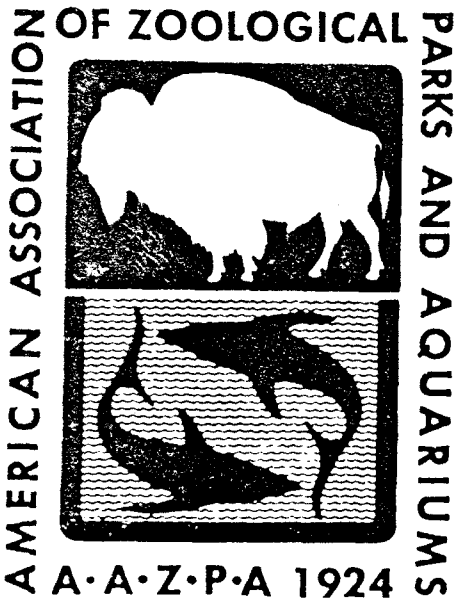

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CAPTIVE MANAGEMENT AND DISPLAY TECHNIQUES FOR BATS

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The mammalian order Chiroptera is second only to rodents in number of species (864 as opposed to over 1600 species). Bats comprise about 20% of all mammal species, yet have received only minor attention from zoological parks. The average layman is totally uninformed about bats and at best recognizes there are big, fruit-eating bats (flying foxes), small, insect-eating forms, and, of course, blood-eating vampires. However, bats represent the most diverse order of mammals with repect to food habits and are unique in their adaptations for nocturnal aerial locomotion. Also, the general public's misconceptions regarding bats enhance the impact of an interpretive education program.

The focus of zoological parks has switched from one of general entertainment to one of education. This involves displays which conform more to natural settings and promoting normal behavioral repertoires. When a display such as this is coupled with appropriate graphics, a popular, yet educational, exhibit emerges. To accomplish this goal the following questions must be considered. 1) What group or groups of bats are desired? 2) What are the institutional space and budgetary limitations? 3) What behavioral aspects do you wish to display?

Although there are a multitude of species which may be chosen, many are not suited for display due to difficulties in management, roosting requirements, and availability. Within the United States, the majority of bats are insectivorous (Barbour and Davis, 1969), and many species are readily available. Many of the species have been kept in captivity and successful diets have been formulated (Rasweiler, 1977). There are several points that should be considered which will influence the choice of species and exhibit design. Insectivorous bats exhibit a wide variety of roosting habits but tend to use crevices of various sorts. Therefore, during the roosting period, individuals would be difficult to observe. In captivity, they tend to become obese and will refuse to fly if all food is presented in food dishes.

New World Tropical species, primarily the family Phyllostomatidae, are readily obtainable and represent the widest variation in feeding habits. Within this family are frugivores, insectivores, pollen and nectar feeders, omnivores, and blood feeders. Frugivores and omnivores are by far the easiest species to maintain, and many diets have been formulated for healthy captivity (Rasweiler, 1977). The insectivore and pollen and nectar feeders tend to be more delicate and difficult to maintain, although they have been successfully kept in

captivity. Interest in vampires is great; but to successfully maintain them, a reliable supply of blood must exist. Rasweiler (1977) gives an excellent description of vampire maintenance and presents a method for blood preparation which facilitates storage and feeding difficulties. Vampires do present a potential health hazard, so considerable thought should be given before selecting this taxa for exhibit.

Flying foxes (Pteropodidae) are probably the most spectacular of bats due to their size and general morphology. They are an Old World group which increases difficulty in availability. Certain states, such as California, have restrictive laws concerning importation and housing. This family is primarily frugivorous and are considered pest species in agricultural areas within their distributional range. They are, however, easy to maintain and make impressive species for display.

European insectivorous bats are similar to United States species and generally would not be worth the added effort in obtaining them. Bat populations in Europe are declining and availability is poor.

The type of exhibit to be constructed is dependent on available space and budget, as well as the theme or focal point one wishes to display. Detailed exhibit designs and maintenance protocols are beyond the scope of this presentation. For some ideas on housing facilities and nutritional considerations, I recommend the excellent review by Rasweiler (1977). The remainder of my presentation will deal with various suggestions for exhibit design and associated educational and research possibilities.

An example of two species of insectivorous species which would be ideal for exhibit are the little brown bat (Myotis lucifugus) and the big brown bat (Eptesicus fuscus). The exhibit may be divided into two separate compartments: 1) daytime roost; and 2) flight room. The roost could simulate an attic, which is a commonly utilized structure by both species. The roost structure need not be larger than 1.2 x 1.2 x 2.4 m. One or several small openings can be placed between the roost and the flight room. Maintaining the bats on a reversed photoperiod (12 dark:12 light), the roost should only be illuminated with red light, whereas the flight room would receive alternating red and white light. In this manner, the exhibit would simulate natural conditions.

The flight room should be large enough to allow manueverability (3 x 9 x 2.4 m, minimum). A water pond placed in the center of the room will allow bats to drink on the wing. All bats should be trained to eat a prepared diet which can be supplemented by releasing flying insects within the flight room. These insects could either be cultured or obtained locally with light traps.

The dimensions given above are only approximations, but should meet minimum requirements for the species as well as allow easy access by keepers for cleaning and feeding. Both rooms can have observation

ports for constant public viewing. The flight room needs no special air conditioning, but the roost should be differentially heated. By maintaining the roost at approximately 20°C and using heat strips or some other heat source at the roof peak, a thermal gradient can be maintained to allow bats to select a desired microclimate. High temperatures at the peak could vary from 36° to 40°C.

I recommend the use of an ultrasonic bat monitor and graphics to create an exceptional education display. The general public is fascinated by the sonar echolocation ability of bats but have little understanding of how it works. With an exhibit such as described above, the public can observe first hand echolocation capabilities. Secondly, with a bat monitor they can listen to vocalizations during flight manuevers. Relatively inexpensive ultrasonic monitors are available (WESTEC Services, Inc., 3211 Fifth Ave., San Diego, California 92103). This machine converts the ultrasonic emmissions of bats to human audible frequencies. Each species has a distinctive sonar pattern (Simmons et al., 1979) which enables the listener to distinguish species by differences in tonal qualities. Vocalizations within a species also change dependent on the activity of the individual (i.e., orientation, foraging, or communicating). These variations are also apparent to the listener.

In lieu of flying insects within a flight room, placement of obstacles such as wires can produce the desired changes in sonar repertoire. In such an instance, the bats would have to negotiate a maze to reach platforms containing food dishes.

Phyllostomatid bats tend to be easy to maintain in captivity and would make interesting exhibits during flight and roosting periods. This family should be housed at temperatures above 27°C. Because they are high temperature species and tend not to select crevices for roost sites, they are more active and visible during the roosting phase.

I maintained an experimental exhibit at the Las Vegas Valley Zoo for over a year using the California leaf-nosed bat (Macrotus californicus). The exhibit measured about 1 x 1 x 1.2 m, which was designed internally to simulate a mine tunnel. Using techniques from model railroad landscaping, the interior was formed with chicken-wire, wet newspaper and molding plaster. A dilute tempra solution was applied with a spray bottle achieving a realistic rock finish. Four individuals were comfortably housed in this exhibit; during the day they would hang from projections allowing good visibility, and in late afternoon they would begin flying and hovering over the food dish. They would take mealworms both while hovering or after landing, which are methods utilized in the wild. Vitamins were added to the water dish as well as to the meal worms.

Molding plaster tended to chip easily wherever bats alighted. A thin coat of block bond, a plaster impregnated with short

fiberglass strands, was applied and stained, providing a surface which proved to be not only durable, but easy to clean.

A frugivorous phyllostomatid bat (Carollia perspicillata) has proven to be easy to maintain and breed in captivity. Porter (1978) studied social behavior in this species in a laboratory setting. Harem formation and associated social interactions were described which could be utilized in an interpretive display. Phyllostomatids are characterized as "whispering bats" (i.e., produce low intensity, highly directional ultrasounds which can only be detected by sophisticated and expensive equipment). Commercial bat monitors cannot detect these sounds; however, communication calls are of greater intensity and lower frequency which can readily be detected.

Although only a few examples have been presented, it should be apparent that a variety of bats can be exhibited within the confines of a modest budget. Many species will readily breed in captivity and are relatively long-lived. A knowledge of basic bat biology coupled with some imagination and experimentation, unique and educational exhibits can be devised. Such a program would foster research programs which would then produce better displays. Due to common misconceptions and folklore, bats tend to emotionally charge the general public; and regardless of positive or negative feelings, people are attracted. I have found that because of the gross misinformation common to bats, people are strongly influenced and emotionally affected when presented with accurate facts.

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