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POLICY STATEMENT

The primary purpose of the *Laboratory Primate Newsletter* is to provide information on maintenance, breeding, and procurement of nonhuman primates for laboratory studies. A secondary purpose is to disseminate general information about the world of primate research. Requests for information, for special equipment, or for animal tissues or animals with special characteristics will be included in the *Newsletter*. As a rule, the only research articles or summaries that will be accepted for the *Newsletter* are those that have some practical implications or that provide general information likely to be of interest to investigators in a variety of areas of primate research. However, special consideration will be given to articles containing data on primates not conveniently publishable elsewhere. General descriptions of current research projects on primates will also be welcome.

The *Newsletter* appears quarterly and is intended primarily for persons doing research with nonhuman primates. There is no charge for new issues or the current issue. Volumes 1-6 may be purchased for $4.00 per volume, Volumes 7-9 for $2.50 per volume, and back issues for the current year for $0.75 each. (Please make checks payable to Brown University.)

The publication lag is typically no longer than the 3 months between issues and can be as short as a few weeks. The deadline for inclusion of a note or article in any given issue of the *Newsletter* has in practice been somewhat flexible, but is technically the fifteenth of December, March, June, or September, depending on which issue is scheduled to appear next. Reprints will not be supplied under any circumstances.

PREPARATION OF ARTICLES FOR THE *NEWSLETTER*.--Articles and notes should be submitted in duplicate and all copy should be double spaced. Articles in the References section should be referred to in the text by author(s) and date of publications, as for example: Smith (1960) or (Smith & Jones, 1962). Names of journals should be spelled out completely in the References section. Technical names of monkeys should be indicated at least once in each note and article. In general, to avoid inconsistencies within the *Newsletter* (see Editor's Notes, July, 1966 issue) the scientific names used will be those of Napier and Napier [*A Handbook of Living Primates*. New York: Academic Press, 1967].

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Managing Editor: Kathryn M. Huntington

CONTENTS

REPRODUCTIVE PHYSIOLOGY OF PRIMATES[1]

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In the late 1950's the production of poliomyelitis vaccine from *Macaca mulatta* caused the government of India to place an embargo upon the exportation of this species (Schmidt, 1969). This action reflected the concern of that government about the high incidence of transit losses and the decimation of the native population. This action placed a severe strain upon the availability of these primates for normal research usage (Neurauter, 1968).

In more recent years, more and more governments are restricting the exportation of their nonhuman primate populations for any use. The list of "endangered species" grows longer with each passing month. Today the list includes all of the Lemuridae, Indriidae, and Daubentoniidae families, two species of gibbons (*Hylobates*), *Gorilla gorilla*, orangutans (*Pongo pygmaeus*), several species of spider monkeys (*Ateles*), all of the uakaries (*Cacajao*), and several others (Anon., 1970).

The resultant shortage of animals has caused prices to rise for both research and zoological garden animals, and an increase in the black market supply of others. Because of this, there is a great deal of interest and activity relating to the breeding of nonhuman primates in captivity. The concept of production "farms" in peninsular and island settings in the southeastern United States and the Caribbean (patterned after the successful breeding colonies on Cayo Santiago) has been proposed. The National Center for Primate Biology has recently undertaken vastly expanded studies on breeding methods, and the focus in modern zoological gardens has changed from simply display to establishment of self-perpetuating units. Many nearly extinct species now find their final refuge in such an environment. Primate research facilities are orienting their research programs towards reproductive physiology in an effort to solve this pressing problem. The following report outlines

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[1]A similar version of this article with additional tables of data appeared in the *Proceedings, Annual Meeting of the American Association of Zoo Veterinarians, Oct. 12-14, 1970*. East Lansing, Mich.: Michigan State Continuing Education Center, 1970. Pp. 51-66.

The author wishes to express his appreciation to Mr. Richard M. Harrison and Mr. Dennis A. Jewett for their contributions to the research cited. This work was supported by USPHS Grant No. FR00366 to the Center for Lab. Animals Resources, Contract 70-2061 from the Center for Population Research, National Institutes of Health and NIH Research Career Development Award HD35306. Published with the approval of the Director, Michigan Agricultural Experiment Station (Journal Article No. 5262).

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patterns of reproductive management successful in the past, and details the relationship of basic physiological principles to a successful breeding program.

Adaptation of Estrous Cyclicity to Captive Conditions

Normal purchases of primates from dealers fall into three major classifications: (a) pregnant females; (b) adult, proven animals, normally several years postpuberal; and (c) adult animals of young age. Primates in the first category are normally characterized as having an abnormally high incidence of abortion (Valerio, Courtney, Miller, & Pallotta, 1968) and have the disadvantages of an unknown time of mating and an unknown sire. Mature adult primates are often selected because of their proven ability to sire young, yet have the disadvantage of a pre-established social structure from which they are removed for placement in another.

Young, puberal adults are the animals of choice for the establishment of a breeding colony. Valerio (1970) has observed a tendency for rhesus monkeys (*Macaca mulatta*) under laboratory conditions to mimic their natural cyclic patterns for the first year in captivity (mating from November through January), but subsequently the breeding cyclicity is attenuated and conceptions can occur in every month of the year.

In squirrel monkeys (*Saimiri sciureus*) living in a seminatural environment (DuMond, 1968), a distinct seasonality of cycling occurs, as in the wild state (Rosenblum, 1968). With confinement, there is a very definite shift in the time of year of the mating and birth seasons. In one report (DuMond, 1968) the birth peak shifted, over a three-year period, from March to July-August. The birth season then remained constant in later years.

Once the captive animals become acclimated to their environment (normally one to two years) regular cyclicity is observed. In our colony of cynomolgus monkeys (*M. fascicularis*), a colony of zoo origin and long captivity, nearly all animals are characterized by regular cycles averaging 29.6 days with a range from 25 to 33. The adaptation of these animals to a single-cage environment is further emphasized by the production of ten normal offspring last year from 12 regularly cycling females. Nine of these births occurred within 43 days, indicating a high conception rate once the mating began. Most of these matings were accomplished by daily exposure for two hours with males from Day 11 to Day 15. This year, with changes in our research experiment requirements, we are attempting to control the time of conception within one-half hour. On the basis of accurate menstrual cycle records, the final stages of preovulatory follicular development can be projected. The morphological changes which occur in the developing follicle, when observed nonsurgically through the laparoscope, allow us to more precisely determine the stage of follicular maturation (see the article on page 16 of this *Newsletter*). This procedure allows us to establish a precise timetable for limitedduration matings. Even with this restricted period of mating, animals have conceived, as judged by failure to return to regular cycling.

In dealing with any new species, it is necessary to have a knowledge of its reproductive parameters as a baseline. Unfortunately, such information on primates is often difficult to find. Table 1 lists some of the known reproductive parameters of the primate families. The data in this table have been obtained from reports of a large number of investigators. It is evident that much of the necessary information is lacking. With the exception of macaques, squirrel monkeys, baboons (*Papio*), galagos (*Galago*), langurs (*Presbytis*), and chimpanzees (*Pan*) (all of which are used in research environments), and man, reproductive characteristics of primates are relatively unknown. Available information reflects a limited number of animals in zoos or private collections.

Physiological Principles Applied to Breeding in Captivity

Assuming the presence of fertile and mutually compatible animals (a major assumption in primates!) there are four basic parameters which, if known, greatly enhance the breeding efficiency: (a) the starting date of either menstruation or estrus; (b) the exact time of ovulation, whether naturally or artificially induced, relative to the start of estrus or time of mating; (c) the time requirement for sperm capacitation; and (d) the fertilizable life of the ovum. It is unfortunate that the only species in the animal kingdom in which all of these are known is the rabbit. The relationship of these four factors to successful mating is illustrated in Figure 1. One must know the start of

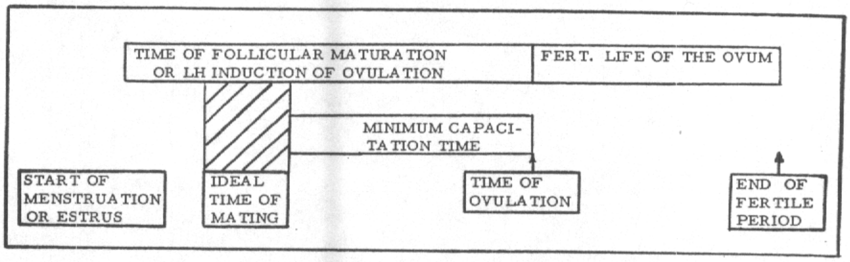

Fig. 1. The relationship of the time of ideal mating with follicular maturation, ovulation, capacitation, and the fertilizable life of the ovum.

menstruation (if it occurs) or of the period of sexual receptivity (estrus) in order to predict the approximate day or time of ovulation. Spermatozoa capacitation, the phenomenon which occurs in the female reproductive tract and by which spermatozoa attain the ability to fertilize the ovum, normally is measured in hours, and ideally occurs prior to ovulation. The fertilizable life of the ovum is short in most

Table 1

Reproductive Parameters of Primates[a]

	Gest. length (days)	Age of matur. (yr.)	Season of birth[b]	Estrus cycle length	Births in captivity 1959-1962[c]	Length of menstr. (days)	Length of estrus if evident (days)
PROSIMIANS							
Tupaiidae							
Tupaia (Treeshrew)	41-50	0.5					
Urogale (Philippine treeshrew)	54-56						
Ptilocerous (Feather-tailed treeshrew)							
Lemuridae							
Lemur (Lemur)	120-135	1.5	Mar.-Jun.				
Lepilemur (Sportive lemur)	120-150	1.5	Sept.-Nov.		0		
Hapalemur (Gentle lemur)			Dec.-Jan.				
Cheirogaleus (Dwarf lemur)	70		polyest.	30	some		2-5 da.
Microcebus (Mouse lemur)	59-62	0.8	Dec.-Mar.	45-55	many		2-5 da.
			polyest.				
Phaner (Fork-marked dwarf lemur)					0		
Indriidae							
Indri (Indris)	60						
Propithecus (Sifaka)	150	2.5	Jun.-Jul.				
Avahi (Avahis)			Aug.		0		
Lorisidae							
Loris (Slender loris)	160-174		Apr.-May	2×/yr.	1		
			Nov.-Dec.				
Nycticebus (Slow loris)	193		All yr.	42.3	3		
Arctocebus (Angwantibo)	131			38-45	1		
Perodicticus (Potto)	< 219		All yr.	39	2		
Galago (Galago)	124-146	1.0	Apr.-Nov.	31.7	36		5-6 da.
Tarsiidae							
Tarsius (Tarsier)	180		All yr.	23.5			24 hr.
ANTHROPOIDEA							
Callitrichidae							
Callithrix (Marmoset)	140	1.2			45		
Cebuella (Pygmy marmoset)					10		
Saguinus (Tamarin)	140		All yr.		14		
Leontideus (Golden lion tamarin)	132-134				12		
Callimico (Goeldi's marmoset)							
Cebidae							
Cebus (Capuchin)	180	3-4	All yr.	18		24	
Saimiri (Squirrel monkey)	167	3	Jul.-Aug.	8-12	58	none	

Aotus (Douroucouli)			Jun.		8		
Callicebus (Titi)			Dec.-Mar.		1		
Pithecia (Saki)					0		
Chiropotes (Bearded saki)							
Cacajao (Uakari)					some		
Alouatta (Howler monkey)	139	3.5-4.0	All yr.				
Ateles (Spider monkey)	139		All yr.	24-27	62	3-4	
Lagothrix (Woolly monkey)	225	4		23-26			
Brachyteles (Woolly spider monkey)					0		
Cercopithecidae							
Cercopithecus (Guenon & talapoin)	180-213		All yr.	30	many		
Erythrocebus (Patas monkey)	170		Dec.-Feb.	30	24		
Mandrillus (Drill & mandrill)	245			32.6	many		
Cercocebus (Mangabey)			Apr.-Nov.	29	49		
Papio (Baboon)	175	4-6	All yr.	32.3	many	4-9	
Theropithecus (Gelada)			Feb.-Apr.		11		
Macaca (Macaque)	146-186	3.5-4.5	Mar.-Jun.	28	many	2-6	9
Cynopithecus (Celebes black ape)	155-175			31	5		
Colobus (Guereza)			All yr.		16		
Presbytis (Langur)	168	3-4	All yr.	30	21	2-3	5-7
Nasalis (Proboscis monkey)	166		All yr.		0		
Simias (Pagai Island langur)							
Rhinopithecus (Snub-nosed langur)					3		
Pygathrix (Douc langur)							
Hylobatidae							
Hylobates (Gibbon)	210	5-8	All yr.	29.8	66	2-5	
Symphalangus (Siamang)	230-235				1		
Pongidae							
Pongo (Orangutan)	227-275			29-32	33	3-4	
Pan (Chimpanzee)	227	7-10	All yr.	37	many	2-3	
Gorilla (Gorilla)	251-289		All yr.	30-39		8	
Hominidae							
Homo (Man)	280	12-14	All yr.	28	too many	2-8	

[a]Data in the table are from the following: Asdell, 1946; Bantin, 1966; Berkson & Chaicumpa, 1969; Blackwell & Menzies, 1968; Castellanos & McCombs, 1968; Clewe, 1969; Douglas & Butler, 1970; Doyle, Pelletier, & Bekker, 1967; Elder, 1938; Guilloud, 1969; Hampton & Hampton, 1965; Hampton, Hampton, & Lendwehr, 1966; Hendrickx & Kraemer, 1969, 1970; Holmes, Haines, & Bollert, 1968; Kriewaldt & Hendickx, 1968; Lang, 1967a; Mahoney, 1970; Manley, 1965; Napier & Napier, 1967.

[b]Season of birth: In northern hemisphere if known, otherwise in native habitat.

[c]These data are from the *International Zoo Yearbook*, Vols. 1-5, and represent births in Zoological Gardens.

species (6 to 20 hours) and is the most critical parameter. The fertilizable life of the sperm can also be of importance if mating occurs a long time before ovulation. However, since the fertilizable life of the sperm of most species appears to be between 24 and 72 hours, and since the period of maximum receptivity in the female usually occurs near the time of ovulation, this factor is of less importance. Ideally, for maximum conception, mating should precede ovulation by the period of time necessary for capacitation to occur.

For the highest conception, especially with the rarer species, one should allow mating, capacitation, and ovulation to occur naturally, but occasionally it becomes necessary to superimpose an artifical regimen upon the animal to bring about pregnancy. Such techniques as ovulation induction, superovulation, steroid treatments to control estrus or enhance fertilization, and artificial insemination are accomplished facts in many nonprimate species. In the nonhuman primates these techniques have been used with some success.

Ovulation Induction

As early as 1935, Hisaw, Greep and Fevold (1935), using crude ovine anterior pituitary extracts, reported ovulation induction in three out of four macaques. Hartman (1938) reported a total of seven ovulations out of 104 cycles in anovulatory adult rhesus monkeys. Later (Hartman, 1942), he reported an additional six ovulations out of forty-six cycles. Pfeiffer (1950) attempted to prevent ovulation in rhesus monkeys with 0.5 mg of progesterone daily from the 10th to the 14th day of the cycle. Four ovulations were obtained from eleven monkeys after the end of treatment.

Most of the work on the induction of ovulation in nonhuman primates has been carried out by van Wagenen and her colleagues and has been summarized by her (van Wagenen, 1968). Beginning in 1935, she unsuccessfully attempted to induce ovulation in macaques with pregnant mares serum (PMS) (van Wagenen & Cole, 1938). Later work with purified follicle stimulating hormone (FSH) and interstitial cell stimulating hormone (ICSH) of ovine origin was ineffective in inducing ovulation. In 1956, Knobil, Morse, and Greep (1956) reported the importance of species-specificity in some primate pituitary hormones. This led to the important observation (Simpson & van Wagenen, 1957; van Wagenen & Simpson, 1957a, 1957b) that, in a significant number of cases, multiple ovulation was obtained with gonadotropins of primate origin. Subsequently, Knobil, Kostyo and Greep (1959) induced ovulation in hypophysectomized macaques by treatment with porcine FSH and human chorionic gonadotropin (HCG).

In the intervening years, various ovulation-inducing agents have been studied for their effect on ovulation in rhesus monkeys. Dede and Plentl (1966) used Pergonal (human menopausal gonadotropin, HMG) injections for 8 to 10 days followed by two-day injections of HMG and HCG. The animals were then mated or artificially inseminated and pregnancies were obtained.

Wan and Balin (1969), using HMG and HCG, clomiphene citrate, and dl-18-methyl estriol to induce ovulation in macaques, were successful in 60%, 59% and 32% of the treated cycles, respectively. They were also successful in obtaining high incidences of single ovulations in contrast to Simpson and van Wagenen (1962), who reported multiple ovulations on each ovary.

Bennett (1967a, 1967b) induced multiple ovulation in squirrel monkeys with various regimes of PMS and HCG. He demonstrated that ova can be recovered from the oviducts and suggested that, probably because of the elevated level of estrogens from the ovary, tubal transport could be speeded up by the high level of PMS employed. Bennett began injections without reference to the stage of the cycle.

In our experiments relating to ovulation induction in squirrel monkeys we found that we could induce follicular growth most effectively with FSH (Dukelow, 1970, Table 2) and that these could be ovulated as single or multiple ovulatory sites using HCG (Dukelow, 1970, Table 3). HMG yields good follicular growth but few of them ovulate, probably due to the HMG-induced hyperstimulation syndrome observed in many human patients. PMS was not effective in stimulating follicular growth, but when injected for nine days (with HCG included in the last four days), superovulation equivalent to that obtained by Bennett (1967a) was observed. This induction of superovulation is not difficult, but it should be emphasized that although this research technique is useful in the laboratory, it has less application in the area of breeding management. In primates, the problem is often to merely obtain a pregnancy, not to alter litter size to astronomical proportions.

Sperm Capacitation

In 1951 Austin (1951) and Chang (1951) independently discovered that a period of uterine incubation was required to enable sperm to penetrate the ovum (capacitation). These studies were done with rats and rabbits. Since that time capacitation has been found to exist in the hamster, mouse, ferret, and sheep. Although a capacitation requirement has not been demonstrated in primates, Hartman (1933) reported that the mean and modal ovulation date for rhesus monkeys was Day 13 of the cycle, and van Wagenen (1945) stated that the optimum time for insemination in this species was from noon on Day 11 to noon of Day 12 of the cycle. These data suggest that monkey sperm also requires a period of uterine incubation before fertilizing the ovum.

We used four indirect techniques to demonstrate (Dukelow & Chernoff, 1968, 1969) that both human and rhesus monkey sperm do require capacitation. In the same year, Marston and Kelly (1968) estimated, based on the time of the sperm penetration, that rhesus monkey sperm require 3 to 4 hours for capacitation. More recently Seitz, Rocha, Brackett, and Mastroianni (1970) have utilized the rhesus uterine lumen to incubate human sperm used in successful *in vitro* fertilization trials. Their incubation period was from 4 to 5 hours. It would appear that capacitation not only is required in primates (as in all other mammals studied), but that the time requirement is between 3 and 5 hours.

Recognizing that progesterone will inhibit the capacitation process (Chang, 1958) (at levels far below that required to inhibit ovulation; Harrison & Dukelow, 1971), we have been attempting to determine levels of a progestin, Pregn-4, 6-diene-6-methyl-17a-hydroxy-3,20 dione acetate (megestrol acetate), which will allow ovulation but inhibit fertilization possibly by preventing capacitation. Levels between 50 and 100 μg per day began to interfere with ovulation in squirrel monkeys. Others have suggested that levels of 40 μg per day to women will allow ovulation but prevent fertilization, presumably due to an action on capacitation and gamete transport.

Semen Collection and Artificial Insemination

Many techniques commonly used in other domestic animals have been applied to primates as a means of semen collection. The commonly used techniques with primates involve electrical stimulation of either the penis or the accessory sexual glands. As with other domestic animals, certain criteria must be used in selecting the males which will be utilized for semen collection, and it is a well recognized phenomenon that not all males are capable of artificial ejaculation. In the case of rhesus monkeys, the proper choice of males is of prime importance. They should be in a strong physical state and of proven fertility. Since larger animals can be quite dangerous and because of the close working relationship of the male and the animal technician, the canine teeth should be removed from all experimental subjects before they are used. The penile electrode technique (Mastroianni & Manson, 1963) has been widely used in many laboratories, including our own. In some species which lack a distinct glans, such as chimpanzee, this technique is not possible because of the inability to keep the electrodes on the penile shaft. To improve this, workers at the Yerkes Regional Primate Research Center have developed a sheath with brass ring electrodes imbedded in the inner surface. Placing this over the penis eliminates the necessity for the foil strips. Another form of electroejaculation frequently used is the rectal probe. This was first described for use with monkeys in 1965 and was used on rhesus, pigtailed (*M. nemestrina*), and Japanese (*M. fuscata*) monkeys, and Celebes black apes (*Cynopithecus niger*). The construction of the rectal probes that are used has been described in several publications (Fussell, Roussel, & Austin, 1967; Gilman, 1969; Healey & Sadleir, 1966; Lang, 1967b; Roussel & Austin, 1968; Valerio, Ellis, Clark, & Thompson, 1969; Weisbroth & Young, 1965). This type of electroejaculation consists of placing the probe electrodes within the rectum in the vicinity of the male accessory glands and through their stimulation to elicit ejaculation. This type of probe (Roussel & Austin, 1968) has also been used for semen collection from chimpanzees, gibbons, gelada baboons (*Theropithecus gelada*), mangabeys (*Cercocebus*), rhesus, cynomolgus, and stumptailed monkeys (*M. arctoides*), vervets (*Cercopithecus aethiops*), patas (*Erythocebus patas*), and cebus monkeys (*Cebus*), and tree shrews (*Tupaia*).

Artificial Insemination

Primate semen coagulates, but will liquefy to a small degree by incubation at 37 degrees C. The coagula are not affected by compounds capable of dissolving fibrin coagula such as Evans Blue, cysteinamine, N-acetyl cysteine and bromsulphalein. Many enzyme preparations have been used in attempts to liquify the coagulum. Varizyme (streptokinase-human plasminogen-streptodoronase) was used without success (Weisbroth & Young, 1965).

Collagenase, a-amylase and B-amylase are ineffective. The best results have been obtained with 1% solutions of Pronase, a-chymotrypsin and trypsin (bovine pancreas, type I) (Roussel & Austin, 1967a). Lipase also has a dissolving effect on the coagula (Roussel & Austin, 1968) at a concentration of 1% in a 3% sodium glutamate solution. In our laboratory a 2% lipase solution dissolved the squirrel monkeys coagulum but the time requirement for this incubation precludes the recovery of motile sperm.

One interesting approach to the prevention of the formation of the coagulum is the collection of semen directly into a 2% chymotrypsin solution (Hoskins & Patterson, 1967). By this procedure complete dissolution was obtained within 5 minutes.

Several workers have successfully frozen and thawed nonhuman primate semen but no fertilization has occurred using semen which has been frozen. The semen of rhesus, stumptailed, and patas monkeys, vervets, and chimpanzees have been frozen and thawed with recoveries of motile sperm ranging from 50 to 54% (Roussel & Austin, 1967b). The semen was frozen in an extender consisting of 20% egg yolk, 64% of a 3.0% w/v sodium glutamate solution and 14% glycerol. Semen was added to the extender in a ratio of 1:10 and equilibrated for 30 minutes at room temperature. The semen was ampuled (0.5 ml. in 1.2 ml. glass ampules) and lowered into the nitrogen refrigerator for deep-freezing.

The best semen extenders reported for freezing chimpanzee semen (Sadleir, 1966) were: (a) egg yolk and 2.9% sodium citrate, with 10% glycerol; (b) milk and egg, with 10% glycerol; and (c) glucose and egg yolk, with 7% glycerol.

Baboon semen has been frozen by the nitrogen vapor technique just described with the semen extended in the sodium glutamate and egg yolk solution (Roussel & Austin, 1967b) containing 500 i.u. penicillin and 500 mg streptomycine per ml (Kraemer & Vera Cruz, 1969). Generally speaking, attempts at artificial insemination in nonhuman primates have involved placement of the coagulum into the vagina without dilution of the semen (Dukelow, 1971). This is normally done with the female (unanesthetized) held in an inverted position, and the liquified semen sprayed onto the cervix with a syringe. The coagulum is then inserted into the vagina and the female is held in the inverted position for 15 to 20 minutes. In the squirrel monkey (Bennett, 1967b), three females were inseminated and 72 hours later ova were recovered up to the 4 cell stage.

It is possible to inseminate rhesus monkeys intraperitoneally (van Pelt, 1970). In 8 animals so treated, 3 became pregnant on the first cycle. Two of these pregnancies were terminated by cesarean section in the eighth week; one pregnancy went full term. The semen was collected by the penile electrode technique, diluted and washed, and injected intraperitoneally in volumes varying from 22 to 183 ml.

Summary and Conclusions

The successful breeding of primates in captivity is dependent upon a variety of factors. Of greatest importance is the knowledge of the animals' breeding habits in the wild state and the reproductive parameters of the species. Lacking the latter, extrapolation from closely related species can be useful. An adequate period of time (normally one or two years) is required for the adaptation of the animal to the captive environment. After this adaptation, and when normal cyclicity has begun, culling pressure should be exerted against those animals which fail to reproduce.

An understanding of the basic concepts of reproductive physiology is required and variations in cycle length, ovulation time, capacitation time, and the fertilizable life of the gametes must be taken into account.

Emphasis must be placed on obtaining pregnancies under conditions similar to natural matings. The techniques of estrus and ovulation induction and artificial insemination should be considered only when natural mating fails. Once under consideration, however, these techniques can be utilized to overcome natural problems of incompatability among the captive primates.

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LAPAROSCOPY AND PRECISE MATING TECHNIQUES TO DETERMINE GESTATION LENGTH IN *MACACA FASCICULARIS**

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Using precise mating techniques and laparoscopy, two births of cynomolgus monkeys (*Macaca fascicularis*) have occurred at the Endocrine Research Unit at Michigan State University. The first mating (No. 54) occurred between 10:00 a.m. and 1:00 p.m., on July 31, 1970 (Day 14 of the cycle). Laparoscopy was not used immediately before or during pregnancy; however, such an examination was carried out under Sernylan (Parke-Davis) anesthesia at 11:00 a.m. on July 4, 1970. At that time one ovulation point, estimated to be 6 to 10 hours was observed. A normal female offspring was born between midnight and 6:00 a.m. on January 12, 1971. The gestation length was between 164 days, 11 hours and 164 days, 20 hours. Implantation bleeding was observed from August 18 to August 24, with moderately heavy flow.

The second female (No. 42) was mated between 10:55 a.m. and 11:25 a.m. on August 13, 1970 (Day 12 of the cycle). Laparoscopy was performed under Sernylan anesthesia on August 16, 1970 (Day 15 of the cycle) at 12:45 p.m. A newly formed corpus luteum was observed and photographed. On November 18, 1970 (Day 97 of pregnancy) at 10:00 a.m., pregnancy was confirmed by laparoscopic examination of the uterine fundus, circulatory vessels and ovarian ligaments. No adverse effects of either laparoscopy or Sernylan anesthesia on either Day 3 or Day 97 of pregnancy were observed. A normal female offspring was born at 9:15 p.m. on January 26, 1971. The gestation length was between 165 days, 10 hours, 30 minutes and 165 days, 11 hours.

Another female (No. 7) was subjected to precise mating and laparoscopy, but the pregnancy was terminated by cesarean section for other experimental purposes. Accordingly, the exact gestation length could not be determined. She was mated between 9:20 a.m. and 9:50 a.m. on September 15, 1970 (Day 11 of the cycle). Laparoscopy was performed at 9:30 a.m., September 16, 1970 (Day 12 of the cycle) and a fresh ovulation point was observed. Pregnancy was terminated on Day 92, December 16, 1970.

All three of the above pregnancies were by different males.

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CHIMPANZEE BREEDING: AN EXPERIMENTAL PROGRAM AT LEMSIP

Wayne E. Johnson, Wendell H. Niemann and J. Moor-Jankowski

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There is great concern these days about the decreasing availability of chimpanzees for medical research. Laboratory breeding of the animals has been hampered by the widely held belief that apes cannot be successfully bred in cages under laboratory conditions. For these reasons, we decided to initiate a small breeding program at the Laboratory for Experimental Medicine and Surgery in Primates (LEMSIP).

Of 50 chimpanzees, mostly juveniles, housed at LEMSIP, 4 young adult males and 4 young adult females were selected as potential breeders. Originally acquired as 1-year-old infants by the 6571st Aeromedical Laboratory, Holloman Air Force Base, New Mexico, and transferred to LEMSIP in 1969, these animals had opportunities for some adult and peer associations during their juvenile and adolescent years, but no breeding experience. The chimpanzees chosen for the breeding program were selected on the bases of the following criteria for males: size, body weight, and temperament; and for females: menstrual bleedings and periodic sex skin activity. Two of these animals (No. 107, Annie; and No. 204, Debbie) are part of the longstanding "Holloman Panel" blood group program (Wiener, Moor-Jankowski, Kratochvil, & Fineg, 1966); the third female (No. 116, Shirley) is a chronic Australia antigen carrier, and has been used in hepatitis studies since 1966 (Lichter, 1969; Prince, in press).

As timed pregnancies were not our goal, compatible pairs remained together until conception was confirmed. Each pair was housed in a LEMSIP suspended cage, which is made of aluminum bars and measures 5 × 5 × 6-1/2 feet. The animals were fed selected fruits in the morning, vitamin cocktails at noon, and Purina Monkey Chow in the afternoon; they were kept on Isoniazid (American International Products, New York, N. Y.) prophylaxis (Moor-Jankowski, Muchmore, & Davis, 1970). Water was available to them at all times.

After a female had missed two menstrual cycles, it was removed from the cage and bimanual palpations were done to confirm conception. Three of the four conceived within four months. Two of the pregnant females were 11 years old and one was 13 years old; the males were between 10 and 12 years old. The age of the animals was determined on the basis of information provided by the Holloman Air Force Base.

One of the three pregnant animals, Debbie, delivered a normal,

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A fourth pregnancy was obtained (No. 16) with short-time mating, but the pregnancy was prematurely terminated. Unfortunately the laparoscopy records and early termination did not allow precise determination of ovulation time or gestation length.

Over 80 matings have been carried out with the four reported pregnancies. Matings have ranged from Day 11 to Day 15 of the cycle. This seemingly low level of fertility is due to the planned, wide variation in the time of mating relative to ovulation. These studies represent efforts to determine the fertilizable life of the cynomolgus monkey ovum *in vivo*, and will be reported in detail at a later date. This is believed to be the first report of the use of laparoscopy and short-time, single mating sessions to precisely determine gestation length, and of the use of laparoscopy to diagnose pregnancy in these animals.

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ADVANCED DEGREE PROGRAM WITH A SPECIALTY IN PRIMATE BEHAVIOR OFFERED

The Department of Psychology at the University of Georgia is now offering a master's degree and Ph.D. with a specialty in Primate Behavior. This program is being conducted with the cooperation of the Yerkes Regional Primate Research Center and in conjunction with the development of a parallel program in the new Department of Anthropology. An effort will be made to include a background in primate anatomy, paleontology, physiology, phylogeny, development and ecology, in addition to the field and laboratory studies of behavior on which will be the major emphasis. Interested students are invited to write either department for further information.

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FACILITIES AVAILABLE TO SCIENTISTS AT MONKEY JUNGLE

The Monkey Jungle encourages students of primatology to make use of its facilities, particularly to study animals in a seminatural environment. Living quarters are available at no charge. The primates living in a seminatural environment at the Monkey Jungle include marmosets, squirrel monkeys, howler monkeys, uakaris, and cynomolgus monkeys. A great variety of other kinds of monkeys are housed in cages. If interested, send a short written proposal to Frank V. DuMond, Director, Monkey Jungle, 14805 S.W. 216th Street, Miami, Florida 33170.

healthy infant on January 25, 1971, while the other two animals aborted. One of the latter, Shirley, has been on a routine Australia antigen procurement program involving plasmapheresis of blood in the amount of three per cent of body weight every two weeks under phencyclidine hydrochloride (Sernylan, Parke, Davis) anesthesia, which lasts about 2 hours each session. She aborted in the second month of pregnancy. The other animal, Anne, has been immunized since 1966 with red and white cell concentrates (buffy coats) of a *Papio cynocephalus*. She aborted in the seventh month of pregnancy; it could not be ascertained whether her abortion was related to a possible maternal-fetal incompatibility created by the immunization program.

We at LEMSIP are concerned about the rapid depletion of wild primate animals and the ultimate loss of an extremely useful tool for experimental medicine and surgery. We hope that the success in getting these chimpanzees to breed within the limited possibilities of time, space, and available staff at LEMSIP, will encourage other laboratories with adult chimpanzees to undertake similar efforts.

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MONKEY CADAVERS AVAILABLE

The Regional Primate Research Center currently has *Macaca mulatta*, *M. nemestrina*, and *Papio anubis* cadavers suitable for use as anatomical and surgical specimens. They have been infused with a solution of 10 per cent formalin, glycerin, and phenol. In most cases the brain has been removed. At present, we request only that the recipient assume the necessary freight expenses. Please direct all inquiries to: Tim Bauer, Regional Primate Research Center, I-421 Health Sciences Building, University of Washington, Seattle, Washington 98105.

NOTE ON AN ISOLATED CASE OF VIRAL ERUPTION OBSERVED IN A COLONY OF CHIMPANZEES*

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It is a generally accepted concept that anthropoids, specifically the chimpanzee, are susceptible to many viral diseases of human origin (Douglas *et al.*, 1970; Fiennes, 1967; Ruch, 1967). Chickenpox, a usually benign infectious disease of the child caused by herpesvirus, has been observed by Heuschele (1960) in anthropoids. In this case, the animal's frequent physical contacts with the public made it likely that the infection was contracted from man.

This report describes the occurrence of a maculo-vesicular eruption in a chimpanzee, which suggested the possibility of a serious pox-virus infection similar to one described by Milhaud *et al.* (1969). In order to prevent the spread of the disease in the colony and to avoid any risk of transmission of an unidentified virus to persons working with the animal, a prompt diagnosis was essential, followed by adequate prophylactic action.

The disease occurred in April 1970 in an animal that had been living for a year in a colony of 7 animals. The chimpanzee was about 29 or 30 months old, weighing 10.7 kg at the time of his illness. One morning, during casual observation, a macular rash was found on the upper part of the torso, the face, the anterior part of the neck, in one armpit, and on the palm of one hand. These maculae were round or oval, well delineated, and of various sizes. In a short time they were transformed into vesicles measuring 1 to 3 mm in diameter, surrounded by a fringe of normal skin. At this stage, a diagnosis of chickenpox was considered. A second macular rash, which turned into vesicles, appeared in the suprapubic area. The clinical picture observed 5 or 6 days after the onset, with elements of different stages in various sites, seemed to bear out the diagnosis. The exanthema was mostly discrete, but it had an itchy character. The dessication stage was short and it was accelerated by the fact that the animal scratched his wounds, which, however, did not become infected. After obtaining

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samples of vesicular fluid in order to carry out viral studies, the chimpanzee was subjected to a 4-day treatment with antibiotics (penicillin 500,000 U, streptomycin 0.50 g).

No trace of rash was detected on the mucosa and no general symptoms were observed, with the exception of a rectal temperature of 38.4°C (101.1°F) on the first day. The general state of the animal, his appetite, behavior and activity continued to be very good. He recovered fully in 8 days.

Method

The following material obtained on the second day of the illness was sent to the laboratory: Several samples of vesicular fluid drawn off with a sterile pipette, several samples of the secondary scabs formed on scratch wounds, and slides prepared from vesicular fluid and scabs.

The choice of cells used to isolate viruses of the herpesvirus group is very important. Most of these viruses can develop well on monkey kidney (M.K.) cells, rabbit kidney (R.K.) cells, which are the best cells for cultures of human herpesvirus, mouth cancer (K.B.) cells, and uterine cancer (Hela) cells. Only chickenpox and zona viruses do not follow this rule. These two herpesviruses multiply only on cells of human origin, such as amnion, fibroblasts, diploid cells. They can also be cultivated in a continuous strain on fibroblasts derived from patas monkeys (*Cercopithecus patas*). In addition, Maurin and Betz (1969) advocate isolation on thyroid cells.

The fluid of cultures of amniotic cells, M.K. cells, and K.B. cells were inoculated directly. The cultures were incubated in vertically-positioned pyrex tubes. Inoculated cells and control tubes were examined by microscope every day.

Results of Viral Studies

No cytopathogenic effect on M.K. cells was detected and a transplantation on the eighth day was negative. Inoculated K.B. cells were unsuccessful due to bacterial contamination. Cytopathogenic effects characteristic of herpesvirus appeared in the amniotic cells on the fifth day of culturing. Formed groups of round, ball-like and inflated cells, some very large in size, were found. These infected groups grew very slowly. On the ninth day, by means of a pasteur pipette, cells were dislodged from the tube in order to be transplanted into a special culture tube (Lighton tube). This latter tube could hold a mobile thin glass slide on which the culture would develop. Viruses of the chickenpox type are released very slowly by infected cells. Therefore, transplantations must be carried out with these cells and not by means of the floating fluid. Unfortunately, attempts to prepare a subculture of the virus were not successful. We were able to stain (hematoxylin) infected cells in the last tube. Despite the inferior technical quality, the following findings in the stained cells demonstrated that this virus belonged to the herpes group: 1. Cytopathogenic effect was manifested only by nuclear lesions. 2. Presence of eosinophilic inclusions. 3. Fragmentation of chromatin with shifting of its particles to the proximity of the nuclear membrane. 4. Destruction of nucleoli. (Total destruction of the nucleoli is a characteristic finding in herpesvirus infections. In this case, however, the nucleoli, though showing fragmentation and shifting of the chromatin, seemed to subsist.)

Discussion

This appeared, from the clinical point of view, to be a typical case of chickenpox because the illness appeared without any previous prodromal signs and because of its symptomatology, development, evolution, and lack of effects on the general state of the chimpanzee. The poxvirus diagnosis was discarded because the vesicles appeared in a short time on the maculae without an intervening papular stage, the absence of hyperthermia, the normal behavior of the ape, and the continued good general state of health.

Virologic investigation, which had not been carried out for the cases reported by Heuschele (1960), confirmed that the infective agent belongs to the nitavirus or herpesvirus group (Joubert & Tuaillon, 1965). These viruses can be identified by their cytopathogenic effects seen by direct inspection and after staining. The virologic diagnosis of herpesvirus varicellae is further suggested by the following: The *elective* character of the virus culture, successfully carried out only on human cells; the *slowness* of the cytopathogenic effect on human amnion characterized by limited groups of infected cells; and the failure to obtain cultures on M.K. and K.B. cells, while herpesvirus hominis and herpesvirus simiae (B virus) grow readily on such cells.

However, this very probable diagnosis remains incomplete because the serologic identification by neutralization or by the technic of fixation of fluorescent antibodies could not be obtained.

The chimpanzee could have been infected only by human contact or some mechanical vector, since no other animal was introduced into the laboratory at the time. There was no contact with children. Only the staff had frequent contacts with the colony. No member of the staff, or their families, had chickenpox or any other rash brought about by a dermotropic virus, although some of their children went to schools where epidemics of chickenpox were in progress. The contagion could only have been indirect, by means of a healthy carrier or some material, but it has been impossible to ascertain how it occurred.

The sick animal had not been isolated before, during, or after the eruptive stage. He continued to be in contact with other members of our colony, some of them older, some younger than himself. The highly contagious nature of this disease among human beings makes it surprising that only one animal was affected by the disease. A thorough clinical study of all chimpanzees in our colony conducted during and after the supposed period of incubation gave negative results. No hypothesis could be advanced to account for this non-dissemination of the disorder.

Coming as a follow-up of the study published by Heuschele (1960), the analysis of this case, typical from the clinical point of view, confirmed by (not quite complete) virologic investigations, suggests once more that chimpanzees are very receptive to viral diseases of human origin.

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MEETING ANNOUNCEMENTS: SYMPOSIUM ON VIRUSES OF SOUTH AMERICAN NONHUMAN PRIMATES

The Symposium will be held in Mexico City on August 14, 1971. It will be part of the II Seminar on the International Movement of Animals sponsored by the Pan American Health Organization (P.A.H.O.).

Organizers of this symposium are Dr. Pedro Acha, P.A.H.O., Washington, D. C., and Dr. Luis V. Melendez, Harvard Medical School, New England Regional Primate Research Center, Southborough, Mass. 01772.

PRIMATE ZOONOSES SURVEILLANCE[1]

This is Report Number 3 (June-September, 1970) in this series which summarizes information received from selected centers (see *Laboratory Primate Newsletter*, 1970, *9* [4], 32) that utilize large numbers of nonhuman primates, and other contributors. It is intended primarily for the use of the participants and others with responsibility for the care of nonhuman primates. It should be stressed that much of the information is preliminary.

The table of contents is as follows:

The summary indicates that, during the first three quarters of 1970, diarrheal disease was the leading category of infectious disease, with *Shigella* spp. the most frequently specified cause and *Escherichia coli* the second. Respiratory disease, specifically pneumonia and upper respiratory infection, was the second most common category of infectious disease.

The report of an epidemic of encephalomyelitis in Section III, A is of particular interest. Further publication is planned after the results of challenge studies to identify the virus are analyzed.

The Special Report in Section IV, A (pp. 11-12) is reproduced below with permission of the authors.

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[1]Based on a report issued by the Center for Disease Control, Atlanta Georgia 30333.

Serum Neutralizing Antibody Titers for Herpesvirus in Nonhuman Primates[2]

Of major concern to nonhuman primate users is the occurrence of B virus (*Herpesvirus simiae*) in the animal under study. Inasmuch as this virus group is frequently associated with latent infections, it is difficult to (1) detect its presence, and (2) differentiate between the various herpesviruses recovered from tissues of monkeys and apes. Literature surveys are not clear regarding the prevalence of this virus group in many simian species now employed in the laboratory. Furthermore, what information is provided indicates a wide range of seropositives in the different, and at times within the same, species examined. It would appear then that a detailed study of the prevalence of antibodies to this virus group would be helpful in attempting to define the presence and specific detection of herpesviruses and their antibodies.

Four herpesviruses were selected to initiate this serologic survey: SA8, *H. tamarinus*, *H. hominis*, and *H. simiae*. SA8 was originally described by Malherbe and Harwin as recovered from the African green monkey and considered as an African simian herpesvirus. Recently, this virus has been recovered from baboons both in Dr. Malherbe's laboratory, as well as in ours. *H. tamarinus* was simultaneously described by Holmes and colleagues and Melnick and colleagues as a marmoset isolate, and, subsequently, shown by Melendez and his group to be a latent virus of several species of South American monkeys. *H. hominis* is well described as a human agent. *H. simiae*, which is frequently recovered from various species of macaques, was originally described as a human pathogen in the studies of Sabin and Wright.

There is some indication that infection with these viruses is more common in certain geographic areas and simian species (Table 1). This is most marked with SA8 and *H. tamarinus*. Antibody to *H. tamarinus* was most frequent in New World species, especially the squirrel monkey. Antibody to SA8 was most frequent in African species, especially vervet monkeys and baboons. Antibody to *H. hominis* is prevalent in all species tested as is antibody to *H. simiae*. How much of this antibody is due

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[2]Reported by S. S. Kalter and R. L. Heberling, Simian Virus Reference Laboratory (NIH Grant No. RR-00361), World Health Organization Collaborating Laboratory on Comparative Medicine: Simian Viruses (Grant No. Z2/181/27), and the Division of Microbiology and Infectious Diseases, Southwest Foundation for Research and Education, San Antonio, Texas.

Sera used in this study were provided by the Yerkes Regional Primate Research Center; 6571st Aeromedical Research Laboratory, Holloman AFB, New Mexico; Delta Regional Primate Research Center; Institute for Comparative Biology, San Diego, California; Smallpox Eradication Unit (WHO); West African Research Organization; Gorgas Memorial Laboratory (Panama); National Center for Primate Biology; and Institute Merieux.

Table 1

Summary of Results of Serum Neutralization Tests for Herpesviruses

Animal	Origin	Viruses[a]			
		SA8	*H. tamarinus*	*H. hominis*	*H. simiae*
Vervet	Africa	33/40	--	14/40	--
		0/17	--	0/17	3/17
Baboon					
(Africa)	Africa	42/42	0/37	44/44	13/46
(Captive)		5/26	0/27	18/25	--
		3/38	0/38	11/50	12/56
Chimpanzee	Africa	3/84	0/38	2/38	0/38
		0/38	0/38	7/38	--
Orangutan	Asia	0/22	0/22	0/22	--
Gorilla	Africa	0/14	0/14	7/14	--
Patas	Africa	8/38	0/38	6/43	2/27
		1/38	--	--	0/38
		21/37	--	--	--
Rhesus	Asia	0/42	--	8/41	2/25
Cynomolgus	Asia	1/40	2/37	14/38	10/44
"Macaques"	Asia	11/40	4/42	24/44	24/44
Mangabey	Africa	10/81	1/37	16/38	17/28
Talapoin	Africa	1/19	--	0/19	4/19
Squirrel	So.Amer.	--	22/35	0/35	--
"So.Amer." Monkeys[b]	So.Amer.	--	2/40	--	--
Galago	Africa	0/35	0/35	0/35	0/35

[a]Figures shown represent ratio of number positive to number tested. A dash indicates tests not done.
[b]Spider, howler, and capuchin monkeys. Not squirrel monkeys.

to antigenic crossing is still under study. Of concern, however, is the finding of a few vervets and talapoins with B virus antibody that may not be explained by cross-reactions, as these animals did not have antibody to the other viruses (with one exception) tested thus far.

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RESIDENCY PROGRAM OFFERED AT YERKES REGIONAL PRIMATE RESEARCH CENTER

A residency program for two D.V.M. graduates is being initiated at the Yerkes Regional Primate Research Center. The positions will be as clinical veterinarians working with the veterinary department, which includes a clinical veterinarian, veterinary pathologist, registered nurse, registered radiology technologist, two veterinary technicians, and five laboratory technicians. Primary responsibilities will include the care and management of a large Great Ape colony (85 chimpanzees, 35 orangutans, 15 gorillas) and monkeys of various species (numbering 500-600). The veterinary department is a service unit and provides assistance to research investigators in the areas of surgery, reproductive endocrinology, restraint and anesthesia, preventive medicine, pediatric care, and pathological and radiological diagnosis.

Two applicants will be hired in June 1971, one for one year, the other for a two-year program. The position will include benefits of a research associate with Emory University. The annual salary will be $10,000. Candidates will be requested to visit the Center, expenses paid, for a personal interview and orientation session.

No formal course work will be offered but there will be encouragement of individual pursuit of special interests. All facets of veterinary clinical pathology, histopathology, electron microscopy, surgery and radiology are available.

The Center for Disease Control, located nearby, offers regularly scheduled short courses in virology, hematology, microbiology, parasitology, public health, etc.

Interested applicants are asked to forward a brief biographical sketch and curriculum vitae to: Dr. M. E. Keeling, Yerkes Regional Primate Research Center, 954 Gatewood Road, Atlanta, Georgia 30322.

* * *

REQUEST FOR A YOUNG MALE SIAMANG

The Yerkes Primate Center has need for a young male siamang (*Symphalangus syndactylus*), preferably 5-7 years old, to mate with a female siamang that we have. Please contact Duane M. Rumbaugh, Yerkes Regional Primate Research Center, Emory University, Atlanta, Ga. 30322.

THE USE OF INTRAMUSCULAR NEMBUTAL IN CONJUNCTION WITH ETHER FOR LUMBAR PUNCTURES IN BONNET MACAQUES

B. R. Srinath[1]

Indian Institute of Science

This paper describes the use of pentobarbital sodium (Nembutal, Abbott Laboratories), a short-acting barbiturate, as a preanesthetic in conjunction with ether anesthesia in a series of experiments with bonnet monkeys (*Macaca radiata*) involving collection of cerebrospinal fluid through lumbar puncture. Although some workers (Taylor, 1969) have reported the successful use of phencyclidine hydrochloride (Sernylan, Parke-Davis) as premedication for halothane anesthesia in rhesus monkeys (*Macaca mulatta*), we found that it was not suitable for our conditions.

In our procedures, the initial injection of Nembutal was administered intramuscularly while the animals were temporarily held immobile in a squeeze cage. We found a dose of 30 mg/kg body weight to produce drowsiness in approximately 5 minutes and deep sedation in 6-8 minutes. When they were deeply sedated, the monkeys were removed from the squeeze cage and prepared for lumbar puncture. Preparatory procedures, such as clipping of hair and application of ethyl alcohol, were done rapidly since the Nembutal induced sedation rarely lasted longer than 20 minutes.

Ether induction following the preliminary sedation was relatively simple. A corrugated cup with a cotton pledget delivering ether vapor was placed 1/2 inch from the monkey's nose. Ether concentration was increased when the eye reflexes returned.

We have found the heart rate, jaw tension, and the eye reflexes to be good indices of depth of sedation and anesthesia. Heart rates averaging approximately 180 beats per minute, were common under Nembutal sedation, the respiration was deep and regular and its rate was approximately 50 per minute.

The area of the lumbar region between the last lumbar vertebra and the first sacral vertebra was sterilized with ethyl alcohol and was pierced with an 18-gauge stylet-fitted lumbar puncture needle to a depth of 2 cm. The stylet was removed immediately after the needle touched the soft area of the spinal canal. Clear cerebrospinal fluid free from blood was collected in a sterile test tube for further examination.

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[1]The author wishes to express his thanks to the late Prof. P. S. Sarma, Professor of Biochemistry, and Prof. N. R. Moudgal, Department of Biochemistry, for their help and encouragement.

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Rapid recovery from the anesthesia was one of the primary advantages of the Nembutal-ether technique. In our experience, the animals subjected to minor surgical procedures, such as removing cerebrospinal fluid through lumbar puncture, usually began moving about 15 minutes after ether was withdrawn and were able to hold themselves upright within 25 minutes or so. This compares favorably with the long recovery (sometimes 4 hours or more) that has been observed when the only anesthetic used was an intravenous barbiturate.

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NEW PRODUCTS AND SERVICES*

Supplier of Laboratory-Raised African Green Monkeys

MELOY LABORATORIES [6631 Iron Place, Springfield, Virginia 22151; Telephone (703) 354-4450] purchased wild African green monkeys throughout 1967 and 1968 for the purpose of producing newborns for experimental programs. The breeding colony is now being maintained in order to supply interested investigators with either newborn or laboratory-raised African green monkeys. Mothers can be supplied on loan with infants.

If you wish to purchase such animals, contact R. C. Gregoire, Senior Biologist, at the above number (ext. 59).

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*All information in this section has been abstracted from material supplied by the vendor.

COMMENTS ON MINIMUM REQUIREMENTS IN THE HUSBANDRY OF THE GOLDEN MARMOSET (*LEONTIDEUS ROSALIA*)*

F. V. DuMond

Monkey Jungle, Inc.

The golden lion marmoset (*Leontideus rosalia*) is perhaps the most severely endangered of all primates. The feral population is presently estimated to be under 600 (Coimbra-Filho, 1970). Their importation has been prohibited since 1966. The urgency of the problem is clear, given these facts: First, the most recently imported feral animals have already been in captivity 5 years; second, the maximum life expectancy for *Leontideus* in captivity is 10 years (Napier & Napier, 1967); and third, problems have been encountered in inducing captive-born animals to reproduce. Obviously the problems of multi-generation husbandry must be solved for this species within the next 3 to 5 years.

Many of us in the field have rather successfully kept pairs of imported *Leontideus*, had them reproduce, and rear offspring in a wide range of types of facilities. However, as Clyde Hill (1970) and Epple (1970a) point out, apparently no self-perpetuating group has yet been permanently established. Hill suggests that health problems have been a fundamental reason for this failure, while later noting that no verified third-generation offspring have ever been produced by any marmosets. Epple mentions excessive fecundity and heaviness in some captive-born animals as possibly associated with this failure.

Recent findings in the area of marmoset nutrition and medical problems seem to have adequately defined most requirements for general health maintenance (Bernirschke & Richart, 1963; Coimbra-Filho, 1965, 1969; Cosgrove *et al.*, 1968; Crandall, 1964; de Boulay & Crawford, 1968; Epple, 1970a; Hampton *et al.*, 1965; Kingston, 1969; Levy & Artecona, 1964; Nelson *et al.*, 1966; Ruch, 1959). This leads to speculation that factors not related to health may be responsible for some of the reproductive failures so far experienced with these animals. The fact that, as indicated earlier, most captive-born marmosets fail to reproduce or appropriately rear their offspring, whereas those reared in the feral environment successfully do so when in captivity, suggests that factors inhibiting reproduction in captive groups may be related to some aspect of the social or physical environment which influences reproductive behavior, reproductive physiology, or both.

Unfortunately, our knowledge of marmoset social behavior is very incomplete. However, one thing that seems clear is that the formation

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and maintenance of marmoset social units are governed by a relatively strict and invariable set of "rules" which must be understood and carefully provided for in the design of a breeding facility and in the management of the animals therein. While it is not clear what these rules are or exactly how they operate, some educated guesses are possible. For example, it is reasonable to expect that a species which customarily produces twins, frequently in heterosexual pairs, and which apparently mates permanently, might also possess some mechanism which would tend to inhibit the formation of permanent sibling breeding units. Although Epple (1970a) recorded several instances of breeding among siblings in *Callithrix jacchus*, it occurred only after they were separated from the parental unit.

A step or steps in the sequence of behavioral ontogeny associated with the development of the mechanism just mentioned might well be critical to the continuing development of reproductive behavior. Perhaps, members of sibling pairs which fail to go through some phase of development which includes separation from the parental unit and individually seeking out or encountering an outside individual of the opposite sex, never complete their behavioral development. However, the manner in which pair-bond formation is accomplished has never been observed in the field. The key to successful husbandry, then, could be in learning what elements in the environment, social and physical, are prerequisite to the accomplishment of these hypothetical steps in their development and in making provision for them.

Social studies on various species of marmosets (Coimbra-Filho, 1969; Epple, 1967, 1970a; Lorenz, personal communication; Moynihan, 1970; Thorington, 1968), along with personal observations which include *Leontideus*, *Saguinus fuscicollis*, *Saguinus oedipus*, and *Callithrix geoffroyi* seem to be in general agreement that marmosets, including *Leontideus*, normally live in family social units consisting of the parents, new offspring, and frequently some older offspring.

Epple (1967) reports that apparently only the α male and α female are reproductive and, although other adults may be tolerated, strange individuals intruding in the area occupied by an established unit are attacked by group members of the same sex with a ferocity almost unparalleled among primates. Coimbra-Filho (1969) reports that hunters have encountered groups of a dozen or more in the field and suggests that members may leave the group, pair up, mate, bear offspring, then may reunite sometime later with the former group and be tolerated. The findings of Coimbra-Filho (1969) and Epple (1967) suggest that the α pair in some way inhibit all other mating and that separation is a necessary step in reproduction as postulated above.

The writer's experience with *Leontideus* in captive groups indicates that older offspring may suddenly be set upon with the same relentless ferocity at some time after they are adult. Once this rejection occurs, there is apparently no other remedy but to remove the rejected animal as promptly as possible, as the attacks will continue until it is killed.

Personal observations over a period of five years with a group of *Saguinus fuscicollis* in the Rainforest section at the Monkey Jungle tend to support Epple (1967). During this period there were seven birth episodes, and apparently the same female was the mother on all occasions, although other adult members of the troop carried the young. The group increased in number to twelve, then split, and five or six animals left the Rainforest permanently.

Thorington (1968) observed that units of *Saguinus midas* in Colombia coalesced at times during foraging. Thus, intermittent coalescing of neighboring units and/or units expanded to the point of separation of adult offspring may explain the presence of groups larger than the single pair with its young.

The community cage would not seem to be the ideal facility for multi-generation breeding unless large enough to include several territorial ranges and to permit the hypothesized necessary separation from the parental group. As suggested above, even if a group of eight to ten individuals can live compatibly, only the α pair reproduces, so nothing is gained by risking the possibilities of the fatalities common to large groups of marmosets in confinement.

Territorial ranges of marmosets seem to be quite extensive. Moynihan (1970) estimates ranges of *Saguinus geoffroyi* to be equal to that of the larger Cebidae. Personal observations in the four-acre Rainforest area are in agreement with Thorington (1968) and Moynihan (1970) in that marmosets seem to be gallery forest or forest edge foragers, seldom ascending to more than 30 feet in height. In the Rainforest section all marmosets have utilized the entire perimeter in foraging while employing the inner portions primarly for resting and for routing to the centrally located feeding station or to other areas of the perimeter.

These pecularities in marmoset ecology and social organization predicate relatively inefficient utilization of total jungle area. For example, the four-acre Rainforest provides space enough for only one marmoset unit with a single breeding female while well over 200 squirrel monkeys (*Saimiri sciureus*), including 50 or more breeding females, peacefully occupy the same area. Thorington (1968) estimated a density of one tamarin per 7 to 15 acres, suggesting that forest utilization was relative to the amount of available low scrub edge. Moynihan (1970) noted that on Barro Colorado Island during the 1920's, when most of the vegetation was second growth low scrub, *Saguinus geoffroyi* were quite abundant. Now that the forest has matured, eliminating most of the low scrub, they have become quite scarce.

If each reproducing female requires something in the order of half a mile or more of forest edge, it becomes clear that vast areas, interlaced with streams or rivers would be necessary to accommodate even a small number of units. This naturally eliminates semi-free ranging settings of limited acreage such as the Rainforest section from consideration as a conservation site.

The Golden Marmoset Breeding Facility recently completed at the Monkey Jungle is an attempt to provide an environment compatible with the requirements discussed. A small section of subtropical jungle is enclosed in an aluminum frame structure 18 feet high, approximately 54 feet long, by 25 feet deep (Figure 1). Five pie-shaped sections are

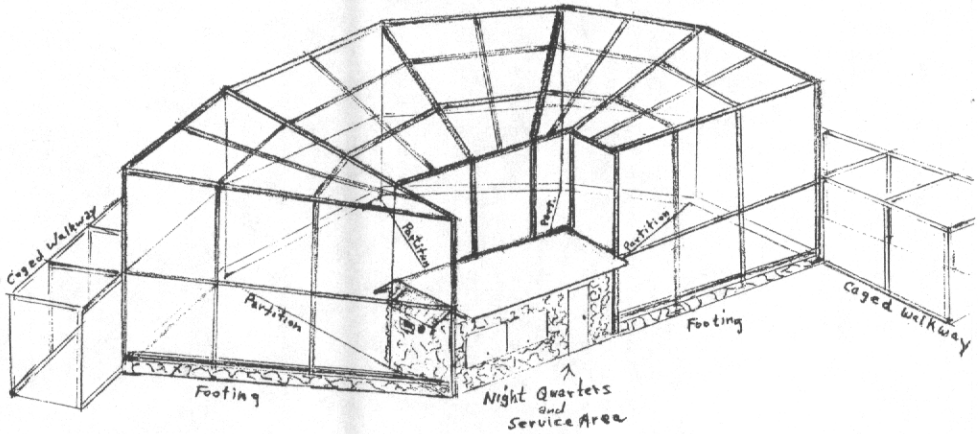

Figure 1. Sketch of the Golden Marmoset Breeding Facility (not drawn to scale). The approximate overall dimensions are 18 feet high, 25 feet deep, and 54 feet long. The framework is of anodized aluminum, covered with 1 × 2 inch 14-gauge galvanized welded wire mesh. Wire mesh partitions divide the facility into 5 pie-shaped sections. The night quarters and service area building is of concrete block construction and measures 14 feet × 5 feet × 7 feet high, excluding the rock facing and roof gable. The caged walkway protects the public from free-ranging macaques and forms the viewing area.

arranged radially about a small concrete block construction night shelter and service area. Each segment, designed to house one breeding unit, is approximately 18 feet high × 15 feet × 25 feet. These sections are filled with thick foliage and terminate at an opening in the concrete house where nest boxes and feeding stations are located (Figure 2). Since *Leontideus* have been observed utilizing holes in trees for sleeping (Coimbra-Filho, 1969; and the writer's observations in the Rainforest), it would seem that nest boxes would be a necessary adjunct to the marmoset facility. In our case, with the very large outdoor enclosures, the nest boxes, described in more detail later, will also greatly facilitate animal management.

The jungle in each section has been augmented with plantings of *Ficus jaquinifolia*, Cattley guava (*Psidium cattleianum*), *Bougainvillea* sp., and *Jatropha hastata*. With these and the existing jungle, a simulated gallery forest "scrub" environment has been incorporated into the eighteen-foot-high growth within the sections. A more protected

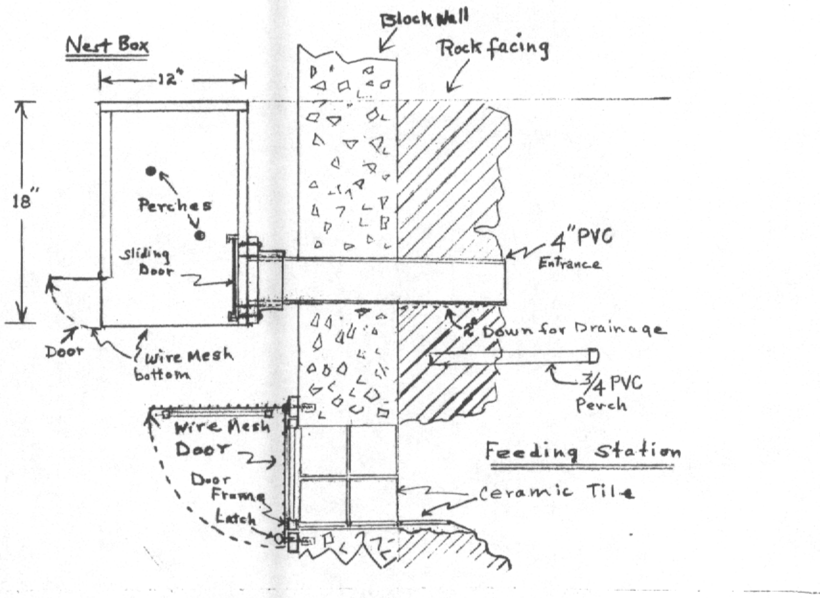

Figure 2. Side view of nest box and feeding station. The nest box is 12 × 12 × 18 inches. Note that the main sleeping perch in the nest box is located high enough so that tails do not contact the wire floor and become soiled. The nest box is constructed of the following materials: 3/4-inch plywood, 1/2- × 1-inch wire mesh, 3/4-inch dowel perches, 4-inch Sch 40 PVC plastic pipe, and a 4-inch PVC slip fit flange. A 4-inch slip PVC cap is used to cover the entrance pipe if the nest box is removed.

dense interior provides shelter from solar radiation and a measure of isolation for each unit while permitting a certain amount of "border" contact, which Thorington (1968) observed in the field with *Saguinus midas*. Provisioning at the feeding stations should reduce the need for foraging over a large area (primate ranges are related to the concentration of food and the amount of searching necessary to extract the daily ration). Thus an attempt has been made to provide some of the hypothesized natural elements of a larger environment in a highly compressed space.

It is hoped that each section will provide enough natural features and space so that the social units will adopt the area as a limited "home range" and accept wire partitions as territorial boundaries. It is hoped that the development of behavior suggesting pair formation between offspring from neighboring sections will be observed. These pairings may then be tried out in a vacant section. Permitting the animals to initiate the formation of pair bonds may insure the proper timing of the event and contribute to more compatible pairings. Moynihan (1970) speculates that siblings may separate from the parental unit as a group, then encounter other animals or separated sibling groups. He also noted the presence of some solitary another through the wire) for the captive-born female. This pair was separated out and placed in its own section. Copulation has been observed, but so far there has been no evidence of conception. Later an attachment was noted between the feral female and captive-born male. This pair was united in a second section separated from the earlier pair so as to avoid any residual attachment. The female of the latter pair delivered twins March 29, 1971, and is for the first time successfully rearing her off-spring with the aid of the captive-born father. The parents of the captive-born father are also in the facility and are successfully rearing twins delivered March 19, 1971.

In summary, we have attempted to incorporate the findings of several investigators of marmoset husbandry and behavior, and the limited information from the field in designing a breeding facility for the endangered *Leontideus rosalia*. Flexibility was incorporated into the design so that each of several hypotheses on the mechanics of pair-bond formation might be provided for on an experimental basis. Certain elements of the feral environment were also incorporated on the possibility that they might in some way relate to the social interactions or behavior of the animals.

It is the writer's opinion that this approach to primate husbandry is novel and should be exploited more widely. Hopefully, the minimum requirements have been considerably overshot; if so, we then have a working model which can be investigated to gain a better understanding of the behavioral development of *Leontideus*. Prerequisites for perpetuative husbandry of this threatened animal might then be adequately defined and routinely accomplished by all of the several breeding centers presently contemplated by the Wild Animal Propogation Trust (a corporation of members of the American Association of Zoological Parks and Aquariums) formed for the conservation of threatened species.

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animals in his study site. The design of the breeding facility would also permit siblings from one unit to be placed adjacent to siblings from another unit for observation and eventual pairing. If neither of these work, random pairings may be arbitrarily made and placed in vacant sections remote from either of the parental units.

The physical environment of the facility includes a number of features considered important or helpful for the maintenance of the health and hygiene of the animals in it. The whole outside area is open to the sun and rain, the ground is covered with 2- to 4-inch decorative riverbed rock which may be easily cleaned with a hose, washing fecal debris through the rock and out of reach of the animals.

The animals have access to individual nest boxes (Figure 2) where insulation permits conservation of body heat so that artificial heat will not be required during our occasional cold weather. During daylight hours they can move up and get direct sunlight most of the day. It has been learned from experience in the Rainforest section that healthy marmosets, including *Leontideus*, seem not to suffer discomfort even during our most severe cold spells. Total access to direct sunlight may be a beneficial factor here.

What has proven to be more hazardous to marmosets, particularly the very young, are the not infrequent low pressure summer rain episodes which can dump up to 20 inches of rainfall during three to four days of almost continual rain. For this reason, a shelter on the block house extends 30 inches out, covering the feeding stations, entrances to nest boxes and outside perches, providing a small but dry living area in and about the feeding stations and nest boxes.

Although it is impossible to eliminate roaches and rodents in an outdoor facility, every measure has been taken to eliminate nest sites and food sources that would attract these pests, and to otherwise maintain good sanitation. The nest boxes are removable, have interchangeable perches and wire bottoms for sanitation and easy observation of the animal within. The boxes and perches, however, are not removed or cleaned normally unless animals become diseased, as familiar odors from scent marking seem important for the animals' well-being (Epple, 1970b; Kingston, 1969; R. Lorenz, personal communication). Nest boxes are held in place by means of a short piece of 4-inch P.V.C. plastic pipe about 3 inches from the wall to eliminate roach hiding places. The riverbed rock covering the floor minimizes rodent ground burrowing. The feeding stations are of ceramic tile and are centrally located so they are easily kept clean, thus reducing food spoilage and available food which attracts vermin.

Several of the concepts outlined above have already proven fruitful. Shortly after introduction into the facility, two pairings were made by placing a heterosexual pair of twins in a section adjacent to a feral pair that had two unsuccessful pregnancies and had shown indications of poor compatibility. Almost immediately the feral male formed an attachment (as judged by the great amount of time that they spent in contact with one

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PRIMATE ETHOGRAM PROJECT

Stuart A. Altmann

University of Chicago

At the request of the National Institute of Mental Health (NIMH), we are preparing a comparative catalog of social behavior in primates. At a minimum the catalog will cover the sub-family cercopithecinae (macaques, baboons, vervets, mangabeys, etc.); other groups will be included if time permits.

The primary concern of the NIMH in instigating this project was that a bewildering array of catalogs of primate behavior are being used at present by various investigators, yet it is clear to those who are familiar with the species involved that in some cases different labels are being used for what is essentially the same pattern of behavior. The result is that, at present, it is often extremely difficult to compare the results of research carried out by one investigator with those obtained by another. A standard catalog of social behavior patterns would help alleviate this problem.

Beyond that, a search for behavior homologs is of general biological interest. Such comparative studies are relevant to an understanding of evolutionary processes and taxonomic affinities.

The purpose of this catalog is not that of providing an "official" list that must be used by all investigators, but rather to indicate the total or partial synonomies in the literature, to bring together what is now known about the repertoires of behavior in these animals, to suggest some standard terminology, and to provide a provisional list of behavior patterns that might be of particular use to new investigators.

We are interested in obtaining prepublication copies of primate ethograms, particularly where the study of behavior patterns has been a focus of research. Of course, no unpublished material will be used without the permission of the author, but we would like to circumvent the problem of publication delay, so that our catalog will be as current as is practicable. We are also interested in obtaining sound recordings of primate vocalizations and film clips that illustrate patterns of primate behavior. We would appreciate receiving copies of any such material. If you anticipate extensive duplication costs, please communicate with us about the material you have and about the anticipated cost of duplicating it. Correspondence and materials should be sent to Stuart A. Altmann, Allee Laboratory of Animal Behavior, 5712 South Ingleside Avenue, Chicago, Illinois 60637.

BREEDING CENTER FOR CHIMPANZEES

The Primate Foundation of Arizona is establishing a breeding colony of chimpanzees (*Pan troglodytes*). This is a positive step towards preventing the extinction of this Great Ape and will be the first facility with this as its sole purpose in this nation. The advantages of captive breeding are numerous, but the major one is, of course, preventing the extinction of an animal so valuable to mankind and scientific research.

The primary goal of the Foundation is to achieve efficient breeding of chimpanzees. As breeding success permits, surplus chimpanzees will be made available to zoos, qualified researchers, educational institutions, etc.

The secondary goal of the Foundation is to further knowledge of the chimpanzee and its potential value to mankind. The facilities will be made available for scientific research or educational activities which will not interfere with the breeding program.

Approximately forty acres of land has been leased from the Federal Government. Here an indoor area will be built to include: individual sleeping cages; larger cages for isolation of new arrivals, for observation, treatment of illness, delivery and newborn care, etc.; a large exercise cage; observation, laboratory and treatment facilities; an isolation and nursery area; a food storage and preparation area; offices; and living quarters for the Resident Director. The individual inside cages will assure close observation and will facilitate medical examination or treatment of each chimpanzee.

The outdoor area will be divided into several sections. This arrangement will permit separation of chimpanzees into colonies according to such variables as compatability and breeding success; allow periodic change of locale for any one group, thus imitating their nomadic habits in the wild; and permit re-vegetation of depleted areas. Confinement within these sections will be accomplished by a combination of water moats and solid walls. Each section will contain various combinations of hills, ravines, grassy areas, undergrowth, marshes, etc. Obstructions, tunnels, caves, etc. will be scattered around the periphery of each section.

It is believed these physical facilities will enable researchers to study the chimpanzee under controlled conditions, while providing diversity of terrain and vegetation to encourage behavioral activities similar to those in the wild.

The Primate Foundation of Arizona is most desirous of receiving letters of verbal support for our project from all who are interested. We will also be happy to answer questions or provide more information about our facility and its development. Correspondence should be sent to: The Primate Foundation of Arizona, 326 West McDowell Road, Phoenix, Arizona 85003.

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FRENCH UNIVERSITY COURSES IN LABORATORY ANIMAL MEDICINE

Special Biology and Pathology of Laboratory Animals (March 1, 1971-May 27, 1971):

> University course sponsored by the Faculty of Medicine of Paris-Cretéil. 120 hours, theoretical and practical. Designed for persons with M.D., D.V.M., or similar degrees.

General Biology and Pathology of Laboratory Animals (October 18, 1971-December 18, 1971):

> University course sponsored by the Faculty of Medicine of Paris-Créteil. 120 hours theoretical and practical. Designed for persons with M.D., D.V.M., or similar degrees.

For information, contact Dr. J.-C. Friedmann, Laboratoire d'Expérimentation Animale, Institute de Recherches sur les Maladies du Sang. Hôpital Saint-Louis, 75 Paris 10.

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MEETING ANNOUNCEMENTS: 4TH INTERNATIONAL CONGRESS OF THE INTERNATIONAL PRIMATOLOGICAL SOCIETY

The Fourth International Congress of the International Primatological Society will be held in Portland, Oregon, from 15 through 18 August, 1972. The Oregon Regional Primate Research Center has been asked to organize the Congress and to act as the host institution. Three full-day symposia are planned, with invited papers to be given on primate behavior, primate reproduction, and medicine/pathology; and a half-day of panel discussion on three specific topics in primate odontology will be held. Short papers are invited in these general areas, as well as in paleontology, haemotology and genetics, histology, and neurology/biology; final date for submission of abstracts is 11 January 1972. Please address all inquiries to Dr. William Montagna, General Chairman of the Congress, Oregon Regional Primate Research Center, 505 N.W. 185th Avenue, Beaverton, Oregon 97005, U.S.A.

CONGRESS PASSES ANIMAL WELFARE AMENDMENTS*

The House of Representatives on December 7, 1970, and the Senate the following day (Dec. 8) considered and passed H.R. 19846, "The Animal Welfare Act of 1970."

The prompt movement of this bill through the two Houses of Congress illustrates the well-known fact that legislators consider the flag, motherhood and "man's best friend" as inviolate subjects that one cannot vote against.

Some points made by Representative Foley in introducing the bill to the House of Representatives were:

"First, the bill expands the definition of the term 'animal' to include additional species. At present the act applies only to live dogs, cats, rabbits, hamsters, guinea pigs, and nonhuman primate mammals.

"This bill, within its definition includes all warm-blooded animals designated by the Secretary, with certain specific limitations and defined exceptions.

"Second, the bill regulates more individuals and organizations which handle live animals, and will bring into the framework of the legislation for the first time exhibitors such as circuses, zoos, carnivals, road shows, and wholesale pet dealers.

"Third, the bill establishes by law the humane ethic that animals should be accorded the basic creature comforts of adequate housing, ample food and water, reasonable handling, decent sanitation, sufficient ventilation, shelter from extremes of weather and temperature, and adequate veterinary care including the appropriate use of pain-killing drugs, analgesics and tranquilizing drugs. The bill specifically guarantees the absolute authority of the research institutions to conduct research experiments so that the enlightened leadership of the United States in the medical and scientific research field will not in any way be diminished.

"Fourth, the bill strengthens the Secretary of Agriculture's enforcement authority by broadening the statutory concept of 'commerce,' and by increasing the penalties against persons convicted of interfering with, assaulting, or killing Government inspectors, and by broadening the discovery procedures for obtaining adequate information to sustain proper administration."

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*Excerpted from *Bulletin National Society for Medical Research*, 1971, *22* [1], 1.

RECENT BOOKS AND ARTICLES*
(Addresses are those of first authors)

BOOKS

The primate brain: Advances in primatology. Volume 1. Noback, C. R., & Montagna, W. (Eds.) New York: Appleton-Century-Crofts, 1970. ($18.75)

This volume is the first in a continuing series of "monographic surveys" each focusing on a specific topic in the field of primatology. The 11 chapters in this inaugural volume discuss the recent developments and current issues in the study of the primate nervous system, approaching the topic from a phylogenetic point of view. The first six chapters deal with the sensory-motor evolution of the primate brain, while Chapters 7 through 11 present a comparative anatomic study of primate evolution. Contents: Morphology of the primate retina, Lee R. Wolin & Leo C. Massopust, Jr.; The primary optic pathways and nuclei of primates, Roland A. Giolli & Johannes Tigges; Structural and functional aspects of the visual pathways of primates, Charles R. Noback & Lois K. Laemie; The pyramidal tract in the primates, W. J. C. Verhaart; The allocortex in primates, Heinz Stephan & Orlando J. Andy; Functional architecture of motor and sensory cortices in primates in the light of a new concept of neocortex evolution, Friedrich Sanides; The fossil evidence of prosimian brain evolution, Leonard B. Radinsky; Gross brain indices and the analysis of fossil endocasts, Harry J. Jerison; Allometric and factorial analysis of brain structure in insectivores and primates, George A. Sacher; Data on size of the brain and of various brain parts in insectivores and primates, Heinz Stephan, Roland Bauchot, & Orlando J. Andy; Neural parameters, hunting, and the evolution of the human brain, Ralph L. Holloway, Jr.

Animal psychophysics: The design and conduct of sensory experiments. Stebbins, W. C. (Ed.) New York: Appleton-Century-Crofts, 1970. ($18.75)

Among the many chapters of interest to primate workers are the following: Studies of hearing and hearing loss in the monkey, W. C. Stebbins; Detectability of tones in

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*In many cases, the original source of references in the following section has been the Current Primate References prepared by The Primate Information Center, Regional Primate Research Center, University of Washington. Because of this excellent source of references, the present section is devoted primarily to presentation of abstracts of articles of practical or of general interest. In most cases, abstracts are those of the authors.

quiet and in noise by rats and monkeys, G. Gourevitch; Vision in monkeys with lesion of the striate cortex, M. Glickstein, S. Barrow, & E. Luschei; Sensory neurophysiology and reaction time performance in nonhuman primates, J. M. Miller, J. Kimm, B. Clopton, & E. Fetz; The use of reaction time in monkeys for study of information processing, R. W. Reynolds.

Baboon ecology. Altmann, S. A., & Altmann, Jeanne. Chicago: U. Chicago Press, 1971. ($12.00)

The authors describe the ecologically significant behavior of baboon groups, and how that behavior enables these animals to cope with the problems of their environment. The book is based both on a complete review of the literature and on the authors' own field research, particularly on the yellow baboons of the Amboseli Game Reserve, Kenya.

Prehistory of society: Comparative psychological studies. Tikh, Nina A. Leningrad: Leningrad University Press, 1970. [In Russian]

Observations on monkeys and apes are suggesting answers to questions about human labor, thought, speech, and communication in the development of society. Chapter titles are as follows: Social life as an evolution factor; Unity and struggle of inner contradictions in the association of primates: rivalry and struggle for biological advantages within the herd; Unity and struggle of inner contradictions in the association of primates: mutual help and cooperation; Particular groups within the herd of apes: male-female; Particular groups within the herd of apes: mother and cub; Care of the posterity in the herd of apes; Particular groups in the herd of apes: cubs and younger animals. Formation of the new herd; Means of communication in the herd; Experimental research in the field of cultivation of new means of intercourse and the problems of speech origin; Association of prehominidesa (an attempt of reconstruction).

Embryology of the baboon. Hendrickx, A. G. With contributions by M. L. Houston, D. C. Kraemer, R. F. Gasser, & J. A. Bollert. Chicago: U. Chicago Press, 1971. ($15.00)

Chapter 1, "Reproduction," contains a general description of the anatomy of the female reproductive organs, vaginal exfoliative cytology, and the menstrual cycle. Data on breeding and reproductive performance, important to a study of normal embryology, are also included. Chapter 2, "Methods," explains the recording, collecting, processing, reconstructing, and photographing techniques used in studying the embryo. Chapters 3 through 8 describe and illustrate twenty-three stages of baboon development, beginning with the one-day-old fertilized ovum and ending with the seven-week-old embryo in which the long bones have begun to ossify. Chapter 9, "Placenta," investigates the morphology of the developing and term placenta, and placental circulation. It also contains a short section on the comparison and classification of the primate placenta.

Atlas of comparative primate hematology. Huser, H.-J. New York/ London: Academic Press, 1970.

DISEASE

Acute lymphocytic leukemia in owl monkeys inoculated with *Herpesvirus saimiri*. Meléndez, L. V., Hunt, R. D., Daniel, M. D., Blake, B. Joan, & Garcia, F. G. (New England Reg. Primate Res. Cen., Harvard Med. Sch., Southborough, Mass.) *Science*, 1971, *171*, 1161-1163.

This study demonstrates for the first time that *Herpesvirus saimiri* can induce acute lymphocytic leukemia in owl monkeys (*Aotus trivirgatus*) and that malignant lymphoma can be induced in this species of nonhuman primates by the inoculation of the virus by various routes (intravenous, subcutaneous, and intradermal).

An epizootic of measles in a marmoset colony. Levy, B. M., & Mirkovic, R. R. (Univ. Texas Dental Science Inst., P.O. Box 20068, Houston, Texas 77025) *Laboratory Animal Science*, 1971, *21*, 33-39.

A measles epizootic occurred in a colony of marmosets in 1966, resulting in the death of 326 animals. Edematous upper eyelids and progressive lethargy were the only clinical signs noted. The typical histopathological change was an interstitial giant cell pneumonitis. A measles virus was isolated from moribund animals. Although several possibilities were examined, the source of the epizootic could not be established.

Modification of the tuberculin response of rhesus monkeys by Isoniazid therapy. Gibson, J. P., Rohovsky, M. W., & Newberne, J. W. (Dept. Pathology & Toxicology, The Wm. S. Merrell Co., 110 E. Amity Rd., Cincinnati, Ohio 45215) *Laboratory Animal Science*, 1971, *21*, 62-66.

During routine tuberculin testing, a group of recently acquired *Macaca mulatta* were found to be infected with tuberculosis. Isoniazid therapy (20 mg/kg/day) caused 9 positive monkeys to become negative to the tuberculin test within 3 weeks after therapy was initiated. Following 2 months of therapy, the entire colony remained negative for 6 months. At necropsy, many of the animals had gross lesions of tuberculosis, and organisms were cultured from the lesions. These findings indicate that Isoniazid therapy alters the tuberculin response of monkeys and suggests that such therapy should be used with caution, since the tuberculin test may not be reliable in treated animals.

Cutaneous streptothricosis (Dermatophiliasis) in owl monkeys. King, N. W., Fraser, C. E. O., Garcia, F. G., Wolf, L. A., & Williamson, Martha E. (New England Regional Primate Research Center, Harvard Med. School, Southborough, Mass. 01772) *Laboratory Animal Science*, 1971, *21*, 67-74.

The clinical and pathological features of naturally occurring cutaneous streptothricosis in 5 owl monkeys (*Aotus trivirgatus*) was reported. This disease, caused by the actinomycete, *Dermatophilus congolensis*, is characterized by a proliferative and exudative dermatitis, the lesions of which clinically resemble papillomas. This was the first report of the occurrence of this disease in nonhuman primates. The owl monkey strain of *D. congolensis* is similar to other strains of the organism already described.

Toxoplasmosis in *Aotus trivirgatus* and *Callicebus moloch*. Seibold, H. R., & Wolf, R. H. (Delta Regional Primate Research Center, Tulane U., Covington, La. 70433) *Laboratory Animal Science*, 1971, *21*, 118-120.

Spontaneous toxoplasmosis in 2 owl monkeys, *Aotus trivirgatus*, and one titi, *Callicebus moloch*, is described. The history of the owl monkeys suggested that a period of approximately 3 weeks elapsed between infection and death. The lesions were low-grade pulmonary inflammation, necrosis of the intestinal mucosa and mesenteric lymph nodes, and focal necrosis of the liver and adrenal cortex. Diagnosis was established by demonstration of structures morphologically characteristic of *Toxoplasma gondii* in the tissues.

Incidence of neutralizing antibodies to Herpes B virus in the Taiwan monkey (*Macaca cyclopis*). Pryor, W. H., Jr., Chiang, H., Raulston, G. L., & Melendez, L. V. (Research Animal Branch, USAF Sch. Aerospace Med., Brooks Air Force Base, Texas 78235) *Primates*, 1970, *11*, 297-301.

A group of 46 recently captured Taiwan monkeys (*Macaca cyclopis*) was tested for neutralizing antibody for herpesvirus B. Results indicated that 11 (24%) were positive, 25 (54%) were negative, and 10 (22%) were suspect. This is thought to reflect the incidence in nature. Subsequent samples from the same animals, acquired 7 months post-arrival, indicated 10 (22%) positive, 27 (59%) negative, and 9(20%) suspects. A number of animals (18) converted from one category to another, presumably from loss or acquisition of immunity during the period. A suggestion of geographic difference in incidence of titers was detected on the first sample. Twentyeight human caretakers and veterinarians were tested with no positives, 25 negatives, and 3 suspect.

PHYSIOLOGY AND BEHAVIOR

Composition of milk from talapoin monkeys. Buss, D. H., & Cooper, R. W. (Div. Biol. Growth, Southwest Found. Res. & Educ., San Antonio, Texas 78228) *Folia Primatologica*, 1970, *13*, 196-206.

Twenty-two samples of milk from talapoin monkeys were analyzed for their total lipid, protein, carbohydrate, and ash contents. The component fatty acids, amino acids, and major minerals were also measured in many of the samples. Talapoin monkey milk was very similar to milk from other primates, especially other Old World monkeys. Some factors affecting the milk composition were also determined.

Territorial behavior in primates: a review of recent field studies. Bates, B. C. (Unit for Research on Medical Applications of Psychology, Univ. Cambridge, 5 Salisbury Villas, Station Road, Cambridge, England) *Primates*, 1970, *11*, 271-284.

Primate field studies of the last decade have reported much information of relevance for understanding primate territoriality. This paper reviews some of that material, considering the primate use of home range and core areas, intertroop vocalizations, and the relevance of these concepts for the analysis of territorial behavior. Finally, several reports of field studies of territorial behavior are reviewed. The data reviewed suggest that there are territory-related spacing mechanisms operating in some primate species. However, territorial relations between primate groups are far from universal even among those species which do establish territories; the significance of territoriality will have to be understood as one of a number of ecological adaptations.

Distribution of the electrophoretic variants of serum alpha$_1$-antitrypsin in six species of the macaques. Omoto, K., Harada, S., Tanaka, T., Nigi, H., & Prychodko, W. (Dept. Anthropology, Faculty Sci., Univ. Tokyo, Hongo, Tokyo, Japan) *Primates*, 1970, *11*, 215-228.

Individual variations of α_1-antitrypsin of the macaques were investigated by means of starch gel electrophoresis. The material comprised a total of 1,084 plasma samples taken from six species, namely, *Macaca irus*, *M. mulatta*, *M. cyclopis*, *M. nemestrina*, *M. speciosa*, and *M. fuscata*, including several geographical groups. At least 10 phenotypes which were assumed by analogy to the human Pi-system to be under genetic control of five codominant alleles (tentatively denoted by $Pi_{Mac}^{A, B, C, D, E}$) were identified. It was considered that these alleles are commonly possessed by different macaque species. A marked difference in the distribution of allele frequencies was found both within and between species groups. Several aspects of this new polymorphic variation in the macaques were discussed with special reference to the geographical distribution of the alleles and the origins of the Japanese macaque, *M. fuscata*.

Hemoglobin variation in macaques. Ishimoto, G., Tanaka, T., Nigi, H., & Prychodko, W. (Dept. Legal Medicine, Mie Prefectural University Sch. Med., Tsu, Japan) *Primates*, 1970, *11*, 229-241.

A total of 1,333 hemolysates obtained from six different species of macaques, *M. fuscata*, *M. cyclopis*, *M. mulatta*, *M. arctoides (speciosa)*, *M. nemestrina*, and *M. fascicularis (irus)*, were examined by starch gel electrophoresis. Three major hemoglobins, tentatively designated S, F, and P, and one minor component were found among the samples, in which P and a minor component were observed only in some samples of *M. fascicularis*. The hemoglobin types observed and their incidence in each species agreed, on the whole, with results reported by earlier workers. However, in addition to marked differences among macaque species, there existed striking geographical differences in the distribution of hemoglobin components within the same species. The distribution of hemoglobin types observed among the species are presented, together with the results of the determination of hemoglobin concentration in a two-band type and of the alkali-resistant pigment of the macaques.

Baseline values for adult baboon cerebrospinal fluid. Butler, T. M., & Wiley, G. L. (Veterinary Div., 6571st Aeromed. Res. Lab., Holloman Air Force Base, New Mexico 88330) *Laboratory Animal Science*, 1971, *21*, 123-124.

A lumbar puncture technique was used to collect cerebrospinal fluid from 30 baboons. Laboratory analyses and their respective mean results were as follows: total protein, 64.13 mg%; specific gravity, 1.0041; glucose, 64.7 mg%; sodium, 154.4 mEq/l; potassium, 2.72 mEq/l; and white blood cells, 1.8/cu mm.

BREEDING

Biology of reproduction in the squirrel monkey (*Saimiri sciureus*): II. The ovary. Srivastava, P. K., Cavazos, F., & Lucas, F. V. (Dept. Pathology, Univ. Missouri, Sch. Med., Columbia, Mo. 65201) *Primates*, 1970, *11*, 265-270.

Gross and microscopic observations on the squirrel monkey ovary are described. The luteal tissues are present in two broadly distinct stages of activity. The degree of follicular development appears to be affected by the level of luteal activity. Circumstantial evidence is presented to indicate that the squirrel monkey female may be an induced ovulator.

Annual changes in the menstruation of rhesus monkeys. Keverne, E. B., & Michael, R. P. (Primate Behav. Res. Labs., Bethlem Royal Hosp., Monks Orchard Road, Beckenham, Kent, England) *Journal of Endocrinology*, 1970, *48*, 669-670.

The data presented show a high incidence of summer amenorrhoea and long cycles in a laboratory colony in London. It is suggested that, in addition to light and temperature, pheromones may also be an exteroceptive factor contributing to the synchronization of periods of increased reproductive activity in the two sexes.

The pregnancy sign in savannah baboons. Altmann, S. A. (W. C. Allen Lab. Anim. Behav., U. Chicago, 5712 Ingleside Ave., Chicago, Ill. 60637) *Laboratory Animal Digest*, 1970, *6* [3], 7-10.

A simple indicator of pregnancy in savannah baboons is described. Essentially it is a change from black to red in the paracallosal skin. This change is clearly visible both in the laboratory and in the field.

Breeding of the silvered leaf monkey, *Presbytis cristata*, in Malaya. Medway, Lord. (Great Glemham House, Great Glemham, Saxmundham, Suffolk, IP17 1LP, England) *Journal of Mammalogy*, 1970, *51*, 630-632.

In pooled counts of *P. cristata*, tallied in the humid equatorial environment at Kuala Selangor (3° 21'N, 101° 15'E) on 11 dates from November 1968 through November 1969, four age groups are enumerated: full-grown, infants with adult coat coloration, infants with intermediate coloration, and infants with the distinctive natal coloration. Variations in the numbers of all infants, and of infants with the natal coloration, are not statistically significant, indicating that births occurred with equal frequency throughout the year, without seasonal variation.

INSTRUMENTS AND TECHNIQUES

Primate restraint system for studies of metabolic responses during recumbency. Howard, W. H., Parcher, J. W., & Young, D. R. (Biomed. Res. Br., Ames Research Center, NASA, Moffett Field, Calif. 94035) *Laboratory Animal Science*, 1971, *21*, 112-117.

A system was devised to restrain primates, seemingly without adverse effect on the animal. The system provides a means for study of bone resorption and calcium metabolism in monkeys, and would be useful for other kinds of studies requiring restraint alone or with recumbency.

A method for chronic intravenous drug administration in squirrel monkeys. Stretch, R., & Gerber, G. J. (Dept. Psychol., Univ. Western Ontario, London 72, Ontario, Canada) *Canadian Journal of Physiology and Pharmacology*, 1970, *48*, 575-581.

A system for the infusion of drug solutions into the blood stream of relatively unrestrained and unaesthetized squirrel monkeys, via a chronic intravenous catheter, is described. Results pertaining to the maintenance of schedule-controlled behavior by response-contingent infusions of *d*-amphetamine sulfate are included to illustrate a specific application of the technique.

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ERRATUM

There is an error on page 17 of the January, 1971 issue of the *Newsletter* in the abstract of the paper entitled "Detection of pregnancy in the rhesus monkey by the measurement of serum progestins." The progestin levels referred to on the 12th line of the abstract should be 1 ng/ml (one nanogram per milliliter), rather than 1 mg/ml.