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Standards and guidelines for the breeding, care, and management of laboratory animals

A Report of the
Subcommittee on Primate Standards
Committee on Standards
Institute of Laboratory Animal Resources
National Research Council

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Institute of Laboratory Animal Resources

The Institute of Laboratory Animal Resources (ILAR), was founded in 1952 as a subsidiary of the National Academy of Sciences–National Research Council. Established as a coordinating agency, the Institute disseminates information, surveys existing and required resources, establishes standards, and promotes education in the field of laboratory animal resources so that needed information and quality animal stock will be available to research workers. In this effort, ILAR works to enlighten the research animal scientist, veterinarian, technician, and supplier by furnishing them with information and guidelines developed through the participation of authorities in the field.

PREFACE

These standards and guidelines are made available because of the increasing extent to which nonhuman primates (hereafter referred to as primates) are being used as laboratory animals. They apply to experimental colonies, to production colonies, and to facilities used by importers for maintaining and conditioning primates.

Subcommittee on Primate Standards
Institute of Laboratory Animal Resources

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CLASSIFICATION AND DESCRIPTION OF LABORATORY PRIMATES

The main groups of nonhuman primates are:

Prosimians
New World monkeys
Old World monkeys
Baboons
The great apes

In the sections that follow, the divisions of these groups (e.g., suborders, families) are named and the primates comprising them are described.

PROSIMIANS

The suborder Prosimii is composed of a number of phylogenetically primitive primate forms. Primates in this group are found in Africa and Asia. As a group they are small; they have cutaneous glands specialized for "marking," dentition specialized for use in grooming, and two or three pairs of mammary glands; they grow and mature rapidly; and they are usually nongregarious.

With one exception, all nocturnal primate species belong to the suborder Prosimii; however, not all prosimians are nocturnal.

Tupaiidae (Tree Shrews)

This family is composed of 5 genera and about 15 species, found largely in forested areas of eastern Asia.

There is some question of whether tree shrews are true primates; they are sometimes considered insectivores.

Adults weigh less than 0.4 kg. Not counting the tail, they are 10 to 22 cm long; the tail is 9 to 22 cm long.

Tree shrews have been studied only slightly in their natural habitats. Observations of captive animals, largely *Tupaia* spp., have disclosed interspecific differences in social order, activity patterns, and food preferences.

Tree shrews are diurnal.

Lemuridae (Lemurs, Avahis, Sifakas, Indris, and Aye-Ayes)

This family is composed of 10 genera and about 20 species, which are limited in range to parts of Madagascar (Malagasy Republic) and the islands of Comoro. Sizes range from that of a small rat to that of a medium-sized dog.

Encroachment on the natural habitat, mostly by clearing of forests, threatens many lemur species with extinction. The capture and export of lemurs is illegal.

Lorisidae (Lorises, Pottos, Galagos, and Angwantibos)

This family is composed of 6 genera and about 12 species, which are found in Asia and sub-Sahara Africa.

All species are nocturnal and largely arboreal. Adults weigh 0.2 to 1.5 kg and are 17 to 39 cm long (head and body).

Lorises, pottos, and angwantibos are stocky, short-tailed, small-eared, and slow-moving. Galagos (or bushbabies) are slender, long-tailed, large-eared, and fast-moving.

Galagos in captivity have received considerable study; lorises and pottos, however, have received little attention.

Tarsiidae (Tarsiers)

Three species of the genus *Tarsius* are found in Indonesia and the Philippines. Adults weigh 80 to 150 g, they are 8 to 16 cm long (head and body), and the tail is 13 to 27 mm long.

In appearance and behavior, tarsiers are similar to *Galago* spp. They are nocturnal and largely arboreal. They are almost completely insectivorous and carnivorous. They are very difficult to maintain in captivity.

NEW WORLD MONKEYS

New World monkeys are found chiefly in Central and South America. They differ greatly in many respects, since they fall into two families and 14 genera.

All are highly arboreal. All are diurnal except the genus *Aotus*. Some have prehensile tails.

The common laboratory species can be divided into four groups according to size. In ascending order, these groups are:

Tamarins and Marmosets, *Saguinus* spp. and *Callithrix* spp.

Squirrel Monkeys, *Saimiri sciureus;* Night or Owl Monkeys, *Aotus trivirgatus;* Titi Monkeys, *Callicebus* spp.

Ringtail or Capuchin Monkeys, *Cebus* spp.

Spider Monkeys, *Ateles* spp.; Woolly Monkeys, *Lagothrix lagotricha;* Howler Monkeys, *Alouatta* spp.

For further information on taxonomy the reader is referred to Hershkovitz' reports cited in the bibliography.

Following are average measurements for the more commonly used monkeys:

	Weight (kg)	Crown to heel (cm)	Tail length (cm)
White-lipped marmoset	0.5	35	37
Squirrel monkey	1.0	45	45
Capuchins	2.8	70	52
Spider monkey	6.0	85	77

OLD WORLD MONKEYS

Most Old World monkeys in routine laboratory use fall into the following classification:

Cercopithecoids
- *Cercopithecus aethiops,* vervet, or African green monkey
- *C. mitis,* Sykes monkey

Cynopithecoids
- *Cercocebus* spp., mangebeys
- *Macaca* spp., macaques

M. fascicularis (M. irus), crab-eating macaque or cynamolgus monkey
M. fuscata, Japanese macaque
M. mulatta, rhesus monkey
M. nemestrina, pig-tailed macaque
M. radiata, bonnet macaque
M. arctoides (M. speciosa), stump-tailed macaque
Cynopithecus niger, Celebes crested macaque

Coloboids

Presbytis cristatus, silvered langur, or leaf-monkey
P. entellus, Hanuman langur

The animals in this group with which we have had the most experience are the macaques, especially *M. mulatta.* Since the standards that apply to the macaques apply, with a few exceptions, to the other species, the macaques are considered here as typical of the entire group. In later sections, references to the macaques should be interpreted as applying to Old World monkeys in general; certain exceptions are noted.

Approximate measurements for adult macaques are given below. They apply to *M. mulatta, M. nemestrina,* and *M. arctoides.*

	Weight (kg)	Crown to rump (cm)	Crown to heel (cm)
Females	5–8	50	70
Males	8–14	50–60	70–90

In general, *M. fuscata* and *C. niger* are 10 percent larger than *M. mulatta,* and *M. fascicularis* is 10 percent smaller than *M. mulatta.*

BABOONS

Baboons are large, extremely hardy, essentially terrestrial members of the family *Cercopithecidae,* subfamily *Cercopithecinae.* Three genera are commonly recognized: *Theropithecus, Mandrillus,* and *Papio.*

Although baboons are essentially vegetarians, they also eat insects, eggs, mussels, crayfish, and small mammals.

In their native habitat, eastern and southern Africa, baboons live in closed social-system groups of 3 to 50 animals, each large group guarded by one dominant male and several other adult males.

Following are approximate measurements for baboons:

	Male adult	Female adult	Infant
Crown to rump (cm)	78–83	60–65	23–27
Crown to heel (cm)	118–123	98–103	37–41
Crown to tip of tail (cm)	138–143	100–105	45–50
Shoulder to heel of hand (cm)	55–60	55–60	15–18
Weight (kg)	20	10	0.7–1.0

THE GREAT APES

The apes (Pongidae) are divided into four major primate types. Classification is undergoing revision, and names are changing also. Nevertheless the four types are clear:

Gorilla
Two forms: Lowland (*Gorilla gorilla gorilla*)
Mountain (*G. g. beringei*)

Chimpanzee
Two forms: Typical (*Pan troglodytes*)
Pygmy (*P. paniscus*)

Orangutan
One form: *Pongo pygmaeus*

Gibbon
Two forms: Gibbon (*Hylobates* spp.)
Siamang (*Symphalangus syndactylus*)

Gorillas are the largest of the primates, saddleback males often weighing 135 to 227 kg (300 to 500 lb). They are found in the forested regions of central Africa, from coastal lowland areas to volcanic mountains. Chimpanzees cover a similar range, except that the pygmy chimpanzee is found only on the left bank of the Congo River.

Gorillas and chimpanzees are covered with black hair. (Color variations, including albinos, have been observed.)

Asian pongids include the orangutan of Borneo and Sumatra and the gibbons of southeastern Asia. The male orangutan has long red hair and weighs up to 182 kg (400 lb). The gibbon is the smallest ape, weighing 7 to 9 kg (15 to 20 lb) when full grown. A siamang may weigh twice that.

The Asian apes are almost exclusively arboreal, moving from place to place without touching the ground. Gorillas and chimpanzees are primarily terrestrial, but often nest in trees.

All apes are primarily frugivorous and herbivorous, but show a tendency to eat insects.

FACILITIES: DESIGN AND CONSTRUCTION

Facilities for the care and maintenance of laboratory primates should be designed with the aim of insuring:

Maximum comfort and welfare of the animals
Dependable measures for restraint and security
Minimum opportunity for transmission of contagious diseases and parasites
Control of ventilation, temperature, humidity, light, and noise

DESIGN

Receiving Area

A receiving area is needed for the admission and immediate handling or selection of primates from incoming shipments. It is essential in facilities where large colonies are maintained.

This area should be provided with efficient restraining equipment and with facilities for sanitizing the area and equipment after each use.

Quarantine and Conditioning Area

This area is for housing newly arrived primates until they are in a good state of health and nutrition and suitable for research purposes. Diagnosis and treatment of respiratory, enteric, and parasitic infections are the essentials of a quarantine and conditioning program.

The facilities should be designed to prevent the spread of infections from one group of incoming animals to another. Therefore, several small rooms to house each incoming group separately are better for this purpose than a single large one.

Where colonies are small, the quarantine area may be used as the receiving area.

Postquarantine Holding Area

The postquarantine holding area is the area where animals are housed permanently.

Cages, equipment, and rooms in the holding area must be sanitized before new groups of animals are moved in from the quarantine and conditioning area. So far as possible, each new group should be segregated in the holding area.

Quarantine and holding areas should be designed to have separate equipment and separate personnel for handling animals. Observance of these precautions will aid in preventing transmission of disease from the quarantine area to the holding area.

Isolation Area

This area, which is a special holding area, is for animals requiring complete isolation, that is, animals known to have a contagious disease.

Infirmary

An infirmary, or treatment area, should be maintained for animals needing specific treatment. It should be separate from the postquarantine holding area.

Other Areas

Other areas that should be included in plans for a primate facility are:

Offices
Lunchroom
Shop
Surgical and postsurgical recovery rooms
Diagnostic, necropsy, and research laboratories
Special diet kitchen

Pharmacy
Cage- and equipment-washing area
Cage- and equipment-maintenance area
Storage areas for feed (refrigerated and nonrefrigerated), cages, equipment, and expendable items
Locker rooms and toilets
Disposal area (incinerator)
Janitorial supply area

PREVENTING CONTAMINATION

Facilities should be designed, constructed, and operated with a view to preventing soiled, contaminated material and equipment from coming into contact with clean, uncontaminated material and equipment.

Crossovers from contaminated to clean areas should be minimized.

The design and construction of cages, feeding equipment, and waterers should:

Make cleaning simple and efficient

Minimize the opportunity of transmitting microorganisms, parasites, and vermin

CONSTRUCTION

Walls

Exterior walls should be resistant to fire, liquids, moisture, rodents, and vermin. Wood walls are not recommended.

Interior bearing walls and partitions should be made of material that will prevent transfer of liquids between rooms. Satisfactory materials include masonry, tile brick, cement block, and poured cement. Where necessary they may be sealed or sized for waterproofing with silicone, resin, plastic, or neoprene-based materials. When tile is used, the grout should be sealed. Cages should be designed or positioned in such a manner that animals cannot reach the walls with their hands.

Ceilings

Materials used for constructing ceilings should meet the same requirements as for interior walls, and they should have the same finishing coat.

Ceilings should meet walls and partitions in a close fit. Crevices that develop as a result of settling or vibration should be filled with caulking compound or similar material.

A false, or restraining, ceiling of wire mesh should be put in place to prevent escaped animals from grasping or resting on lights or other ceiling fixtures; alternatively, fixtures should be recessed flush with the ceiling.

Floors

New floors should be constructed of dense-mix concrete, terrazzo, or glazed tile. Such floors should be smooth, impervious to moisture, and easy to clean. The application of a waterproofing compound to the floor is recommended. It should extend 6 inches up the adjoining walls and partitions.

Doors

Doors providing entrance to buildings should have latches and locks, and should fit tightly.

Door frames and partitions should be sealed with caulking compound (or similar material) where they join the wall.

Inward-opening doors are desirable for animal rooms.

A double door or vestibule between primate rooms and connecting corridors or the outside contributes to security.

Windows

If outside windows exist, they should be covered with screens fine enough to keep out insects, yet strong enough to prevent animals from escaping. High-tensile-strength stainless steel screening that will serve both these purposes is available.

Lights

At least 30 foot-candles of light should be provided at cage level in animal rooms. Lights should be easy to clean. Fixtures, switches, and outlets should be installed so that rodents and insects cannot find shelter in them.

Light fixtures in indoor gang cages and in chimpanzee rooms should be flush with the ceiling or placed above a wire cage ceiling.

SEWAGE DISPOSAL SYSTEM

The sewage disposal system in an animal facility should be constructed and operated in compliance with federal, state, and local laws and regulations. When a new system is contemplated, authority to dispose of animal wastes through the municipal system must be obtained.

Each animal room and outdoor cage should be adequately drained by means of floor drains, a drainage trench system, or a wet-vacuum system.

The advice of a qualified sanitary engineer should be obtained before deciding on the type and capacity of system to be installed.

CAGES AND EQUIPMENT

General Requirements

CAGE DESIGN AND SIZE Cage design should augment the disease-control program.

The bottom of a cage should be perforated or of woven wire with spaces large enough so that feces will fall through to the stainless steel dropping pans and troughs.

Solid removable partitions or solid cage sides should separate animals in adjacent cages. This kind of separation reduces injuries and inhibits the spread of pathogens.

Openings should be of sufficient size to assure adequate lighting and ventilation and to permit thorough washing inside the cages.

Movable backs facilitate the tasks of restraining and transferring the animals.

The sides and back of a standard cage* may be solid or 5/8-in. mesh or 10- or 12-gauge smooth expanded metal.

If several cages are banked so that one side is common to adjacent cages, the side in question must be solid or consist of mesh through which fingers cannot pass.

Doors may be of the hinged, sliding, or guillotine type, or a combination of these. Latches should be fastened with a lock, snap, or spring bolt; they must be tamperproof.

The proper size of a cage depends on the size of the animals, their normal postural attitude, and the type of research being conducted. It is necessary to consider whether the animals are to be caged singly or in groups and whether they are to be held for short or long periods.

*"Standard cage" denotes a cage suitable for housing any of the Old World monkeys (except the bonneted macaque or other particularly long-tailed species) that are in routine laboratory use. Figure 1 shows one type of standard cage.

FIGURE 1 Standard cage, "Oregon" type

MATERIALS Cage materials should be nontoxic; resistant to water, food wastes, and excretory products; and of sufficient hardness and strength to resist chewing, clawing, and permanent bending by the species contained. Acceptable materials include fiber glass, plastic, stainless steel, stainless metal alloys, aluminum, or galvanized metals. Cages that are permanently installed in the building may be of ribbon slate, resin-coated compressed asbestos, tile, or poured concrete.

EQUIPMENT Feed hoppers inside a cage should be constructed to prevent soilage of feed. A preferable alternative is to bolt or weld the hoppers outside the cage and provide openings through which they can be reached. Hoppers should be of strong, rustproof metal or durable plastic. They should be tamperproof.

Watering devices should provide an *ad libitum* source of fresh, potable water. They should be designed for ease of removal, ease of cleaning, and prevention of back-siphoning. They should be checked several times a day for proper functioning. Two points should be kept in mind concerning *automatic* watering devices: medication is not easily controlled when they are used; animals often must be trained to use them.

When dowel- or rung-type perches are used in cages, they should be located at different heights, and one should not be located directly over the other.

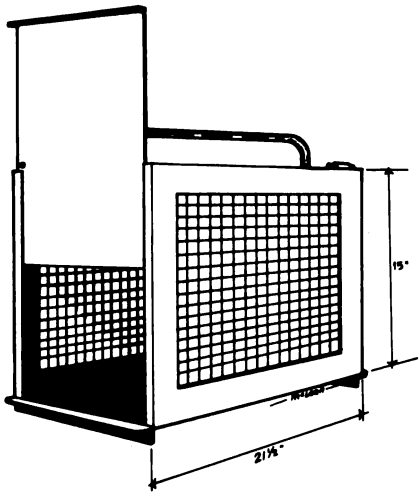

FIGURE 2 Transfer cage.

TRANSFER CAGES

By means of transfer cages, primates can be transferred to another cage or area with a minimum of handling, restraint, and fright, and with a minimum of injury to animals and personnel.

Transfer cages (see Figure 2) should have guillotine doors, which make possible the simultaneous opening of transfer-cage and holding-cage doors. Those for large species should have casters to facilitate moving them to another area.

Transfer cages must be maintained in a sanitary condition.

Cages for Prosimians

TUPAIIDAE A 2- by 2- by 2-ft cage is ample for a breeding pair of tree shrews. Reinforced hardware cloth is satisfactory as construction material. Floors may be made of wire mesh or sheet metal and should be covered with peat moss, wood chips, or other nesting material.

Recommended equipment includes vertical and horizontal climbing surfaces, a perching shelf, and, at floor level, two or more nest boxes, each with a small entrance.

LORISIDAE Electric-weld wire (1/2 in. by 1 in.) or hardware cloth (1/2 in. by 1/2 in.) on a nonporous, easily cleaned framework is suitable for cages. A 3- by 3- by 3-ft cage provides ample room for a breeding pair of Lorisidae weighing 750 g or more. Lesser dimensions are suitable for smaller species.

Each pair of animals should have a nest box. When the animals are first put in the cage, two nest boxes are advantageous. After the animals have slept together regularly, one box can be removed. The boxes should be easy to remove. They should be capable of being closed; this facilitates daytime handling of the animals.

A flat shelf or wood dowels 1/2 in. to 1 in. in diameter make satisfactory perches.

Cages for New World Monkeys

Cages for New World monkeys should be constructed of wire mesh at the top and on at least two sides. This type of construction is desirable because it provides areas over which the animals can climb.

MARMOSETS A cage 18 in. wide, 18 in. deep, and 24 in. high, with removable perches, is suitable for a breeding pair of marmosets. Up to four juvenile animals can be maintained in such a cage.

SQUIRREL MONKEYS A cage 12 in. wide, 22 in. deep, and 21 in. high will accommodate two adult squirrel monkeys or three juveniles. A gang cage 59 in. wide, 38 in. deep, and 67 in. high (inside dimensions) will accommodate 20 adults or 30 juveniles.

Perches, which should be removable, should be high enough to enable the monkeys to rest on them without having their tails touch the bottom of the cage.

CAPUCHINS AND RINGTAILS A cage 24 in. wide, 32 in. deep, and 32 in. high will accommodate two adults or three or four juveniles.

These monkeys are best housed in groups. Ten to fifteen adults can be properly housed in a walk-in facility 5 ft wide, 6 ft deep, and 7 ft high.

SPIDER MONKEYS A cage 36 in. wide, 40 in. deep, and 40 in. high will accommodate two adult spider monkeys. A walk-in facility 5 ft wide, 6 ft deep, and 7 ft high will accommodate ten adults.

Cages for Old World Monkeys

INDIVIDUAL CAGES The following are desirable dimensions of individual cages for macaques:

For an adult female: 30 to 32 in. high, 28 in. deep, and 28 to 30 in. wide. (Cages with these dimensions are commercially available.)

For an adult male: 45 to 48 in. high, 42 in. deep, and 42 to 45 in. wide.

For two young adults weighing 3 to 8 kg or three or more animals weighing 2 to 5 kg: 30 to 32 in. high, 28 in. deep, and 28 to 30 in. long. (These dimensions are satisfactory provided the paired or grouped animals are compatible.)

A standard cage is not suitable for the bonneted macaque (*Macaca radiata*). This species has a pendulous tail that is roughly equal to the crown–rump length. For this reason, an adult needs a cage with greater height equipped with a perching bar.

Although general experience indicates that *M. fascicularis, Presbytis* spp., *Cercopithecus aethiops,* and *C. mitis* are not as prone to tail-head injury as *M. radiata,* one must always be vigilant for the exception.

Variations in these dimensions are permissible, but height should not be less than indicated above. These heights are necessary for cartwheeling and other exercises.

Platform-type perches may be especially useful when more than one animal occupies a cage. They should be designed so that waste materials cannot collect on them and constructed of materials that are easily cleaned, such as metal doweling.

A cage with a movable back that can be brought forward to restrain the animal against the cage front is called a squeeze cage. It can be effectively used for restraining a monkey so that procedures such as inoculation, drawing blood, or diagnostic skin tests may be performed without removing the monkey from the cage.

Scissors-type nets may also be used to capture a caged monkey, but this method of catching monkeys is awkward, time-consuming, and dangerous to personnel when compared with transfer cages (see page 13) and squeeze cages (see above).

GANG CAGES Gang cages provide space at economical cost. They allow room for exercise and the establishment of social groups where this is required. However, the individual animal cannot be as closely observed

under this system as when individually caged. Transmission of disease and parasites between animals occurs more readily in gang cages, and animals are more difficult to capture and restrain.

In group caging, a minimum of 2 sq ft of floor space per animal is suggested, provided no more than 10 animals are caged together.

Gang caging in excess of 100 animals requires zoo or compound facilities, standards for which are beyond the scope of this guide. Some of the biomedical research institutions that have facilities for housing large numbers of animals will furnish information about enclosures upon request.

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INDOOR-OUTDOOR ENCLOSURES If indoor–outdoor enclosures are used, at least 2 sq ft of floor space per adult animal should be provided in the shelter area and 2 to 4 sq ft per animal in the outside area.

The enclosure should not be more than 7 ft high. Greater height adds to the difficulty of catching obstreperous animals.

Perches should be placed along the walls of the outside area in step fashion. A perch of open-frame (rather than mesh) design is recommended for cleaning ease. One-inch galvanized pipe, formed to make a perch 26 in. long and 8 in. wide, will accommodate two animals.

It is recommended that there be enough perches to accommodate two thirds of the group at any one time.

Construction materials should be the same as those recommended for outdoor baboon gang or colony cages (see below) except that the woven galvanized wire fencing may be 11-gauge and should have a 1-in. diamond. If several outdoor–indoor enclosures are built adjacent to one another, sidewalls should be of solid construction to prevent fighting and spread of disease.

Animals should enter the outdoor enclosure through a top-mounted swinging door 15 in. high and 12 in. wide. When locked in place, such a door can be operated as a guillotine-type door. This arrangement permits the capture of animals by locking all of them inside one of the enclosures and then allowing one or two to escape through the hatch into a squeeze cage. The guillotine door permits closing off an enclosure while it is being cleaned.

Doors should be provided between inside and outside enclosures for use by personnel.

The indoor area should be heated in cold weather. Radiant heating is recommended. Use of heated air is discouraged because of drafts and hot blasts–health hazards resulting from improper system design and operation.

Cages for Baboons

INDIVIDUAL CAGES Individual cages for adult baboons should be made of aluminum, stainless steel, or galvanized iron.

A cage suitable for holding one adult should have the following inside dimensions: width, 32 in.; depth, 36 in.; height, 47 in. (See Figure 3.)

JRE 3 Individual cage for baboons.

The floor should be gridded and should consist of tubular metal adequately supported. It should be high enough above the dropping pan to prevent the animal from touching excreta.

A movable back is desirable. With it, the cage can be used as a squeeze cage.

Guillotine doors should be located on one side of the cage front, not in the middle.

Two perch bars made of 1-in. aluminum pipe should be attached to the front and back of the cage (penetrating the movable back) opposite the side on which the door is located. They should be about 12 in. above the floor and 6 in. apart.

Cages may be suspended from an overhead support or may rest on casters with locking devices to prevent cage movement.

GANG CAGES Gang cages are especially well suited for outdoor use but can also be used effectively indoors. (See Figure 4.)

Tops of cages may be flat or arched. The superstructure should be made of 2-in. (outside diameter) galvanized iron pipe arranged and supported to obtain maximum strength. If the top of the cage is arched, the superstructure should have a radius of 25 ft.

The material covering the superstructure must be strong, resilient, and rustproof. Woven wire fencing made of 9-gauge galvanized iron wire having a 2-in. diamond is recommended.

FIGURE 4 The baboonery at the Southwest Foundation for Research and Education, San Antonio, Texas.

Because of the tendency of baboons to fight, the ceiling should be at least 15 ft high. An animal attacked in a cage with a high ceiling can usually escape by climbing the cage wall, since an aggressor seldom continues pursuit more than 7 or 8 ft above the floor.

Each outdoor cage should have a built-in shelter in which animals can be protected from sun, cold, rain, and snow. The shelter should face downwind and should be heated in cold weather. Radiant heating is preferred. Other heating systems are permissible but they must be designed to ensure safety of the animals and to require minimum maintenance.

Each animal in a gang cage should have at least 28 sq ft of floor space. In the shelter, each animal should have at least 2 sq ft of floor space.

The entrance to the outdoor cage should be at least 40 in. wide and 7 ft high. It should be designed so that a person must enter through a vestibule.

Cages for the Great Apes

Designing cages for the great apes—gorillas, chimpanzees, and orangutans—is difficult because of the speed with which the young grow and the great size attained by the adults. A cage suitable for one stage of growth is not suitable for the next.

If it is sturdy enough, a cage designed for an adult monkey is suitable for a young ape. However, if adults are to be held longer than 1 month, special construction is required. Housing of juveniles and adolescents is not a problem if cages specially constructed for adults are available; such cages are also satisfactory for the younger animals.

Cages for adults should be constructed of impervious material such as poured concrete, tile, or terrazzo and should be of the indoor–outdoor type.

The wall separating the indoor and outdoor sections should contain a guillotine door operated from the inside corridor only. Attendants should be able to lock the door from either the outside or the inside. Double locking can be accomplished with two long steel rods. One rod projects through a hole in the door from the inside corridor; the other projects through a hole from outside the exterior wall of the cage. Either rod, when inserted through its hole in the door and padlocked there, prevents the door from being raised.

Indoor and outdoor rooms should be adequately drained and should have direct sewer connections. Floors should be sloped for rapid runoff of liquid wastes and cleaning water, unless a wet-vacuum cleaner is used. Drainage trenches should be so located that no animal can reach them. A false floor

made of pipes or other smooth material may be used to keep animals out of their excreta.

INDOOR ROOM The indoor room should be at least 5 ft by 5 ft if it is intended for one adult animal and 5 ft by 10 ft if intended for two. Ordinary room height is adequate.

The room should be heated in cold weather. Use of copper pipes for transmitting heat is recommended; these should be built into the floor or exterior wall. Warm-air systems are permissible if the air is draft-free and not extremely hot.

The room should have an off-the-floor resting place which should not be attached to a cold exterior wall unless a thermal barrier is provided. The resting place should be large enough to permit all the animals to rest comfortably on it at the same time. It should be easy to clean.

Lighting must be sufficient to permit thorough inspection for cleanliness.

Attendants should be able to see the animals and inspect the entire room without opening the main door. For example, the corridor side of the room may be constructed of 6-gauge woven wire and may include a guillotine door to which a transfer cage can be attached. Because of space limitations, the main door probably will be of the swinging type. If so, it should swing inward.

An automatic, noncontaminating watering device should be installed with extra-strong fittings in the room or the outside cage.

OUTDOOR ROOM The outdoor cage should be at least 5 ft by 5 ft and 7 ft high. If the cage is large, part of it should be roofed so that the animals will have shade in hot weather. The roof should cover the woven-wire or barred ceiling of the cage. The size of the roof will depend on the orientation of the building, the height of the walls, and the type of construction.

The entrance door should be of the sliding type. The frame should be made of 2-in. (outside diameter) galvanized iron pipe, which should be covered with 6-gauge galvanized iron wire having a 2-in. diamond. (Iron bars as fencing should be avoided; chimpanzees often reach out to grab passersby.) Tension bolts should be fastened to the vertical pipes to keep the woven wire taut.

The outer edges of the fencing are usually finished by twisting adjacent strands of wire around each other. Since some animals are strong enough to unravel these edges, they should be covered with a steel plate or similar cover or placed out of reach.

Adjacent outside rooms should be connected with a sliding steel door 1/4 in. thick to facilitate transfer of animals.

SQUEEZE CAGE It is sometimes desirable to have a temporary cage into which an ape can be placed for special treatment and handling. A squeeze cage is useful on these occasions. Provisions should be made to attach the squeeze cage securely to the corridor door of the room. A guillotine door should be built into the corridor door for easy access to the squeeze cage.

MANAGEMENT PROCEDURES

QUARANTINE AND CONDITIONING

Following are guidelines for operating a quarantine program:

Upon arrival at the facility, primates should be examined, preferably by a veterinarian with training and experience in laboratory-animal medicine.

Newly arrived primates should be quarantined for 30 to 60 days before being added to the resident colony. The period of quarantine depends on the source, species, and condition of the animals on arrival.

The quarantine period should be extended upon diagnosis of certain infectious diseases.

Animals in quarantine may be housed individually or in pairs. Housing of large groups in gang cages during the quarantine period is not recommended.

Daily observations should be made by a person trained in recognizing signs of disease. All abnormalities should be reported daily to the veterinarian or individual responsible for animal health.

Animals showing signs of illness should be removed from contact with healthy animals. Immediate steps should be taken to diagnose the illness, and necessary treatment instituted.

The primate quarantine areas should be used to house primates *only*.

Personnel working in quarantine areas should wear distinctively colored garments and should be restricted to these areas for the entire work period. If this is not possible, the conditioned animals should be cared for before the animals in quarantine. Personnel should change clothes before entering other areas of the colony.

Personnel working in quarantine areas should be required to wear protective garments, including cap, mask, gloves, and protective footwear, as directed, and to observe all other prescribed safety precautions.

All handling equipment, such as nets, transfer boxes, and gloves, should not be removed from the quarantine area, and should be sanitized daily.

Presence of certain infectious diseases may require daily sterilization of equipment.

Personnel with recognizable respiratory or gastrointestinal ailments should have limited contact with primates.

The number of animals received in one shipment should not overtax the staff. Several small shipments received over a period of time are more desirable than a single large shipment.

After the primates have completed the quarantine period, it is desirable to add a conditioning period before using them in research. The purpose of the conditioning period is to further stabilize metabolism, nutrition, and health, and to improve the animals' suitability as biological models. The length of this period will depend on the research requirement for which an animal will be used.

COLONY MAINTENANCE

Colony-maintenance procedures have a purpose similar to that of facilities. They are intended to provide the animals with the care and comfort they cannot provide for themselves in a laboratory environment.

Environmental Control

VENTILATION Ventilation should be considered in relation to the density of the animal population, the species of animals housed, and the nature of the laboratory activity. Ten to fifteen changes of fresh, adequately diffused air should take place each hour.

The effect of air movement on an animal's body-surface temperature must be considered in relation to cage design and location. Sudden changes in temperature, drafts, pockets of dead air, and sizable gradients of temperature from floor to ceiling are not permissible. Recirculation of air is not recommended. A mechanical ventilating system is necessary in most indoor primate facilities.

TEMPERATURE The temperature maintained in the animal rooms should be appropriate to the species. If animals are routinely maintained outdoors, provision should be made for a heated, sheltered area to which the animals may have access when the temperature falls below comfortable levels.

High- and low-temperature alarm systems are valuable for the animals'

protection, and graphic records are useful for determining system performance.

A diurnal pattern of lighting with a minimum of 12 hours of light per day is recommended.

Feeding

Food should be available daily unless otherwise indicated for health or scientific reasons. It should be palatable and of sufficient quantity and nutritive value to meet the normal daily requirements (*Nutrient Requirements of Laboratory Animals,* NAS-NRC Pub. 990, National Academy of Sciences–National Research Council, Washington, D.C., 1962) for the condition, size, and species involved.

Food receptacles should be accessible to all animals and located so as to minimize contamination by excreta. They should be cleaned and sanitized regularly to prevent the food from molding, deteriorating, or caking.

Watering

Potable water should be readily accessible at all times or offered at least twice daily, except where otherwise indicated for health or scientific reasons. Preferably, water receptacles should be of the closed type, such as water bottles with sipper tubes, or automatic watering devices. Water bottles should be sanitized at least weekly. If open receptacles are used, they should be sanitized daily.

Sanitation

DAILY CLEANING OF CAGES Excreta should be removed from cages at least once daily. When hosing or flushing methods are used for this purpose, precautions should be taken to keep the animals dry. Care should be taken to prevent splashing of material into adjacent cages.

If drop pans or troughs are used, they should be washed daily.

SANITATION OF CAGES Cages should be cleaned and sanitized before new animals are introduced, and often enough to prevent an accumulation of debris and excreta. (See *Federal Register,* Vol. 32, no. 37, Part II, p. 3280, United States Department of Agriculture, regulations for Public Law 89-544.)

HOUSEKEEPING Premises (buildings and grounds) should be kept clean and in good repair in order to prevent injury to the animals and to facilitate prescribed husbandry practices. Premises should remain free of accumulations of trash.

VERMIN CONTROL An effective program for the control of insects and avian and mammalian pests should be in operation.

PERSONAL HYGIENE Facilities to maintain cleanliness among animal colony personnel should be provided. Clean clothing suitable for use in the animal facility should be worn.

Type and Number of Employees

A sufficient number of employees should be engaged to maintain the prescribed level of husbandry practice. Supervision should be provided by persons having a background in animal husbandry or care. This qualification may be satisfied by completion of an animal-care-technician course or by equivalent practical experience in animal care.

ARTIFICIAL REARING

This section applies to rearing Old World monkeys and baboons. Information on rearing chimpanzees can be obtained from the Delta Regional Primate Research Center, Covington, Louisiana 70433; the 6571st Aeromedical Research Laboratory, Holloman Air Force Base, New Mexico 88330; and the Yerkes Regional Primate Research Center, Emory University, Atlanta, Georgia 30322.

Infant Care

The mother of a newborn primate usually eats the placenta and membranes and in the process cuts the cord and cleans the infant. If the infant is strong and vigorous, it is usually able to cling firmly immediately postpartum.

Normal births usually take place at night.

Infants derived by Caesarean section from anesthetized mothers are likely to be depressed. They should be resuscitated promptly.

Removing the infant from the mother can result in injury to either or

both. Care must be taken. With the chimpanzee and baboon it is usually necessary to sedate the mother. Phencyclidine hydrochloride* is satisfactory for this purpose.

Upon removal from the mother, the infant is weighed and examined for defects, and the cord is wiped with antiseptic and tied. At this time the infant may be identified by a tattoo number.

Newborn baboons weigh 500 to 1,000 g, and rhesus monkeys 375 to 550 g. Pig-tailed macaques, Japanese macaques, and Celebesian apes are in a weight range similar to that of rhesus monkeys, but they tend to be heavier. Crab-eating macaques and vervets weigh about 100–150 g less than rhesus monkeys.

A weight loss of 10 percent usually occurs during the first 36 hours after birth. Normal, healthy infants usually regain their birth weight by 5 days of age. During the first 60 days, Old World primates attain a weight almost double their birth weight; baboons increase their weight by about 60 percent.

The first 48 hours after birth are critical to the infant's survival. The infant's clinical condition is assessed most reliably by its weight and amount of fluid intake. The color of the mucous membranes and skin, character and rate of respiration, heart rate, and change in weight also can be used to determine the infant's condition. Food intake, character and frequency of stool, and behavioral observations also are important and should be recorded daily until the infant is weaned.

After 30–60 days of age infants should be placed together in a play cage for at least 2 hours daily. The larger the group the better. Physical contact among infants is important in establishing normal social relationships.

Housing

For the first 15 days of life the infant is housed in a standard human incubator or a germ-free isolator. Temperature is maintained between 88 and 92°F and relative humidity at 45–50 percent. The primate infant has poor thermostability; even after it is 2 weeks old, its temperature will tend to approach ambient temperature. Sudden drops of more than 2 or 3°F should be avoided.

The incubator can be divided into two compartments (Figure 5), each with a surrogate (a cloth pad to which the infant clings, as it would to its mother) and a bottleholder for *ad libitum* feeding.

At about 14 days of age, strong, vigorous infants should be transferred

*Sernylan (Parke-Davis).

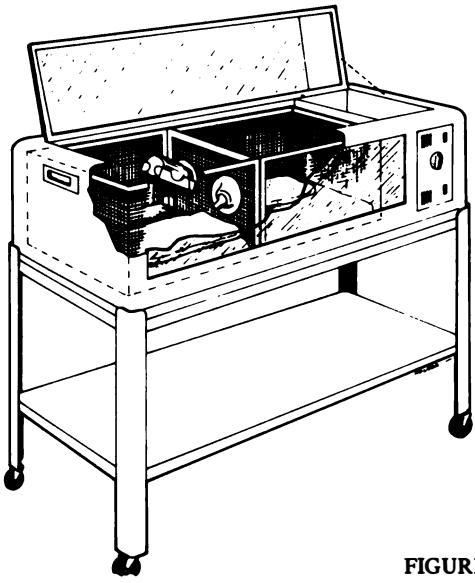

FIGURE 5 Converted human incubator.

to cages about 18 in. wide, 18 in. long, and 24 in. deep (Figure 6). They should be caged singly to permit individual observation. Each cage should contain a surrogate and a bottleholder. Room temperature should be maintained at 85°F.

Feeding and Weaning

Infants are fed at first from 4-oz and later from 8-oz human-infant nursing bottles, which should have the standard rubber premature-infant or regular nipple. A doll bottle and nipple is often more effective for feeding infants of the smaller species for the first few weeks.

Bottles and nipples should be sterilized with the same care that is exercised in sterilizing for human infants, and high standards of cleanliness should be maintained. Cleanliness minimizes the danger of diarrhea and pneumonia, which are the most commonly encountered infant infections.

Bottle-feeding is accomplished in three stages, discussed below. The formulas should be prepared daily in bottles. Tap water should be used as the diluent. Bottles containing newly prepared formula should be sterilized. They should then be cooled and kept in a refrigerator until the formula is

FIGURE 6 Infant cag

fed. Usually the formula is warmed to about body temperature before it is fed.

First Stage The infant should receive its first feeding 6 to 12 hours after birth and subsequent feedings at 2-hour intervals for the next 24 hours, except during the period from 10 p.m. to 6 a.m.

In these first feedings the diet should consist of dextrose or glucose solution (5 to 10 percent), and it should be fed *ad libitum*. For an Old World monkey, the amount of intake per feeding ranges from 10 to 15 cc; for a baboon, from 15 to 25 cc.

Second Stage From day 2 the infant receives a commercial human-milk-substitute baby formula.* As before, the formula is fed every 2 hours except during the period from 10 p.m. to 6 a.m.

For the first 3 days of this stage, the formula should be fed with a 10-percent dextrose solution in water at a ratio of 1:1. By day 4 the formula should be fed full strength to Old World monkeys; the 1:1 ratio should be continued for baboons until weaning.

Between the second and the fifth day, a strong, vigorous infant can be started on a self-feeding, *ad libitum* feeding schedule. Every 2 hours (nine

*SIMILAC (Ross Laboratories) or SMA-S26 (Wyeth Laboratories).

times a day) the infant is given a bottle containing 15 to 35 cc of formula, the amount depending on the infant's size. As the bottle is placed in the holder (see the preceding discussion of housing), a gentle tapping noise is made to help the infant locate the bottle.

Many nurseries continue hand-feeding after the first 3 to 5 days of life, feeling that burping is essential after each feeding to prevent vomiting. Burping the infant is accomplished by placing the infant in the erect position, gently tapping and massaging its back after it has consumed several cubic centimeters of formula.

VARIATIONS IN FORMULAS

The basic formulas are (1) dextrose or glucose solution and (2) commercial human-milk-substitute baby formula. These are referred to under "First Stage" and "Second Stage."

Experienced laboratories have successfully reared Old World monkey infants on a formula in which the standard concentration of 20 calories per fluid ounce was followed.

Unpublished data* suggest that a standard formula diluted 1:1 with tap water is preferable for baboons because it reduces a tendency toward electrolyte imbalance that occurs in this species when the full-strength formula is fed. The calorie deficit is made up by adding glucose or dextrose or by increasing the total volume of formula to be consumed. In addition, from 8 to 12 weeks of age until weaning, a baby cereal (35-percent protein) is added to the formula.

Third Stage After 5 days of feeding at 2-hour intervals (second stage), infants should be fed at 4-hour intervals, five bottles per day, until weaning. At each feeding, an Old World monkey receives 20 to 80 cc of the same formula that was fed in the second stage; a baboon, up to 120 cc.

Throughout bottle feeding, adequacy of intake should be judged by daily rate of gain. Satisfactory rates of gain are different for different species. Figure 7 shows growth rate for the rhesus infant.

In addition to formula, each infant should receive 1/4 cc of a standard pediatric multivitamin preparation with an iron additive (where this is not provided in the formula) every other day until it is weaned to adult food.

*W. R. Voss, Director, Primate Colony, Department of Virology, Baylor University College of Medicine, Houston, Texas.

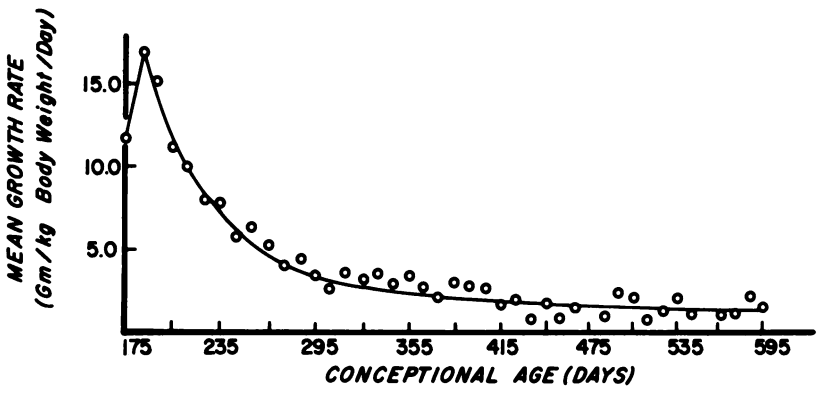

FIGURE 7 Growth rate (body weight) of infant rhesus macaque monkeys (*Macaca mulatta*) from birth to 595 days conceptional age (average of 10 animals).

It is desirable to continue the vitamin supplementation until the infant is 6 months old.

When they are about 30 days old, infants may be taught to accept milk from a pan; teaching must be gradual. Generally, the animals have their incisors at this age, and solid food can be introduced into the diet. When they are about 6 months old, they may be placed entirely on an adult feeding schedule.

Basically, weaning consists in decreasing the milk intake and increasing the intake of solid food, such as commercial monkey diet and fruit, and maintaining adequate daily caloric intake while the change is in progress.

The caloric intake of rhesus infants is given in Figure 8. If quantities are adjusted to correspond with differences in the weight of the animals, requirements stated in the figure can be applied to baboons.

The commercial monkey diet is more acceptable if soaked in formula at first.

DISEASE CONTROL

General

Frequent inspection, periodic examination, and sanitation are important factors in disease control.

All animals should be observed daily for signs of illness. The procedures to be followed when such signs are noted are stated under "Quarantine," page 22.

FIGURE 8 Caloric intake of infant rhesus macaque monkeys (*Macaca mulatta*) from birth to 505 days conceptional age (average of 10 animals).

Personnel should not be allowed in an area to which they have not been assigned without permission from a person responsible for animal health.

A dead animal should be removed as soon as discovered, placed in an impervious container, refrigerated, and held for necropsy examination and ultimate incineration.

Tuberculosis

Tuberculosis is frequently encountered in colonies of Old World monkeys. New World monkeys are less susceptible but should be examined frequently.

Newly arrived animals must be tested on arrival and at 2-week intervals until each animal in the group has passed 3 consecutive negative tests. The intradermal palpebral test is customarily used to detect tuberculosis. Usually 0.1 ml of Koch's Old Tuberculin (KOT) containing 15 mg of KOT or the comparable purified protein derivative is injected. The injection site is examined at 24, 48, and 72 hours. A positive reaction is indicated by redness and swelling at the injection site, frequently involving the entire eyelid and accompanied by a profuse exudate.

Routine radiographic examination of the chest of each animal on arrival is encouraged to detect advanced cases of tuberculosis which may be tuberculin-negative.

Immediate elimination of all positive reactors is recommended, followed

by necropsy and histopathological diagnosis. Testing should be repeated at 1- to 3-month intervals after the initial quarantine period. See Appendix I, "Suggested Standard Procedures for Detection of Tuberculosis," p. 44.

Pneumonia

Pneumonia is commonly encountered in primate colonies. It is generally associated with improper environmental control and with the stress induced by capture and transportation. It is primarily a problem during the first month after arrival and is seldom a problem in well-conditioned animals that are properly housed.

Pulmonary Acariasis (Lung Mites)

Pulmonary acariasis is commonly encountered in wild-born Old World monkeys, particularly macaques. The effect of the parasite on the health of the animal is considered to be of minor significance unless the respiratory system is heavily involved.

Enteric Diseases

Enteritis is probably the most common of the diseases affecting laboratory primates. Major causative organisms are *Salmonella, Proteus,* and *Shigella.* Other intestinal pathogens, including protozoa, helminths, and viruses, may be responsible for various intestinal disorders.

Many enteric disorders are related to lowered resistance resulting from the stress of capture and transportation, to unfamiliar diets, and to unfamiliar colony confinement.

Good husbandry practices are essential to the prevention and control of enteric disorders regardless of their cause.

SAFETY AND SECURITY

Construction in all primate areas should be designed to prevent the escape of animals.

A vestibule, equipped with self-closing doors at all access points, should

intervene between cages and the outside doors of the buildings. The vestibule doors should have locks.

Cages should be properly constructed (discussed under "Cages and Equipment," p. 11).

The primate areas should be completely enclosed.

Equipment and procedures must insure the safety of personnel, must be noninjurious to the animals, and must minimize the possibility of transmission of infection from animal to man, animal to animal, and man to animal.

Restraint of animals should be both effective and gentle, with emphasis on protecting animals and handlers from injury.

The canine teeth may be surgically removed from large primates that are aggressive and require frequent handling. Clipping off the ends of the canine teeth frequently results in the formation of abscesses and is not recommended.

PERSONNEL MANAGEMENT

The reliability of biomedical data obtained from laboratory primates depends largely upon sound preventive medicine practices, rigid environmental control, and the services of highly motivated and properly trained animal technicians.

References and source materials for technician training are available from the Institute of Laboratory Animal Resources, National Research Council, 2101 Constitution Avenue, Washington, D.C. 20418, and from the American Association for Laboratory Animal Science, P.O. Box 10, Joliet, Illinois 60434. A correspondence course in basic animal care may be obtained at a nominal cost from the Ralston Purina Company, 835 South 8th Street, St. Louis, Missouri 63102. The laboratory veterinarian should assist technicians in interpreting and applying the information in these materials and should provide supplementary training and guidance.

Animal Handlers

SUITABILITY AND HEALTH Animal handlers must be strong, agile, highly motivated, and emotionally fit to work with primates.

They must have an understanding of the animals' needs and must feel concern for their humane and proper care.

They should be in good health. New employees should have a complete pre-employment physical examination, which should include chest x-ray, tuberculin test, and stool culture.

The fact that certain of the diseases occurring in primates are transmissible to humans makes it necessary to give continuing consideration to employees' health.

Employees should not eat, drink, or smoke in the animal areas.

Employees should have physical examinations annually and chest x-rays and tuberculin tests semiannually. An immunization program should be maintained for all employees.

Employees should not work in animal areas when they are ill.

All bites, scratches, or other injuries should receive prompt medical care and should be reported to the designated person.

TRAINING New employees should receive training in primate handling and management. This training should be continued and should stress both animal and personal health considerations.

EQUIPMENT Appropriate clothing should be provided for personnel working with primates. Freshly laundered clothing should be available daily.

The following should be worn in animal areas: shoes or boots that can be washed and sanitized, disposable face masks, caps, and shields or other eye protection, as indicated.

Protective gloves should be worn, preferably with attached sleeves to the shoulder for arm protection, for catching and restraining monkeys.

PRECAUTIONS

B virus infections are found mainly in the *Macaca mulatta,* but other Old World species have been implicated. When transmitted to man, B virus infection usually produces a fatal encephalomyelitis. The danger to persons working with *M. mulatta* or its tissues should be recognized.

All primates, especially those newly received, should be viewed as possible vectors of a number of diseases transmissible to man, such as tuberculosis, the dysenteries (salmonellosis, shigellosis, amebiasis), B virus, yellow fever, and infectious hepatitis. A physician should be consulted for appropriate prophylactic guidance.

NUTRITION

The nutritional needs of many species of primates can be met with commercially available diets. Vitamin, mineral, and protein supplementation

may be indicated for infants, breeding animals, nursing mothers, and animals in an undernourished or otherwise poor condition. Some species require constant supplementation.

Fresh water should be available to the animals at all times.

Tree Shrews

Tree shrews, essentially omnivorous, have been successfully maintained in captivity on commercial monkey and dog diets and also on diets consisting of a wide variety of fruits, vegetables, insects, and meats.

Maximum food consumption is stimulated when moderate portions of of fresh food are offered at regular intervals during the day.

Tupaia infants have been successfully hand-reared from birth on the following formula: 2/3 pint whole cow's milk, 1/3 pint evaporated milk, 1/2 raw egg yolk, and 1 teaspoon corn syrup. Feeding of 4 or 5 g of this formula every 8 hours through the first 3 weeks has been recommended. Semisolid foods have been introduced at 4 or 5 weeks of age.

Lorisidae

The Lorisidae are primarily carnivorous and insectivorous; they occasionally eat fruits and leaves. In captivity they can be maintained satisfactorily on commercial monkey diets. Transition to such diets should be made gradually.

Smaller species may have difficulty in chewing hard biscuits; this can be overcome by soaking the biscuits in water.

Since the Lorisidae are nocturnal, fresh food should be placed in the cage daily just before dusk.

New World Monkeys

It is generally agreed that if New World monkeys are not exposed to ultraviolet rays, vitamin D_3 must be provided to prevent rickets and osteomalacia. Other nutritional requirements are similar to those for Old World monkeys.

Old World Monkeys

Almost all species of Old World monkeys can be adequately maintained on commercial diets. Supplementation—vitamins, minerals, and high-protein

or high-caloric dietary preparations—may be indicated for infants, pregnant animals, nursing mothers, and animals in an undernourished or otherwise poor condition.

Presbytis entellus and *P. cristatus* are notable exceptions. These leaf-eating species require green alfalfa supplemented with fresh green vegetables. Without these nutrients they die of starvation. After 4 months in the laboratory a conventional laboratory diet can replace the green vegetables, but the green alfalfa must be continued.

Baboons

Commercial rations adequately fortified with minerals and vitamins are usually suitable for routine colony maintenance. A formula with the following analysis has been found satisfactory: carbohydrate, 46.70 percent; fat, 9.35 percent; protein, 20.85 percent; CA/P, 1 to 1.2; calories per 100 g, 354. (See Table 1.)

Chimpanzees

Diets proposed for Old World monkeys (see above) are adequate for adult chimpanzees, provided they are given in appropriate quantities.

Supplements of fruit and vegetables are desirable in order to relieve monotony in the diet. They may also be provided to correct a deficiency or for experimental purposes. See the bibliography for chimpanzee diet studies by Nees *et al.*

EUTHANASIA

Killing an experimental animal quickly and painlessly is an acceptable part of many investigations. Euthanasia may also be necessary to halt an animal's suffering or to prevent a lingering death from disease.

Euthanasia may be accomplished by administering an overdose of an injectable anesthetic agent, exposing the animal to an inhalant anesthetic for a prolonged period, or injecting one of the commercially available lethal compounds prepared for this purpose. A qualified individual should examine the animal to assure that death has occurred before disposing of the carcass.

TABLE 1 Recommended Raw-Ingredient Formula for Custom-Made Baboon Rations[a]

Ingredient		Percent
Corn, yellow, ground		35
Wheat middlings, standard		20
Meat and bone meal		10
Soybean oil meal		10
Skim milk, dried		10
Alfalfa-leaf meal, dehydrated		2
Bone meal, steamed		2
Corn oil		6
Molasses, cane		2
Salt, iodized		1
Vitamin B compound premix[b]		1
B_{12}	5.1 mcg/lb	
Niacin	66.5 ppm	
Pantothenic acid	56.3 ppm	
Pyridoxine	15.0 ppm[c]	
Riboflavin	6.7 ppm	
Folic acid	2.2 ppm	
Thiamin	3.5 ppm	
Vitamin A stabilized concentrate, sufficient to furnish 10,000 IU per pound of ration		1
Irradiated yeast, sufficient to furnish 700 IU of vitamin D per pound of ration		
Ascorbic acid, 30 g per 100 pounds of ration		
Isonicotinic acid hydrazide, 0.015%		

[a] Recommended by the Southwest Foundation for Research and Education, San Antonio, Texas.
[b] Total pyroxidine hydrochloride content to be not less than 1 g per 100 pounds of feed.
[c] 7.5 ppm without isoniazid.

IDENTIFICATION AND RECORDS

Identification of individual animals is generally desirable. Tattoos, neck chains, or collars may be used for this purpose.

Records on experimental animals are essential to good animal care. Notations concerning source, pertinent dates, vital statistics, health status, reproductive history, manipulations, and eventual disposition are recommended. Clinical records and necropsy reports should be accurately maintained on each primate.

BREEDING

BREEDING SYSTEMS

Free-Ranging Breeding

The following shows the locations of certain free-ranging colonies:

Macaca mulatta–Cayo Santiago, near Puerto Rico. Further information may be obtained from
Laboratory of Perinatal Physiology
National Institute of Neurological Diseases and Blindness
San Juan, Puerto Rico 00753

M. fuscata–Oregon Regional Primate Research Center, Beaverton, Oregon 97005

Baboons–Sukhumi Primate Center. Further information may be obtained from
Institute of Experimental Pathology and Therapy
Academy of Medical Sciences
Sukhumi, Georgia, U.S.S.R.

Chimpanzees–Holloman Air Force Base, New Mexico. Further information may be obtained from
6571st Aeromedical Research Laboratory
Aerospace Medical Division
Holloman Air Force Base, New Mexico 88330

Breeding success under free-ranging conditions depends largely on the social organization of the species involved. Other factors to be considered follow.

Adequate food and water are necessary.

Time must be allowed for establishment of a social order in the group. Although the animals may copulate within one or two days, early conception is not likely.

This system requires little labor.

This system provides maximum opportunity for exercise of animals and for normal social development of infants.

Clinical observation and collection of specimens for laboratory examination are difficult.

Colony Caging

Colony caging has been successful with most Old World monkeys in routine laboratory use, including *Macaca mulatta, M. nemestrina, M. arctoides,* and *M. fascicularis*. A proved sire is placed in a colony-type cage with 3 to 12 females. Females are left in the cage until they are pregnant, whereupon they are placed in separate cages for delivery.

The advantages of this system:

Labor is saved by having fewer cages to clean and fewer groups of animals to feed and water.

The need for daily examination for mating or estrus is eliminated.

The disadvantages:

Conception date is difficult to establish.

Reintroduction of females into the home cage after parturition often precipitates fighting, which is repeated until the social order is re-established.

Caged Breeding

In this system of breeding, females are caged individually or in small groups apart from the male. They are generally moved into the male's cage during each estrual period until they become pregnant.

The system has several advantages:

It permits individual breeding records to be maintained on the females and the offspring.

It facilitates clinical laboratory examination and observation of the animals in general.

It identifies the nonbreeders, who can be eliminated from the breeding group.

Permanently Paired Mating

This system has the advantages listed for caged breeding (above) but is extremely expensive to maintain for the larger species because of the number of males required.

BREEDING IN RELATION TO CERTAIN SPECIES

Tree Shrews

Tree shrews are best caged in male–female pairs. This practice prevents the fighting that often occurs between members of the same sex.

Copulation has been observed throughout the year in captive tree shrews. Some estrus cycle and birth data, however, suggest the existence of seasonal breeding in *Tupaia.* A basic 10- to 12-day estrus cycle, with the period of sexual receptivity lasting 2 to 4 hours, is reported in one species.

The gestation period is believed to be 6 to 7 weeks.

Generally, one, two, or three babies are born. Two is the common number in most species.

In captivity, infant tree shrews often are abandoned by the mother shortly after birth. Occasionally they are eaten by the mother or by other adults in the cage.

Lorisidae

The species of Lorisidae that have been carefully studied seem to be seasonal breeders.

With the possible exception of several of the smaller Galago species, the Lorisidae are fairly solitary. Caging of male–female pairs is generally successful, but caging of groups is generally unsuccessful.

It seems likely from periodic fluctuations of body weight and testicle size that the male is as great a factor in breeding seasonality as the female.

The vulva of the Lorisidae is imperforate from birth until puberty. Thereafter it opens at regular, seasonally specific intervals for estrus.

Galago spp. that do not conceive during the first seasonal estrus usually cycle at approximately 30-day intervals for several months or until conception occurs. The gestation period for *G. crassicaudatus panganiensis* is 132 ± 5 days, and for *G. senegalensis braccatus,* 139 ± 5 days. The infants are well developed and fully haired at birth.

It is advisable to isolate females for parturition and during early stages

of infant development. Infants are often left alone in the nest box and are thus very vulnerable to attack.

Galago infants gain about 80 percent of their birth weight per week during the first 12 weeks of life. Sexual maturity is generally reached between the ninth and the twelfth month.

New World Monkeys

Good reproduction is achieved when breeding pairs of marmosets are housed in cages 18 in. wide, 18 in. deep, and 24 in. high.

Successful breeding of squirrel monkeys has been achieved with pairs, with groups containing one male and five females, and with groups containing multiple males and females. Mothers with babies usually do well when left in the cage in which breeding took place.

Little information is available on the breeding of other New World monkeys in a laboratory situation.

Old World Monkeys

Most of the successful breeding of Old World monkeys has been with macaques, especially *M. mulatta.*

Cercocebus spp. have not been successfully bred in the laboratory environment. However, modest success has been achieved with *Cercopithecus mitis* and *C. aethiops* by following, in general, macaque breeding practices.

Female macaques become sexually mature at 3 to 4 years of age; males, at 4 to 5 years.

Signs of the menstrual cycle vary among Old World monkeys in routine laboratory use. For example, *M. mulatta* shows bleeding primarily; *C. niger* displays prominent perineal tumescence with little bleeding; *M. nemestrina* shows both bleeding and tumescence. With *Cercopithecus* spp. the bleeding is scanty.

A successful timed-pregnancy breeding program for macaques requires day-to-day records of the menstrual history of each female. Females can be trained to present their perineum for daily examination to determine the onset of menses.

Limiting breeding-troop size to 10–12 females and 1 male permits the observer to keep the daily records without which timing of pregnancies is impossible. Groups of more than 12 females cannot be adequately observed.

Radiography also can be used in estimating the gestational age of a preg-

nancy in which the conception age is unknown, and is a fairly reliable tool in the hands of an experienced radiologist.

The first day of menstrual bleeding is designated as day 1 of the cycle. Peak days for ovulation are days 11 through 14. It is generally believed that mating from noon of the 11th day until noon of the 12th day is most likely to result in conception. The female is placed in the male's cage the morning of day 11 and remains with the male 24 to 48 hours.

Belligerent animals should not be placed together, as this results in fighting and poor conception rates.

Animals should not be placed together when there would be immediate competition for food.

Maintenance of a male room eliminates most of the social competition and thus fosters a higher conception rate. It is generally recommended that there be 1 male for every 20 to 25 females.

The female monkey usually "menstruates" once following conception. This is referred to as placental or implantation bleeding. It lasts longer (15 to 20 days) than the menstrual cycle (3 to 5 days) and is brighter in color than menstrual bleeding. Observation of this bleeding permits tentative diagnosis of pregnancy by the 17th to 25th day; rectal palpation at the 30th to 35th day is needed to confirm the diagnosis. One must keep in mind the possibility that placental bleeding may result from an intrauterine hemorrhage after an early abortion.

The usual gestation period for *M. mulatta* is 163 to 165 days. However, it may be as long as 180 days, and infants born as early as 147 days after conception have been known to survive. After 180 days, life is in jeopardy and the infant should be delivered by Caesarean section.

M. fascicularis follows the same gestational pattern as *M. mulatta; M. nemestrina* averages 173 ± 3 days. Limited experience with *C. aethiops* shows the period to be 135 to 160 days.

Baboons

Baboons reproduce readily in captivity after adapting to the new environment. Ovulation and conception seldom occur until after the mature female has been in her new surroundings 6 to 8 months.

The baboon has a menstrual cycle of approximately 35 days' duration. The optimum time for mating is the 17th day—or 2–4 days before the onset of detumescence. The gestation period is 164 to 186 days.

Breeding animals may be caged in groups or in pairs. When a gang cage is used, a ratio of 1 male to 10 to 12 females is recommended.

Chimpanzees

Chimpanzees reproduce readily in captivity provided they are adapted to their new environment and have been raised with sufficient social stimulation to permit ready acceptance of a member of the opposite sex.

When one considers that most of the apes are imported as infants and raised in some form of isolation, it is understandable why their reproduction rate is rather low.

Observers differ as to the proper male–female ratio, but they agree that a male and a female should "be acquainted" before they are paired. If male and female are customarily apart, pairing is more likely to be effective if they are brought together while the female is in substantial perineal swelling and is receptive to the male's advances.

Female chimpanzees are at breeding age when they are 9 to 10 years old; males, when they are a year or so older. The menstrual cycle is about 35 days and the gestation period between 245 and 256 days.

APPENDIX I

Suggested Standard Procedures for Detection of Tuberculosis

ILAR Subcommittee on Laboratory Animal Quality Standards

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PREFACE

The objective of the Institute of Laboratory Animal Resources' Subcommittee on Laboratory Animal Quality Standards is to recommend sampling and testing procedures for the detection of infectious agents in laboratory animal colonies. In developing the report on tuberculosis, the group considered the advice of several primatologists. Although there is not complete agreement on universally applicable testing procedures for tuberculosis in primates, or on the species and families within the order Primates that should be routinely tested, the subcommittee members feel that the procedure as presented gives the best possible assurance that an individual or colony is tuberculosis-free.

The report is presented as "*Suggested* Standard Procedures" to encourage further comment by specialists in primate medicine.

AGENT

Mycobacterium tuberculosis

ANIMALS

All nonhuman primates

INTRODUCTION

Tuberculin-testing is the single most practical and reliable method for detection of tuberculosis in primates. Necropsy and x-ray examination are valuable adjuncts.

Available evidence indicates that Old World monkeys are more susceptible to tuberculosis than New World monkeys and prosimian primates. Nevertheless, tuberculosis can occur in all nonhuman primates. These standards, therefore, shall apply to *all* nonhuman primate colonies.

Most primate colonies will fall within one of two categories. *Transient colonies* are those in which animals are held for a limited time, usually before delivery to a using laboratory. Typical of such colonies are those maintained by importers and dealers holding animals for sale, and quarantine, isolation, and conditioning colonies maintained by both dealers and research institutions to prepare animals for use in research. Because of their continually changing populations, such colonies can never be termed tuberculosis-free, but animals leaving such colonies can be termed tuberculosis-free if they meet the criteria specified below under A(1–3).

Maintenance colonies represent the usual laboratory situation. Animals are maintained for longer periods and the populations are relatively stable. Only tuberculosis-free primates should be admitted to such a colony.

SAMPLING PROCEDURE

A. *Transient Colony*

1. Each animal shall be examined by chest x-ray on arrival to detect advanced cases of tuberculosis which may be tuberculin-negative.

2. Each animal in an incoming group* shall be tuberculin-tested at 2-week intervals† until all animals in the group have passed three consecutive negative tests.

If a positive reaction occurs, the reactor shall be necropsied and appro-

*"Group" refers to a population with a similar history and environment. For example, a shipment of animals received at one time and kept physically isolated from older and newer arrivals would constitute a group. All animals housed in one room in a research facility would constitute a group, assuming effective separation of these from primates in other rooms.

†There is a considerable difference of opinion regarding the proper interval between tuberculin tests, due largely to inadequate data on the length of time required for an infected animal to become tuberculin-positive. It is the opinion of the committee that the intervals given will be adequate if the testing programs for transient and maintenance colonies are rigorously adhered to.

priate tests for confirmation shall be performed. Such tests shall include histopathological examination, acid-fast stains, and cultures for the purpose of determining the type of organism involved. All remaining animals in the reactor's group shall be retested at 2-week intervals until all animals in the group have passed three consecutive negative tests.

3. Each animal shall receive a final tuberculin test not more than 2 weeks prior to delivery to a maintenance colony. The final negative test in A(2) shall satisfy this requirement if delivery is made not more than 2 weeks subsequent to it.

B. *Maintenance Colony*

1. All additions to the colony shall meet the requirements outlined in A(1–3).

2. Each animal shall be tuberculin-tested at 3-month intervals. All animals with a positive tuberculin test shall be necropsied and appropriate confirmatory tests shall be performed as outlined in A(2).

3. All animals dying of unexplained causes shall be necropsied and appropriate confirmatory tests for tuberculosis shall be performed.

4. In the event that a positive tuberculin reactor appears in the colony or tuberculosis is discovered at necropsy, all animals in the group shall be tested at 2-week intervals until all have passed three consecutive negative tests, as in A(2).

TESTING PROCEDURE

1. 0.1 ml of Koch's Old Tuberculin (KOT),* containing 15 mg of KOT, shall be injected into the upper eyelid with a 25-gauge needle. Injury to the eyelid must be avoided. Proper restraint or drug immobilization of the animal is essential.

Intradermal injections in other sites may be used (e.g., near the umbilicus), but the palpebral site is preferred because of the ease of reading the test and the dramatic response in animals with a positive reaction. If other sites are used, and removal of hair is required, injury to the skin must be avoided.

2. Injected animals shall be examined daily for three successive days.

*Nonhuman primates require larger doses of tuberculin to elicit a response than does man. While smaller doses of KOT than recommended (15 mg in 0.1 ml) are frequently used, there appear to be no adverse effects from the higher dose, and there is reason to believe that the latter may be more effective in eliciting a response.

Other tuberculins (e.g., PPD) have been used. However, the committee recommends the use of KOT until adequate evidence is obtained that other preparations are equally effective.

Positive reactions may range from a minimal reddening, usually with slight edema, through severe swelling with closure of the eyelids, to hemorrhage into the injection site and necrosis in the more severe reactions.

Doubtful reactors shall be placed in isolation and retested in the opposite eyelid within 2 weeks. If the retest is negative or doubtful, the animal shall be retested three times at 2-week intervals. Upon completion of three consecutive negative tests, it may be returned to the colony.

3. All positive reactors shall be considered infected and infective and shall be removed from the colony immediately for necropsy and confirmatory tests as in A(2).

4. Retention of positive reactors is not justified except in the most unusual circumstances. If compelling reasons exist for maintaining a positive reactor, it must be isolated in an area completely removed from other primates and properly equipped for work with infectious agents, and investigators and caretakers must take effective precautions to prevent transmission to humans or to other primates. Treatment with isoniazid is recommended.*

PERSONNEL

Investigators, caretakers, and others in regular or frequent contact with primates in either transient or maintenance colonies shall be examined at least twice yearly for evidence of active tuberculosis.

Persons with infective tuberculosis shall not be admitted to primate colonies.

EVALUATION

False negative tuberculin reactions may occur early in the infection before hypersensitivity develops, or late in the disease when a previously positive animal may become nonreactive (anergic).

Animals with early infections will usually become tuberculin-positive within a few weeks' time, hence the recommendation for initial testing at

*Isoniazid prophylaxis appears to be valuable in the prevention of tuberculosis in primates, although treatment of active cases is less satisfactory. Evidence indicates that isoniazid does not always result in eradication of tubercle bacilli from infected animals and the disease may become active on cessation of therapy, not only in animals previously known to be infected, but also in animals with no prior evidence of infection. In addition, the possibility of toxic drug reactions and selection of drug-fast strains must be considered. For these reasons the committee does not consider continuous drug prophylaxis a substitute for an adequate testing program.

2-week intervals. Probably few of these early infections (before the development of a tuberculin-positive reaction) result in the shedding of organisms, so they do not represent a great hazard.

Animals with far-advanced disease who have become anergic will show lesions in the lungs demonstrable by x-ray examination. Such animals are usually prolific shedders of tubercle bacilli, so every attempt should be made to prevent their introduction into colonies.

A few instances are known where positive tuberculin reactors have appeared in maintenance colonies 6 to 9 months after their introduction into the colony, although tuberculin tests were negative in the intervening period. In these instances no source of infection could be found, either in other primates or in humans. The possibility exists, therefore, that a rare animal may develop a disease that progresses much more slowly than is usual

Primates may be infected with human, bovine, or avian strains of tuberculosis. Although the majority of infections are of the human type, isolation and determination of the infecting type of organism is important since it may provide evidence for unsuspected sources of infection.

A transient colony cannot be certified as tuberculosis-free because of the constant introduction of untested animals. However, individual animals from such a colony that meet the criteria in A(1–3) may be designated tuberculosis-free. A maintenance colony meeting the criteria in B(1–3) may be designated tuberculosis-free. In the event tuberculosis is subsequently detected in such a colony, re-establishment of the tuberculosis-free status shall be dependent on successful completion of the testing program outlined in B(4).

REFERENCES

Dolowy, W. C., M. H. Frank, G. E. Cox, and A. L. Hesse. 1958. Detection of Pulmonary Tuberculosis in Laboratory Monkeys by Chest Radiography. Amer. J. Vet. Res. *10*:225–229.

Habel, K. 1947. Tuberculosis in a Laboratory Monkey Colony: Its Spread and Control. Amer. Rev. Tuberc. *55*:77–92.

Ruch, T. C. 1959. Diseases of Laboratory Primates. W. B. Saunders, Philadelphia, Pa., p. 598.

Schmidt, L. H., R. Hoffmann, and P. N. Jolly. 1955. Induced Pulmonary Tuberculosis in the Rhesus Monkey: Its Usefulness in Evaluating Chemotherapeutic Agents. Trans. Conf. Chemotherap. Tuberc. *14*:226–231.

APPENDIX II

Selected Bibliography

Asdell, S. A. (ed.), *Patterns of Mammalian Reproduction* (2nd ed.), Cornell University Press, Ithaca, New York (1964).

Beischer, D. E., and D. E. Furry, "*Saimiri sciureus* as an Experimental Animal," *Anatomical Record, 148,* 615–624 (1964).

Buettner-Janusch, J., "The Breeding of Galagos in Captivity and Some Notes on Their Behavior," *Folia Primatologica, 2,* 93–110 (1964).

Buettner-Janusch, J., (ed.), *Evolutionary and Genetic Biology of Primates,* Academic Press, New York, 2 vols. (1963 and 1964).

Butler, H., "The Breeding Cycle of the Senegal Galago *(Galago senegalensis senegalensis),*" *Proceedings of the Zoological Society of London, 129,* 147–149 (1959).

Butler, H., "The Reproductive Biology of a Strepsirhine *(Galago senegalensis senegalensis),*" *International Review of General and Experimental Zoology, 1,* 241–296 (1964).

Coid, C. R., and A. C. Laursen, "Monkeys," *in* W. Lane-Petter (ed.), *Animals for Research,* Academic Press, London and New York (1963).

Committee on Animal Nutrition, *Nutrient Requirements of Laboratory Animals,* NAS-NRC Pub. 990, National Academy of Sciences–National Research Council, Washington, D.C. (1962).

Conaway, C. H., and M. W. Sorenson, "Reproduction in Tree Shrews," *in* I. W. Rowlands (ed.), *Comparative Biology and Reproduction in Mammals,* Academic Press, New York and London, pp. 471–492 (1966).

Cook, N., "Notes on Captive *Tarsius carbonarius,*" *Journal of Mammalogy, 20,*173–178 (1939).

Cowgill, U. M., "A Bidiurnal Cycle in the Feeding Habit of *Perodicticus potto,*" *Proceedings of the National Academy of Sciences, 54,* 420 (1965).

Cowgill, U. M., "Visiting in Perodicticus," *Science, 146,* 1183–1184 (1964).

Cowgill, U. M., A. Bishop, R. J. Andrew, and G. E. Hutchinson, "An Apparent Lunar Periodicity in the Sexual Cycle of Certain Prosimians," *Proceedings of the National Academy of Sciences, 48,* 238–241 (1962).

Deinhardt, J. B., J. Devine, M. Passovoy, R. Pohlman, and F. Deinhardt, "Marmosets as Laboratory Animals I. Care of Marmosets in the Laboratory, Pathology and Outline of Statistical Evaluation of Data," *Laboratory Animal Care, 17*(1), 11–29 (1967).

Draper, W. A., "Laboratory Maintenance of the Tree Shrew (*Tupaia glis* Diard 1820)," *Laboratory Primate Newsletter, 2*(4), 1–2 (1963).

Fiennes, Richard, *Zoonoses of Primates,* Cornell University Press, Ithaca, New York (1967).

Fooden, J., "Identification of the Stump-tailed Monkey, *Macaca speciosa,* I. Geoffroys, 1826," *Folia Primatologia, 5*(3), 153–164 (1967).

Grand, T., E. Duro, and W. Montagna, "Observations on the Development of a Potto Born in Captivity," *American Journal of Physical Anthropology, 22,* 329–332 (1964).

Haddow, A. J., and J. M. Ellice, "Studies on Bush-Babies (*Galago* spp.) with Special Reference to the Epidemiology of Yellow Fever," *Transactions of the Royal Society of Tropical Medicine and Hygiene, 58,* 521–538 (1964).

Hartman, C., "The Corpus Luteum and the Menstrual Cycle Together with the Correlation between Menstruation and Implantation," *American Journal of Obstetrics and Gynecology, 19,* 511–519 (1930).

Hartman, C. G., and W. L. Straus, Jr. (eds.), *The Anatomy of the Rhesus Monkey,* Hafner Publishing Co., New York (reprinted 1961).

Hendrickx, A. H., and F. H. Kriewaldt, "Observations in a Controlled Breeding Colony of Baboons," *in* H. Vagtbord (ed.), *The Baboon in Medical Research,* Vol. II, University of Texas Press, Austin, Texas (1967).

Hershkovitz, P., "Primates, Comparative Anatomy and Taxonomy," *American Journal of Physical Anthropology, 21*(3), 391–398 (1963).

Hershkovitz, P., "Taxonomic Notes on Tamarins, Genus Saguinus (Callithricidae, Primates), with Descriptions of Four Forms," *Folia Primatologica, 4,* 381–395 (1966).

Hill, W. C. O., *Primates, Comparative Anatomy and Taxonomy,* University Press, Edinburgh: I. *Strepsirhini* (1953); II. *Haplorhini: Tarsioidea* (1955); III. *Pithecoidea. Platyrrhini* (Families Hapalidae and Callimiconidae) (1957); IV. *Cebidae. Part A.* (1960); V. *Cebidae. Part B.* (1962); VI. *Catarrhini Cercopithecoidea Cercopithecinae* (1966).

Hofer, H., A. H. Schultz, and D. Starck (eds.), *Primatologia, Handbuch der Primatenkund,* S. Karger, Basel: Band I. *Systematik Phylogenie Ontogenie* (1956); Band II. *Haut und Sinnesorgane, Nervensystem* (partially published); Band III. *Verdauungstrakt Urogenitalorgane Endokrine Organe* (1958), *Blut- und Kreislauforgane Respirationsorgane Zahne und Gebiss* (1960); Band IV. *Skelet und Muskulatur* (partially published).

Hume, E. M., "Monkey Welfare," *Proceedings of the Nutrition Society, 16,* 87–93 (1957).

Jeffree, G. M., "Phosphatase Activity in the Limb Bones of Monkeys (*Lagothrix humboldti*) with Hyperparathyroidism," *Journal of Clinical Pathology, 15,* 99–111 (1962).

Jolly, A., "Prosimians' Manipulation of Simple Object Problems," *Animal Behaviour, 12,* 560–570 (1965).

Kaufmann, J. H., "Studies on the Behavior of Captive Tree Shrews (*Tupaia glis*)," *Folia Primatologica, 3,* 50–74 (1965).

Kerr, G. R., and H. A. Waisman, "The Rearing of the Infant Rhesus Monkey (*Macaca mulatta*)," *Laboratory Primate Newsletter, 5*(2), 1–8 (1966).

Kolar, von K., "A Report on the Reproduction and Early Stages of Development of *Galago senegalensis* in Captivity" [translated from German], *Der Zoologische Garten,* Band 31 (1965).

Lane-Petter, W., A. N. Worden, B. F. Hill, J. S. Paterson, and H. G. Vevers, *The UFAW Handbook on the Care and Management of Laboratory Animals* (3rd ed.), The Williams and Wilkins Company, Baltimore, Maryland (1967).

Lapin, B. A., and L. A. Yakovleva, *Comparative Pathology in Monkeys,* Medgiz, Moscow (1960); english translation: U.S. Joint Publications Research Service, Charles C Thomas, Springfield, Illinois (1963).

Lewis, G. C., "Notes on a Pair of Tarsiers from Mindanao," *Journal of Mammalogy, 20,* 57–61 (1939).

Lowther, Florence De L., "The Feeding and Grooming Habits of the Galago," *Zoologica, 24,* 477–480 (1939).

Lowther, Florence De L., "A Study of the Activities of a Pair of Galago senegalensis moholi in Captivity, Including the Birth and Postnatal Development of Twins," *Zoologica, 25,* 433–462 (1940).

Manley, G. H., "Reproduction in Lorisoid Primates," *Journal of Reproduction and Fertility* (abstract), *9,* 390–391 (1965).

Manley, G. H., "Reproduction in Lorisoid Primates," *Comparative Biology of Reproduction in Mammals* (Symposia of the Zoological Society of London), Academic Press, London and New York, pp. 493–509 (1966).

Manley, G. H., "Prosimians as Laboratory Animals," *in* R. N. T-W-Fiennes (ed.), *Some Recent Developments in Comparative Medicine* (Symposia of the Zoological Society of London), Academic Press, London and New York, pp. 11–39 (1966).

Nees, P. O., and P. N. Deres, "Survey of Existing Methods of Feeding and Housing the Chimpanzee," *ARL-TR-65-11,* Aeromedical Research Laboratory, Holloman AFB, New Mexico (1965).

Ramaswami, L. S., and T. C. Anad Kumar, "Some Aspects of Reproduction of the Female Slender Loris (*Loris tardigradus lydekkerianus Cabr.*)," *Acta Zoologica, 46,* 257–273 (1965).

Ratcliffe, H. L., *Adequate Diets for Captive Wild Animals, and Notes on Tuberculin Tests for Apes and Monkeys* (2nd ed.), Penrose Research Laboratory of the Zoological Society of Philadelphia, Philadelphia, Pennsylvania (1963).

Rohles, F. H., Jr., *The Chimpanzee. A topical bibliography* [with addenda], 6571st Aeromedical Research Laboratory, Defense Documentation Center, Alexandria, Virginia: *ARL-TDR-62-9* (1962), *ARL-TDR-63-27* (1963), *ARL-TR-67-4* (1967).

Ruch, T. C., *Bibliographia Primatologica.* A classified bibliography of primates other than man. *Part I.* Anatomy, embryology and quantitative morphology; physiology, pharmacology and psychobiology; primate phylogeny and miscellanea, Charles C Thomas, Springfield, Illinois (1941).

Ruch, T. C., *Diseases of Laboratory Primates,* W. B. Saunders Co., Philadelphia, Pennsylvania (1959).

Sanderson, I. T., *The Monkey Kingdom,* Chilton Co., Philadelphia, Pennsylvania (1963).

Sauer, R. M. (ed.), "Care and Diseases of the Research Monkey," *Annals of the New York Academy of Sciences, 85,* 737–991 (1960).

Schaller, G. B., *The Mountain Gorilla: Ecology and Behavior,* University of Chicago Press, Chicago, Illinois (1963).

Schmidt, L. H., *Proceedings of the Second Conference on the Procurement and Production of Rhesus Monkeys* (Appendix B), National Academy of Sciences–National Research Council, Washington, D.C. (1955).

Sorenson, M. W., and C. H. Conaway, "Laboratory Maintenance of Tree Shrews (*Tupaia longipes, T. chinesis, T. gracilis, T. minor,* and *Tana tana*)," *Laboratory Primate Newsletter, 3*(2), 1–2 (1964).

Sorenson, M. W., and C. H. Conaway, "Observations of Tree Shrews in Captivity," *Sabah Society Journal, 1,* 77–91 (1964).

Sorenson, M. W., and C. H. Conaway, "Observations on the Social Behavior of Tree Shrews in Captivity," *Folia Primatologica, 4,* 124–145 (1966).

Southwest Foundation for Research and Education, *The Baboon–An Annotated Bibliography,* Southwest Foundation for Research and Education, San Antonio, Texas (1964).

Sprankel, H., "On the Behavior and Breeding of *Tupaia glis* Diard 1820" [translated from German], *Zeitschrift fur Wissenschaftliche Zoologie, 165* (1/2), 186–220 (1961).

Stare, F. S., S. B. Andrus, and O. W. Portman, "Primates in Medical Research with Special Reference to New World Monkeys," *in* D. E. Pickering (ed.), *Proceedings of a Conference on Research with Primates,* Tektronix Foundation, Beaverton, Oregon (1963).

Tullner, W. W., and R. Hertz, "Chorionic Gonadotropin Levels in the Rhesus Monkey During Early Pregnancy," *Endocrinology, 78,* 204–207 (1966).

T-W-Fiennes, R. N. (ed.), *Some Recent Developments in Comparative Medicine* (Symposium of the Zoological Society of London), Academic Press, London (1966).

Ulmer, F. A., Jr., "A Longevity Record for the Mindanao Tarsier," *Journal of Mammalogy, 41*(4), 512 (1960).

Ulmer, F. A., Jr., "Observations on the Tarsier in Captivity" [translated from German], *Der Zoologische Garten,* Band 27 (1963).

Vagtborg, H. (ed.), *The Baboon in Medical Research,* Vol. 1, University of Texas Press, Austin, Texas (1965).

Vagtborg, H. (ed.), *The Baboon in Medical Research,* Vol. 2, University of Texas Press, Austin, Texas (1967).

van Bogaert, L., and J. R. M. Innes, "Neurologic Diseases of Apes and Monkeys," *in* J. R. M. Innes and L. Z. Saunders, *Comparative Neuropathology,* Chapter 4, Academic Press, New York (1962).

Voss, H., *Bibliographie der Menschenaffen* (*Schimpanse, Orang, Gorilla*), G. Fischer, Jena (1955).

Wharton, C. H., "The Tarsier in Captivity," *Journal of Mammalogy, 31,* 260–268 (1950).

Whitney, R. A., D. J. Johnson, and W. C. Cole, *The Subhuman Primate, A Guide for the Veterinarian,* Publication 100-26, Edgewood Arsenal, Maryland (1967).

Yerkes, R. M., *Chimpanzees: A Laboratory Colony,* Yale University Press, New Haven, Connecticut (1943).