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WORKING PARTY FOR THE PREPARATION OF THE FOURTH MULTILATERAL CONSULTATION OF PARTIES TO THE EUROPEAN CONVENTION FOR THE PROTECTION OF VERTEBRATE ANIMALS USED FOR EXPERIMENTAL AND OTHER SCIENTIFIC PURPOSES (ETS 123)

6th Meeting
Strasbourg, 25-27 March 2003

Species-specific provisions for Non-Human Primates

Background information for the proposals presented by the Group of Experts on Non-Human Primates

PART B

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NON-HUMAN PRIMATES

SECTION B : SCIENTIFIC JUSTIFICATION

1 Introduction

Normal behavioural repertoire

The aim for captive primates should be for them to have the facility to carry out a wide range of normal behaviour providing it does not result in injury or distress to itself or another animal (Schapiro et. al. 1996). It is particularly important that the enclosure should enable the animals to adopt normal postures and a range of locomotor behaviour (Buchanan-Smith 1997, Home Office 1989, International Primatological Society 1993, Marriott *et al.*1993, Olfert *et al.*1993, Poole 1991, Poole *et al.*1994, Reinhardt 1997a, Snowdon and Savage 1989, Whitney and Wickings 1987). Test conditions lacking adequate environmental enrichment should be regarded as testing under abnormal conditions (Kessel and Brent, 1995a; Reinhardt *et al.*1996), which in certain cases may lead to false conclusions from the results.

However, in captivity, non-human primates may perform abnormal behaviours, such as locomotor stereotypies, self directed behaviour and even self mutilation. Such behaviours are indicative of unsatisfactory environmental conditions according to Bayne *et al.* (1992), Broom and Johnson (1993). However, the presence of stereotypies may reflect past, not present, environments (Brent and Hughes 1997, Broom and Johnson 1993, Mason 1991a, b, Mason and Mendl 1993). The causes may be either a restricted social environment during development or early infant separation from the mother and the behaviour may be untreatable (Capitanio 1986, Mason and Berkson 1975, Novak and Drewson 1989, O'Neill 1989) or only eliminated with considerable effort (Kessel and Brent 1997). Cage height may also be a factor, as long-tailed macaques were found to exhibit less self-directed stereotypy in taller cages as compared with those in shorter ones (Watson and Shively, 1996). In a study of the influence of cage size and behaviour, pairs of common marmosets were found to show stereotypies and higher levels of aggression and startle responses in smaller cages (Kitchen and Martin, 1996). From this literature, it is apparent that three factors can induce abnormal behaviour in mammals, but that these act in combination, for primates they are single housing, small cages and lack of environmental complexity. Thus, minimum or even optimum cage size alone cannot be quantified scientifically.
From this literature, it can be concluded that the captive environment should provide non-human primates with an adequately complex social and physical environment. Cage dimensions should allow for sufficient structures to enable them to carry out a wide range of normal behaviour and exhibit a minimum of abnormal ones.

2 Health

Health:
Non-human primates are known to sometimes harbour viruses, bacteria, protozoa and other endoparasites that can be harmful or even fatal when transmitted to humans. Herpes B virus, Marburg virus and *Mycobacterium tuberculosis* are the three pathogens which have received the widest concern. (Hazards of handling simians, Laboratory Animal Handbooks 4, 1969). Additional agents, e.g. of the retrovirus group pose a health risk to other primates in a colony. Some diseases are endemic in certain areas in the wild population but not in others and may lead to severe outbreaks when transmitted to primates from areas that are free of the agent. Unfortunately the reservoir species for certain diseases are not always known and not all species show clinical symptoms after infection.

The use of purpose-bred animals has helped to minimise such health problems, and reputable breeders will supply a health certificate based on their health monitoring scheme. This may help shorten the compulsory quarantine period. The fact that infections may go unobserved for a long time necessitates a regular screening of the animals. Eradication of the disease is not always easy through treatment, but knowing the microbiological status of the animals will allow the necessary precautions to be taken to prevent transmission to other animals and the staff. Guidelines for health monitoring have been proposed by FELASA (1999).

Some diseases may be transmitted from humans to primates. Typical is tuberculosis for which most non-human primates are highly susceptible and cannot effectively be treated. Therefore, screening of the staff, and precautions with personnel with health problems is essential.

Rodents, birds and insects, and for animals in the source country, wild conspecifics may be a threat to the captive bred groups. Especially for groups in outdoor enclosures preventive measures against intrusion of possible disease vectors are essential.

The reason for scrupulous separation of animals from different geographical areas during transport and until the health status of the animals has been clarified is that transmission from some silent pathogens in reservoir species causing severe outbreaks of disease in animals from other geographical areas cannot be excluded.(FELASA, 1997).
The following references cover the subject of health monitoring: FELASA (1997, 1999), OIE (1999a,b).

3 Housing and enrichment

3.1 Social housing

It has already been pointed out that being part of a compatible group provides a sense of security for the vast majority of non-human primates. It also provides opportunities for a whole range of species-specific social activities such as grooming, embracing, huddling, patting and kissing (Cheney *et al.*1987, Jolly 1985).In most species, social bonds are forged and maintained by grooming which is therefore of paramount importance in maintaining social cohesion (Williams and Bernstein 1995). In addition it has been demonstrated that grooming has a relaxing effect on the animal being groomed, lowering the heart rate (Boccia et al. 1989). Singly housed primates are particularly prone to show abnormal behaviour, whereas keeping them in groups reduces the incidence of this behaviour (in long tailed macaques Line *et al.*1990, rhesus monkeys, Schapiro *et al.*1996, squirrel monkeys, Spring *et al.*1997, macaques and baboons, Woolley 1997). Isolation and prevention of contact with companions may also lead to altered physiological parameters e.g. elevated blood pressure in baboons (Coelho *et al.*1991), altered cell mediated immune responses in rhesus monkeys (Schapiro *et al.*1997).

Reinhardt *et al.*(1995a) pointed out that many of the reasons commonly given to justify single housing, such as difficulties in creating compatible pairs and aggression between cage mates are not supported by the evidence. Most Old World primates are put into groups as juveniles aged up to twelve months as this avoids most of the problems of incompatibility, but it is possible to form compatible groups of macaques well into adolescence. In some species such as vervets and rhesus monkeys there may be disruption in such groups as they approach maturity. However, Reinhardt *et al.*(1995a) and Lynch and Baker (1998) were successful in establishing adult macaques as long term compatible pairs. For this procedure to succeed, it is necessary to assess the attitudes of the animals to the prospective partners and to carefully monitor their behaviours after introduction. Reinhardt *et al.* (1995a) outlined a nine step partner evaluation and introduction technique. It is important, however, to bear in mind that placing two animals in a bare small cage can lead to conflict; an appropriately complex cage environment should also be provided (APHIS 1999).

For groups of maturing same sex monkeys, the proximity of members of the opposite sex in nearby cages can lead to intra-group aggression among previously amicable animals, especially males. Same sex grouped monkeys should therefore be well separated from enclosures containing members of the opposite sex.

To conclude, virtually all primates commonly used in laboratories are highly social and need to be kept with one or more compatible conspecifics, this provides them with a sense of security, companionship and opportunities for a wider range of normal behaviour. Their physiological condition also benefits.

Separation and weaning

Young monkeys have a long period of dependency on their mothers and natal group. During this period they learn about their environment under the mother's protective vigilance, they also learn social and parenting skills from other group members.

Early separation results in extreme distress to the infant at the time, but it is now well established that it damages normal development and results in animals which are physiologically and immunologically abnormal, as adults. Nursery rearing, in the absence of adults, also commonly results in behavioural abnormalities, such as locomotor stereotypies and auto-aggression (Capitanio 1986, Marriner and Drickamer 1994). Even separation for as little as two weeks during the animal's first year of life can have permanent adverse effects on the immune system of pig tailed macaques (Laudenslager *et al.* 1990).

For most species, the best way to produce behaviourally and physiologically normal monkeys, suitable for breeding and long term study, is to ensure, wherever practicable, that they remain in the natal group for as long as possible, ideally for the first 18 months of their lives. Juveniles separated from their mothers for whatever reason should be reared in social, preferably well organised groups.

3.2 Environmental complexity

Primates should be housed in enriched environments which allow them to carry out a normal behavioural repertoire, showing species-typical behaviour which is complete and well balanced (Brent and Long 1995, Chamove and Anderson 1989, Fragaszy 1991, Olfert et. al. 1993, Poole 1991, 1992, Rose 1994, Toates 1995, Line 1987).

Animals cannot be expected to carry out every natural behaviour in captivity but, excluding the extremes, behaviour seen in nature provides a useful guide (Veasey et. al. (1996), Rosenblum and Andrews 1995, McGrew 1981). Captive conditions should fit within the adaptive range of the species (Kaumanns 1997).

However the animals should be able, as in the wild to carry out a complex daily programme of activity. While it is seldom possible to provide the majority of features of the wild habitat in a laboratory, major attributes can be provided. In the wild, primates require a secure environment (provided by a familiar home range and their social group), a sufficient amount of appropriate complexity (to enable them to carry out a wide behavioural repertoire) and facilities to enable them to achieve objectives. Finally, as natural environments are not invariant, a level of novelty to which they can respond adaptively is necessary. If these features are incorporated into the captive environment, primates can lead a full and interesting life (Poole 1998).

A sense of security

Non-human primates show adaptive flight responses. They respond to ground predators by fleeing upwards into trees or cliffs and downwards to mid-level branches or to the ground to avoid aerial predators (Seyfarth and Cheney 1980). In addition, while social groups are cohesive, a certain amount of dispersion of individuals has been observed in both field and captive studies. There is general agreement among primatologists that enclosures for primates should enable them to fully utilise the vertical dimension (Abee 1985, Buchanan-Smith 1997, Dukelow and Asakawa 1987, International Primatological Society 1993, Maple and Perkins 1996, Olfert *et al.*1993, Poole *et al.*1994, Reinhardt *et al.*1996, Queyras et al.1997).

Their sense of security both from predators and also from rivals, depends on being able to reach a high point in their environment; dominant squirrel monkeys used the highest available perches (Williams *et al.*1988). Furthermore, long tailed macaques (Woodbeck and Reinhardt 1991), rhesus monkeys (Watson and Shively 1996) marmosets and tamarins (Caine et. al. 1992; Prescott and Buchanan-Smith 2002; Ely et al. 1998; Kerl and Rothe 1996; Buchanan-Smith et al. 2002) all show preferences for the upper part of their cages.

Hediger (1964) pointed out that a captive mammal's liability to panic and hence its sense of security depends on the enclosure allowing for an adequate flight response. In the case of primates, this relates to the enclosure being of adequate height to allow adequate vertical movement ; primates tend to move to a position where they can look down on the perceived threat.

A second, important, factor which provides the primate with a sense of security, is the presence of one or more social companions. Apart from orang utans and some prosimians, primates live in social groups. This enables them to detect predators more efficiently and escape from them or defend themselves against their smaller enemies. The most vulnerable time in the life of an adult wild primate is when it emigrates from one troop to another. Even when unwelcome, the isolated animal will attempt to attach itself to a group, for example, living on the periphery of an established social group, as in forest dwelling guenons, or joining bachelor troops, as in langurs and desert baboons. For the vast majority of primates, therefore, a social group is essential to ensure their security.

Complexity

A complex environment, which includes swings, perches and branches allows the animals to display a wide locomotor repertoire. Captive rhesus macaques were observed by Dunbar (1989) to walk, gallop, leap, climb, swim and hang from climbing structures. Long tailed macaques, rhesus monkeys and vervets are good swimmers. Leaping is a common mode of locomotion for arboreal species, such as callitrichids, squirrel monkeys and long tailed macaques. Observations in the wild show that squirrel monkeys can leap considerable distances when travelling from branch to branch (Fleagle *et al.*1981) and long tailed macaques commonly make leaps of 2.2 m (Cant 1988). Enclosures should allow for leaping in these species. Space allowances for juveniles should be the same as adults of the species as the former require plenty of space for play (Goosen *et al.*1984). Play is a good indicator of welfare in the young as it is only carried out in a relaxed situation (Fagen 1993, O'Neill et. al. 1990, Thompson, 1996, Pereira et. al. 1989).

Tactile stimuli are also valuable (such as a soft substrate for foraging). Where primates need to be singly housed, fleece pads can be sprinkled with food items. Lam et. al (1991) provided such fleece pads and found that stereotyped behaviour declined by 73%; after the food had been depleted, rhesus monkeys continued to use the fleece for grooming.

Opportunities to achieve objectives.

Primates need to be able to exert some control over their environment, both physical and social; this is essentially a need to be able to achieve objectives. As Sambrook and Buchanan-Smith (1997) have pointed out, this is an adaptive aspect of behaviour. It enables them to adjust to change, alter confronting stimuli, organise response strategies and apply their cognitive capacities (Rosenblum 1991, Neveu & Deputte 1996). It also reduces stress, as indicated by plasma cortisol levels, in a captive environment (Hanson *et al.*1976). A primate's ability to produce predictable environmental changes through its own actions enables it to be comfortable in a captive environment (Fragaszy and Adams-Curtis 1991).

Although puzzle feeders and foraging boxes (Meunier *et al.*1989, Florence & Riondet 2000) are more effective in reducing stereotypic behaviour and increasing activity in rhesus monkeys, watching videos and manipulating video game joysticks, can also be beneficial (Platt and Novak, 1997).

Novelty

Some novelty should also be introduced at intervals (for example objects, which can include destructible materials) or minor changes in the conformation or arrangement of cage furniture (Sambrook and Buchanan-Smith 1997).

It can be concluded that primates require an environment which encourages them to carry out a daily complex programme of activity.

3.3 Enclosures - dimensions and flooring

As previously mentioned, primates' ability to utilise three dimensions and the expression of complex social behaviour necessitates the use of cages and enclosures which have a vertical dimension sufficiently high for them to feel secure and control their social environment. Primates should be able to perch higher than a perceived threat and IPS (1993) recommends that this should be above human eye level. If the cages are to be of adequate height, two tier housing will be impractical as lower-row animals are forced to remain below human eye level (NRC/ILAR 1998). Two tier housing is also unsuitable because the animals in the lower cages are not only subject to poorer lighting conditions, which is unsatisfactory for a diurnal animal, but the stressful situation also increases unnecessary experimental variables (CCAC 1993, IPS 1993). Primates in lower tier cages are also less easily observed by the staff (Reinhardt 1997c, 1999). Visual barriers will help to prevent monkeys in social housing from being stressed by agonistic behaviour of other group members.

For various reasons, it may be necessary to separate an animal from a partner or group. In this situation, it is advantageous for housing to be provided within visual contact of the original cagemate(s) (Lynch 1998, Reinhardt et. al. 1995a).

The animals will spend much time foraging if a substrate is provided in which food can be scattered. The substrate, which must be clean and free from toxic residues, can take the form of straw, wood wool, wood chips, shredded paper, vegetation or soil (Westergaard and Munkenbeck-Fragaszy 1985, McKenzie *et al.* 1986). Chamove *et al.* (1982) found that the provision of a wood chip substrate with scattered food significantly reduced aggression in the majority of socially housed primates. Foraging can also be encouraged by the provision of browse (Shumaker 1995).

Cage inclusions should be sufficient to encourage a natural range of locomotor behaviour (walk, jump, climb, run) by providing, platforms, perches and climbing frames. Young primates also like to use mobile furniture, such as swings and ropes. A complex environment reduces both inactivity and aggression in social groups (Chamove *et al.* 1982, McKenzie *et al.* 1986, Chamove and Anderson 1989).

To conclude, the size of the enclosure/cage will depend not only on the size and number of animals, but also on the inclusion of adequate space for foraging facilities, high platforms or perches and opportunities to carry out a typical repertoire of locomotor and cognitive behaviour. Cages for experimental animals should also be in a single tier to allow for them to be of adequate height, to enable them to retreat from fear-inducing stimuli as they will be stressed if unable to reach an appropriate elevation (Burt and Plant 1990, King and Norwood 1989, Whitney and Wickings 1987)

To avoid the stresses associated with social isolation, unless absolutely essential, experimental animals should not be singly housed. Separation of an animal for experimental purposes can be achieved either by training or enticing the animal into a small subdivision of the cage, with or without further restraint.

3.4 Feeding

Scattered food will encourage foraging (Chamove *et al.* 1982), or where this is difficult puzzle feeders can be provided. Variations in dietary components can provide interest and environmental enrichment

A varied diet, however, should not be provided if it is likely to influence experimental results (Coates 1999). However, many standard diets are available in different flavours and these can be used to provide variation.

3.5 Substrate

Except for disease eradication programmes, deep litter systems have been shown to be both hygienic and labour saving as Chamove *et al.* (1982) found that bacterial growth was inhibited in wood chip substrate and that it need only be swept out and removed once every 1-4 weeks. In outdoor enclosures the base may be natural vegetation, however, larger primates can root up grass and low herbs, leaving an unsatisfactory muddy substrate. This can be prevented by planting under wire mesh or, as is common practice in many zoos, covering the soil with a non-toxic bark chip substrate with rapidly growing shrubs planted at intervals.

3.6 Handling and training the animals

Staff/animal relations

From the standpoint of non-human primate welfare, the caregiver's role is of prime importance. Good, friendly relations between familiar carers and monkeys reduce stress and also act as enjoyable stimulation for both staff and animals (Bayne et. al. 1993).

In contrast, where keepers make no effort to socialise with the animals, because the animals cannot avoid them, any contact will be stressful (Heath 1989, Olfert et. al. 1993, Van Vlissingen 1997,)

Training

Handling or anaesthetising primates is stressful and an increasing number of facilities are training animals to co-operate in many routine procedures, such as injections, blood sampling, urine collection, vaginal smears, oral drug administration and moving to another cage (UFAW 1992, Biological Council 1992, Reinhardt 1997d, Laule 1999). Training animals is not difficult and does not require specialist knowledge (see Pryor 1984) and most caregivers will have trained their monkeys to take treats from the hand. Positive reinforcement must always be used. It is but a short step to familiarise an animal with, say being touched by a needle, to getting it to accept an injection followed by a suitable reward (Reinhardt *et al.* 1995a, Laule 1999). It is even possible to train a macaque to willingly enter a restraint box and accept dosing through a stomach tube, a relatively unpleasant procedure (Jaeckel 1989). As primates are highly intelligent, training need not be time consuming and can save much time and stress to the animals and their caregivers in the long run. There will, of course, also be some individuals who may be difficult to train and some procedures which may be too aversive so that, for these situations, traditional methods will be unavoidable.

3.7 Training staff

As non-human primates require specialist care, it is essential that staff should receive special training covering the biology, husbandry,health, behavioural needs and psychological wellbeing and safety aspects of primatology. Special courses are usually available run by veterinary, laboratory animal science or technicians' organisations or in university laboratory animal science or primatology departments. A useful document outlining the levels of expertise required to manage non-human primates was published by the International Primatological Society (1993) in a section entitled « IPS Code of Practice : 2 Levels of Training for Care Giving Staff ».

GENERAL READING

A continuously updated database of relevant publications, established can be found at the following web site http://www.animalwelfare.com/Lab_animals/biblio/enrich.htm. There is an excellent, well documented review in the American APHIS' Final Report on Environmental Enhancement to Promote the Psychological Well-Being of NonHuman Primates : http://www.aphis.usda.gov/ac/eejuly15.html. Also the document from the Council of Europe – GT 123 (99) 9 « Report on workshop of the European Federation for Primatology » and « The Psychological well-being of nonhuman primates » published by the National Research Council in 1998 provide useful information.

The following are valuable for reference and general reading and information on species not considered specifically in the above guidelines (such as *Cebus* and *Aotus*):

Poole, T (ed.) (1999) *The UFAW Handbook on the Care and Management of Laboratory Animals (7th edition): Volume 1 Terrestrial Vertebrates* Blackwell Science Ltd., Oxford

Taylor Bennett B, Abee CR, Henrickson R. (1995) *Nonhuman Primates in Biomedical Research, Biology and Management*. San Diego, Academic Press,

Taylor Bennett B, Abee CR, Henrickson R, 1998 *Nonhuman Primates in Biomedical Research, Diseases*. San Diego, Academic Press.

FURTHER RESEARCH WHICH WOULD BE OF VALUE

The value of various forms of dietary variation and content (for example, access to medicinal herbs, and dietary effects (if any) on excess multiple births in marmosets, and on psychological well-being).

Further studies on the effects of weaning age and post-weaning rearing conditions on social skills, immune competence, physiology and breeding success.

Assessment of possible adverse auditory stimuli, in the typical laboratory environment.

The value of visual stimulation, including light quality, using choice experiments.

The correlation between group size, cage size enrichment, and group compatibility using behavioural and non-invasive physiological measures.

The influence of staff working in the animal unit during nocturnal animals' rest periods.

REFERENCES

Bayne, K. A. L., S. L. Dexter, and G. M. Strange (1993). Effects of food treats and human interaction. *Contemporary Topics in Laboratory Animal Science* 32(2): 6-9.

Bayne, K. A. L., J. K. Hurst, and S. L. Dexter (1992). Evaluation of the preference to and behavioral effects of an enriched environment on male rhesus monkeys. *Laboratory Animal Science* 42(1): 38-45.

Biological Council (1992) *Guidelines on the Handling and Training of Laboratory Animals.* Universities Federation for Animal Welfare, Potters Bar, UK

Boccia, M.L., Reite, M. & Laudenslager, M. 1989. On the physiology of grooming in a pigtail macaque. Physiology and Behavior 45: 667-670.

Brent, L. and A. Hughes (1997). The occurrence of abnormal behavior in group housed baboons. *American Journal of Primatology* 42(2): 96-97.

Brent, L. and K. E. Long (1995). The behavioral response of individually caged baboons to feeding enrichment and the standard diet: A preliminary report. *Contemporary Topics in Laboratory Animal Science* 34(2): 65-69.

Broom, D. M. and K. G. Johnson (1993). *Stress and animal welfare*. Chapman and Hall: London, England.

Buchanan-Smith, H. M. (1997). Considerations for the housing and handling of New World primates in the laboratory. In *Comfortable Quarters for Laboratory Animals*, Eighth Edition, 1997, V. Reinhardt, ed., Animal Welfare Institute: Washington, D.C., pp. 75-84.

Buchanan-Smith HM, Shand C and Morris K (2002). Cage use and feeding height preferences of captive common marmosets (*Callithrix jacchus*) in two-tier cages. Journal of Applied Animal Wekfare Science 5: 139-149.

Burt, D.A. and M. Plant (1990). Observations on a caging system for housing stump-tailed macaques. *Animal Technology* 41(3): 175-179.

Canadian Council on Animal Care (CCAC) (1993). *Guide to the Care and Use of Experimental Animals, Volume 1* (2nd Edition). E. D. Olfert, B. M. Cross, and A. A. McWilliam, eds., Canadian Council on Animal Care: Ottawa, Canada, 212 p.

Cant, J. (1988). Positional behavior of long-tailed (Macaca fascicularis) macaques in Northern Sumatra (Indonesia). *American Journal of Physical Anthropology* 76(1): 29-38.

Capitanio, J. P. (1986). *Behavioral pathology. Comparative Primate Biology, Vol. 24: Behavior, Conservation, and Ecology* 24: 411-454.

Chamove, A. S. and J. R. Anderson (1989). Examining environmental enrichment. In *Housing, Care, and Psychological Well Being of Captive and Laboratory Primates,* E. F. Segal, ed., Noyes Publications: Park Ridge, New Jersey, pp. 183-202.

Chamove, A. S., J. R. Anderson, S. C. Morgan-Jones, and S. P. Jones (1982). Deep wood chip litter: hygiene, feeding and behavioral enhancement in eight primate species. *International Journal for the Study of Animal Problems* 3(4): 308-318.

Cheney, D. L., R. M. Seyfarth, B. B. Smuts, and R. W. Wrangham (1987). The Study of Primate Societies, In *Primate Societies*, B. B. Smuts, D. L. Cheney, R. M.
Seyfarth, R. W. Wrangham, and T. T. Struhsaker, eds., University of Chicago Press: Chicago, Illinois, pp.1-8.

Coates, M. E. (1999) Chapter 6 Nutrition and feeding. In *The UFAW Handbook on the Care and Management of Laboratory Animals* Volume 1 7th Edition, T. Poole ed. , Blackwell Science, Oxford pp.

Coe, C.L. & Scheffler, J. 1989. Utility of immune measures for evaluating psychological well-being in nonhuman primates. Zoo Biology Supplement 1: 89-99.

Coe, C.L., Rosenberg, L.T. Fischer, M. & Levine, S. 1987. Psychological factors capable of preventing the inhibition of anibody responses in separated infant monkeys. Child Development, 58: 1420-1430

Coelho, A. M., K. D. Carey, and R. E. Shade (1991). Assessing the effects of social environment on blood pressure and heart rates of baboons. *American Journal of Primatology* 23: 257-267.

Dahl, J. F. (1989). An inexpensive climate-controlled enclosure for gibbons utilizing appropriate technology, In *Housing, Care and Psychological Well Being of Captive and Laboratory Primates*, E. F. Segal, ed., Noyes Publications: Park Ridge, New Jersey, pp.323-335.

Deputte, B.L. 2000. Primate socialization revisited: theoretical and practical issues in social ontogeny. Advances in the Study of Behavior, 29: 99-157.

Dunbar, D. (1989). Locomotor behavior of rhesus macaques on Cayo Santiago.
Puerto Rican Health Sciences Journal 8(1): 79-85.

Ely A, Freer A, Windle C and Ridley RM (1998). Assessment of cage use by laboratory-bred common marmosets (*Callithrix jacchus*). Laboratory Animals 32: 427-433.

Fagen, R. (1993). Primate juveniles and primate play. In *Juvenile primates: life history, development, and behavior*, Pereira, M. E. and L. F. Fairbanks, eds.
Oxford University Press: New York. Chapter 13, pp. 182-196.

FELASA Working Group on Non-Human Primate Health (1997) Sanitary aspects of handling primates during transport. *Laboratory Animals* 31, 298 - 392

FELASA Working Group on Non-Human Primate Health (1999) Recommendation of Non-Human Primate Colonies. *Laboratory Animals*, 33, (Suppl.1) S1:3 - S1:18

Fleagle, J. G., R. A. Mittermeier, and A. L. Skopec (1981). Differential habitat use by Cebus apella and Saimiri sciureus in central Surinam. *Primates*
22(3):361--367.

Florence, G. Riondet, L. 2000 Influence of a puzzle feeder on rhesus macaque behaviour: learning phase. Folia Primatologica, 71: 249-267.

Fragaszy, D. M. (1991). The expression of natural behavioural repertoires in captivity. Primatology Today: *Proceedings of the XIIIth Congress of the International Primatological Society*, Elsevier Science Publishers BV: Amsterdam, pp.726-727.

Fragaszy, D. M. and L. Adams-Curtis (1991). Environmental challenges in groups of capuchins. In *Primate Responses to Environmental Change*, H. O. Box, ed., Chapman and Hall: New York, pp.237-264.

Goosen, C., W. Van der Gulden, H. Rozemond, H. Balner, A. Bertens, R. Boot, J. Brinkert, H. Dienske, G. Janssen, A. Lammers, and P. Timmermans (1984).
Recommendations for the housing of macaque monkeys. *Laboratory Animals* 18: 99-102.

Gust, D. A., T. P. Gordon, A. R. Brodie, and H. M. McClure (1994). Effect of a preferred companion in modulating stress in adult female rhesus monkeys.
Physiology and Behavior 55: 681-684.

Hanson, J. P., M. E. Larson, and C. T. Snowdon (1976). The effects of control over high intensity noise on plasma cortisol levels in rhesus monkeys.*Behavioral Biology* 16: 333-340.

Heath, M. (1989). The training of cynomologus monkeys and how the human/animal relationship improves with environmental and mental enrichment. *Animal Technology* 40: 11-22.
Hediger, H. (1964). *Wild animals in captivity.* Dover Publications Inc.: New York, p 207.
Home Office, Animals (Scientific Procedures) Act (1989). *Code of Practice for the Housing and Care of Animals Used in Scientific Procedures*. Her Majesty's Stationery Office, London. Available on line at http://www.homeoffice.gov.uk/hcasp.htm on 12/21/98.
International Primatological Society (IPS) (1993). International guidelines for the acquisition, care, and breeding of nonhuman primates. Codes of practice 1-3
Primate Report 35: 3-29. (Also *Primate Report* Special Issue (1993) (eds) T. B. Poole and M. Schwibbe)
Jaeckel, J. (1989) The benefits of training rhesus monkeys living under laboratory conditions. In: *Laboratory Animal Welfare Research – Primates*. pp. 23-25 Universities Federation for Animal Welfare, Potters Bar, England (also see video produced by Ciba-Geigy, Switzerland)
Jolly, A. (1985). *Evolution of Primate Behavior*, 2nd Edition, Macmillan: New York, p 526 .
Kaumanns, W. (1997). General aspects of primate keeping and colony management.
In Abstracts of the Second EUPREN/EMRG Winter Workshop : *The housing of non-human primates used for experimental and other scientific purposes: Issues for consideration*, Rome 27.09.1996. [Monograph online available from: http://www.dpz.gwdg.de:80/eupren/eupren.htm (March 23, 1998)]. European Primate Resources Network (EUPREN).
Kerl J and Rothe H (1996). Influences of cage size and cage equipment on physiology and behaviour of common marmosets (*Callithrix jacchus*). Laboaratory Primate Newsletter 3: 10-13.
Kessel, A.L. and L. Brent (1995). An activity cage for baboons, Part I.
Contemporary Topics in Laboratory Animal Science 34(1): 74-79.
Kessel, A.L. and L. Brent (1997). Rehabilitating a baboon (*Papio hamadryas hamadryas* X *Papio hamadryas cynocephalus*), from single housing to social housing: a case study. *American Journal of Primatology* 42(2): 121.
King, J.E. and V.R. Norwood (1989). Free-environment rooms as alternative housing for squirrel monkeys. In *Housing, Care and Psychological Well-being of Captive and Laboratory Primates*, E. F. Segal, ed. Noyes Publications: Park Ridge, New Jersey, pp. 102-114.
King, J.E. and V.R. Norwood (1989). Free-environment rooms as alternative housing for squirrel monkeys. In *Housing, Care and Psychological Well-being of Captive and Laboratory Primates*, E. F. Segal, ed. Noyes Publications: Park Ridge, New Jersey, pp. 102-114.
Kitchen, A. M. and A. A. Martin (1996). The effects of cage size and complexity on the behaviour of captive common marmosets, Callithrix jacchus jacchus. *Laboratory Animals* 30: 317-326.
Lam, K., N. M. J. Rupniak, and S. D. Iversen (1991). Use of a grooming and foraging substrate to reduce cage stereotypies in macaques. *Journal of Medical Primatology* 20: 104-109.
Laudenslager, M. L., D.E. Held, M. L. Boccia, M. L. Reite, and J. J. Cohen (1990). Behavioral and immunological consequences of brief mother-infant separation: a species comparison. *Developmental Psychobiology* 23: 247-64.
Laule, G. E. (1999) Chapter 4 Training laboratory animals. In *The UFAW Handbook on the Care and Management of Laboratory Animals* Volume 1 7th Edition, T. Poole ed. , Blackwell Science, Oxford pp. 21-27
Laule, G. E. and T. Desmond (1998). Chapter 17: Positive reinforcement training as an enrichment strategy. In *Second nature: environmental enrichment for captive animals*, Shepherdson, D. J., J. D. Mellen, and M. Hutchins, eds., Smithsonian Institution Press: Washington, D.C.
Line, S. W. (1987). Environmental enrichment for laboratory primates. *Journal of the American Veterinary Medical Association* 190(7): 854-859.
Line S.W, K. N Morgan, H Markowitz, JA Roberts and M Ridell 1990, Behavioural reponses of female long-tailed macaques (M. fascicuaris) to pair formation. *Laboratory Primate Newsletter*. 29 1-5
Lynch, R. (1998). Successful pair housing of male macaques. *Laboratory Primate Newsletter* 37(1): 4-6.
Lynch, R. and D. C. Baker (1998). Enrichment and exercise room for free roaming.
Laboratory Primate Newsletter 37(1): 6.
OIE (1999) Zoonoses transmissible from non-human primates In: *International Animal Health Code*. World Organisation for Animal Health, Paris pp 48-53.

OIE (1999) Quarantine Measures applicable to non-human primates. In: *International Animal Health Code*. World Organisation for Animal Health, Paris pp 364-367

Marriner, L. M. and L. C. Drickamer (1994). Factors influencing stereotyped behavior of primates in a zoo. *Zoo Biology* 13(3): 267-275.

Marriott, B. M., R. W. Marriott, J. Norris, and D. Lee (1993). A semi-natural habitat for housing small nonhuman primates. *Journal of Medical Primatology* 22(6): 348-354.

Mason, G. J. (1991a). Stereotypies: a critical review. *Animal Behaviour* 41: 1015-1037.

Mason, G. J. (1991b) . Stereotypies and suffering. *Behavioral Processes* 25:103-115.

Mason, G. J. and M. Mendl (1993). Why is there no simple way of measuring animal welfare? *Animal Welfare* 2(4): 301-319.

Mason, W. A. and G. Berkson (1975). Effects of maternal mobility on the development of rocking and other behaviors in rhesus monkeys: A study with artificial mothers. *Developmental Psychobiology* 8: 197-211.

McGrew, W. C. (1981). Social and cognitive capabilities of nonhuman primates: lessons from the wild to captivity. *International Journal for the Study of Animal Problems* 2(3): 138-149.

McKenzie, S. M., A. S. Chamove, and A. T. C. Feistner (1986). Floor-coverings and hanging screens alter arboreal monkey behavior. *Zoo Biology* 5(4): 339-348.

Mendl, M. and R. C. Newberry (1997). Social conditions. In *Animal Welfare*, M.C. Appleby and B. O. Hughes, eds. CAB International: New York, New York, pp. 171-203.

Meunier, L. D., J. T. Duktig, and M. S. Landi (1989). Modifications of stereotypic behavior in rhesus monkeys using videotapes, puzzlefeeders, and foraging boxes. *Laboratory Animal Science* 39(5): 479.

National Research Council, Institute of Laboratory Animal Resources (NRC/ILAR) (1968). *Nonhuman primates: standards and guidelines for the breeding, care, and management of laboratory animals, a report*. National Academy Press: Washington, D.C., 35 p.

Neveu, H. & Deputte, B.L. 1996. Influence of the availability of perches on the behavioral well-being of captive, group-living mangabeys. American Journal of Primatology, 38: 175-185

Novak, M. A. and K. H. Drewson (1989). Enriching the lives of captive primates: Issues and problems. *In Housing, Care and Psychological Well-being of Captive and Laboratory Primates*, E. F. Segal, ed. Noyes Publications: Park Ridge, New Jersey, pp. 161-182.

Olfert, E. D., B. M. Cross, and A. A. McWilliam, (eds.), (1993). *Guide to the Care and Use of Experimental Animals*, Volume 1 (2nd Edition). Canadian Council on Animal Care, Ottawa, Canada, 211 p.

O'Neill, P. (1989). A room with a view for captive primates: Issues, goals, related research and strategies. In *Housing, Care and Psychological Well-being of Captive and Laboratory Primates*. E. F. Segal, ed., Noyes Publications: Park Ridge, New Jersey, pp. 135-160.

O'Neill, P., Price, C., and Suomi. S. Designing captive primate environments sensitive to age and gender: Related activity profiles for rhesus monkeys (Macaca mulatta). *American Association of Zoological Parks and Aquariums (AAZPA) Regional Proceedings 1990*. pp. 546-551. AAZPA, Wheeling, WV.

Pereira, M. E., J. M. Macedonia, D. M. Haring, and E. L. Simons (1989).
Maintenance of primates in captivity for research: the need for naturalistic environments. In *Housing, Care and Psychological Well-being of Captive and Laboratory Primates*, E. F. Segal, ed., Noyes Publications: Park Ridge, New Jersey, pp. 40-60.

Platt, D. M. and M. A. Novak (1997). Videostimulation as enrichment for captive rhesus monkeys (Macaca mulatta). *Applied Animal Behaviour Science* 52: 139-155.

Poole, T. (1991). Criteria for the provision of captive environments. In *Primate responses to environmental change*, H. O. Box, ed., Chapman and Hall: London, England, pp. 357-374.

Poole, T. (1992). Nature and evolution of behavioral needs in mammals. *Animal Welfare* 1(3): 203-220.

Poole, T., P. Costa, W. J. Netto, K. Schwarz, B. Wechsler, and D. Whittaker (1994). *Non-human primates. In The Accommodation of Laboratory Animals in Accordance with Animal Welfare Requirements*: Proceedings of an International Workshop Held at the Bundesgesundheitsamt, Berlin, 17-19 May 1993, O'Donoghue, P. N., editor, Bundesministerium für Ernährung, Landwirtschaft und Forsten: Bonn, Germany, pp. 81-86.

Poole, T, (1998) A systematic approach to environmental enrichment using the “scan” system. *Animal Technology* 49: 7-17.

Prescott MJ and Buchanan-Smith HM (2002). Predation sensitive foraging in captive tamarins. In Miller L (Ed). Eat or be eaten: Predation sensitive foraging among primates, pp. 44-57. Cambridge: Cambridge University Press.

Pryor, K. (1984) *Don’t Shoot the Dog* Simon and Schuster, New York

Queyras, A., M. Scolavino, and A. Vitale (1997). Research and animal welfare needs when studying social learning: the case of a colony of captive common marmosets. In Abstracts of the Second EUPREN/EMRG Winter Workshop : *The housing of non-human primates used for experimental and other scientific purposes:*

Issues for consideration, Rome 27.-27.09.1996. [Monograph online available from: http://www.dpz.gwdg.de:80/eupren/eupren.htm (March 23, 1998)]. European Primate

Reinhardt, V. (1997a). Species-adequate housing and handling conditions for old world nonhuman primates kept in research instutions. In *Comfortable Quarters for Laboratory Animals*, V. Reinhardt, ed., Animal Welfare Institute: Washington, DC., pp. 85-93.

Reinhardt, V. (1997b). Training nonhuman primates to cooperate during handling procedures: a review. *Animal Technology* 48(2): 55-73.

Reinhardt, V. (1997c) Lighting conditions for laboratory monkeys: are they adequate? *AWIC Newsletter* 8 (2): 3-6

Reinhardt, V. (1999) The monkey cave: the dark lower row. *Laboratory Primate Newsletter* 38 (3): 8-9

Reinhardt, V., C. Liss, and C. Stevens (1995a). Restraint methods of laboratory non-human primate: a critical review. *Animal Welfare* 4(3): 221-238.

Reinhardt, V., C. Liss, and C. Stevens (1995b). Social housing of previously single-caged macaques: What are the options and the risks? *Animal Welfare* 4(4): 307-328.

Reinhardt, V., C. Liss, and C. Stevens (1996). Space requirement stipulations for caged non-human primates in the United States: A critical review. *Animal Welfare* 5(4): 361-372.

Rose, M. A. (1994). Environmental factors likely to impact an animal's well-being. In *Improving the well-being of animals in the research environment--Proceedings of the conference held at the Marriott Hotel, Sydney,October, 1993*, Baker, R.M., G. Jenkin, and D. J. Mellor (eds.) Australian and New Zealand Council for the Care of Animals in Research and Teaching (ANZCCART), Glen Osmond, Australia, pp. 99-116. ISBN 0 646 181165.

Rosenblum, L. A. (1991). Subjective and objective factors in assessing psychological well-being in nonhuman primates. In *Through the Looking Glass: Issues of Psychological Well-Being in Captive Nonhuman Primates*, M. A. Novak and A. J. Petto, eds., American Psychological Association: Washington, D.C., pp. 43-49.

Rosenblum, L. A. and M. W. Andrews (1995). Environmental enrichment and psychological well-being of nonhuman primates. In *Nonhuman Primates in Biomedical Research, Biology, and Management*, B. T. Bennett, C. R. Abee, and R. Henrickson, eds., Academic Press: New York., pp. 101-112.

Sambrook, T. D. and H. M. Buchanan-Smith (1996). What makes novel objects enriching? A comparison of the qualities of control and complexity. Laboratory *Primate Newsletter* 35(4): 1-4.

Schapiro, S. J., M. A. Bloomsmith, S. A. Suarez, and L. A. Porter (1996). Effects of social and inanimate enrichment on the behavior of yearling rhesus monkeys. *American Journal of Primatology* 40(3): 247-260.

Schapiro, S. J., P. N. Nehete, J. E. Perlman, and K. J. Sastry (1997). Social housing condition affects cell-mediated immune responses in adult rhesus macaques. *American Journal of Primatology 42(2): 147*.

Seyfarth, R.M. & Cheney, D.L. 1980. The ontogeny of vervet monkey alarm-calling behavior: a preliminary report. Zeitschrift für Tierpsychologie. 54:37-56.

Shumaker, R. (1995). List of browse species used by the National Zoo in Washington, D.C. In *Primate-Talk* (internet listserv), Wisconsin Regional Primate Center, Madison, Wisconsin, date unknown, cited 1995.

Snowdon, C. T. and A. Savage (1989). Psychological well-being of captive primates: General considerations and examples from callitrichids. In *Housing, Care and Psychological Well-being of Captive and Laboratory Primates*, E. F. Segal, ed., Noyes Publications: Park Ridge, NJ, pp.75-88.

Spring, S.E., J.O. Clifford, and D. L. Tomko (1997). Effects of environmental enrichment devices on behaviors of single and group-housed squirrel monkeys.
Contemporary Topics in Laboratory Animal Science 36(3): 72-75.

Thompson, K. V. (1996). Chapter 34: Behavioral development and play. *In Wild Mammals in Captivity: Principles and Techniques*, D.G . Kleiman, M. E. Allen, K. V. Thomson, and S. Lumpkin, eds., University of Chicago Press: Chicago, Illinois, pp. 352-371.

Toates, F. (1995). *Stress: conceptual and biological aspects*. John Wiley and Sons, Ltd.: New York.

Van Vlissingen, J. M. F. (1997) Welfare implications in biomedical research. In Abstracts of the Second EUPREN/EMRG Winter Workshop : *The housing of non-human primates used for experimental and other scientific purposes: Issues for consideration*, Rome 27.09.1996. [Monograph online available from: http://www.dpz.gwdg.de:80/eupren/eupren.htm (March 23, 1998)]. European Primate Resources Network (EUPREN).

Veasey, J. S., N. K. Waron, and R. J. Young (1996). On comparing the behaviour of zoo housed animals with wild conspecifics as a welfare indicator. *Animal Welfare* 5(1): 13-24.

UFAW (1992) *Animal Training: A Review and Commentary on Current Practice.* Universities Federation for Animal Welfare, Potters Bar, UK

Watson, S. L. and C. A. Shively (1996). Effects of cage configuration on behavior of cynomologous macaques. *International Primate Society/American Society of Primatologists Congress Abstract No. 674. IPS Congress Abstracts*, Madison, Wisconsin.

Westergaard, G. C. and D. Munkenbeck-Fragaszy (1985). Effects of manipulatable objects on the activity of captive capuchin monkeys (Cebus apella). *Zoo Biology* 4(4): 317-327.

Whitney, R. A. and E. J. Wickings (1987). Macaques and other old world simians.
In *The UFAW Handbook on the Care and Management of Laboratory Animals* 6th edition, T. B. Poole, ed., Longman Scientific and Technical: Essex, England, pp.599-627.

Williams, L. E. and I. S. Bernstein (1995). *Study of primate social behavior. In Nonhuman Primates in Biomedical Research, Biology, and Management*. B.T. Bennett, C. R. Abee, and R. Henrickson, eds., Academic Press: New York, pp. 77-100.

Woolley, A. P. A. H. (1997). Requirements of biomedical research in terms of housing and husbandry: pharmacology and toxicology. In Abstracts of the Second EUPREN/EMRG Winter Workshop : *The housing of non-human primates used for experimental and other scientific purposes: Issues for consideration, Rome* 27.09.1996. [Monograph online available from:
http://www.dpz.gwdg.de:80/eupren/eupren.htm (March 23, 1998)]. European Primate Resources Network (EUPREN)

MARMOSETS (*Callithrix*) AND TAMARINS (*Saguinus*)

SECTION B: SCIENTIFIC JUSTIFICATION

2.2 Temperature
Background

The allowance for slightly higher temperature than 28 °C takes into account the Callitrichid ecological niches that are geographically distributed in tropical regions (Rylands; 1993, 1997). In experimental conditions, consideration should be given to the effect of environmental temperature on marmosets' core temperature rhythm (Palkova et al., 1999; Petry et al., 1990).

2.3 Humidity
Background

Values above 70% RH will not impact upon the welfare of the animals for the ecological considerations mentioned above.

2.4 Lighting
Background

Marmosets and tamarins are day-light active species (Erkert, 1997) and the period of behavioural activity is 11-12 hours (Stevenson et al., 1988). In order to reduce experimental variation, illumination and intensity of light should be standardized (Wechselberger et al., 1994).

4.1 Social housing
Background

Marmosets and tamarins are highly social animals exhibiting a complex natural behaviour (Caine, 1993; Garber, 1993; Stevenson et al., 1976). The social structure is most often represented by an extended family group with a monogamous mating strategy (Anzenberger, 1992; Dunbar, 1995a; Epple, 1978; Evans et al., 1984). The suppression of subordinate female reproduction is due to hormonal and behavioural mechanisms (Abbott et al., 1993; Porter et al., 1997). In the laboratory conditions, the animals are commonly maintained in breeding pairs with one or more sets of twins (Hubrecht, 1997; Pryce et al., 1997; Tardif et al., 1993). When grouping same-sex animals the success is often unpredictable and may depend on the environment and individual temperament: twins or a parent with offspring are more likely to be compatible (Eckert, 2000). In general, social interactions should be carefully monitored to prevent the outbreak of aggressive behaviours within captive groups (Anzenberger, 1993; Sutcliffe et al., 1984). The infants are reared cooperatively by all family members (Achenbach et al., 1998; Bales et al., 2000; Dunbar, 1995b; Savage et al., 1996; Snowdon, 1996), thus enabling the juveniles to achieve adequate experience as future breeders (Johnson et al., 1986; Missler et al.,1992). However, in tamarins, the eldest set of twins may be rejected as a new offspring is generated.

4.2 Environmental complexity
Background

The natural environment of marmosets and tamarins incorporates features of complexity and unpredictability that stimulate the expression of a complete behavioural repertoire. One of the consequences of laboratory conditions is generally the reduction of space and the impoverishment of the social and physical environment that barely satisfies the behavioural requirements of the animals (Kerl et al., 1996; Kitchen et al., 1996; Schoenfeld, 1989). An environmental enrichment programme for laboratory marmosets and tamarins is unquestionably an essential component in the improvement of their well-being and has the advantage to incorporate natural and artificial elements that enhance either species-typical and potentially adaptive new behavioural patterns. In the literature several studies describe various enrichment techniques and their impact on the animal welfare (Box et al., 1993; Buchanan-Smith, 1994,1996,1997; Dettling, 1997; Heath et al., 1993; Poole, 1990; Sambrook et al., 1997; Scott, 1991; Snowdon et al., 1989). The use of different materials and items for cage furniture in callitrichid primates has been proved beneficial to increase their behavioural repertoire, the control over the environment and their foraging propensities (Dettling, 1997; Forster, 1996; Hannaford, 1996; Harrison et al., 1988, 1994; Hosey, 1999; 1998;. Kelly, 1993; McGrew, 1986; Roberts, 1999; Vitale et al. 1997)

4.3 Enclosures- dimensions and flooring

Background

Existing guidelines (European Council Directive, 1986; ILAR guidelines, 1996; Home Office Code of Practice, 1989,1995) provide diverse minimum requirements for cage dimensions of marmosets and tamarins, either for floor area or height. These variations are most probably due to the limited scientific data available on space needs of these species and to the diversity of common practices in various countries.

The present proposals take into account several factors such as: the arboreal nature of the animals, their locomotory patterns and flight reaction, the need for adequate space for social interactions and for the inclusion of enrichment devices. The minimum enclosure/cage sizes for experimental animals allow for sufficient enrichment, although the restriction of space should be limited only to the time required by the experimental procedure. It is more important to provide tamarins with a good volume of space than it is marmosets, if their wellbeing and breeding success are to be maximised, (Prescott and Buchanan-Smith, in press).

4.7 Cleaning

Background

The proposal for cleaning procedures considers the scent marking behaviour of marmosets and tamarins (Bartecki,1990; Epple, 1970, Epple et al, 1986, 1993; Pryce, 1997).

REFERENCES – Marmosets and Tamarins part B

86/609/EEC: Council Directive of 24 November 1986 on the approximation of lows, regulations and administrative provisions of the Member State regarding the protection of animals used for experimental and other scientific purposes.

Abbott DH; Barrett J; George LM (1993): Comparative aspects of the social suppression of reproduction in female marmosets and tamarins. Pp. 152-163 in MARMOSETS AND TAMARINS: SYSTEMATICS, BEHAVIOUR, AND ECOLOGY. A.B. Rylands ed. Oxford, Oxford University Press.

Achenbach GG; Snowdon CT (1998): Response to sibling birth in juvenile cotton-top tamarins (*Saguinus oedipus*). BEHAVIOUR 135(7): 845-862.

Anzenberger G (1992): Monogamous social system and paternity in primates. Pp. 203-224 in PATERNITY IN PRIMATES: GENETIC TESTS AND THEORIES. R.D. Martin; A.F. Dixson; E.J. Wickings ed. Basel, Karger.

Anzenberger G (1993): Social conflict in two monogamous New World primates: Pairs and rivals. Pp. 291-329 in PRIMATE SOCIAL CONFLICT. W.A. Mason; S.P. Mendoza ed. Albany, SUNY Press.

Bales K; Dietz J; Baker A; Miller K; Tardif SD (2000): Effects of allocare-givers on fitness of infants and parents in callitrichid primates. FOLIA PRIMATOLOGICA 71(1-2): 27-38.

Bartecki U; Heymann EW (1990): Field observations on scent-marking behaviour in saddle-back tamarins, Saguinus fuscicollis (Callitrichidae, Primates). JOURNAL OF ZOOLOGY 220(1): 87-99.

Box HO; Rohrhuber B (1993): Differences in behaviour among adult male, female pairs of cotton-top tamarins (*Saguinus oedipus*) in different conditons of housing. ANIMAL TECHNOLOGY 44(1): 19-30.

Buchanan-Smith H (1994): Environmental enrichment in captive marmosets and tamarins. HUMANE INNOVATIONS AND ALTERNATIVES 8: 559-564.

Buchanan-Smith H M (1996): Enriching the lives of marmosets and tamarins in captivity. SHAPE OF ENRICHMENT 5(4): 3-5.

Buchanan-Smith H M (1997): Considerations for the housing and handling of New World primates in the laboratory. Pp. 75-84 in COMFORTABLE QUARTERS FOR LABORATORY ANIMALS. V. Reinhardt ed. Washington, DC, Anim Welfare Inst.

Caine NG (1993): Flexibility and co-operation as unifying themes in Saguinus social organization and behaviour: The role of predation pressures. Pp. 200-219 in MARMOSETS AND TAMARINS: SYSTEMATICS, BEHAVIOUR, AND ECOLOGY. A.B. Rylands ed. Oxford, Oxford University Press.

Dettling A (1997): Physical environment and its influence on behaviour in captive common marmosets (*Callithrix jacchus*). Pp. 54-59 in HANDBOOK: MARMOSETS AND TAMARINS IN BIOLOGICAL AND BIOMEDICAL RESEARCH. Pryce C; Scott L; Schnell C ed. Salisbury, UK, DSSD Imagery.

Dunbar R I M (1995a): The mating system of callitrichid primates: I. Conditions for the coevolution of pair bonding and twinning. ANIMAL BEHAVIOUR 50(4): 1057-1070.

Dunbar R I M (1995b): The mating system of callitrichid primates: II. The impact of helpers. ANIMAL BEHAVIOUR 50(4): 1071-1089.

Eckert K (2000): Same-sex pairing of marmosets: A discussion. LABORATORY PRIMATE NEWSLETTER 39(2): 14.

Epple G (1970): Quantitative studies on scent marking in the marmoset (Callithrix jacchus). FOLIA PRIMATOLOGICA 13: 48-62.

Epple G (1978): Reproductive and social behavior of marmosets with special reference to captive breeding. PRIMATES IN MEDICINE 10: 50-62.

Epple G; Belcher AM; Kuederling I; Zeller U; Scolnick L; Greenfield KL; Smith AB III (1993): Making sense out of scents: Species differences in scent glands, scent-marking behaviour, and scent-mark composition in the Callitrichidae. Pp. 123-151 in MARMOSETS AND TAMARINS: SYSTEMATICS, BEHAVIOUR, AND ECOLOGY. A.B. Rylands ed. Oxford, Oxford University Press.

Epple G; Belcher AM; Smith AB III (1986): Chemical signals in callitrichid monkeys: A comparative review. Pp. 653-672 in CHEMICAL SIGNALS IN VERTEBRATES 4: ECOLOGY, EVOLUTION, AND COMPARATIVE BIOLOGY. D. Duvall; D. Mueller-Schwarze; R.M. Silverstein ed. New York, Plenum Press.

Erkert HG (1997): Circadian rhythms in the marmoset: Their significance for fundamental and applied research. Pp. 128-144 in HANDBOOK: MARMOSETS AND TAMARINS IN BIOLOGICAL AND BIOMEDICAL RESEARCH. Pryce C; Scott L; Schnell C ed. Salisbury, UK, DSSD Imagery.

Evans S; Poole TB (1984): Long-term changes and maintenance of the pair-bond in common marmosets, *Callithrix jacchus jacchus*. FOLIA PRIMATOLOGICA 42(1): 33-41.

Forster FC (1996): Novel objects and learning as enrichment for captive common marmosets (*Callithrix jacchus jacchus*) . AUSTRALIAN PRIMATOLOGY 10 (3): 2-10.

Garber PA (1993): Feeding ecology and behaviour of the genus Saguinus. Pp. 273-295 in MARMOSETS AND TAMARINS: SYSTEMATICS, BEHAVIOUR, AND ECOLOGY. A.B. Rylands ed. Oxford, Oxford University Press.

Hannaford G (1996): Feeding bowl height preferences in captive common marmosets (*Callithrix jacchus jacchus*). AUSTRALIAN PRIMATOLOGY 11(1): 5-13.

Harrison ML; Sherwood RJ; Tardif SD (1988): Differential use of wooden **cage** furniture in callitrichid primates: Implications for psychological well-being. Pp. 40 in THE PSYCHOLOGICAL WELL-BEING OF CAPTIVE PRIMATES, CONFERENCE. ed. Boston, Harvard Medical School,. (Abstract).

Harrison ML; Tardif SD (1994): Social implications of gummivory in marmosets. AMERICAN JOURNAL OF PHYSICAL ANTHROPOLOGY 95(4): 399-408.

Heath M; Libretto SE (1993): Environmental enrichment for large scale marmoset units. ANIMAL TECHNOLOGY 44(3): 163-173.

Heymann EW (1992): Seed ingestion and gastrointestinal health in tamarins? LABORATORY PRIMATE NEWSLETTER 31(3): 15-16.

Home Office (1989) Code of Practice for the Housing and Care of Animals used in Scientific Procedure, HMSO, London.

Home Office (1995) Code of Practice for the Housing and Care of Animals in Designated Breeding and Supply Establishments. HMSO, London.

Hosey GR; Jacques M; Burton M (1999): Allowing captive marmosets to choose the size and position of their nest box. ANIMAL WELFARE 8(3): 281-285.

Hubrecht RC (1997): Current practice in maintaining marmosets: results of a UK survey. Pp. 24-38 in HANDBOOK: MARMOSETS AND TAMARINS IN BIOLOGICAL AND BIOMEDICAL RESEARCH". Pryce C; Scott L; Schnell C (eds), Salisbury, UK, DSSD Imagery.

ILAR Commission on Life Sciences (1996): Guide for the Care and Use of Laboratory Animals, National Academy press, Washington D.

Johnson LD; Petto AJ; Boy DS; Sehgal PK; Beland ME (1986): The effect of perinatal and juvenile mortality on colony-born production at the New England Regional Primate Research Center. Pp. 771-779 in PRIMATES: THE ROAD TO SELF-SUSTAINING POPULATIONS. K. Benirschke ed. New York, Springer-Verlag.

Kelly K (1993): Environmental enrichment for captive wildlife through the simulation of gum-feeding. ANIMAL WELFARE INFORMATION CENTER NEWSLETTER 4(3): 1-2 & 5-10.

Kerl J; Rothe H (1996): Influence of cage size and cage equipment on physiology and behavior of common marmosets (*Callithrix jacchus*). LABORATORY PRIMATE NEWSLETTER 35(3): 10-13.

Kitchen A M; Martin A A (1996): The effects of cage size and complexity on the behaviour of captive common marmosets, *Callithrix jacchus jacchus*. LABORATORY ANIMALS 30(4): 317-326.

McGrew WC; Brennan JA; Russell J (1986): An artificial "gum-tree" for marmosets (*Callithrix j. jacchus*). ZOO BIOLOGY 5(1): 45-50.

Missler M; Wolff JR; Rothe H; Heger W; Merker HJ; Treiber A; Scheid R; Crook GA (1992): Developmental biology of the common marmoset: Proposal for a "postnatal staging". JOURNAL OF MEDICAL PRIMATOLOGY 21(6): 285-298.

Palkova M; Sigmund L; Erkert HG (1999): Effect of ambient temperature on the circadian activity rhythm in common marmosets, *Callithrix j. jacchus* (primates). CHRONOBIOLOGY INTERNATIONAL 16(2): 149-161.

Petry H, Maier J (1990): Radiotelemetric studies on body temperature in marmosets (*Callithrix jacchus*). ZEITSCHRIFT FUER ERNAEHRUNGSWISSENSCHAFT 29(3): 197-207.

Poole TB (1990): Environmental enrichment for marmosets. ANIMAL TECHNOLOGY 41(2): 81-86.

Porter T A; Snowdon C T (1997): Female reproductive status and male pairmate behavior in cotton-top tamarins. ANNALS OF THE NEW YORK ACADEMY OF SCIENCES 807: 556-558.

Prescott MJ and Buchanan-Smith HM (in press),. Cage sizes for tamarins in the laboratory. Animal Welfare.

Pryce C; Samson NA (1997): Integrating marmoset husbandry and research. Pp 39-46 in HANDBOOK: MARMOSETS AND TAMARINS IN BIOLOGICAL AND BIOMEDICAL RESEARCH". Pryce C; Scott L; Schnell C (eds), Salisbury, UK, DSSD Imagery.

Roberts RL; Roytburd LA; Newman JD (1999): Puzzle feeders and gum feeders as environmental enrichment for common marmosets. CONTEMPORARY TOPICS IN LABORATORY ANIMAL SCIENCE 38(5): 27-31.

Rylands AB (1997): The Callitrichidae: A biological overview. Pp. 1-22 in "HANDBOOK: MARMOSETS AND TAMARINS IN BIOLOGICAL AND BIOMEDICAL RESEARCH". Pryce C; Scott L; Schnell C ed. Salisbury, UK, DSSD Imagery.

Rylands AB (ed) (1993) : MARMOSETS AND TAMARINS: SYSTEMATICS, BEHAVIOUR, AND ECOLOGY. Oxford, Oxford University Press.

Sambrook T D; Buchanan-Smith H M (1997): Control and complexity in novel object enrichment. ANIMAL WELFARE 6(3): 207-216.

Savage A; Snowdon C T; Giraldo L H; Soto L H (1996): Parental care patterns and vigilance in wild cotton-top tamarins (*Saguinus oedipus*). Pp. 187-199 & 539 in ADAPTIVE RADIATIONS OF NEOTROPICAL PRIMATES. M.A. Norconk; A.L. Rosenberger; P.A. Garber ed. New York, Plenum Press.

Schoenfeld D (1989): Effects of environmental impoverishment on the social behavior of marmosets (*Callithrix jacchus*). AMERICAN JOURNAL OF PRIMATOLOGY (Suppl. 1): 45-51.

Scott L (1991): Environmental enrichment for single housed common marmosets. Pp. 265-274 in PRIMATE RESPONSES TO ENVIRONMENTAL CHANGE. H.O. Box ed. London, Chapman & Hall.

Snowdon C T (1996): Infant care in cooperatively breeding species. ADVANCES IN THE STUDY OF BEHAVIOR 25: 643-689,. (Book title: Parental Care, J.S. Rosenblatt, et al., eds. San Diego, Academic Press.

Snowdon CT; Savage A (1989): Psychological well-being of captive primates: General considerations and examples from callitrichids. Pp. 75-88 in HOUSING, CARE AND PSYCHOLOGICAL WELLBEING OF CAPTIVE AND LABORATORY PRIMATES. E.F. Segal ed. Park Ridge, New Jersey, Noyes Publications.

Snowdon CT; Savage A; McConnell PB (1985): A breeding colony of cotton-top tamarins (*Saguinus oedipus*). LABORATORY ANIMAL SCIENCE 35(5): 477-480.

Stevenson MF; Poole TB (1976): An ethogram of the common marmoset (*Callithrix jacchus jacchus*): General behavioural repertoire. ANIMAL BEHAVIOUR 24: 428-451.

Stevenson MF; Rylands AB (1988): The marmosets, genus Callithrix. Pp. 131-222 in ECOLOGY AND BEHAVIOR OF NEOTROPICAL PRIMATES, VOL. 2. R.A. Mittermeier; A.B. Rylands; A.F. Coimbra-Filho; G.A.B. Fonseca (eds). Washington, DC, World Wildlife Fund.

Sutcliffe AG; Poole TB (1984): Intragroup agonistic behavior in captive groups of the common marmoset *Callithrix jacchus jacchus*. INTERNATIONAL JOURNAL OF PRIMATOLOGY 5(5): 473-489.

Tardif SD; Clapp NK (1993): Breeding the cotton-top tamarin (*Saguinus oedipus*) in captivity. Pp. 45-53 in A PRIMATE MODEL FOR THE STUDY OF COLITIS AND COLONIC CARCINOMA: THE COTTON-TOP TAMARIN: *SAGUINUS OEDIPUS*. N.K. Clapp ed. Boca Raton, CRC Press.

Vitale A; Queyras A (1997):The response to novel foods in common marmoset (*Callithrix jacchus*): The effects of different social contexts. ETHOLOGY 103(5): 395-403.

Wechselberger E; Erkert HG (1994): Characteristics of the light-induced phase response of circadian activity rhythms in common marmosets, *Callithrix j. jacchus* [Primates-Cebidae]. CHRONOBIOLOGY INTERNATIONAL 11(5): 275-284.

SQUIRREL MONKEYS (*Saimiri sciureus*)

SECTION B: SCIENTIFIC JUSTIFICATION

The recommendations are based on personal experience gained by the authors (H. Contamin, N. Herrenschmidt, and H.Weber during the past more than 10 years with squirrel monkeys in breeding and experimental colonies of the Pasteur Institute in Cayenne, French Guyana, the Primate Centre at Strasbourg, France and Novartis Pharma Ltd., Basel, Switzerland. They include personal information obtained from G. Dubreuil, CNRS - Marseille and M. Huber, formerly ROCHE, Basel. An overview on squirrel monkeys is published in the book of Rosenblum and Coe,(1985) and their care and management by Mendosa (1999).
Complementary comments on the chapters 1 to 6:

1. Introduction
Background

The taxonomic classification of the various species and subspecies has been undergoing changes throughout the years and has recently been subject to genetic analysis. For practical reasons it seems at present appropriate to differentiate between two subgroups only. In contrast to previous opinion animals of both subspecies can mate and produce viable offspring.

2.2. Temperature:
Background

The squirrel monkeys live in regions with warm climates of the Amazon area to cool climates of the mountain ranges of Peru and Bolivia. Though the species may tolerate a wide range of temperatures, within the habitat of individual colonies, temperatures are not usually subject to sudden substantial variations. Within the forest animals apparently seek the regions with most suitable temperatures in the canopy.

2.4. Lighting:
Background

Little is known about the minimal light requirements for squirrel monkeys ecept that they are daylight active and only feed when there is light. (Parker CE, 1966, Psychon. Sci, Vol. 6, 111-112). Based on current experience and best practice, light intensities of 400 lux and above seem to ensure healthy animals, normal behaviour and reproduction. Provision of UV for upto 1 hour/day has proved useful in in avoiding osteopathogenesis due to possible lack of vitamin D3 in the diet. Animals having access to outdoor enclosures may cater for their needs by moving to the exterior. However, in indoor enclosures, even with large windows, UV exposure is eliminated by the glass. When providing UV with UV lamps time limits and distance to the lamp must be controlled according to the instructions.

3. Health
Background

For the health monitoring of squirrel monkeys reference is made to the FELASA recommendation Health Monitoring of Non-human Primate Colonies (1999), *Laboratory Animals,* 33 (Suppl.1), S1:3 - S1:18.

4.1. Social housing
Background

Saimiris usually live in groups of around 20 individuals, (Robinson and Janson 1987; Emmons and Freer 1990), and, therefore, groups of 5 and more animals, though they may sit together in small subgroups, are preferable to pair housing for any form of permanent housing. The minimal enclosure sizes for less than 5 animals are only given for possible cases of incompatibility or if experiments of longer duration require smaller groups than 5.

With their long rearing period, female saimiris produce one offspring (rarely twins) every one to two years. Reproductive performance is rather low compared to macaques, though in stabilised colonies a 50% reproduction rate may be reached. Since, in nature, the leading male may change according to its (“fatty“) reproductive state, an appropriate exchange of males may be considered.

The authors are not aware of literature on the exact ”imprinting“ age of young squirrel monkeys, which may start soon after birth. However, the fact that animals leave their mothers at quite an early stage and are easily adopted by other females and that hand reared infants attach to their foster parents indicates that this takes place within the first six months of life. Nevertheless, if not necessary, weaning and separation from the parent colony should not take place before 6 months of age.

4.3. Enclosures – dimensions and flooring

Background

Although enclosure dimensions for group housing are based on enclosures for two animals, it is recommended - as mentioned for 4.1. to keep squirrel monkeys in larger groups. Fewer than 5 animals in a group should only be kept in cases of incompatibility or experimental requirements. Based on the dimensions given for each additional animal above 6 months of age 5 animals will require 5.5m³ which is less than the $8m^3$ required by the Swiss Animal Protection Act but considered to be sufficient to provide structures and retreat possibilities. The linear space increase given for each additional animal is, therefore to be taken as guidance. Splitting a group may be preferable to simply adding additional space. Judgement should be based on the condition and behaviour of the colony.

The enclosure dimensions suggested for experimental individual or pair housing correspond with two of the present cages recommended by the Appendix A of ETS 123 for unlimited housing of saimiris and with the cages required by the Swiss Animal Welfare Act for temporary housing of monkeys. They are based on allometric measurements and would allow an animal to sit on or under a perch and walk and turn with ease. These cage dimensions are considered as acceptable for experimental conditions where larger enclosures would be contra-productive to animal welfare and/or for a limited time as justified by the experimental protocol..

4.4. Feeding

Background

Like some other South American monkeys, Squirrel Monkeys do not seem able to utilise D2 but rely on D3 which is synthesised in the skin under the influence of UV light. Since UV is absorbed by most types of glass it is recommended, for animals maintained indoors, to ensure a sufficient supply of vitamin D3 in the diet to avoid osteopathogenesis. The risk of vitamin D3 intoxication is low since South American species are known to be very tolerant to excessive vitamin D3. Most commercially available diets are absolutely adequate for feeding to Squirrel Monkeys and for providing sufficient Vitamin C and D3. Feeding meal-worms, crickets or other insects bears the risk of transmitting bacterial diseases.

4.8 Handling:

Background

Squirrel monkeys can be trained to come forward for titbits or drinks as rewards. They are also capable of learning how to solve tasks for reward. For catching for investigation or treatment, animals should be trained to enter gangways with trap cages or individual enclosures

Though animals can be trained to accomplish tasks, attention should be paid to appropriate recovery periods when subjected to experiments repeated at intervals. Task performance requires energy for concentration. Sessions of three to four hours duration seem to be well tolerated by

Squirrell Monkeys. However, single experimental sessions lasting longer should not be repeated more frequenetly than at weekly intervals and the monkeys should be under close veterinary supervision.

GENERAL REFERENCES

Ausmann LM, Gallina DL, Nicolosi RJ (1985) "Nutrition and Metabolism of the Squirrel Monkey" in Handbook of Squirrel Monkey Research. Rosenblum LA and Coe CL eds. Plenum; New York. Pp 447-488.

Bantin GC (1966) "Establishment of a Squirrel Monkey Colony" J. Inst. Animal Tech.. Vol. 17, 66-73

EAZA husbandry guidelines for the Callithricidae. J Bryan Caroll ed, EAZA Bristol Zoological Gardens, 2002

Emmons LH and Freer F (1990) Monkeys (Primates) Neotropical Rainforest Mammals: A Field Guide, pp. 134-153. Chicago: University of Chicago Press.

FELASA (1999) Health Monitoring of Non-human Primate Colonies *Laboratory Animals,* 33 (Suppl.1), S1:3 - S1:18.

Knapka JJ, DE Barnard, KAL Bayne, SM Lewis, BM Mariott & OT Oftedal (1995). Nutrition in Non Human Primates in Biomedical Research; Biology and Management. Academic press, San Diego, USA pp. 211-248

Lehner et al "Biological activities of vitamins D2 and D3 from growing Squirrel Monkeys" Laboratory Animal Care vol. 17, 433-493

Mendoza, S. P. (1999) Chapter 37. Squirrel Monkeys. In Poole, T. (Ed.) *The UFAW Handbook on the Care and Management of Laboratory Animals.* 7th Edition Blackwell Science, Oxford pp. 591-600

Robinson GJ and Janson CH (1987) Capuchins, squirrel monkeys and ateline: Socioecological convergence with Old World primates: In: Smuts BB, Cheney DL, Seyforth RM, Wrangham RW, Strutsaker TT (Eds). Primate Societies, pp 69-82. Chicago; University of Chicago Press.

Rosenblum LA and Coe CL Eds (1985), *Handbook of Squirrel Monkey Research*. Plenum Press, New York

MACAQUES AND VERVETS

SECTION B REFERENCES

Most of the relevant discussion regarding the basis for the species-specific provisions for Macaques and Vervets and literature has been surveyed in the Introduction, however the following additional references are of value:

Barbe, S. (1999) The influence of environmental enrichment on social behaviour in captive long-tailed macaques (*Macaca fascicularis*). *Folia Primatologica* 70, 193

Baskerville, M. (1999) Chapter 39 Old World Monkeys. In *The UFAW Handbook on the Care and Management of Laboratory Animals* (7th Edition) *Volume 1 Terrestrial Vertebrates* Poole, T. (Ed). Blackwell Science, Oxford pp. 611-635

Bertrand M, (1969) The behaviour of the stumptail macaque. In: *Bibliotheca Primatologica* no 14. Karger, Basel/ NewYork.

Buerge T, B Panoussis and H Weber (1997) : Primate housing facilities for pharmaceutical research in Switzerland (an example). Proceedings of Second EUPREN/ EMRG Winter Workshop. In *Primate Report* 49, Ed. M Schwibbe German Primate Center, Göttingen, pp 19-22

Isbell L, DL Cheney, RM Seyfarth. 1991 Group fusion and minimum group sizes in vervet monkeys. *American Journal of Primatology* 25, 57-65

Lambrechts C, JV Seier, Mdhluli C, 2001, Management and breeding of the vervet monkey in South Africa. In: *Proceedings of VII. FELASA Congress, Mallorca 1999*,
in press

Line SW, KN Morgan, H Markowitz, JA Roberts and M Ridell 1990, Behavioural reponses of female long-tailed macaques (M. fascicuaris) to pair formation. *Laboratory Primate Newsletter*. 29 1-5

Seiers JV, 1986, Breeding vervet monkeys in a closed environment. *Journal of Medical Primatology* 15, 339-349

Seiers JV. and PW de Lange, 1996, A mobile cage facilitates periodic social contact and exercise for singly caged adult vervet monkeys. *Journal of Medical Primatology* 25, 64-68.

SECTION B: EXPLANATORY PART AND REFERENCES

1. Introduction:
Background

The species nomenclature is based on commonly accepted terms (Jolly C.E. 1993). Other names, occasionally to be found in some publications are not considered to be correct and may be due to the fact that hybridisation of species can occur.

3. Health:
Background

Like all Old World species, baboons are very susceptible to tuberculosis and have to be protected from contamination through humans. They are also susceptible to the Ebola viruses and - if originating from certain African areas - may be carriers of yellow fever virus for which, however, vectors for transmission are missing in Europe. Simian immunodeficiency virus (SIV) could be of concern in transplantation studies and transmission to Asian species may induce clinical symptoms in the same.

4.1. Social housing/ breeding
Background

The proportion males to females and group sizes recommended for breeding groups are based on the average subgroup sizes observed in the wild and ensure adequate reproduction However, other group sizes with a single male may also be acceptable. Since both species mentioned are not organised as harems, females may mate with different males. Therefore, if the genetic background is relevant, single male groups will be appropriate.

With about 4 months infants start walking on their own when the troop is on the move. Between the age of 8 to 14 months the infants begin to interact with other animals of the colony with increasing independence and, therefore, can be separated and integrated into peer groups with less stress. For animals that have to be separated from their mothers below the age of 8 months for veterinary reasons adoption by other adult females in stable colonies may be considered. This may be problematic with older infants, in which case housing with peers is recommended if the infant cannot be left in the group. Animals foreseen for breeding should be left in their maternal colony in order to acquire parental skills and complete social competence.

It is evident that for most experimental purposes and stock single sex groups will be formed. It is preferable to have groups of 4 and more animals in order to avoid bullying of individual animals. Since conflicts due to competition may occur when males and females are housed in the same room the sexes should be housed in separate rooms.

4.3. Enclosures - dimensions and flooring
Background

The proposed dimensions are based on morphometric characteristics of growing and adult male baboons allowing them to sit upright on and under two perches and move at least 4 steps in one direction. For experimental purposes the dimensions required could also be provided with two or more interconnected modules with the minimal volume per animal. This would have the advantage of providing retreat if required or temporarily separating individuals.

Baboons have a growth spurt up to the age of 4-5 years. After 5 years size (but not body weight) does not increase much. Sexual maturity is attained between 4.5 (females) and 7 (males) years. In immature animals the time budget is dominated by play. From 4 years onward play regresses and conflicts may occur especially in confined conditions, thus requiring careful observation of the group. In such cases groups of three may not be ideal. Therefore, baboons older than 3 years may have to be kept in compatible pairs or preferably in larger same sex groups.

Determination of age: At the age of 4 years both male and female baboons have attained a weight of approximately 9 kg. Since, however, weight may differ more than size, depending on nutritional conditions during development, other criteria may be more helpful in determining the age of animals for which the birth date is not known. In baboons the testicles of males drop between the age of two to three years. Dentition/ tooth eruption may also be helpful in as much as at the age of 3 years the first two secondary incisivi as well as most premolars and molars have erupted. The canines in males erupt between 3 and 4 years of age.

Indoor/Outdoor enclosures In most European regions it is necessary to ensure that all animals have access to an indoor enclosure with the recommended minimal space allowances to accommodate all the animals of a group should detrimental weather conditions force to prevent them from moving to an additionally provided outdoor enclosure. In some parts of Europe it is entirely possible to provide the minimum space allowance by an outdoor enclosure. Nevertheless, under such circumstances additional accommodation must be provided to allow shelter from inclement weather, shade from the sun and overnight sleeping quarters. The size of such sheltered or indoor areas should be large enough to accommodate all of the animals harmoniously for their resting periods.

4.8. Handling

Background

Young baboons are often easier to handle than macaques or vervets. With adult male baboons, though they too may be trained to come forward for the minor manipulations mentioned in section A safety precautions for personnel may be necessary in view of their strength and large canines.

SELECTED REFERENCES:

Alberts SC and Altmann J (2001) Immigration and hybridization patterns of Yellow and Anubis baboons in and around Amboseli, Kenya. American Journal of Primatology, 53: 139- 154.

Altmann J (1980) Baboon mothers and infants. Cambridge, MA, USA Harvard University Press.

Altmann J, Altmann SA, Hausfater G and McCuskey SA (1977) Life history of yellow baboons, physical development, reproductive parameters and infant mortality. Primates 18, 315 - 330

Altmann SA and Altmann J (1970) Baboon ecology: African field research. Bibliotheca Primatologica, No. 12

Castracane DV, KC Copeland, P Reyes and TJ Kuehl (1986) Pubertal endocrinology of Yellow Baboons (*Papio cynocephalus)*: Plasma tesosteron, testis size, body weight and crown rump length in males, Amer. J. Primatol. 11, 263-270

Coelho, A.M. Jr. (1985). Baboon dimorphism: growth in weight, length and adiposity from birth to 8 years of age. In Watts, E.S. (ed.), Nonhuman primate models for human growth and development, Alan R. Liss,New York, pp. 125-159.

Coelho, A.M. Jr. and Rutenberg, G.W. (1989). Neonatal nutrition and longitudinal growth in baboons: adiposity measured by skinfold thickness. Am. J. Hum. Biol. 1: 429-442.

Glassman, D.M., Coelho, A.M. Jr., Dee Carey, K., & Bamblett, C.A. (1984). Weight growth in savannah baboons: a longitudinal study from birth to adulthood. Growth 48: 425-433.

Hausfater G (1975) Dominance and reproduction in baboons (Papio cynocephalus): a quantitative analysis. Contrib. Primatol. Vol. 7 Basel, S. Karger

Jolly CJ, (1993) Species, subspecies, and baboon systematics. In: „Species, concepts and primate evolution." Kimbel WH and LB Martin (eds.) Plenum, New York pp 67-107

Kingdon J (1997) The kingdon field guide to African mammals. San Diego, Academic Press

Kummer H (1968) Social organisation of Hamadryas baboons: a field study. Basel, S. Karger

Muehlenbein MP, BC Campbell, CM Philippi, MA Murchinson, RJ Richards, F Svec and L Myers (2001) Reproductive maturation in a sample of captive male baboons. J. Med. Primatol. **30**, 273-282

Ransom TW and Rowell TE (1972) Early social development of feral baboons. In: "Primate socialization" FE Poirrier ed. New York, Random House, pp 105-144

Rhine RJ, GW Norton, BJ Westlund (1984) The waning of dependence in infant free ranging yellow baboons *(Papio cynocephalus)* Mikumi National Park. Amer. J. Primatol. **9,** 213-228

Shohoji, T. & Sasaki, H. 1987. An aspect of growth analysis of weight in savannah baboons. II Gender comparison by adjusting age. Growth 51:425-431

Sigg H, Stoiba A, Abblegen JJ, Dasser V, (1982) Life history of hamadryas baboons: physical development, infant mortality, reproductive parameters and family relationships- Primates **23**, 473-487

Stammbach E (1987) Desert, forest and mountain baboons: multilevel societies. In: „Primate societies" BB Smuts, DL Cheney, RM Seyfarth, RW Wrangham and TT Struhsaker eds. Chicago, the Chicago University Press. pp 112-120

Strum SC, and Western JD (1982) Variatins in fecundity with age and environment in olive baboons (Papio anubis). Am. J Primatol. **3**, 61-76.

Swindler DR (2002) Primate dentition; an introduction to the teeth of non-human primates. Cambridge University Press, Cambridge, UK