europe, with a concomitant increase in interest from private keepers. In the late 1800s, Carl Hagenbeck, Jr., who inherited a pet store from his father, became the largest dealer in exotic species in the world. Hagenbeck supplied reptiles and other animals to both animal dealers and zoos in the United States.

In 1519 Hernando Cortés and his soldiers arrived at the Aztec capital of Tenochtitlan, now known as Mexico City. There they discovered probably the world’s largest royal menagerie, maintained by the Aztec emperor Montezuma. The Aztecs revered snakes as important religious symbols, which is probably why they kept so many. In the United States, reptiles were first introduced to the public with the creation of the first modern zoos. The oldest zoo in the United States, the Philadelphia Zoo, opened on July 1, 1874, having on display 212 animals, including eight reptiles. The collection slowly evolved into one of the most prominent reptile collections in the United States.

Of reptiles, it is probable that the European tortoises—the Greek or spur-thighed tortoise (*Testudo graeca*) and Hermann’s tortoise (*T. hermanni*)—were the first to be kept by private owners in England. A European tortoise (probably a succession of tortoises) was the pet of a succession of seven Bishops of Peterborough in England

from 1601 until the death of the last in 1821. In 1625, the Bishop of London, William Laud, purchased a spur-thighed tortoise that moved with him to Lambeth Palace when he became the Archbishop of Canterbury. Here the tortoise lived for another 120 years. The most famous early pet tortoise in England is a Mediterranean spur-thighed tortoise called Timothy, who was cared for and observed by Gilbert White, the father of Ecology in England. His observations are discussed in detail in his book *The Natural History of Selbourne*.⁵ Perhaps the oldest living European tortoise in the United Kingdom was another Mediterranean spur-thighed tortoise also named Timothy.⁶ For more than a century he belonged to the Courtenay family, Earls of Devon, living in the Rose Garden at Powderham Castle. This tortoise was originally found on board a captured Portuguese pirate ship in 1854 and eventually died in 2004.

In the United States, while reptiles were probably kept as pets prior to World War II, the growing economy following its end, and with it more leisure time, contributed to the increased popularity of reptiles as pets.⁷ People traveling to Florida on vacation would often return with reptiles and many other non-domestic “pets.” Traveling circuses offered American anoles (*Anolis carolinensis*) and red-eared sliders (*Trachemys scripta elegans*) for sale. Starting in the 1960s, several animal dealers in Florida began importing and offering a great variety of reptiles, many of which would be sold in pet stores in northern cities. In New York City, starting in the early 1960s, a number of pet stores specialized in reptiles and other wild animals. Soon reptile dealers in Florida were distributing price lists for direct purchase by the private sector. It would take another 30 years for the reptile business to take a major leap forward, when the first reptile expo (or show) had its grand opening in Florida. Expos are events where reptile breeders come together to offer captive-bred reptiles (and amphibians) for sale. In addition to live animals, items that can be purchased at shows and expos include feeds, feeder foods (e.g., insects), cages, equipment, supplies, books, publications, jewelry, and gift items. A large expo may attract 5,000 to 10,000 people and more than 500 vendor tables. Expos and shows also often feature educational workshops and speakers covering a variety of topics, including care and husbandry, general species information, habitat, breeding, animal photography, diseases, and veterinary medicine.

As Murphy² points out, to understand the history and evolution of the art and science of keeping reptiles in captivity it is important to recognize the contributions made by private fanciers and herpetoculturalists. Prior to the nineteenth century, detailed recommendations for captive care were limited. In the 1970s herpetoculture in Europe and the United States went through a major growth phase; many of the techniques currently used, and the astounding array of captive-bred taxa now available, are a result of the collective commitment and skill of the private sector. Zoological institutions lagged behind the private sector and slowly shifted over to breeding those species having high conservation value; in contrast, in the private sector, the focus was on “pet” species and those that could be sold to other reptile breeders. Most people keeping captive-bred animals will agree that overall they are healthier than their wild-collected counterparts. Further, captive-bred reptiles

have conservation value, since they reduce the demand for wild-collected animals.

Reptiles are also maintained and used by academicians in universities across the United States, both for education and for research. While a few individuals in universities have established breeding groups of certain reptiles, many still purchase their animals from reptile wholesalers or breeders. Much research on the nervous system and reproductive system been conducted on a handful of species such as the American anole (*Anolis carolinensis*) and the leopard gecko (*Eublepharis macularius*).

REPTILE TRADE AND PET REPTILE OWNERSHIP

In a 2001 report by US Department of Agriculture titled *The Reptilian and Amphibian Communities in the United States*, the United States is listed as the major importer of live reptiles for the pet industry.⁸ In the early 1990s, US imports and exports accounted for 80% of total world trade for about 70 reptile species listed under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Throughout the 1990s, about 2 million live reptiles were imported into the United States each year. In the mid- to late 1990s, lizards made up over 80% of all live reptile imports, snakes accounted for 11%, turtles about 3%, and crocodiles less than 1%. The number of live reptiles exported from the United States between 1993 and 1998 was approximately four to five times the number imported. Eighty-five percent of the exports were red-eared slider turtles going to South Korea, Japan, and European countries.

In the 2005–2006 American Pet Products Manufacturers Association, Inc., National Pet Owners Survey, the percentage of households in the United States in 2004 that own a reptile remained unchanged from 2002 at 4%. In comparison, in 2004, 39% of US households owned dogs and 34% owned cats. While percentage of households owning reptiles did not change in 2004, the number of households increased from 4.1 million in 2002 to 4.4 million in 2004. As of that year, 45% of all reptile owners had a turtle or tortoise, and ownership of lizards increased from 15% to 20%. However, iguana ownership fell from 17% to 15%. This correlates with the reduced sale of iguanas in the pet trade and their replacement with other lizards such as bearded dragons, geckos, and chameleons. Ownership of snakes increased from 16% to 19%. The greatest percentage of reptiles (38%) was purchased from pet stores, followed by 17% that were caught.

REPTILE MEDICINE: LITERATURE AND PROFESSIONAL ASSOCIATIONS

For the most part, prior to the 1950s, the reptile medical literature was scant and confined to descriptive reports of a handful of diseases and neoplasms. Examples include the life cycle of a pathogenic amoeba of reptiles, *Entamoeba invadens*,⁹ the reporting of a pathogenic pseudomonad species, *Pseudomonas reptilovorus*,¹⁰ the isolation of *Serratia anolium* (*Serratia marcescens* biotype A₄) from tumor-like lesions in the lizard *Anolis equestris*,¹¹ and the first description of fibropapillomas of the green turtle, *Chelonia mydas*.¹² Although we have no specific information, probably few

(if any) veterinarians had any expertise with these animals. It was almost three decades later that the first articles reviewing diseases^{13,14} and medicine of reptiles¹⁵ were published. The first text that included a section on reptile disease also was published.¹⁶ Those publishing on medicine and health problems of reptiles were self trained, since no formal training programs were available in veterinary colleges at that time.

Starting in the 1970s, the increasing popularity of reptiles as pets in the private sector, and the realization that many wild reptiles did not adapt very well to captive conditions, stimulated a need for veterinary medical information. In 1973, Fredric Frye published his first book on reptile medicine.¹⁷ Over the next 30 years, other books followed.^{18–24} Texts reviewing reptile disease also were published.^{25–27}

Several professional organizations have been instrumental in the development of reptile medicine as a discipline. The American Association of Zoo Veterinarians (AAZV) was officially founded in 1960 and at that time probably had fewer than 35 members. At the first conference in 1968, there were fewer than 50 attendees. Today the AAZV has 1,120 members. Valuable contributions on reptile medicine can be found in AAZV conference proceedings. The association's journal, the *Journal of Zoo Animal Medicine*, was founded in 1970 and, as it evolved, was renamed the *Journal of Zoo and Wildlife Medicine* in 1989. Articles on reptile medicine and disease can be found in each issue. Established in 1983, the American College of Zoological Medicine (ACZM) is an international specialty organization recognized by the American Veterinary Medical Association (AVMA). As of September 2006, there are 99 ACZM diplomates. A certification examination in reptile medicine was offered in 2004, and currently two members have passed the reptile certifying examination. In addition to the certification examination, ACZM is responsible for establishing training requirements and evaluating and accrediting training programs in zoological medicine.

In 1991, the Association of Reptilian and Amphibian Veterinarians (ARAV) was formed; it now has more than 1,100 members. The ARAV is closely associated with the AAZV and other veterinary organizations. This society publishes a peer-reviewed quarterly, the *Journal of Herpetological Medicine and Surgery*. The annual meeting hosted by this society, along with its annual proceedings, is a valuable source of information for veterinary students and practitioners on current issues in herpetological medicine.

Another specialty organization recognized by the AVMA is the American College of Laboratory Animal Medicine (ACLAM). This college was founded in 1957 to encourage education, training, and research in laboratory animal medicine; to establish standards of training and experience for veterinarians professionally concerned with the care and health of laboratory animals; and to recognize qualified persons in laboratory animal medicine by certification examination and other means. Currently there are more than 700 ACLAM diplomates. In the late 1960s and 1970s, there were close ties between the AAZV and the ACLAM. Because of their training in primate medicine, many ACLAM-boarded veterinarians provided invaluable support for veterinarians in zoological institutions. A small number developed an interest in reptile medicine

and made contributions in this field. However, given the number of laboratory animal veterinarians in universities and colleges in the United States, relatively few have had specific training in reptile medicine. More with training in reptile medicine are needed to address health issues of reptiles being used in universities for education and research.

CURRENT CURRICULA FOR THE TRAINING OF UNDERGRADUATE VETERINARY STUDENTS

As with more traditional animal groups, before a clinician can be expected to appropriately treat reptiles she or he must have an understanding of anatomy, physiology, husbandry, medicine, and surgery. Although this training requires the student to take courses common to all vertebrate species, some level of specific training is necessary. The majority of veterinary schools offer didactic, pre-clinical courses in zoological medicine that include basic reptile husbandry and medicine.²⁸ Titles for these courses vary from college to college and include Multispecies Medicine (Auburn University), Special Species Medicine (Colorado State University), Special Animal Medicine (Oregon State University), Special Species (University of Wisconsin), Pet Bird and Exotic Species Medicine (Iowa State University), Companion Bird and Exotic Animal Medicine (Kansas State University), Avian, Zoo and Exotic Animal Diseases (Louisiana State University), Non-mammalian and Avian Medicine (Ohio State University), Avian and Exotic Pets (Oklahoma State University), Medicine and Surgery of Non-traditional Pets (Purdue University), Comparative Medicine (Tufts University), Non-domestic Pet Medicine (University of California, Davis), Exotic Pet Medicine (Tuskegee University), and Exotic Animal Medicine (University of Georgia). However, most veterinary colleges provide less than six hours of lecture material on reptile medicine. Wet laboratories are offered in some of these courses that offer students experience in gross anatomy and common clinical procedures. Based on an assessment by the ACZM of courses offered in zoological medicine in North American veterinary colleges, only four veterinary colleges currently offer elective didactic courses specifically in reptile medicine (see Table 1). In the United States, in addition to the classes offered during the academic year, some specialty courses such SeaVet (offered through University of Florida) and AquaVet

(offered through Cornell University and the University of Pennsylvania) include lecture material on aquatic reptiles.

In the clinical training years, most veterinary schools (22/32) provide some opportunities for students in zoological clinical sciences.²⁸ Of these, 18 schools have clinical clerkships specifically for non-domestic species that go by various names. Some examples are Zoological Medicine (Colorado State University, University of California, Davis, University of Florida); Clinical, Wildlife, Exotic and Zoo Animal Medicine (Cornell University); Exotic Animal, Wildlife, and Zoo Animal Medicine (Kansas State University); Avian, Zoo, Exotic, and Marine Animal Medicine (Louisiana State University); Clinical Exotic Pets and Bird Practice (Michigan State University); Companion Avian and Exotic Animal Medicine (University of California, Davis); and Avian and Zoological Medicine (University of Tennessee). This clinical clerkship is a core course in only three schools, one of which is the University of Florida.

The clerkship in Zoological Medicine at the University of Florida is two weeks in length. At the University of Florida, reptiles represented 24% of the total number of client-owned cases admitted to the Zoological Medicine Service (ZMS) from January 2000 to August 2005. For the same period, reptiles represented 31% of the total number of animals (primarily injured wildlife) donated to the ZMS. Additionally, the ZMS evaluates reptiles at several zoological collections during biweekly visits. Students routinely accompany the veterinary faculty member providing support for these institutions, along with the zoological medicine resident who is on field duty for that week.

FULFILLMENT OF EDUCATIONAL NEEDS IN REPTILE MEDICINE

The species that most veterinarians will treat in practice have been changing over the past several decades. The typical veterinarian may not see a domestic pig in practice but will probably routinely see pet reptiles. Given the strong possibility for veterinarians in companion-animal practice to work with reptiles, we believe that students should have at least 10 to 20 hours of didactic training in a core didactic course in veterinary school. The lecture topics offered in the core didactic course may be mixed with avian and small-mammal medicine and should focus on clinical evaluation, husbandry, and basic medical procedures. Students should

Table 1: Courses in reptile medicine in veterinary colleges in North America

College	Title of Course	Credits	Contact Hours	Elective
Cornell University	Reptile Medicine and Surgery	1	14	Yes
North Carolina State University	Advanced Topics in Reptile Medicine	2	40	Yes
	Sea Turtle Medicine	2	40	Yes
Texas A&M University	Reptile and Amphibian Med and Surgery	1	16	Yes
University of Florida	Reptile Medicine and Surgery	1	20	Yes

also have an opportunity to include at least one clinical rotation where reptiles are commonly examined and treated. This level of training should provide a basic understanding of reptile biology and husbandry, physical examination of commonly kept pets, and concepts of diagnosing and treating some of the more common diseases seen in reptile medicine. Students interested in further training should be given access to advanced elective courses in reptile medicine such as those currently offered at the University of Florida (see Table 2).

Ideally, every school should provide the basic core and advanced reptile didactic course material to all veterinary students. While this is the only way to ensure that basic knowledge of reptile medicine is imparted to all students within a reasonable time span, it is not easy to add a new course to a curriculum that is typically packed with material and has limited slots for new courses. Then there is the issue of needing staff members or faculty with the broad experiences in reptile medicine needed to oversee such a course. Realistically, most schools will continue to offer lectures in reptile medicine as a component of more general courses in exotic pet and zoological medicine. Schools lacking instructors capable of presenting this core material should hire visiting reptile medicine specialists to provide the needed lectures. Advanced clinical training could be obtained at other veterinary schools with large zoological programs that can serve as centers of excellence in reptile medicine.

Clinical experience in reptile medicine should be provided within the framework of a zoological medicine rotation. This should be offered within the school's teaching hospital, provided there is a sufficient case load and available clinical expertise. Alternatively, students can attend externships in zoos or specialty practices where this experience is available. All veterinary schools should maintain a list of approved externships and provide information as to whether they provide reptile experience.

Table 2: A typical lecture outline for a core didactic class in reptile medicine

Lecture Title	Hours of Lecture
Taxonomy and Biological Concepts	1
Reptile Anatomy	2
Herptoculture	1
Advanced Nutrition	1
Physical Examination	2
Clinical Techniques	1
Diagnostics	2
Reptile Infectious Diseases	5
Antimicrobial Therapy	2
Anesthesia	1
Surgery	2

OPPORTUNITIES FOR POST-GRADUATE TRAINING AND BOARD CERTIFICATION

Internships and Residencies that Include Training in Reptile Medicine

There are presently no private, academic, or zoo internships or residency programs that emphasize training in reptile and amphibian medicine. This reflects the diversity of these programs, which typically give no special emphasis to any particular vertebrate group. For more information on relevant training programs, the reader is directed to the Web sites of the Veterinary Internship and Residency Matching Program (VIRMP), the AAZV, and the ACZM.^a

Board Certification

In North America, the only recognized board certification for reptile medicine is within the American College of Zoological Medicine. Veterinarians may take the certification section in reptile and amphibian medicine after successfully completing the more general qualification examination. There are presently two diplomates of the ACZM certified in reptile and amphibian medicine. To be eligible to take the examination, a veterinarian must have completed either an approved three-year training program or six years in an area of zoological medicine. In addition, the examinee must fulfill the publication requirement of five first-authored manuscripts published or accepted in an approved peer-reviewed journal. At least one of these publications must be based on a research project; the remainder can be case reports.

There has been discussion of establishing a certification exam for reptile and amphibian medicine under the American Board of Veterinary Practitioners, similar to that for avian practitioners. An examination committee will be established in the near future.

CURRENT NEEDS, JOB OPPORTUNITIES, AND THE NATURE OF THE JOB MARKET

Zoos and Aquariums

Zoological parks and aquariums need to have veterinarians trained to treat all species in their collections. Currently there are approximately 350 to 400 veterinarians in zoological parks in North America. On an average over the past 10 years there have been 6 to 10 new zoological medicine positions opening at zoological collections every year. While zoos and aquariums do not employ species-specific veterinarians—rather, zoo veterinarians work with a diverse population of animal species—each zoo vet tends to develop a greater level of expertise with certain animal groups. Since most zoological collections have reptile departments, and the reptile house tends to be a major attraction and educational department for the zoo, these veterinarians need be trained in reptile medicine. Several zoo veterinarians have decided to make their careers in zoo medicine because of their special interest in reptile medicine. A few have eventually crossed over from clinician to curator of a reptile department. Zoological collections often include reptile species that are not considered classic companion animals (e.g., venomous snakes and crocodiles). These dangerous species are not generally included in core reptile medicine classes taught to veterinary students. Learning to work with these animals requires additional

training through a residency training program in zoological medicine. For some individuals this will be on-the-job training.

Private Practice

From 1999 to 2005, 79% of graduates of the College of Veterinary Medicine, University of Florida, took jobs in small-animal clinical practice. In the United States, while there is a single specialty practice that has a reptile case load of 75% and several specialty practices with reptile case loads around 25%, many companion animal clinical practices are seeing a smaller, but growing, percentage of reptiles as part of their case load. Our practice at the University of Florida has a large zoological medicine case load that is approximately 24% reptiles. Employers hiring prospective clinicians for high-volume practices are looking for recent graduates with proficiency in assessing and treating diverse animal species, including reptiles. Several veterinarians with expertise in reptile medicine and primarily employed in a companion animal practice have also served as consultants to large reptile breeding operations, laboratories where venomous reptiles are kept for venom production, and businesses importing and selling reptiles to the pet trade. Over the last 15 years there has been a dramatic rise in the number of private captive reptile breeding facilities in the United States, and most will use local practitioners to meet their veterinary needs. As these operations continue to grow, there will be a steady need for veterinarians with expertise in reptile medicine.

Academia

There are no clinicians in veterinary colleges in the United States exclusively employed as reptile clinicians; academic veterinarians working with reptiles are generally doing so as part of an exotic pet or zoological medicine service. Given that only 18 schools have clinical clerkships for non-domestic species, employment opportunities for veterinarians in these programs is limited. While no exact figures are available, on average most programs have two clinicians on these specialty services. Even if this figure doubles over the next five to 10 years, there still will be limited employment for exotic animal/zoo animal clinicians in academia. This is no different from other specialty services in academics, such as neurology and cardiology. Likewise, there are few veterinarians in academia working with reptiles as primary research animals. Typically, those choosing this path had a primary interest in reptile research prior to selecting a career in veterinary medicine.

EMERGING RESPONSIBILITIES

Potential areas of full- or part-time employment for veterinarians specializing in reptile medicine include private exotic practice, large zoological collections, government (including public health), academic, and commercial reptile production facilities. Many of these areas have been discussed in the previous section.

There has been increasing concern about and recognition of the potential for lower vertebrates to harbor, if not facilitate, the emergence of significant zoonotic diseases. Recent studies and reports have shown the ability of captive alligators to harbor the West Nile virus.^{29, 30} This virus not only can kill humans but, given the right conditions, may

have a significant effect on populations of certain free-living wildlife, such as corvid birds. Salmonella is also a well-described zoonosis harbored by captive reptile populations. These examples stress the need for public-health veterinarians familiar with the recognition and management of the diseases of free-living and captive reptile populations.

Many reptile species have historically been exploited for commercial uses such as food, leather, medicinal products, and pets. Although international treaties and changing public opinion have suppressed their exploitation, there is an increasing recognition that commercialization is beneficial to long-term conservation in some countries. Examples of reptiles that are presently exploited include crocodilians, freshwater and marine turtles, lizards, and some snakes. Veterinary support is increasingly needed to assist in developing humane slaughter techniques, improving production through nutrition and disease prevention, and reducing zoonotic disease transmission.

Many species of venomous reptile are maintained in captivity for venom collection. These venoms are used for antiserum development and for research. Venom components are being explored for potential commercialization of novel biologically active compounds. Given that some venomous reptile collections are quite large, with animals numbering in the thousands, and quite valuable, veterinarians are needed to maintain the health of these collections.

The increased movement of live reptiles through international trade has resulted in the establishment of populations in ecosystems where they have not previously existed. Many such introductions are insignificant in their effects on local ecosystems. In several cases, however, introduced reptiles are having significant adverse effects. The most notable example is the introduction of the brown tree snake into the Pacific island of Guam, probably during World War II. This animal is acknowledged as the primary cause of the extinction of many native terrestrial birds on this island. Consequently, much research and money has been invested in finding a means to reduce and/or eradicate this snake. In addition, much time and effort is spent on preventing its introduction to other islands, including those of Hawaii. Veterinarians have been at the forefront in developing strategies for controlling this snake species.

Many reptile species are suffering increasing pressures in the wild, primarily from habitat destruction and over-exploitation. Disease as a contributing cause of diminished populations is just beginning to be recognized. Veterinary input has been essential in evaluating the effect of disease in several reptile populations. Examples include mycoplasmosis in free-living populations of desert and gopher tortoises and fibropapillomatosis in marine turtles. Reptiles (and amphibians) have also increasingly been investigated as bio-indicators of disease threats to wildlife and, potentially, the humans that inhabit their ecosystems.

PERCEIVED FUTURE NEEDS AND PERSPECTIVES

Presently there are no exclusive reptile medical specialists in the United States, and in the foreseeable future the need for such specialists appears limited. However, this does not mean that the field will remain static, with little need for growth. To the contrary, reptile medicine has dramatically increased in sophistication over the last decade.

This is primarily because of a handful of clinicians with the drive and desire to do quality clinical work; to participate at workshops, continuing education programs, and specialty sessions at state and national meetings; and to publish scholarly works such as books and scientific articles in the refereed literature. These activities have encouraged others to pursue careers in this field. Thus we need to be thinking about how to increase the base of this group to make even greater contributions to the field.

Veterinarians with training in reptile medicine will continue to be needed in the context of zoological and exotic animal medical practice. There is also a need for better-educated veterinarians who are capable of working with reptiles in a multitude of settings. Recent graduates who have long-term experience with reptiles as pets have an advantage over those who do not. Therefore, we need to identify new veterinary students with this background and ensure that they receive the best advice possible concerning possible opportunities in this field. When instructional experiences are limited locally, students should be encouraged to take externships at other schools that offer broader experiences.

Most North American veterinary colleges offer six hours or less of instructional time in reptile medicine. Similarly, while most veterinary colleges have clinical programs in zoological or exotic pet medicine, the amount of student exposure to reptile clinical cases is small. Thus it is necessary to be realistic about the level of training a recent graduate can be expected to have gained at his or her own college. Certainly six hours or less is inadequate to prepare veterinary students for a career in this specialty. For the most part, all reptile medicine clinicians have developed their expertise in spite of limited training in veterinary school. In the past, these individuals gained their expertise by post-graduate on-the-job experiences. To a certain degree, this is still true today. Still, there are a few programs, such as the one at the University of Florida, which has earned special recognition in this field because of its location; the array of reptile case material seen through the Zoological Medicine Service; and interactions with zoology department faculty members who are herpetologists and sea turtle biologists, with state agencies such as Florida Fish and Wildlife Conservation Commission, and with federal agencies such as the National Marine Fisheries Service. The University of Florida program receives students from other veterinary colleges into our service, and, while a number have had a specific interest in reptile medicine, they are integrated into the zoological medicine service rotation required of all our veterinary students rather than creating a specific experience in herpetological medicine. While there is an opportunity to create such an experience, we have not done so, primarily because of the time it would take for one of us to orchestrate such an experience and to keep it running for the handful of students who would take it as an elective. Usually one person becomes the driving force for such a program.

The creation of the ARAV was a major turning point in the promotion of reptile medicine as a specialty discipline. The organization is doing its best to recruit veterinary students and new graduates as members. As an example, they are working to expand student outreach by offering a student competition for articles for the 2006 annual conference. This

association can also help by developing a comprehensive listing of goals and objectives for the minimum coursework offered by each veterinary college and by developing and recommending an ideal course to be followed by those schools capable of serving as centers of excellence for students at other colleges who desire educational experiences in reptile medicine. This also could serve as a template or provide guidance for local course development.

The training programs in zoological medicine recognized by the ACZM vary in their ability to provide in-depth experiences in all aspects of zoological medicine. Similar limitations apply at both undergraduate and residency training levels; that is, the case load and local expertise will determine the level of training in this and other fields. Recognized training programs in zoological institutions with large reptile departments are well suited to expose their residents to reptile medicine. It will take a special effort by a clinician involved in the training program to be creative in developing a schedule that maximizes residents' exposure and training in this field, given all the other demands on residents' time.

Veterinarians planning to develop a career in reptile medicine need to be exposed to concepts and methods of research. Currently at the University of Florida, all veterinary students are required to do a research project and present it as either a poster or a platform presentation during the beginning of their senior year. There are also opportunities for veterinary students to pursue a combined PhD. However, it must be realized that relatively few students are capable of such rigorous commitment. Those students capable of doing such programs need to be identified as they enter veterinary college and supervised very closely for a successful outcome. We need to recruit more veterinary students interested in reptile medicine into such graduate programs, either concurrently, during veterinary college, or sequentially, after they graduate. The field of reptile medicine needs more members capable of performing independent research and publishing scientific articles in the refereed literature. Since the inception of the residency training program in zoological medicine at the University of Florida, our residents have been very successful in publishing refereed articles, including those involving reptiles or their diseases, in both clinical and research journals. A listing of their articles can be found at <<http://sacs.vetmed.ufl.edu/Services/ZooMed/InternRes/residentpub.htm>>.

Four of the 28 past or current zoological medicine residents at the University of Florida elected to pursue a graduate program (one already had a MS degree and two were finishing their PhDs when entering the residency), only one of which involved a reptile health problem. Given the problems with emerging infectious diseases, veterinarians in zoological medicine training programs, and those with specific interest in reptile medicine, should consider training programs in public health.

Web-based courses covering recommended didactic elective material could also be developed by specialty organizations or academic programs of excellence and shared across training programs in different schools. Reptile medicine could be enhanced through the creation of workshops to educate non-specialty educators or through faculty exchange between institutions. The Web page for the

zoological medicine program at the University of Florida <<http://sacs.vetmed.ufl.edu/Services/ZooMed/Index.htm>> includes a link to a page listing current research and clinical topics in reptile medicine. This can be expanded to include teaching modules, case material, lecture material, and PowerPoint presentations used in the elective Reptile Medicine and Surgery course offered to third- and fourth-year veterinary students. Streaming videos could be added to enhance the learning experience. More elective courses using the model of AquaVet and Envirovet could be presented as special summer courses or regional courses at appropriate centers of excellence.

There are several dozen universities in the United States where reptiles are kept for either education or research. Some universities have established breeding colonies to meet their research needs. While major universities have full-time laboratory animal veterinarians who provide veterinary support for these investigators, few have received specific training in reptile medicine. A minimal training needs to be defined and provided for trainees in these programs.

CONCLUSIONS

Reptile medicine has come a long way in the last 15 years, but it has an even longer way to go. While in certain ways the most difficult years are behind us, the future is still full of unknowns for those desiring to enter this nascent field. Most veterinary colleges provide few lectures in reptile medicine, and most of these are in elective courses such as special species or exotic animal medicine. Obviously, more lectures should be provided to meet the needs of the increasing numbers of reptiles being kept as pets. Given that most colleges will not have the case load, the faculty, or the commitment to develop much more than they are currently offering their students, it will be up to certain colleges to serve as national centers of educational excellence in reptile medicine. While there are more opportunities today than ever before for veterinarians to work with reptiles, veterinarians can increase their opportunities by seeking post-graduate training in specialty disciplines such as zoological medicine, laboratory animal medicine, or pathology. In each of these specialty areas we can find members who have a primary interest in reptiles. Given the importance of emerging infectious diseases in wildlife, including reptiles, graduate programs in infectious diseases and epidemiology also should be considered.

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NOTE

- a VIRMP <<http://www.virmp.org/virmp/>>; AAZV <<http://www.aazv.org/edcenter1.htm>>; ACZM <<http://www.aczm.org/>>.

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