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THE REARING OF THE INFANT RHESUS MONKEY (MACACA MULATTA)[1,2]

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Over the past 20 years articles concerned with the rearing of laboratory primates have periodically appeared. The mulatta macaque monkey occupies a central position in the field of primate biological research, and most articles have dealt with this particular species. Unfortunately, most of these have also endorsed a protocol for infant rearing that was in practice at one particular institution. It is now apparent that infant macaques will thrive under a wide variety of laboratory conditions, if given reasonable care with regard to diet, housing facilities, health measures and prompt treatment of disease states.

In order to properly approach the problems of infant care we must logically start with conception, fetal growth, and development. Primate pregnancies differ in many ways from those observed in other laboratory animals. While a pregnant rat on a deficient diet will frequently abort or else produce grossly malformed offspring, the primate placenta enables the development of a healthy infant even in the face of severe maternal malnutrition. We have had occasion during the past year to feed pregnant macaques diets containing excess amounts of rather unpleasant-tasting single amino acids. These females showed a considerable degree of malnutrition, one even ending her pregnancy with a combined fetal-placental-maternal weight less than the mother's prepregnancy weight. All infants, however, were well nourished with weight and linear measurements well within the normal range for our primate colony.

The placenta is not infallible, however, and a few considerations must be kept in mind with regard to fetal health. Whenever a drug is given to a pregnant female, we must assume that the drug is also reaching the fetus. Certainly some biochemicals are prevented from reaching the fetus by the placenta. Others diffuse across the placental membranes with a zero gradient between fetal and maternal blood, and a few are actively transported by the placenta to reach a higher level in the fetus than in the maternal organism. This is well known in the case of amino acids, and for years has beeen assumed to reflect the more rapid

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[1] Essentially the same article appeared in the ISMR CB-ACP Bulletin, 1965, No. 39, 6-8. (Issued by the Illinois Society for Medical Research and the Chicago Branch of the Animal Care Panel.)

[2] This research was in part supported by Grant FR-0167 from the National Institutes of Health.

rate of fetal growth and subsequently higher fetal needs. A second assumption, also unfounded, was that once the necessary fetal blood level was achieved, the concentrating mechanisms would be discontinued. The latter does not now appear to be the case, at least for phenylalanine, the one amino acid we have studied. Normally, at full term, there is approximately a 1.5:1 ratio of phenylalanine across the placenta with a maternal serum level of 1-2 mg% and a slightly higher fetal level. In an attempt to produce fetal hyperphenylalanemia, and perhaps brain damage, we gave pregnant monkeys diets high in phenylalanine, with hopes that passive diffusion of this amino acid across the placenta might occur and produce a higher than normal fetal level. To our surprise, we found that not only passive diffusion occurred, but that active transport processes were still very much in evidence. The ratio of fetal: maternal blood phenylalanine levels was still in the range of 1.5:1, but we were able to produce, in one case, in a mother with a serum phenylalanine level of 25 mg%, a fetal serum level of 45 mg%. Whether the same phenomenon exists for other amino acids or other nutrients is not known, but at least in this one case, it appears that this primate placenta will not only concentrate a normal maternal level of nutrient for fetal benefit, but will also concentrate an abnormal maternal level, perhaps to the great detriment of the fetus.

With the mechanisms of birth being similar in most primates, we should anticipate problems in newborn monkeys similar to those seen in newborn humans, most notably those due to prematurity and the trauma of birth processes. Interestingly enough, most authors state that parturition in the monkey is a short, quiet affair, usually accomplished in the early morning hours. We have found quite the contrary, when during the past year, we have been required to sit with animals in labor in order to obtain cord blood for amino acid analysis. All primiparous females have had labor lasting from 12 to 36 hrs., similar to those encountered in the human. Multiparous animals had a shorter labor, but still took several hours--not surprising in view of the length of cervix which had to be dilated.

The knowledge of gestational age can be of practical importance, especially since there are very serious consequences associated with post-maturity in macaques. The data from our first 380 pregnancies revealed a 20% mortality rate for conceptions ending before 150 days and an 18% mortality rate for those lasting longer than 175 days. These compare strikingly with a 3% rate for conceptions ending between these extremes. It is difficult to prevent prematurity. On the other hand, the problems associated with post-maturity may be largely preventable if an examination of the mother is performed to determine the fetal position and presentation, and to ascertain whether the fetus is still alive. If any abnormal signs are present, the indications for an emergency caesarean section should be considered.

Once a vaginal delivery has been accomplished, most female macaques reared in the wild instinctively offer good protection and care for the infant. Occasionally this does not occur, but by and large, feral mothers

are quite dependable.

Because our nursery is staffed on a 24-hr. basis, we are able to make observations on animals close to term at hourly intervals, and thus rescue the newly born infants if they are not receiving adequate care. The latter circumstance is seen most frequently in animals reared without adequate mothering of their own and who seem to have no interest or concern for their offspring, in some instances viciously assaulting the infant until it must be removed for life-saving reasons.

In general, in the rearing of the neonate, we must duplicate the physiological functions performed by the normal mother. Macaque newborns, for example, have very poor thermostability and we often find the body temperature of a newborn infant, separated from its mother, in the range of 93-95°F. This is certainly an unphysiological drop from an ambient uterine temperature of about 100°F.; and an infant delivered into an ambient room temperature of 70°F. will need some protection until his own thermal mechanisms become established. This protection can be provided either by a heating pad, or, more ideally, by an incubator equipped with a humidifier and oxygen source. Even this protection may not be adequate and we have found, in one premature infant, an absolute inability to alter his temperature from the ambient. When the incubator was set at 90°, his temperature was 90°. With a setting of 95°, his temperature climbed to 95°, and this defect was present even at two weeks of age.

The health of the newborn is assessed by his color, the presence of cyanosis, obvious injuries, respiratory rate, and birth weight. We usually chart, at 30-min. intervals, the respiratory rate of any infant who is liable to develop a respiratory problem. A steadily increasing rate from the normal 60-70/min. indicates a need for close examination and perhaps specific therapy.

In terms of postnatal nutritional requirements, we have little data, other than to suppose that monkey breast milk probably supplies a close approximation of the normal needs. Some years ago, Van Wagenen and co-workers demonstrated that milk from the rhesus monkey and human breast milk were comparable but were of much lower protein and ash composition than cow's milk (Table I). In the absence of a ready supply of either monkey or human breast milk, we feed monkeys a commercial milk (Similac, Ross Laboratories), closely comparable to breast milk. For experimental purposes, the commercial milk provides uniform composition of the diet, so that we can define the amino acid and fatty acid intake (Tables II and III).

We routinely and arbitrarily start feeding infants at 8 hr. of age at which time most infants suck vigorously. Nutritional needs are modest during the first day or two, but the need for fluid is more urgent. Consequently the first feedings consist of water and easily metabolized glucose. After 24 hr. of age, a 10% dextrose solution is diluted with

Table I

Gross Composition of Synthetic and Natural Milks (gm/100 ml)

	Protein	Fat	Carbohydrate
Man	1.1	3.8	7.0
Monkey (M. mulatta)	2.1	3.9	5.9
Cow	3.3	3.8	4.8
Similac	1.8	3.5	7.0

Table II

Fatty Acid Composition of Similac Milk Formula (Per cent of total)

Saturated		Unsaturated	
Caproic		Oleic	22.9
Caprylic	.7	Linoleic	32.8
Capric	1.7		
Lauric	20.2		
Myristic	8.1		
Palmitic	11.0		
Stearic	2.4		
	44.1		55.7

Table III

Amino Acid Composition of Similac Milk Formula (mg/100 ml)

Arginine	63	Valine	115
Histidine	40	Cystine	16
Isoleuoine	107	Alanine	38
Leucine	180	Aspartic Acid	82
Lysine	130	Glutamic Acid	337
Methionine	44	Proline	124
Phenylalanine	87	Serine	79
Threonine	77	Tyrosine	94
Tryptophan	25	Glycine	6

equal parts of the commercial milk preparation; and after 48 hr. of age the total nutrition consists of full strength milk. Feedings are given at 2-hr. intervals for the first 48 hr., then at ten feedings daily for the rest of the first week. Feedings at 4-hr. intervals are routine after 12 days, and by 14-16 days of age self-feeding with a bottle is usually accomplished. Depending on the age of the animal, and his dexterity at self-feeding, we use a wide variety of bottles and nipples, starting with a "doll bottle" and working up to liter containers. In addition, various sized clips can be adjusted onto the different cages, which also increase in size as the infant grows.

Despite this intake of nutrient, we have been unable to prevent the postnatal weight loss seen in all primate species. Monkey newborns lose about 10% of their birth weight by the first 36 hr., then slowly start to gain, reaching their birth weight by 5 days of age (Fig. 1).

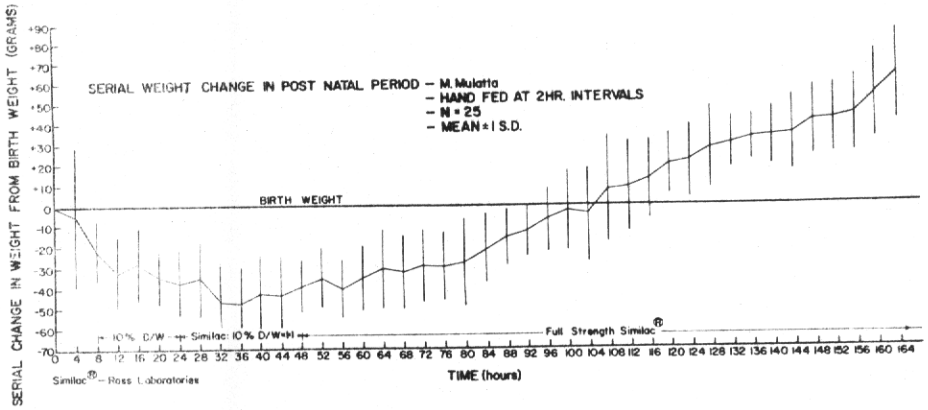

Fig. 1. Weight change in the neonate rhesus monkey. Mean $\pm$ standard deviation of weights from 25 infants, each weighed at 4-hr. intervals, and compared with its own birth weight.

Postnatal growth can be charted against total dietary fluid intake on animals receiving this standardized diet and it is apparent that the older and larger an animal becomes, the less nutrition is required per unit body weight (Fig. 2). Because of the constant composition of diet, we can extend these data in terms of carbohydrate, fat, protein (Table IV), or, if necessary, to the amino and fatty acid intake.

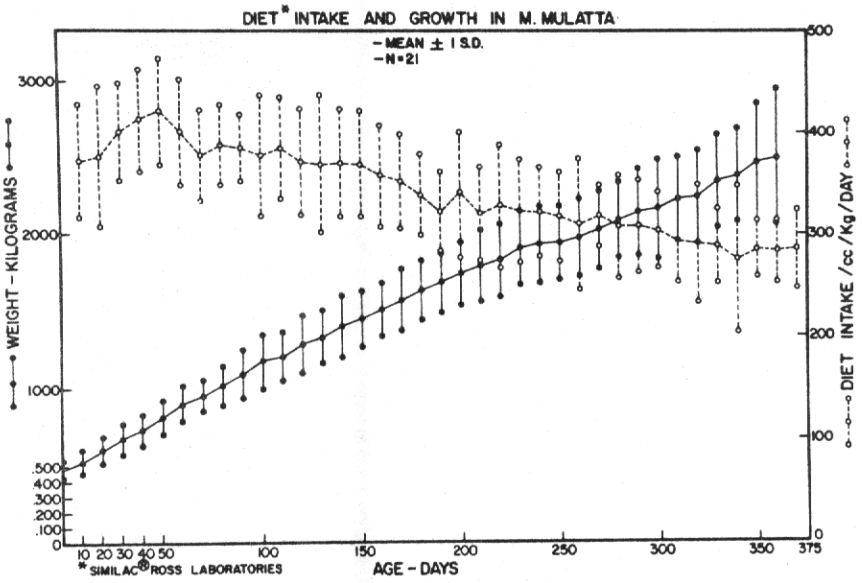

Fig. 2. Ad libitum dietary intake related to growth of macaque infants during the first year of life. It is apparent that a decrease in energy requirement, per unit body weight, occurs with age.

Table IV

Mean Ad Libitum Intake/Kg/Day of 21 Infants

Type of Food	Days of Age 60	120	180	240	300	360
Similac (cc)	401	371	339	322	304	284
Calories	264	244	224	212	200	186
Protein (gm)	7.30	6.75	6.17	5.86	5.53	5.17
Fat (gm)	14.19	13.13	12.00	11.40	10.76	10.05
Carbohydrate (gm)	28.27	26.15	23.90	22.70	21.43	20.02

The Wisconsin Regional Primate Center has two routines for feeding; one consists of decreasing intakes of milk and increasing dependence on solid food such as commercial chow, and the other consists only of milk given at 4-hr. intervals. Both groups routinely receive supplemental fruit and vitamins. When comparing the growth of animals on these two diets, it is gratifying to find that the genetic potential for growth

is expressed similarly on both. We do feel, however, that for nutritional studies, the milk diet permits more accurate control and interpretation of data.

Once the first 48 hr. have passed, it is likely that the infant will survive, if adequate provision is made for proper nutrition, social interaction, and the prevention of infection. The nutritional aspect has already been mentioned. Harlow's group has shown the importance of physical bodily contact between infants in the establishment of normal social patterns. Too often we have seen male macaques who have been raised without this all-important rough-and-tumble contact with age peers and who have been unsatisfactory as breeding males in adult life.

Serious infections in infancy usually involve the respiratory and gastrointestinal systems. An animal which can sustain, without serious complications, an evisceration following a caesarean section, or an injury which exposes large areas of periosteum, will collapse under the influence of a respiratory virus or a modest bronchopneumonia. Unfortunately, easily recognizable clinical signs of severe illness appear late so that intravenous fluids, antibiotics, and all therapeutic adjuncts are often to no avail. We feel that the optimum time for close examination, blood count, cultures, X-ray, and treatment is when the first change in behavior, or disinterest in the diet, is reported. With prompt attention at this time, it is frequently possible to prevent a fatal outcome.

Bowel infections are a scourge of primate centers. Pathogenic E. coli, Proteus, and Shigella infections are the most common found, and once an epidemic becomes established in an animal area, it may be extremely difficult to eradicate. We culture all diarrheas and periodically screen each animal area to be aware of impending infections. All too often we find an animal without diarrhea excreting pathogens and also, too often, we note that a short course of antibiotic (which may be adequate to stop the diarrhea) fails to eradicate the pathogens or makes them resistant to usually appropriate antibiotics.

It is important to realize the need for water in any state of disease. Sick monkeys refuse to eat any solids or milk but it is essential to provide water. An infant macaque is compromised both in his ability to concentrate a urine and his ability to tolerate dehydration. If such an infant is fed a high solute milk formula, the hyperosmolarity may well become worse. Animals of all ages obviously need calories for metabolic purposes but in the absence of chronic malnutrition can probably sustain short periods of inadequate nutrition. They cannot, however, sustain water deprivation.

In general, the problems of raising macaques can be largely eliminated by common sense, close observation, and prompt attention to the early signs of disease. We try to implement modern concepts of general pediatric practice in terms of diet preparation, antisepsis,

and an individualized, rather than routinized, therapeutic program for any ill infant. As in any species, an appreciation of normal parameters of growth and development will permit earlier detection of disease states which threaten the life of the growing infant.

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MICROBIOLOGICAL STUDY OF THE BABOON IN KENYA

A six-week field trip to Kenya, to study the baboon in its native habitat, was completed in March, 1966, by seven scientists of the Division of Microbiology and Infectious Diseases at the Southwest Foundation for Research and Education, San Antonio, Texas.

Baboons were trapped at three widely separated locations, at sea level at Kalifi; at 3,000 ft. at Kimani (adjacent to the Amboseli Reserve), where a special permit was required; and near Mau Narok, where specimens were obtained from two separate troops, one at 6,500 feet and the other at 9,000 feet. Specimens were taken at each location so that the normal bacteriological, mycological, parasitological, and virological flora of the baboon in its native habitat could be studied. In addition to the samples taken from eye, ear, nose, throat, rectum, vagina and skin, hair samples and nail clippings were obtained. In all, 131 baboons were trapped, of which 110 animals were sacrificed and examined, and 21 animals (20 adults and 1 infant) were sent back to Texas. About 85 animals were examined for gross pathological lesions with appropriate specimens obtained for microscopic examination. From each of the three major trapping sites, five to ten skins and skeletons were taken for identification and classification purposes. Soil samples were taken in 75 different locations for bacteriological, mycological, and chemical analyses. The majority of specimens were packed in dry ice and shipped back to the laboratories in San Antonio for final examination.

WHAT IS A PRIMATE?*

It is surprising that a crisp definition of primates should be almost as difficult today as it was a hundred years ago, when St. George Jackson Mivart wrote that primates are: "Unguiculate, clavicu-late placental mammals, with orbits encircled by bone; three kinds of teeth, at least at one time of life; brain always with a posterior lobe and calcarine fissure; the innermost digit of at least one pair of ex-tremities opposable; hallux with a flat nail or none; a well-developed caecum; penis pendulous; testes scrotal; always two pectoral mammae." All things considered, this is not a bad definition.

When we asked Sherwood Washburn, Professor of Anthropology at the University of California, Berkeley, "What is a primate? What would you include? What would you exclude?" his answer was a little different from that of Mivart. He wrote: "The orders of mammals are major groups of great antiquity which share a major mode of adaptation and which have evolved from a common ancestry. Carnivores, elephants, and seals are examples of such major groups whose ancestry stretches back for over 50 million years, and, in spite of evolution into great diver-sity, each shows a common structural and behavioral pattern. The structural-behavioral pattern of the order of the primates is based on adaptation to arboreal life. Trees, particularly in the tropical forests, offer immense resources of leaves and fruit, and many birds and mammals have specialized in ways of harvesting these arboreal riches. In the primates the primitive short fingers and toes became elongated. Nails replaced claws, and the primates climbed by grasping with the hands and feet. This basic arboreal adaptation separates the primates from all of the other mammalian orders and led to a series of charac-teristic adaptive trends. The relatively soft diet and the frequent use of the hands in feeding permitted the dentition to remain simple in form and reduced in number. Arboreal life favored selection for vision and decrease in the sense of smell. Stereoscopic color vision in monkeys and apes evolved along with increase in the size of the brain. In primitive mammals several young were born at one time, and in primates the number was usually reduced to one, which was carried by its mother.

"The primate way is not a necessary consequence of the arboreal life. Squirrels, for example, are a very successful arboreal group, but they climb by claws, have very large incisor teeth, many young, small brains, and lack stereoscopic vision. Primate structural and behavioral adaptation is the result of the events of the evolutionary history of that particular group. Detailed study of the anatomy, particularly the base of the skull in recent and fossil forms, shows that the similarities are due to ultimate common ancestry, not parallel or convergent evolution. The latest serology and immunochemistry support the traditional morpho-

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*From Primate News, 1966, 4 (2), 6-7. (A newsletter about the Oregon Regional Primate Research Center, Beaverton, Oregon.)

logical classification.

"If we view the primates as an ancient, successful adaptation to arboreal life which led to the evolution of many forms, we can see why it is not easy to give a simple definition of the group. A powerful great toe which can be widely abducted is characteristic of the primates, but man is a primate and his great toe cannot be used in this way. Obviously this is because in adapting to bipedal life on the ground, man's great toe lost an ability that had been present in the ancestors. If both evolutionary history and structural adaptation are considered, apparent discrepancies of this sort disappear.

"An additional problem in the definition of a primate is that the contemporary primates contain a wide variety of forms whose ancestry is distinct back into the Eocene period, some 50 million years ago. Some of these creatures have changed very little and deserve to be regarded nearly as living ancestors, but others have evolved in a wide variety of ways. It is easy to see that it would be far harder to define horses if representatives of three-toed and other long-extinct forms were still in existence. But, from any point of view except definition, it would be a great advantage, and the study of the primates is greatly enriched by the existence of the prosimians and of the remarkable fauna preserved on the island of Madagascar.

"Finally, it should be remembered that classifications are made by men and are intended to be useful, to help in understanding animal life. This is shown by the question as to whether the tree shrews should be included in the primates. There is general agreement that they are either primates, or that they are the non-primates most similar to and most closely related to the primates. Clearly, since all the placental mammals were derived from insectivores of the end of the Age of the Reptiles, the point at which any order of mammals is regarded as separate has an arbitrary element. The decision must be based both on the known fossil record and on the understanding of the order in question. In the sense of an arboreally adapted group with some enlargement of the brain and prosimian features of the skull, the primates are distinct back to close to the beginning of the Age of Mammals, and the adaptations of the group may be treated as we have in this note. If the tree shrews are included, then the order can no longer be defined by grasping hands and feet, nails rather than claws, reductions in number of teeth, shortening of snout, enlargement of brain, emphasis on vision, reduction in sense of smell, reduction in number of young or method of caring for the young.

"The primates, minus the tree shrews, have so much in common that inclusion of the tree shrews in the order seems to cause confusion, makes it harder to discuss the evolution and adaptation of the group. Recent detailed study of the tree shrew skull suggests that even in technical detail they are not as close to the primates as used to be thought. However they may be ultimately classified, the tree shrews are extra-

ordinarily useful in helping us to understand the kind of animal from which the primates, using the word in the restricted sense, may have evolved.

"In summary, simple structural definitions of the primates are bound to be misleading because the group has been evolving as a separate mammalian way of life from close to the beginning of the Age of Mammals. The basis for the success of the order seems to have been in locmotor adaptation, a way of climbing. But this had ramifications for teeth and digestion, special senses and the brain, reproduction, maternal care and social life. It is the understanding of this whole evolving complex which defines the primates."

* * *

NEW PREANESTHETIC POSSIBLE CAUSE OF CHIMPANZEE DEATH

We have been using Innovar-Vet (McNeil; released for use with dogs only) in chimpanzees on an experimental basis. Our sample size is admittedly small, numbering only 10 chimpanzees to date, ranging in weight from 16 to 39 kg. Our dose has varied from 1 ml Innovar per 18 kg to 1 ml per 13 kg.

On March 28, 1966, we gave 1 ml per 19 kg to a female chimpanzee intramuscularly followed by 0.4 mg atropine sulfate subcutaneously. Fifteen min. post injection, the animal was dead, apparently due to cardiac arrest. This was, I feel, an untoward reaction to the drug and I wonder if any Newsletter readers have had a similar experience with the use of this drug in primates.--Donald C. Van Riper, Chief, Vivarium Branch, 6571st Aeromedical Research Laboratory (AFSC), Holloman Air Force Base, New Mexico 88330.

SERO-PRIMATOLOGY: A NEW DISCIPLINE

J. Moor-Jankowski, Alexander S. Wiener, and Jerry Fineg

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The term "sero-primatology" has recently been coined by A. S. Wiener to define the characterization of simian populations by differences in the distribution of their serological properties (Moor-Jankowski, Wiener, Kratochvil, & Fineg, in press). It is analogous to the well-established discipline of "sero-anthropology," which deals with differences in the distribution of serological properties among races and other population groups in man. This branch of physical anthropology dates from the discovery, during World War I, by Ludwik and Hanna Hirszfeld (1919), of significant differences in the A-B-O blood-group frequencies among troops of various nationalities. Subsequent investigations also included other blood-group systems (Wiener, 1943), and led to the sero-anthropological mapping of practically all known human populations (Mourant, 1954; Mourant, Kopeć, & Domaniewska-Sobczak, 1958). Sufficient data are now available on the human-type and simian-type[1] blood groups of apes and monkeys (Moor-Jankowski, Wiener, & Rogers, 1964; Moor-Jankowski & Wiener, 1965) to make possible the investigation of the sero-primatology of populations of nonhuman primates.

Family, subfamily, genus, and species are identical in man. In contrast, when dealing with almost all other primates it is necessary first to compare blood-group serology on the level of major taxonomic subdivisions before considering the sero-primatology of individual species.

The bulk of serological data now available on nonhuman primates deals with the distribution of their human-type blood groups and their finer serological characteristics. These criteria define the catarrhine primates and the platyrrhine monkeys as the two largest serologically-distinct subdivisions of nonhuman primates. Among the catarrhine primates, the apes form a separate serologically-discrete subgroup, with the possible exception of the relatively-little-studied gorilla whose blood-group characteristics resemble those of the Old World monkeys rather than the other apes. On the level of individual species, serological information now available for purposes of comparison constitutes a valid criterion for taxonomic classification. For example, despite the relative small size of the series now available, the similarity in the

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[1] Human-type blood groups are determined with reagents originally prepared for testing antigenic specificities of human red cells. Simian-type blood groups are determined with reagents prepared by immunization with red cells of apes and monkeys.

human-type A-B-O blood-group characteristics in Papio cynocephalus and in Papio doguera is as striking as the contrast among Macaca mulatta, Macaca irus, and Macaca nemestrina (Wiener, Moor-Jankowski, & Gordon, 1966).

In sero-primatological investigations, in analogy to sero-anthropology, the most discriminating findings are of course to be expected from comparative studies on population groups existing within individual species of primate animals. The first such differences in the distribution of serological characteristics were observed when the human-type A-B-O blood-group frequencies in a colony of interbred baboons at the Southwest Foundation for Research and Education, San Antonio, Texas, were compared with those of baboons captured in Africa (Moor-Jankowski, Wiener, & Gordon, 1964; Moor-Jankowski, Huser, Wiener, Kalter, Pallotta, & Guthrie, 1965). However, the general nature of the phenomenon of differences in distribution of serological properties in populations or "races" within individual primate species has been demonstrated most strikingly by recent observations on chimpanzees and gibbons, which are presented in this paper.

Chimpanzees

In our investigations of the human-type and simian-type (Moor-Jankowski, Wiener, & Rogers, 1965; Wiener & Moor-Jankowski, 1965; Wiener, Moor-Jankowski, & Gordon, 1965; Wiener, Moor-Jankowski, & Gordon, 1965; Wiener, Moor-Jankowski, Kratochvil, & Fineg, in press; Wiener, Moor-Jankowski, Riopelle, & Shell, 1966) blood groups of chimpanzees, high chi-square values were encountered in certain 2-by-2 contingency tests, suggesting associations between blood factors which, according to serological evidence, did not belong to the same blood group system (Moor-Jankowski, Wiener, Kratochvil, & Fineg, 1966). We postulated that these high chi-square values might have been caused by non-homogeneity of the investigated chimpanzee population, even though all the animals we tested belonged to the same species, Pan satyrus[2]. Upon further inquiry, Dr. W. C. Osman Hill called our attention to the existence of morphologically and geographically defined subgroups within the species P. satyrus, described by him as follows:

> "At the present time it is not possible to state precisely how many valid forms exist, but the undermentioned are certainly recognizable, though whether as species or subspecies is a moot point.
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> "(i) The Masked Chimpanzee (Pan satyrus verus) of Upper Guinea, in which the face has a pale muzzle, bearing short, white

[2] Pan troglodytes according to Fiedler. ("Übersicht über das System der Primates. In H. Hofer, A. H. Schultz, & D. Starck [Eds.], Primatologia. Basel: Karger, 1956.)--Ed.

hairs, whilst the brows and upper face are blackish from birth. Ears are large, pale and prominent; fingers and toes pale, palms and soles brownish, never black, body skin pale.

"(ii) The tschego or choga (Pan satyrus satyrus) occurs in the same area as the next form, i.e., in Lower Guinea, east of the Dahomey gap. Black-faced throughout life, its nose is not swollen; the body skin is black, including that on hands, feet and ears. Ears rather smaller than in verus, and placed somewhat higher. The skull in the male shows a sagittal crest.

"(iii) The koola-kamba of Nigeria and the Western Cameroons is distinguished by its gorilla-like swollen nose, recalling a squashed tomato. The face is blotchy and the hair long and coarse. Ears short, small, black, and adpressed.

"(iv) The long-haired or eastern chimpanzee (Pan satyrus schweinfurthi) has the face completely pallid at birth, but with age it becomes a dirty brownish-pink; ears, hands and feet are also pink. This form comes typically from the eastern part of the range, i.e., Tanganyika and Uganda, but extends thence westward into the Congo, a few stragglers even reaching the Cameroons."[3]

The above description was obtained from Dr. Osman Hill early in 1965, and a single typical animal was chosen and photographed for each of the above population groups from the chimpanzee colony of approximately 100 animals at the 6571st Aeromedical Laboratory, Holloman Air Force Base, New Mexico. The photographs were then sent to Dr. W. C. Osman Hill and approved by him as representative. On the basis of these four photographs and of the above description, the animals at Holloman were classified by one of the authors (J. F.) and lists of the chimpanzees of all four groups were sent to the other authors in New York City to be compared with the previously recorded serological data of these animals.

Several months after the "races" of the Holloman animals were determined on the basis of photographs and correspondence, Dr. Osman Hill visited the colony and classified the animals without prior knowledge of which "race" each had been attributed to previously. Between the two classifications there was disagreement for only four out of the 105 animals listed; one chimpanzee classified previously as P. s. schweinfurthi was determined by Dr. Osman Hill as a possible hybrid of P. s. satyrus, two animals classified as P. s. satyrus were determined to be P. s. schweinfurthi, and one animal classified as P. s. satyrus was determined to be P. s. koola-kamba.

The serological findings on animals of all four "races" tested so far at Holloman are summarized in Tables 1 to 6. Despite the relatively small

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[3]Chimpanzee. In Encyclopaedia Britannica, 1966, 5, 555; quoted with permission of the publishers.

Table 1. Distribution of the human-type A-B-O blood groups among four subspecies of chimpanzees

Subspecies	O		A		Totals
	Number	Per cent	Number	Per cent	
Pan satyrus satyrus	2	14.3	12	85.7	14
Pan satyrus schweinfurthi*	13	39.4	20	60.6	33
Pan satyrus verus*	4	9.5	38	90.5	42
Pan satyrus koola-kamba	1	----	1	----	2
Totals	20		71		91

*For the two subspecies P. s. schweinfurthi and P. s. verus, chi sq. = 9.2, df = 1, $0.001 < p < 0.005$.

Table 2. Distribution of the simian-type C-E-F system among four subspecies of chimpanzees

Subspecies		c	E	F	EF	C	Totals
Pan satyrus satyrus	Number	2	1	7	3	1	14
	Per cent	14.3	7.1	50.0	21.4	7.1	
Pan satyrus schweinfurthi*	Number	2	5	16	10	0	33
	Per cent	6.0	15.2	48.5	30.3	0	
Pan satyrus verus*	Number	27	3	8	4	0	42
	Per cent	64.3	7.1	19.1	9.5	0	
Pan satyrus koola-kamba	Number	0	0	2	0	0	2
Totals		31	9	33	17	1	91

*For the two subspecies P. s. schweinfurthi and P. s. verus, chi sq. = 26.6, df = 3, $p < 0.0001$.

Table 3. Distribution of the H^c factor associated with the simian-type C-E-F system among four subspecies of chimpanzees

Subspecies	h		H		Totals
	Number	Per cent	Number	Per cent	
Pan satyrus satyrus	2	14.3	12	85.7	14
Pan satyrus schweinfurthi*	1	3.3	32	96.7	33
Pan satyrus verus*	17	40.5	25	59.5	42
Pan satyrus koola-kamba	0	----	2	----	2
Totals	20		71		91

*For the two subspecies P. s. schweinfurthi and P. s. verus, chi sq. = 14.1, df = 1, $p < 0.0001$.

Table 4. Distribution of the blood factor $\underline{V}$ of the simian-type V-A-B system among four subspecies of chimpanzees

Subspecies	v		V		Totals
	Number	Per cent	Number	Per cent	
Pan satyrus satyrus	9	64.3	5	35.7	14
Pan satyrus schweinfurthi*	24	72.8	9	27.2	33
Pan satyrus verus*	25	59.5	17	40.5	42
Pan satyrus koola-kamba	2	----	0	----	2
Totals	60		31		91

*For the two subspecies P. s. schweinfurthi and P. s. verus, chi sq. = 1.38, df = 1, $0.2 < p < 0.3$.

Table 5. Distribution of the A^C-B^C types of the simian-type V-A-B system among four subspecies of chimpanzees

Subspecies		O^C	A^C	B^C	A^CB^C	Totals
Pan satyrus satyrus	Number	0	1	9	4	14
	Per cent	0	7.1	64.3	28.6	
Pan satyrus schweinfurthi*	Number	3	4	21	5	33
	Per cent	9.1	12.1	63.7	15.1	
Pan satyrus verus*	Number	5	14	14	9	42
	Per cent	11.9	33.3	33.3	21.4	
Pan satyrus koola-kamba	Number	0	0	2	0	2
Totals		8	19	46	18	91

*For the two subspecies P. s. schweinfurthi and P. s. verus, chi sq. = 7.77, df = 3, $0.05 < p < 0.10$.

Table 6. Distribution of the $\underline{G}^C$ factor of the simian-type G system among four subspecies of chimpanzees

Subspecies	g		G		Totals
	Number	Per cent	Number	Per cent	
Pan satyrus satyrus	5	35.7	9	64.3	14
Pan satyrus schweinfurthi*	6	18.2	27	81.8	33
Pan satyrus verus*	13	31.0	29	69.0	42
Pan satyrus koola-kamba	0	----	2	----	2
Totals	24		67		91

*For the two subspecies P. s. schweinfurthi and P. s. verus, chi sq. = 1.63, df = 1, $0.20 < p < 0.30$.

size of the series, statistically significant differences in distribution both of human-type and of simian-type blood groups have been demonstrated so far for the populations of P. s. schweinfurthi and P. s. verus, which comprise the great majority of the animals tested, and, at the same time, show the most striking differences in blood-group distribution.

Statistically significant differences were demonstrated in the distribution of the human-type blood group O, which ranged from a low of only 9.5 per cent in P. s. verus to a high of 39.4 per cent in P. s. schweinfurthi (Table 1). Also, the differences in distribution of the simian-type C-E-F blood-group system and of the blood factor H^c associated with this system are statistically significant (Tables 2 and 3). The frequency of type c ranged from 6.0 per cent among P. s. schweinfurthi to 64.3 per cent among P. s. verus, and parallel variations were observed in the distribution of blood factor H^c.

On the other hand, no significant differences were demonstrated in the distribution of the simian-type V-A-B blood-group system (Tables 4 and 5) or of the simian-type blood factor G^c (Table 6).

Thus, the serological data so far obtained confirm the subdivisions of the species P. satyrus by Dr. W. C. Osman Hill, based on morphological characteristics, for at least two of the four "races" of chimpanzees.

Gibbons

Human-type A-B-O and M-N blood groups were determined in 24 gibbons maintained at the Delta Regional Primate Research Center of Tulane University, Covington, Louisiana. Four of the animals belonged to the subspecies Hylobates lar pileatus, and the remaining 20 to the subspecies H. l. lar. Although the sample was small, clear differences in the distribution of the human-type blood groups were observed for the two subspecies (Wiener, Moor-Jankowski, Gordon, & Shell, in press) as shown in Table 7.

Table 7. Comparison of the distribution of the A-B-O and M-N types in two subspecies of gibbons*

Subspecies	Number of animals of blood group						
	A_1	B	A_1B	$(M)^{Gi}$	$(N)^{Gi}$	$(MN)^{Gi}$	Totals
Hylobates lar lar	3	7	10	1	14	5	20
Hylobates lar pileatus	0	4	0	4	0	0	4

*The superscript "gi" for "Gibbon" is used to emphasize the difference between the gibbon and human M-N types.

Conclusions

The variations in blood-group distribution in chimpanzees and gibbons reported here are comparable to the extremes of variations encountered in man, namely in isolates of American Indians (Matson & Swanson, 1965) and of Australian aborigines (Simmons, Graydon, Champness, & Gajdusek, 1964). The observations reported here are useful as a new taxonomic parameter. They suggest the general nature of this phenomenon in primates and may help to throw light on the origin of polymorphism and of the varying distribution of blood groups in man.

Acknowledgment

The authors are greatly indebted to Dr. W. C. Osman Hill, Associate Director, Yerkes Regional Primate Research Center, Emory University, Atlanta, Georgia, who first called our attention to the existence of subspecies among chimpanzees, and helped to classify the animals tested by us. The serological studies were assisted by use of the facilities of Hofstra University. The studies were supported in whole by U. S. Public Health Service grants GM-12074-03 and GM-09237-05, and by an A.F. 41(609)-2912 contract from the 6571st Aeromedical Research Laboratory, Holloman Air Force Base. The studies on gibbons at the Delta Regional Primate Research Center of Tulane University, Covington, Louisiana, were supported by U. S. Public Health Service grant FR-00164.

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BABOON INFORMATION CENTER

Southwest Foundation for Research and Education of San Antonio, Texas, initiates its Baboon Information Center program on April 1, 1966. The service that will be rendered is based on the references contained in The Baboon: An Annotated Bibliography, published by the Southwest Foundation in 1964. This book contains 1,589 references with abstracts covering the period 1607 (when the first article of a scientific nature appeared--in this case, in the area of behavioral sciences) through 1963. Ninety per cent of the United States and western European literature is now on file for reproduction, as is thirty-five per cent of the Russian and eastern European literature. Every effort is being made to complete file copies of original articles on all references as early as possible, but it is believed that the collection in its present state will be of real service to investigators. The key-word index and the abstracts in the annotated bibliography will be helpful to an investigator in determining which articles he would like to have. At his request, these will be Xeroxed at a cost of five cents per sheet (paper cost), for which a bill will be sent. There will be no charge for mailing. A supplement to the bibliography will be published in 1967 covering the years 1964 through 1966. In the meantime, annual bibliography references covering each of the three years will be produced. Bibliography reference lists for 1964 and 1965 are now available on request. Copies of the original articles in these lists are already on hand and Xerox copies are available.--Harold Vagtborg, Administrative Director, Southwest Foundation for Research and Education, P. O. Box 2296, San Antonio, Texas 78206.

ON CRITERIA FOR SELECTION OF LABORATORY PRIMATES

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As a primate taxonomist I always have wanted to know exactly which are the criteria used by experimental scientists for the selection of a given species as a laboratory animal to be used in a given experiment. Evidently, basic and general requirements are that the chosen animal must be easy to handle and to obtain, and it must do well in captivity.

These items, though, are not sufficient when it comes to the selection of an organism that is expected to provide definite answers to specific problems. I would expect scientists to be more methodic and specific with the selection of subjects for their experiments. Unfortunately this is not the general rule. As a matter of fact, availability of a large supply is usually the only item considered. And in several known instances not even that has been taken into consideration, as is the case with Leontocebus rosalia, the lion marmoset.

I frequently receive letters from laboratories, institutes, and primate centers concerning the possibility of getting a permanent supply of these marmosets to be used in medical or pharmaceutical research. The reason for that particular choice is a complete mystery to me. The taxonomic position of that species has not been so far perfectly established; it does not reproduce well in captivity, as compared with several other commoner species; and it is one of the rarest marmosets, the species being restricted to a small area in southeastern Brazil. (By the way, severe regulations have been issued concerning capture and shipment of lion marmosets, to protect the remnants of this vanishing animal.)

Scientists should be at least as careful with the selection of their laboratory animals as they are when it comes to choosing instruments and scientific apparatus.

Not long ago I had the opportunity of tackling a similar problem in a book review, where I criticized the inadequacy of species names used throughout the text, which could jeopardize some of the main conclusions. The book resulted from a symposium on maternal behavior in mammals. One of the authors noted differences in this type of behavior among different subspecies of the same species. Several others, though, only identified their subjects as "laboratory mice," or "Rocky Mountain sheep." Yet all of them took pains in describing and explaining in detail the photographic and recording apparatus they had used.

For every type of work there must be a proper tool. And if it can be argued that we still lack much of the information needed to

select more properly the subjects for our experiments, the answer is not to work blindfolded, but to do more basic research, or to provide means and funds for it and encourage its doing.

Tropical America harbors over a hundred species and subspecies of primates, the great majority poorly known. By that I mean that most descriptions are old and inadequate; the geographic distribution unmapped; natural history, physiology, and behavior unknown. So why not spend a little time and money to build a framework of basic knowledge, and then be able to work upon a solid base?

It is not uncommon for a museum taxonomist to receive a skin of some animal with the request for a Latin name, to be entered in the final report on some experiment in which hundreds of specimens were used, most usually from different sources, and God knows if all belong to the same species and subspecies.

I feel it is high time for a change in methods and orientation, and for a more scientific policy to be followed.

* * *

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

Books

The pathology of laboratory animals. Ribelin, W. E., & McCoy, J. R. (Eds.) Springfield, Ill.: Charles C. Thomas, 1965.

This book is based on a conference sponsored by the Section on Microbiology of the New York Academy of Medicine and the New York Pathological Society. It deals with naturally occurring lesions of the rabbit, guinea pig, rat, mouse, hamster, and monkey, and includes tumor types and occurrences, malformations, lesions of infectious and nutritional diseases, comparisons of mortality, and lesion occurrences in pathogen-free and conventional animals. The text deals first with lesions of the organ systems most likely to prove troublesome to the experimentalist, respiratory, reticulo-endothelial, musculo-skeletal, endocrine, renal, cardiovascular, and liver. The lesions as encountered by the authors and discussants in each of the six species of laboratory animals are then covered in detail.

Primatologia. Vol. II/2, Liefering 13. Die circumventrikulären Organe des Zwischenhims. Hofer, H. Basel: Karger, 1965.

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Six tuberculin-positive rhesus monkeys (later confirmed on autopsy to be tubercular) were retested with intradermal injections of 0.2 ml. of a 1:10 dilution of veterinary-type old tuberculin into the eyelids. The first retests produced responses as seen by eye closure at 6 hours. With readings made at 15 minutes, 6, 24, and 48 hours, the earliest virginal site reaction was seen at 24 hours. There was a general tendency for the degree of response as seen by eye closure to be less at retesting. Several monkeys at retest produced negative or questionable responses at 6, 24, and 48 hours, but these were inconsistent in any one monkey from one retest to the other.

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Sera of 52 free-living rhesus from U.P., India, with varying degrees of contact with man were examined for antibodies to representative enteroviruses, arboviruses, myxoviruses and simian viruses. A high proportion of the adult rhesus in maximal human contact had antibodies to para-influenza 3 and measles viruses; evidence of occasional possible infection with poliovirus type 2, an arbovirus of the Japanese B--West Nile complex and respiratory syncytial virus was detected. Infection with simian viruses monkey B and SV 40 was very common in the adult. Antibodies to para-influenza 3 virus were also detected in sera of laboratory-housed rhesus from India, as well as six species of laboratory-housed African monkeys.

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Ninety-six chimpanzees, 54 males and 42 females, ranging in age from less than 3 years to 15 years, were refracted in both supine and sitting positions under Sernylan (Parke-Davis) anesthesia and Cyclogyl (Schieffelin Co.) cycloplegia. Intraocular pressures were obtained under the same conditions. High reliability ($r = +.930$ overall) between refractions and the tendency toward increasing minus refractive error as a function of age was confirmed.

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