THE ISLAND, THE RATTLESNAKE, AND THE SPECIES SURVIVAL PLAN

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Though many varieties of animals occur in limited or restricted habitats, few are as vulnerable as those occupying a niche on an oceanic island. Most island faunas have suffered to a greater or lesser degree throughout recorded scientific history, some to the point of extinction, and mostly due to the activities of Man. Islands, particularly those located in warm tropical climates, have always been exciting ports of call for sailors, naturalists and other travellers, and in general, the degree of vulnerability and persecution of animal populations has been directly proportional to the popularity (for whatever reason) of the specific island.

Insular animal populations, because of their isolation from the mainland, are of great interest to zoologists. Because in most cases gene flow between these populations has long ceased, relationships over time can be assessed through studies of the degree of differentiation exhibited between populations. To the herpetologist, the number of examples are almost endless, ranging from the geckos of Madagascar and elsewhere within the Indian Ocean, to the Aldabra in the Indian Ocean and those of the Galapagos in the Pacific, off the coast of Equador. All of these animals have evolved over the centuries in these specific island habitats, and once habitats are destroyed, then so are their animal populations ... probably forever.

Certainly one case displaying a tremendous degree of insular differentiation occurring within a single group involves the rattlesnakes of the genus *Crotalus*. A great wealth of varieties can be located on a total of 27 islands on either side of the Baja California peninsula, 22 in the Gulf of California and five in the Pacific Ocean. Though the majority of cases of rattlesnake inhabitation involve mainland forms, six are endemics currently classified as distinct subspecies of *C. enyo, C. mitchelli, C. molossus, C. ruber* and *C. viridis*. Three other forms are unique enough to have been afforded specific status, and these are *C. catalinensis, C. exsul* and *C. tortugensis*. Two mainland varieties, *C. e. enyo* and *C. m. mitchelli,* are apparently the most ubiquitous, being found on seven and six islands, respectively. In addition to the above, there is one other island, somewhat removed from the others, that is inhabited by its own endemic rattlesnake.

The case in point, and the topic of this article, is the tiny island of Aruba, located in the southern Caribbean Sea. It is one of the Netherland Antilles, a group of several small islands located not far from the country of Venezuela in northern South America. It is said that during Pre-Columbian times, Aruba was heavily forested, but most of the trees were removed for making charcoal. Subsequently, sparse rainfall and erosion have prevented reforestation, thus leaving the island as it is today, mostly arid and somewhat rocky ... quite unlike the tropical paradise so often alluded to in travel advertisements.

But Aruba does have its beaches, and because of this, tourism and the local population have boomed in the last 15 to 20 years with the introduction of resort hotels and gambling casinos. With an estimated population of 65,000 people, combined with the island's size, a clash between Man and the indigenous fauna was inevitable.

Perhaps the most seriously threatened animal on the island is *Crotalus unicolor,* the Aruba Island rattlesnake, and a number of factors are responsible. First, the primary habitat of this species is a dry, rocky and generally inhospitable portion of the centre of

the island. With continued population growth, much of the original habitat has been altered for use by Man, thus reducing the area available for this species. Second, Aruba is overpopulated with feral goats that were either released or escaped many years ago. As is usually the case, the introduction or non-control of feral animals can, and often does, wreak havoc with indigenous animal populations, particularly in fragile environments such as that occupied by this rattlesnake. And finally, let's face it, *C. unicolor* is a snake, and a venomous one at that. Until very recently, the Dutch government of Aruba hesitated to admit that there was an endemic rattlesnake inhabitating their island for fear of driving off tourists and trade. Since a permit for export of animals from the Aruba government is required prior to allowing import into the United States by the US Fish and Wildlife Service (*C. unicolor* is listed as "Threatened" by the Service), this attitude made it virtually impossible to obtain specimens for captive-breeding programs.

Very little is actually known about *C. unicolor,* and as is the case with many varieties of truly rare animals, much more is known of this animal's biology from work with captive specimens than from observations in nature. It was first collected in the 1880's by Dutch naturalist van Lidth de Jeude and described to science as a variety of *Crotalus horridus* (the Timber rattlesnake) in a publication of the Leyden Museum appearing in 1887. A number of taxonomic changes occurred until 1936, when herpetologist and rattlesnake expert Howard K. Gloyd elevated *C. unicolor* to specific status, again owing to its differentiation from mainland counterparts. Since the original description and until concerted efforts were made in more recent years to locate specimens, only a handful have been available for study. One such was a gravid female acquired by the Staten Island Zoo which died prior to giving birth, but the description of this snake and her brood of twelve dead and slightly premature young by Kauffeld and Gloyd in 1939 presented the first basic information on reproduction in this form. Gloyd published his monograph on rattlesnakes in 1940, and at that time, a total of 17 specimens (including the above female and young) were available.

Though a few of these rattlesnakes have been exhibited in United States zoos over the years, it wasn't until the late 1960's and early 1970's that some effort was made to bring together enough animals to establish a viable breeding group. Among others, a pair was obtained by the Houston Zoological Gardens in 1969 from an animal dealer on Aruba, and two more specimens were acquired in 1976, source unknown. These animals and their offspring produced nine broods of young over the years at the Houston Zoo, the first in 1973.

This information was presented in an article in 1982 by Gary Carl and others in *Herpetological Review.* Considering that broods from a few wild-caught females have numbered anywhere from nine to 15, the captive results were somewhat surprising. In their study, broods consisted of two to five live young (average of 3.6), and when counting stillborn and infertile egg masses, the range was three to eight with an average of about 4.5. Additionally, there seemed to be a decrease in reproductive potential with increasing age (a factor not apparent in some other reptile forms), and the number of stillborn young could well be an indication of inbreeding.

In the early 1980's, the concept of the Species Survival Plan (SSP) was conceived by the American Association of Zoological Parks and Aquariums. As the plan was developed and implemented, first with a few species of mammals, then birds, and then reptiles, it was specifically defined as "an attempt to develop scientific and cooperative programs to propagate and preserve endangered species in captivity through populational management". The criteria for a species to be considered under an SSP management plan included 1) a degree of endangerment in the wild, as defined by the IUCN, USDI, CITES or similar organization, 2) sufficient captive "founder" stock (wild-caught

specimens or their offspring) to ensure bloodline representation, and 3) an organized group of professionals with knowledge of husbandry and breeding techniques and sufficient support, both facilital and financial.

More often than not, the second of these criteria has presented the most problems.

A species must be represented at a certain minimal level in captivity, and if not, there must be some evidence that additional wild-caught animals will be available for introduction into the program. Along with this, the captive history of each specimen must be examined to ensure that mistakes in individual identity will not be made as pairs are selected and placed together for breeding. Ironic as it seems, because of this, a number of the species represented in the fewest numbers in North American collections cannot be considered as candidates for the program.

At this time, there are 38 SPP programs, and these include four birds, 28 mammals, five reptiles, and one amphibian. The Puerto Rican toad *(Bufo lemur)* is the single amphibian representative, but a number of other species are under consideration. The reptiles are the Chinese alligator *(Alligator sinensis),* the Orinoco crocodile *(Crocodylus intermedius),* the Radiated tortoise *(Geochelone radiata),* the Malagasy ground boa *(Acrantophis dumerili),* and *C. unicolor,* the Aruba Island rattlesnake.

A few years ago, the Houston Zoo petitioned the American Association of Zoological Parks and Aquariums in an attempt to have *C. unicolor* included as an SSP target species. The petition was accepted, and work begun to formulate a program that would best insure the continued survival of the species in captivity through selective breeding and other techniques. As with all SSP programs, participants had to be selected. Andrew Odum and Karl Peterson of the Houston Zoo were chosen as Species Coordinator and Studbook Keeper, respectively. The Knoxville Zoo, along with zoos in Los Angeles and San Diego, were chosen as the three Primary Institutions to work with the most genetically valuable specimens, and the author was selected to serve on the SSP Propagation Group, a committee which, in short, makes the decisions affectng the future of captive *C. unicolor.*

The primary objectives of the program, as stated in the coordinators report, and not unlike those of other SSP programs, are "to establish a demographically stable population and to retain the maximum possible genetic diversity within the population". Though these may seem to be relatively simple goals, the captive population makeup of *C. unicolor* is such that some inbreeding will have to occur unless additional wild stock can be obtained. As it turns out, there are only three living founder specimens (wild-bred animals) included in the 68 living United States animals, and these were imported prior to 1975. Additionally, there are only eight founder animals represented genetically in this entire captive population. Of these, a single Houston female contributes approximately 50 per cent of the founder representation. The three living founders have no representation, so every effort is being made to breed these because of the potential effects of advancing age, as mentioned above. Though rattlesnakes may live in excess of 20 years, these animals were adults when imported, thus their exact age is impossible to determine.

Of the entire captive population, 38 specimens are inbred from 25 to 37.5 percent. In order to utilize these inbred animals, a plan is being devised to create a number of sub-populations. Through this technique, inbreeding will occur only within each sub-population, and eventual inter-breeding between these populations will produce specimens with a zero inbreeding coefficient. Specimens produced through this plan may ensure the continued survival of *C. unicolor* in captivity, and may be suitable for future release back on to Aruba assuming conditions on the island are favourable.

In late 1984, a number of specimen transfers took place through the program. The Knoxville Zoo received a founder related female (Houston Zoo born) from the Brownsville Zoo, and it bred with a captive-born San Diego male in February of 1985. On 20 July 1985, a first for the Knoxville Zoo occurred when the female gave birth to one male and one female offspring, some of the most genetically valuable youngsters available, again due to a zero degree of inbreeding. Other broods were produced in 1985 by zoos in Los Angeles and Ft. Worth, so breeding appears to be on the upswing.

Most zoo breeding of *C. unicolor* seems to be on what I term the "Los Angeles" or the "Houston" cycle. The former indicates that breeding takes place in the spring, the latter with breeding occurring in the fall. Though the reasons for this are not clear, specimens at these respective institutions seem to follow these patterns. The above brood was produced on the Los Angeles cycle, but in mid-October of 1985, three months after parturition, the pair was again seen to be engaged in courtship activity. Though actual copulation was not observed, a second brood of five males and three females was born on 28 April 1986, just nine months after the birth of the first. This short birthing interval, combined with the above average captive brood size, has provided not only additional life history information on the species, but a "shot in the arm" for the *C. unicolor* program as well.

Recently, the Propagation Group has been in touch with Julio Maduro, a prominent naturalist on Aruba, and the news is not as dismal as expected. Maduro reported that *C. unicolor* has been afforded specific protected status by the government, which may indicate a much more enlightened attitude than in years past. The remaining habitat has been turned into a small national park, and vehicular traffic has been banned from the area. A program has also been initiated for the removal of feral goats. This, combined with an increased tolerance by locals seems to brighten the future for *C. unicolor* in its native environment.

The Propagation Group has also been in touch with government officials regarding a cooperative effort to ensure the animal's survival, and they seem very favourable toward the efforts of the SSP program. On behalf of the *C. unicolor* project, Species Coordinator Andrew Odum recently received a Nixon Griffis Fund for Zoological Research grant, sponsored by the New York Zoological Society, which will support the initial SSP groundwork on Aruba, including meeting with local officials and finalizing future collaborative efforts. Plans are also being formulated for some Propagation Group members to visit the island for a preliminary study of the habitat and possibly for the procurement of some additional specimens for inclusion in the captive-breeding program. If so, a much more genetically diverse captive population could be the result.

Regardless of potential disasters to natural habitats, islands and otherwise, the future of an ever increasing number of animals may well rest in our zoological parks. Though the situation on Aruba Island is apparently not as grim as predicted, it was only through a last-ditch effort by the Aruba government, local naturalists and the Species Survival Plan that may have turned things around for *C. unicolor.* But how about the others, the geckos, the Komodo monitor, and the giant tortoises ... these may not be so lucky. Zoo work can be exciting and rewarding, and there seems to me no greater reward than in knowing that we are at least partially responsible for the continued survival of an animal species. These are not simply goals for the future, they are commitments that all of us in this field must accept and work hard to achieve ... if not, some species of animals will have no future.

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