

CHAPTER TWO

The Changing Role of Hand Rearing in Zoo-Based Primate Breeding Programs

Ingrid Porton and Kelli Niebruegge

1. THE HISTORY OF HAND-REARING PRIMATES IN ZOOS

The husbandry of nonhuman primates in zoos and laboratories has improved significantly over the past 50 years, with concomitant improvements in the ability of captive primates to breed and successfully rear their own offspring. Nevertheless, there will always be a need for zoos to hand raise some infant primates. In the 1950s and 1960s nurseries devoted to hand rearing infant mammals became a prominent feature in zoos (Ogden and Kasielke, 2001). Reproductive success among the majority of exotic mammals was comparatively low relative to current conditions, and management strategies designed to increase the probability of infant survival were prioritized. For many species there was a zero risk policy and a mother was given little time to become comfortable and adjust her own behavior to that of the newborn infant. At the first indication of infant distress, managers rushed in to remove the neonate from its mother. Some zoos developed a policy of automatically hand rearing high-profile primates, especially the great apes.

The welfare of high-risk infants was not the only consideration when these nurseries were built. Humans caring for and playing with infants in view of the public was a recipe for an instantly successful exhibit. The popularity of nurseries as a zoo exhibit was evident in the number that were built (Ogden and Kasielke, 2001). Slow to mature and so much like human infants, nonhuman primate infants were particularly attractive exhibits. It was not unusual for zoos to prolong a young primate's stay in the nursery well past the age it could have been introduced to a social group. Indeed, an empty nursery was itself a motivation to remove an infant from its mother. In some cases, primates were purposefully hand reared so they could be tamed and used for shows or educational presentations (Taylor, 1978). That the interbirth interval of primates such as gorillas (*Gorilla gorilla gorilla*) was decreased was seen as an added benefit of hand rearing (Taylor, 1978).

The practice of hand rearing primates caused two problems. First, female primates that were raised by humans had no chance to learn parenting skills from their mothers. And second, zoo managers had no opportunity to see that first-time mothers can develop from awkward, rough, and seemingly dangerous caretakers to proficient parents. Thus, the hand rearing cycle continued.

A review of the early nursery literature from the zoo community reveals the focus of caring for the infant was almost exclusively on the physical aspects of hand rearing such as formulas, weight gain curves, and medical issues (e.g., Frueh, 1968; Kirchshofer *et al.*, 1968; Breznock *et al.*, 1979). Indeed, the primary emphasis when hand rearing an infant primate was to keep it alive. The overriding importance placed on a sterile, sanitary environment often translated into a sterile social environment for the infant. For some youngsters, socialization into an adult group was delayed until the individuals were fully capable of defending themselves, which placed them well into adolescence. Unfortunately, too many of these hand-reared primates exhibited stereotypic behaviors and were socially and/or sexually incompetent.

The zoo literature reveals a shifting attitude during the 1970s and 1980s. Increasingly, published articles drew attention to the social needs of all infants and particularly primates (Ott and Joslin, 1981; Miller, 1982; Collier, 1983). Forward-thinking professionals advocated the

investigation of alternative hand-rearing methods that allowed early socialization opportunities with peers and reintegration into adult groups at younger ages. Authors were clearly influenced by the findings of Harlow and colleagues (1971), who experimentally demonstrated the adverse and long-term negative consequences of social isolation upon primates.

Several influential papers helped change the ways in which nonhuman primates are hand reared in zoos. One change was an increased emphasis on encouraging and facilitating maternal rearing. Particularly valuable was the implementation of a 72-hr postpartum observation protocol for apes (Rosenthal, 1989) based on information that human neonates can survive for over 72 hr without nursing. As many ape infants were removed from their mothers precisely because nursing had not been observed in the first day, the protocol provided zoo managers with the confidence to leave infants with nonabusive mothers despite the absence of nursing. This approach was validated by earlier observations that chimpanzee (*Pan troglodytes*) mother/infant pairs sometimes need several days to synchronize their behaviors to facilitate nursing (Rogers and Davenport, 1969). Other methods to keep infant primates with their mothers included maternal skills training programs for apes (Joines, 1977; Keiter and Pichette, 1977; Schildkraut, 1982), distracting new mothers to allow nursing, or tranquilizing mothers to give the infant and dam more time to become accustomed to nursing (Ott and Joslin, 1981).

If infants could not be raised by their mothers, fostering them to an available lactating female was another approach advocated to avoid hand rearing. Examples of this technique were the successful fostering of rejected callitrichid infants in laboratories and the Los Angeles Zoo Marmoset Colony (Collier *et al.*, 1981). However, because zoos typically house fewer individuals per species than, for example, primate laboratories, fostering is more difficult to achieve.

Other important changes in philosophy included the actual methods used to hand rear infant primates. Maple (1980) challenged the idea that extensive human contact with great ape infants was detrimental to their social and psychological development. A concern held by many nursery personnel was that frequent and prolonged interactions with an infant would result in imprinted individuals unable to function appropriately

with conspecifics. Maple (1980) suggested that it was better for caretakers to more closely mimic the amount of social contact infant apes receive from their mothers and, if limited staff prevented realization of the goal, he recommended that volunteers be used.

Peer rearing of infants was recommended as one method to facilitate early and safe exposure to conspecifics. Bringing the infant(s) to the adult facility to gain familiarity with the sight, sound, and smell of adults was viewed as a component of the socialization process. Some (e.g., Meyer and Wilcox, 1982) advocated that infants be moved from the nursery into the adult facility and then into the adult group as soon as possible.

Although these approaches were promoted in the early 1980s, it took time for zoo managers to become comfortable with the added risks associated with these methods. For these procedures to become the norm rather than the exception, they first needed to produce a credible record of positive results. A significant development that advanced best-methods practices was the emergence within zoos of cooperatively managed breeding programs such as the American Zoo and Aquarium Association's (AZA) Species Survival Plan (SSP®). These programs manage all the individuals housed in participating institutions as one population. The SSP® population is genetically and demographically managed through analysis of studbook records and issuance of yearly breeding recommendations. In addition, SSP® Committees are charged with attending to behavioral and husbandry issues. Many of the primate SSP® programs (e.g., Gorilla, Chimpanzee, Golden Lion Tamarin, *Leontopithecus rosali*) directly addressed the hand-rearing issue and developed goals to eliminate all unnecessary hand rearing. In the instances when hand rearing was required, the objective became early resocialization of infants with conspecifics (Porton, 1992 and 1997). SSP® programs also coordinated interzoo transfers of infants to establish peer groups or facilitate the infant's integration into a more appropriate foster group.

2. RESOCIALIZATION GOALS AND TECHNIQUES

The emphasis that zoo professionals have placed on developing hand-rearing protocols that aim to produce socially and sexually competent adults is driven by two goals. One is to increasingly provide for the well-

being of all the animals housed in AZA zoos. Lacking certain social skills, some hand-reared primates may be peripheralized from their social group, subjected to a higher proportion of aggression, and/or exposed to higher levels of stress or depression. Zoo professionals endeavor to develop hand-rearing protocols that do not produce individuals compromised by abnormal or neurotic behaviors.

The second goal is to reduce the number of individuals that are either nonreproductive or have special housing requirements. Zoos face a space crunch. The number of breeding programs that zoos can manage is limited by space (Earnhardt *et al.*, 2001). A minimum viable population size is calculated for each managed program and that figure is used to determine the total number of programs that can be accommodated in participating zoos. Dysfunctional hand-reared individuals that are reproductively incompetent decrease the ratio of effective population size to actual population size and thereby unnecessarily increase the population size required to reach program goals. These individuals may also need special housing accommodations if they cannot live compatibly and safely in social groups. Transferring such individuals outside of AZA zoos is also limited because more stringent disposition policies prevent sending primates to facilities that do not meet AZA housing and care standards.

To achieve their goal, primate managers have pushed the limits to improve resocialization techniques used in zoos. Although infants removed from their mothers and raised by humans are all termed "hand reared," the amount of time infants are exclusively in human care varies to such a degree that the term has become misleading. In reality, there is a large continuum and in some cases the distinction between mother reared and hand reared is becoming increasingly blurred. New terms should be coined to capture these differences and add clarity to discussions. Several examples can illustrate the point. A Sumatran orangutan (*Pongo pygmaeus abelii*) at the Brookfield Zoo was removed from its mother at 1 week for hand rearing. The Brookfield staff developed a training program for the mother and infant with the purpose of reuniting the pair as soon as the infant could be fed reliably with a bottle. When strong enough, the infant was trained to cling to a wiremesh panel while nursing at the bottle; the mother, meanwhile, was trained to stay at the front of its cage while the infant nursed. Familiarity between mother and

infant was maintained through the training sessions, and at 5 months the infant was returned to its mother (Sodaro and Weber, 2000). Although fed by the keepers, the infant was mother reared from that time on.

Black lemur (*Eulemur macaco macaco*) and black-and-white ruffed lemur (*Varecia variegata*) infants that had to be hand reared at the Saint Louis Zoo were fostered into a family group as young as 6 weeks of age. In the case of the black lemurs, the staff took advantage of the foster mother's tolerance of humans and entered the exhibit with the lemurs to continue feeding formula to the reintegrated infants (Knobbe, 1991). Provisioning formula after reintroducing a litter of three 6-week-old ruffed lemurs to their parents and older sibling was solved by building a creep feeder, which the infants readily entered to obtain their designated diet (I. Porton, unpublished observations).

These days, fewer primate infants are being hand reared in isolation from adult conspecifics. Rather, temporary nursery areas are often set up in the same facility in which the adult group is housed. For example, at the Toledo Zoo, a gorilla infant was carried in a sling whenever possible while the keepers worked in the great ape facility. Periodically the infant was shown to the adult gorillas to encourage interest and interaction (Petiniot *et al.*, 1988). Two 3-month-old chimpanzee females from two different zoos were transferred to the Saint Louis Zoo for peer socialization and eventual integration into an adult group. Whereas previous chimpanzees were raised in the Children's Zoo Nursery, these infants were reared by the keepers and a group of docents in the holding cage next to the adults. The infants were thoroughly familiar with their future family and facility well before the physical introduction was carried out (Knobbe and Porton, 2001). Methods for hand rearing Goeldi's monkey (*Callimico goeldii*) at the Brookfield Zoo were modified in the 1990s. As soon as the infant is removed from its mother, it is housed first in an incubator and later in a wire "howdy" cage that sits directly in the parents' cage (Sodaro, 2000).

3. EVALUATION OF HAND-REARED PRIMATES

Despite the number of primates that have been handreared in zoos, there are surprisingly few population level analyses evaluating the outcome of these procedures. Systematic behavioral research comparing the behav-

ior of hand-reared versus parent-reared individuals is rare, as is studbook-based analysis comparing the reproductive rates of hand-reared versus parent-reared primates. Research using studbook records can be hindered by missing data on rearing history, insufficient information on reproductive opportunities, and small sample size. Small sample size also restricts more detailed comparisons between hand-rearing methods and subsequent adult social behavior.

The species for which there is the most information on the consequences of hand rearing is the western lowland gorilla. This is due to the large proportion of gorillas that has been hand reared in zoos, the popularity of gorillas, and the desire by managers to understand the causes of reproductive and parental deficiencies. The first investigation found that mother-reared female gorillas were significantly more likely to copulate and raise their offspring than hand-reared females (Beck and Power, 1988). No statistical difference was evident in the copulatory behavior of hand-reared versus parent-reared males but the sample size was small. A study of the international studbook data revealed similar results for females and also showed that hand-reared males were less successful reproductively than their parent-reared counterparts (Meder, 1993). An updated analysis of the Gorilla SSP[®] population again confirmed that mother-reared male and female gorillas were more successful reproductively than hand-reared individuals (Ryan *et al.*, 2002). Hand-reared gorillas are more likely than mother-reared gorillas to exhibit solitary play, self-directed behaviors, regurgitation and reingestion, and inappropriate aggressive behavior towards same-age or adult conspecifics (Meder, 1989; Olson and Gold, 1985; Gold, 1992).

In a study of copulatory behavior in zoo-born male chimpanzees, 54% of those that were hand reared with peers showed appropriate copulatory behavior versus just 30% of the males that were raised in isolation from conspecifics (King and Mellen, 1994). Thus, hand rearing of male chimpanzees without access to peers produces adults that are very likely to be sexually incompetent.

In a study of captive golden lion tamarins, parent rearing significantly increased offspring survival rates to both 7 days and 16 months of age (Rettberg-Beck and Ballou, 1988). Of 101 tamarins that were hand reared, 32 lived to breeding age. Of these, 15 were allowed to breed, 13

with a parent-reared mate and two with each other. Eight of the ten males and two of the five females bred. The pair comprised of two hand-reared individuals did not produce young but did copulate. Overall, hand-reared tamarins were less reproductively successful than their parent-reared conspecifics, but the results were not statistically significant. Unexpectedly, infants reared without a sibling were more successful breeders than peer-reared infants (Rettberg-Beck and Ballou, 1988).

In another chapter in this volume, we used studbook and survey data to show that parent-reared black-and-white ruffed lemurs, red ruffed lemurs (*Varecia rubra*), and black lemurs were more successful reproductively than their hand-reared counterparts. Nevertheless, over 60% of the male and female hand-reared ruffed lemurs and female black lemurs were reproductively competent.

None of the above studies focused on the effect of methods used to resocialize hand-reared infants on adult reproductive performance. It is likely, however, that the greater emphasis placed on resocializing primate infants at a younger age has contributed to the improved reproductive success observed in hand-reared zoo primates.

4. SUMMARY

Over the past 50 years, zoo managers have displayed many changes in their attitude towards hand rearing of nonhuman primates and in their choice of methods when hand-rearing is necessary. Today most zoos hand rear primates only when it is absolutely necessary. Resocializing infants at a young age is a priority, and many innovative management strategies to accomplish this goal have proven successful. There are numerous opportunities for research that will help guide further improvements including retrospective research using studbook data. Such research would greatly benefit from better management records that could provide the needed data with which to evaluate resocialization techniques. Research aimed at understanding the impact of hand rearing on social behaviors other than reproduction is also encouraged, for the primary goal of zoo management must be the overall welfare of each animal.

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