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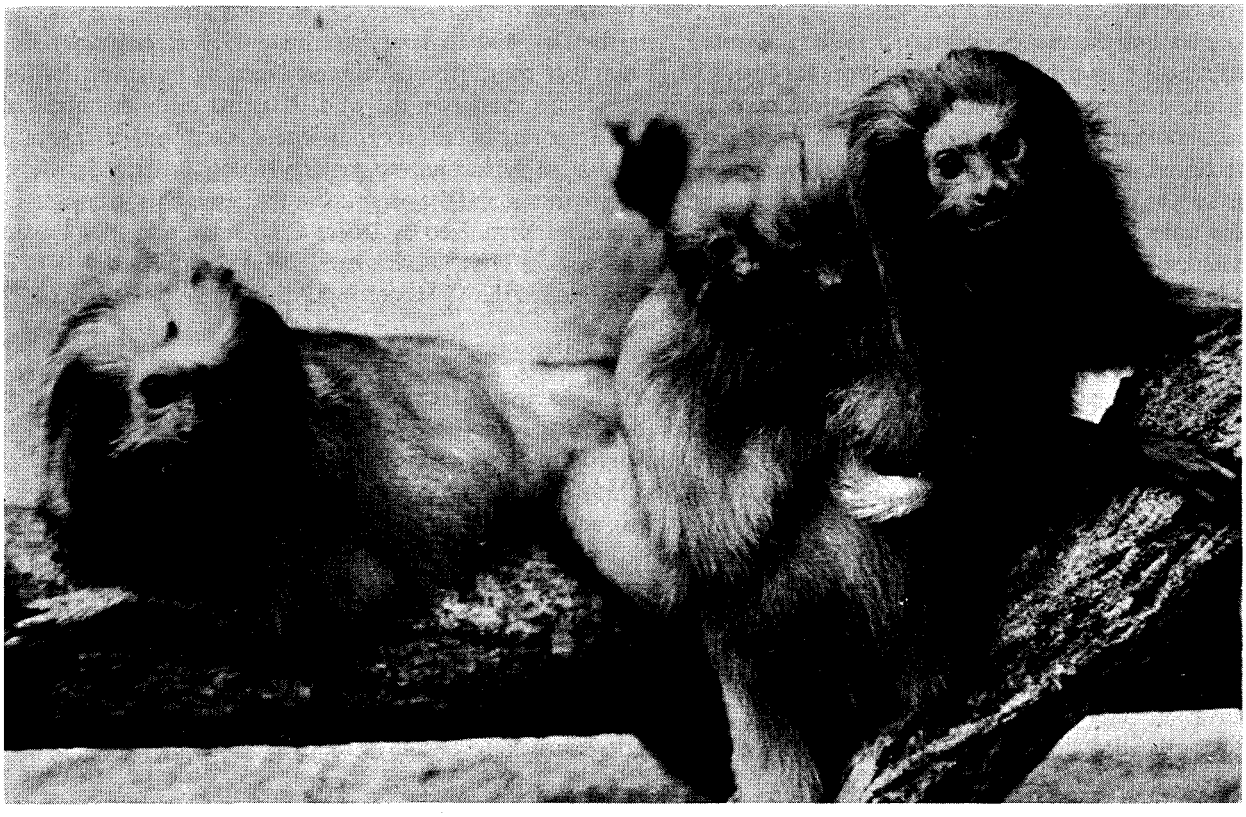

Proceedings of the 2nd Symposium on *Leontopithecus*
held during the Annual Meeting of the International Committees for the
Preservation and Management of the Four Lion Tamarin Species, May 1994

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Editorial

This supplement of the IUCN/SSC Primate Specialist Group Newsletter *Neotropical Primates* presents the summarized proceedings of a two-day symposium on the genus *Leontopithecus* held during the Annual Meeting of the International Committees for the Preservation and Management of the four species: the golden lion tamarin (*Leontopithecus rosalia*), chaired by Devra G.Kleiman (National Zoological Park, Washington, D.C., and Adelmar F.Coimbra-Filho (formerly Director of the Rio de Janeiro Primate Center, Rio de Janeiro); the golden-headed lion tamarin (*Leontopithecus chrysomelas*), chaired by Jeremy J.C.Mallinson (Jersey Wildlife Preservation Trust, Jersey) and Adelmar F.Coimbra-Filho; the black lion tamarin (*Leontopithecus chrysopygus*), chaired by Faiçal Simon (Fundação Parque Zoológico de São Paulo, São Paulo) and Devra G.Kleiman; and the black-faced lion tamarin (*Leontopithecus caissara*), chaired by Admiral Ibsen de Gusmão Câmara (Sociedade Brasileira de Proteção Ambiental, Rio de Janeiro) and Jeremy J.C.Mallinson.

The International Committees were recognized formally by the Brazilian Institute for the Environment and Renewable Natural Resources (Ibama) in 1990 (*L.rosalia*, *L.chrysomelas*, and *L.chrysopygus*) and 1992 (*L.caissara*). Besides acting as consultative committees for Ibama, their aim is to coordinate the captive breeding programs for the species and promote and advise on actions on behalf of their conservation in the wild. A listing of the members of each committee is given on page 58. Each year, Ibama hosts a meeting of the four committees. That held in Casimiro de Abreu, Rio de Janeiro, in May 1993, was preceded by a short symposium to provide the opportunity for those present to hear reports on the status of the captive breeding programs, and the progress in the research and conservation efforts for wild populations. The success of the symposium, organized by Devra G.Kleiman and Inês Castro (Golden Lion Tamarin Conservation Program, National Zoological Park, Washington, D.C.) (see *Neotropical Primates*, 1(2): 10-12, 1993), resulted in the exercise being repeated at the 1994 meeting, held in Ilhéus, Bahia, 24-27 May.

The 1994 symposium and meeting were organized by Maria Iolita Bampi, Head of the Wildlife Department of Ibama, and hosted by Maria Cristina Alves, the coordinator of the *Projeto Mico-Leão Baiano*, the environmental education program for *L.chrysomelas* begun in 1990. Two events also contributed to the meeting. Prior to the symposium, a set of three Brazilian stamps depicting endangered callitrichids (*Saguinus bicolor bicolor*, *Saguinus imperator* and *Leontopithecus rosalia*) were given their First Day of Issue, and on 26 May a Nature Education Center and the Lion Tamarin Rehabilitation Center were inaugurated, both within the grounds of the Cocoa Research Center (CEPEC), Itabuna. The Nature Center is specifically for the environmental education activities of the *Projeto Mico-Leão Baiano*, a program which has received support from the Wildlife Preservation Trusts (WPTI, JWPT, and WPTC), the World Wildlife Fund (WWF), Conservation International (CI), the Santa Cruz University, the Regional Cocoa Growing Authority (CEPLAC), Itabuna, and Ibama. The Rehabilitation Center, sponsored by CEPLAC, Mars, Inc., Conservation International (CI), the Philadelphia Zoo, and Ibama, was established to provide temporary lodging for golden-headed lion tamarins, confiscated or donated, prior to their inclusion in the worldwide captive breeding program.

The publication of these 17 summaries was made possible through the generous support of Wildlife Preservation Trust International (WPTI), Executive Director Mary C. Pearl, and the Jersey Wildlife Preservation Trust (JWPT), Zoological Director, Jeremy J.C.Mallinson, and not least because of the efficient and ready response of the contributors, for which the editors are most grateful.

Anthony B. Rylands** and **Ernesto Rodríguez Luna
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Cover photograph by Adelmar F. Coimbra-Filho:
golden lion tamarins (*Leontopithecus rosalia*)

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Jeremy J. C. Mallinson, Jersey Wildlife Preservation Trust, Les Augrès Manor, Trinity, Jersey JE3 5BF, Channel Islands, GB.

Introduction

The conservation significance of the lion tamarin programmes (for the golden lion tamarin *Leontopithecus rosalia*, golden-headed lion tamarin *L.chrysomelas*, black lion tamarin *L.chrysopygus*, and, more recently, the black-faced lion tamarin *L.caissara*), highlights so well how the adoption of 'flagship' species and the publishing of the plight of remnant populations in depleted environments can promote considerable public attention and support, resulting in the preservation and conservation of both animal species and associated habitat (Mallinson, 1986, 1987, 1989, 1994; Dietz *et al.*, 1994).

Thanks to the participation of numerous specialists, who have provided the impetus, technical advice, and finance for the successful running and coordination of the Lion Tamarin Committees, so much has been achieved to secure the viability of both captive and wild populations of the lion tamarin genus. During the past few years, through the unique collaboration of the Brazilian Institute of the Environment and Renewable Natural Resources (Ibama), zoo personnel and their supporters have promoted fund raising activities to help secure sufficient habitat to sustain viable wild populations and helped to develop environmental education programmes, as well as studies of the demography, behavioural biology and evolution of the species in the states of Bahia, Rio de Janeiro, São Paulo and Paraná.

Management Committees

In June 1990, the International Research and Management Committees (IRMC) provided the main driving force, in collaboration with the Fundação Biodiversitas, Belo Horizonte, and Ibama, Brasília, for the organization of the "*Leontopithecus* Population Viability Analysis Workshop", held in Belo Horizonte, Minas Gerais, Brazil (Seal *et al.*, 1990). The IRMC's include field scientists, zoo specialists, environmental educators, and personnel of governmental and non-governmental organizations. They are recognised by Brazilian Law as technical advisors to Ibama on all issues concerning both wild and captive populations. The Committees meet with Ibama on an annual basis, adopting an interdisciplinary approach on all matters relating to the conservation of the lion tamarin genus, and promoting the interactive management of *in situ* and *ex-situ* populations (Mallinson, 1989).

The majority of the golden and golden-headed lion tamarins and all of the black lion tamarins in captivity outside of Brazil are subject to Management Agreements. These populations remain in the Trusteeship of Ibama, and none of the animals can be sold, traded or otherwise used in commercial transactions (Mallinson, 1994).

The Lion Tamarins of Brazil Fund (LTBF)

The Lion Tamarins of Brazil Fund (LTBF) was established by the International Committees in 1991. An appeal, signed by Gerald Durrell (Founder and Honorary Director, Jersey Wildlife Preservation Trust), was mailed to all holders of lion tamarins outside of Brazil in January 1992. The letter requested donations in support of *in situ* conservation work, in particular the funding of Brazilian field assistants studying lion tamarins in the wild. The appeal raised just over US$10,000 in 1992, a sum that the Committees decided should be evenly distributed between the programmes for the four species, in support of surveys and censuses, behavioural and ecological studies, translocation, and environmental education. The Appendix provides details of the programmes that were supported by the LTBF in 1993.

Recognising the increasing importance of interactive management between captive and wild populations of endangered species, the Management Committees decided to continue to appeal on an annual basis for donations to the LTBF from all holders of lion tamarins. In this way, zoos that are already participating in the development of the scientifically managed captive

populations of lion tamarins outside of Brazil, are also able to contribute funds to aid the conservation of the remnant wild populations of this critically endangered primate genus.

In October 1993, the second appeal was sent out to all overseas holders of lion tamarins. The letter highlighted the International Committees' hope that this annual appeal will continue to generate sufficient funds to enable the Committees to build on past successes, as well to promote further these model programmes for the conservation of endangered species and associated habitats. At the time of the meeting of the Committees in May 1994, a sum in excess of US$17,000 had been donated by 12 collections, including a significant contribution of US$10,000 received from the Japan Marmoset Institute, Tokyo. This sum was divided equally amongst the four species' Committees to be allocated to research and conservation projects.

Although the donations to the fund have been largely one-off contributions, it is important to mention one particularly laudable long-term fund-raising programme set up by the Adelaide Zoological Gardens, Australia. The appeal letter sent out in 1992 resulted in the zoo launching a most innovative fund-raising effort on behalf of the LTBF, with an undertaking to raise US$3,000 per year for a three-year period. As McAlister and Langdon (1993) record:

"During 1992 considerable work was undertaken at the Adelaide Zoological Gardens, South Australia, to improve conditions and display facilities for both golden lion tamarins (*Leontopithecus rosalia*) and cotton-top tamarins (*Saguinus oedipus*). Because of their threatened status, an education and conservation campaign was set up featuring the lion tamarins and using the idea of "A Golden Coin for a Golden Animal". In brief, thanks to generous support from the Electricity Trust of South Australia (ETSA) which paid for the exhibit improvements, a video was made featuring the well-known conservationist, the Honorary Director of the Jersey Wildlife Preservation Trust (JWPT), Dr Gerald Durrell. The video is activated by dropping a $1.00 coin (a golden coin in Australia) through the slot. Excellent footage of golden lion tamarins is then displayed, with a message from Dr Durrell detailing the plight of this beautiful creature, and encouraging people to assist in its preservation and conservation. Contributors are assured that all money raised will be used to contribute to the revegetation project in the Poço das Antas Biological Reserve, Rio de Janeiro, and the reintroduction of captive-born groups of this "flagship" species in its native habitat, projects which form part of the Golden Lion Tamarin Conservation Programme of the National Zoological Park, Smithsonian Institution, Washington, D.C. The funds are being channeled through the "The Lion Tamarins of Brazil Fund", an international appeal started by Dr Durrell in December 1991, and managed by Jeremy Mallinson, Zoological Director of JWPT, and Devra Kleiman of the National Zoological Park, Washington, D.C. Adelaide Zoo's particular campaign for golden lion tamarins has been able to guarantee the funding for a field assistant for three years, and the first allocation of money was forwarded in early 1993.

The publicity surrounding the golden lion tamarin did not stop with this particular project, but continued, using some very provocative posters, to try to boost membership of the Royal Zoological Society of South Australia Inc., and to encourage people to become involved with conservation. The posters and full page advertisements in the local newspapers, once again sponsored by ETSA, were certainly very eye-catching and effective and raised the profile of the Adelaide Zoo considerably."

Summary

The coordinated work of the International Committees for the conservation of the lion tamarin genus represents model programmes that provide excellent examples of what can be achieved through an interdisciplinary approach involving science, interactive management, politics, environmental education, and habitat preservation and restoration.

With our growing understanding of the science of conservation today, the significance of the lion tamarin programmes highlight so well how the importance of 'flagship' species for publishing the plight of remnant populations in degraded environments can promote considerable public attention and support, providing for action on behalf of the animals and their habitats.

As the Management Committees for the lion tamarins provide excellent models for the interactive management of wild and captive populations of endangered species, it is also hoped that the Lion Tamarins of Brazil Fund will, in a similar way, instigate and promote fund-raising efforts by the international zoo community to contribute funds in support of the remaining wild populations of endangered species they have represented in their zoological collections.

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Appendix

Leontopithecus Conservation Programmes Supported by the Lion Tamarins of Brazil Fund

1. Golden Lion Tamarin *Leontopithecus rosalia*

Project: Survey and Translocation of Isolated Lion Tamarin Groups, Rio de Janeiro, Brazil

Principal Investigator/Field Worker: Maria Cecília Martins Kierulff, Federal University of Minas Gerais

Project Objectives: A survey of golden lion tamarins outside of the Poço das Antas Biological Reserve, Rio de Janeiro, and translocation of isolated groups to a larger protected area, considering that these genetically important animals will almost certainly disappear in the near future as a result of continuing deforestation and/or genetic or demographic problems. Techniques already developed for wild and reintroduced tamarins are to be used to trap animals and conduct medical/physical examinations, and to accompany groups and compare behaviour before and after translocation. Project to accomplish rescue of targeted groups; secure protection for the translocation site; provide experience and information necessary for future transfers of wild and reintroduced individuals between subpopulations which will probably be required in the future management of the species, and; increase knowledge of the biological effects of isolation and small population size (see Kierulff, M.C.M., Status and distribution of the golden lion tamarin in Rio de Janeiro, *Neotropical Primates*, 1(4): 23-24, 1993, and Kierulff, M.C.M. and Oliveira, P. P. de. Habitat preservation and the translocation of threatened groups of golden lion tamarins, *Leontopithecus rosalia*, *Neotropical Primates*, 2(suppl.): 15-18, 1994).

1993 Lion Tamarins of Brazil Fund Grant: US$2,500, paid to Dr Devra Kleiman, National Zoological Park, Smithsonian Institution, Washington, D.C. 20018, USA. (Chair of the IRMC for *Leontopithecus rosalia*).

2. Golden-Headed Lion Tamarin *Leontopithecus chrysomelas*

Project: Conservation, Ecology, and Behaviour of Golden-Headed Lion Tamarins in the Una Biological Reserve, Bahia, Brazil

Principal Investigator/Field Worker: James M.Dietz, University of Maryland/Jose Renato Oliveira da Silva, Una, Bahia

Project Objectives: 1) To obtain the biological information necessary to complete a population viability assessment and make management recommendations to Brazilian authorities and funding agencies for the conservation of the species in the Una Biological Reserve; 2) To compare aspects of the behavioural ecology of the species in the Una Reserve with those of the golden lion tamarin in the Poço das Antas Biological Reserve, Rio de Janeiro, and; 3) to create a centre in the Una Reserve for the training of Brazilian scientists and students in the techniques of conservation biology and the study of behavioral ecology. The project was begun in July 1991, following the receipt of authorization from the Brazilian Institute for the Environment (Ibama No.060/91 of 27 February 1991, Edict No.383 of 8 July 1991). Interim progress reports and proposal updates provided in June 1992 and February 1993.

1993 Lion Tamarins of Brazil Fund Grant: US$1,250,

paid to Dr James M.Dietz, Department of Zoology, College Park, University of Maryland, Maryland 20742, USA (Member of the IRMC for *Leontopithecus chrysomelas*).

3. Golden-Headed Lion Tamarin *Leontopithecus chrysomelas*

Project: "Projeto Mico-Leão-Baiano" - Environmental Education Programme

Project Director: Maria Cristina Alves, Ilhéus, Bahia.

Project Objectives: To promote an environmental education programme for the preservation of the golden-headed lion tamarin and its forests by developing an understanding of conservation within local communities. The programme began in 1990 through the combined efforts of national and international NGO's and funding organizations. A Centre for Nature Education has been developed for professionals, school children and the general public. Environmental education programmes for schools, consisting of slide shows for students and specific courses for teachers, help to achieve the Project's principal target by stimulating conservation awareness and the participation of the target community in southern Bahia.

1993 Lion Tamarins of Brazil Fund Grant: US$1,250, paid to Maria Cristina Alves, Director "Projeto Mico-Leão-Baiano", Rodovia Ilhéus-Itabuna Km22, 45600 Itabuna, Bahia, Brazil (Member of the IRMC for *Leontopithecus chrysomelas*).

4. Black Lion Tamarin *Leontopithecus chrysopygus*

Project: Metapopulation Management for the Black Lion Tamarin in the State of São Paulo

Principal Investigator/Field Worker: Claudio Valladares-Padua/Laury Cullen Jr., IPÊ - Instituto de Projetos e Pesquisas Ecológicos, São Paulo

Project Objectives: To carry out studies that will enable metapopulation management for the species, integrating in this way all known subpopulations which have been confirmed to date in five isolated forests (only two of which are in protected areas; the Morro do Diabo State Park and the Caetetus State Ecological Station). Population viability analysis for the species suggests that without active management the chances of its survival over the next 100 years are extremely poor. Translocation and managed dispersal between fragmented populations will be investigated, and the long-term behavioural/ecological studies will be continued. Although the forest fragmentation that exists among the several subpopulations means that they are capable of tolerating stochastic problems, it also impedes natural migration and the guarantee of genetic variability. (See Valladares-Padua, C., Padua, S.M. and Cullen Jr, L., The conservation biology of the black lion tamarins, *Leontopithecus chrysopygus*: first ten years' report, *Neotropical Primates*, 2(suppl.): 36-39, 1994.)

1993 Lion Tamarins of Brazil Fund Grant: US$2,500, paid to Dr Claudio Valladares-Padua through Dr Faiçal Simon, Fundação Parque Zoológico de São Paulo, Avenida Miguel Stefano 4241, Caixa Postal 12.954, 04301 São Paulo, São Paulo, Brazil (Chair of the IRMC for *Leontopithecus chrysopygus*).

5. Black-Faced Lion Tamarin *Leontopithecus caissara*

Project: Distribution, Status, and Conservation of the Black-Headed Lion Tamarin, Superagüi

Principal Investigators/Field Workers: Vanessa G.Persson, Museum of Natural History "Capão da Imbuia", Curitiba, and Maria Lúcia Lorini, National Museum, Rio de Janeiro, Brazil

Project Objectives: To establish population size, threats and habitat viability, and investigate the ecology and behaviour of the species, as well as factors restricting population expansion, in order to formulate a coordinated conservation programme, following the proposals of the Action Plan drawn up by the IRMC for *L.caissara* (see Câmara, I.de G., Action Plan for the Black-Faced Lion Tamarin, *Neotropical Primates*, 1(3):10-11, 1993; Câmara, I.de G., Conservation status of the black-faced lion tamarin, *Leontopithecus caissara*, *Neotropical Primates*, 2(suppl.): 50-51, 1994). (See also Lorini, M.L. and Persson, V.G., Status of field research on *Leontopithecus caissara*: The Black-Faced Lion Tamarin Project, *Neotropical Primates*, 2(suppl.): 52-55, 1994).

1993 Lion Tamarins of Brazil Fund Grant: US$2,500, paid to Admiral Ibsen de G.Câmara, Avenida das Américas 2300 - C-40, 22640-101 Rio de Janeiro, Rio de Janeiro, Brazil (Chair of the IRMC for *Leontopithecus caissara*).

Capitalizing the Ark: The Economic Benefit of Adding Founders to Captive Populations

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The number of species that can be genetically managed in zoos is resource limited (Maguire and Lacy, 1990). Existing facilities can accommodate less than half of the species likely to require captive breeding in the next century (Soulé *et al.*, 1986; Conway, 1986). One means of reducing the size of captive populations, while achieving management objectives, is to add wild-caught founders. Using the world captive populations of the three lion tamarin species currently in captivity, we explore the potential economic benefit of adding new founders to these populations. The result is a reduction in the population sizes required to maintain 90% heterozygosity for a period of 100 years, the stated management objective for lion tamarins. Benefit is measured as the consequent reduction in the total projected cost of each program.

The founding and subsequent breeding of a captive population can be viewed as a series of genetic bottlenecks, in which the population will lose genetic variation due to the random sampling of alleles, or genetic drift (Franklin 1980; Frankel and Soulé, 1981). One effect of drift is an increase in the level of homozygosity (inbreeding), which can lead to a loss of fitness, seen as reduced fecundity and viability of individuals in the population (inbreeding depression). The per generation rate at which a population will lose genetic variation is $1/(2N_e)$, where N_e is the effective population size. There is a consensus that a goal of maintaining 90% of the genetic variation (defined in terms of expected heterozygosity) represents a threshold between a tolerable loss of heterozygosity and the damaging effects of inbreeding (Soulé *et al.*, 1986).

The size of a captive population required to achieve the 90% per 100 year management goal is affected by a number of variables, including the size of the founding population, generation length, population growth rate, and effective population size. The latter three affect the frequency and rate of loss of heterozygosity; management that maximizes these variables minimizes the loss of variation over the life of a program (Ballou, 1987). The number of founders determines the proportion of genetic variation sampled from the wild (the size of the initial bottleneck).

The greater the number of founders, the higher the initial level of heterozygosity. Genetically front-loading the captive population in this manner decreases the severity of the initial bottleneck, allowing for a greater rate of genetic erosion over the duration of the program, while still maintaining the target level of 90% heterozygosity (Fig. 1). Because there is an inverse relationship between the rate of loss of heterozygosity and population size, more founders means that a smaller population can be maintained. We would argue that there is a distinct economic advantage to maximizing founder numbers as early as possible. The result is a smaller population from the outset of the program, which has a considerable effect on the total cost.

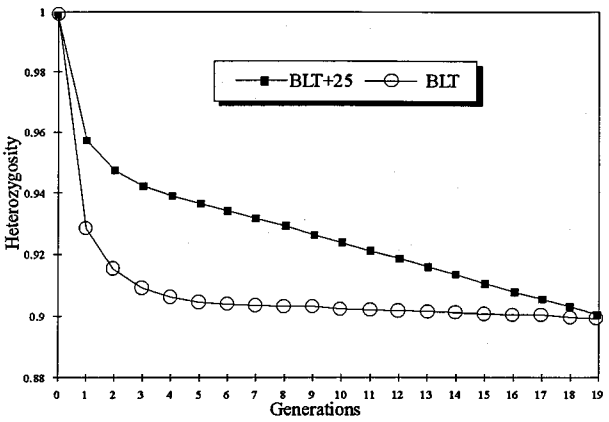

Figure 1. A larger founding population allows a greater rate of genetic erosion, i.e., a smaller maintenance population size, while still achieving the management goal of 90% H over 100 years. Figure 1 depicts the actual heterozygosity of the BLT population and with 25 additional founders.

As of the end of 1992, there were 524 captive golden lion tamarins (GLT) (*Leontopithecus rosalia*), 472 golden-headed lion tamarins, (GHLT) (*L. chrysomelas*), and 81 black lion tamarins (BLT) (*L. chrysopygus*) (Ballou, 1992; Mace, 1992; Valladares-Padua and Simon, 1992), occupying about a third of the 3,000 spaces available to small primates. The black-faced lion tamarin (BFLT) (*L. caissara*) was first described only in 1990; there are currently none in captivity.

We modeled the addition of founders and its impact on population size using *Capacity*, a computer program designed to estimate the population size required to maintain a target level of heterozygosity over the specified duration of a captive breeding program (N_k) (Ballou, 1993). *Capacity* calculates N_k using a number of variables, summarized for each of the three species in Table 1. From an analysis of the recent history of the GHLT population, we assumed a 40% success rate in incorporating the genes of new founders. Figure 2 shows the reduction in N_k for each species as founders are added. Adding founders has very little impact on the GHLT population. A substantial reduction, however, may be realized in the GLT population. The BLT population doesn't even approach a manageable size without the addition of 20-25 founders.

To appreciate the economic benefit new founders may have on these management programs, it was necessary to calculate the cost of keeping a tamarin in captivity. Using the same categories as Kleiman *et al.* (1991), we estimated the cost of keeping a single tamarin for a period of one year to be $1,143. Once we had this estimate, we calculated the Present Discounted Value (PDV) of the cost of keeping a tamarin for 100 years. The fundamental idea behind discounting is that a dollar is worth more today than at some point in the future, i.e., money has *time value*. We therefore place the highest value on costs and benefits that occur now, and then discount them into the future. PDV is calculated using the formula:

$$PDV = \sum_{t=0}^{n} \frac{C_t}{(1+r)^t}$$

where C_t is the cost of maintaining a tamarin in year t ($1,143), n is the number of years in the program (100), and r is the discount rate. Using a 3% discount rate, the discounted cost of keeping a tamarin for 100 years is $37,250. Multiplying this value by the reduction in N_k that can be achieved by adding a certain number of founders yields the total economic benefit of doing so. For example, the addition of even 25 GHLTs has an insignificant effect on total cost. N_k is reduced by only 10 individuals to 333, and the reduction in total cost is only $283,121, or just over 2%. In the case of GLTs, however, the addition of 25 new founders would reduce N_k from 483 to 380 for a saving in excess of $3 million, a reduction of 18%. The results are most dramatic in the case of BLTs, where 25 new founders would bring N_k from 7,413 to 510, decreasing the hypothetical cost of $182 million by 91% to just under $17 million.

Table 1. Population parameters used in *Capacity* (as of 31 December 1992).

	GHLT	GLT	BLT
Population size (N)	472	524	81
Effective population size (N_e)	142	157	24
N_e/N ratio	0.3	0.3	0.3
Founders	106	48	30
Founder genome equivalents (f_g)	39.32	12.80	6.31
Gene diversity (GD)	0.9873	0.9609	0.9208
Generation length (T)	5.2	5.2	5.2
Annual growth rate (l)	1.316	1.316	1.316

We can also take an incremental, or *marginal*, view of benefit by looking at the cost savings that accrue with each new founder. Using a discount rate of 3%, we can say that bringing one more GLT in from the wild would have a Marginal Benefit (MB) of $204,000 over the next hundred years, while the MB of the next BLT founder is $98.5 million (Figure 3). We call the MB of each new founder the *founder dividend* (f_d). Like variable inputs in production, however, founders in a cap-

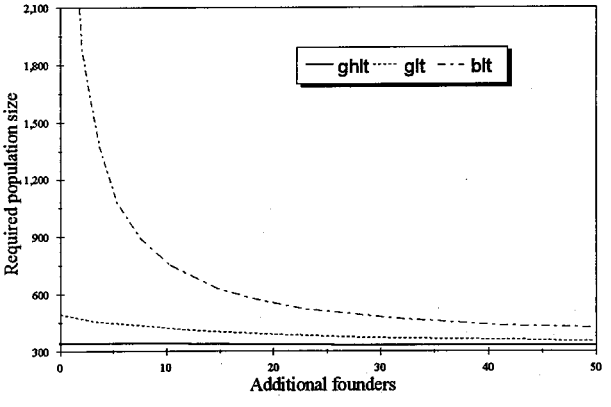

Figure 2. The reduction in maintenance population size (N_k) that can be achieved by addition founders to the three captive populations.

tive population are subject to the Law of Diminishing Marginal Returns, which is to say that the f_d of each new founder is something less than the one before, until there is nothing further to be gained.

How many founders are enough? Ideally, one would continue to add founders until the genetic variation in the captive population mirrored that of the source population, and no further reduction in N_k could be achieved. Practically speaking, however, the number of founders will be determined by the ability of the wild population to withstand the further loss of individuals. The removal of individuals from the wild will probably have costs not reflected in the added cost of maintaining them in captivity. Costs and benefits that are not reflected in financial analysis are referred to as *externalities* (Mishan, 1982). The external costs of removing more lion tamarins from the wild are likely to be fairly low. In the case of GLTs and GHLTs, particularly, the wild populations appear to be at carrying capacity in currently available habitat. As a result, there is high mortality among dispersing juveniles unable to find unoccupied territory. Habitat vacated by removing individuals is likely to be reoccupied very quickly. While we don't know the size of the BLT population with respect to carrying capacity, current population estimates suggest that it, too, could withstand the removal of a significant number of individuals. Social costs are also likely, however. Consensus among members of the management committee would lessen social or political ramifications.

If we divide equally the approximately 3,000 spaces in the world's zoos currently available to small primates (callitrichids) among the 10 endangered callitrichid species now in captivity, we can maintain populations of about 300 each. At present, GLTs and GHLTs far exceed this allocation. If we are to meet current carrying capacity, both need to be reduced. We believe that a target population size of 300 for each species of lion tamarin is a realistic goal.

Based on this study, the f_ds for GHLTs are small and we would not recommend actively recruiting new founders. The GLT population could benefit significantly from adding founders, and we would recommend adding as many as 25-30, provided this can be done without jeopardizing the viability of the wild population. Beyond 30, the f_ds become negligible. In both cases, we would advocate that confiscated or injured individuals be added to the captive populations. The benefit of doing so may well exceed the costs of rehabilitation and reintroduction. If the captive BLT population is to be expanded, a substantial number of founders must be added in order to achieve management objectives at a reasonable population size. The addition of 60 founders would reduce N_k from 7,413 to 430.

Further reduction in N_k would best be achieved through more effective genetic management. If we can reach N_k of 300 for each of the three species, the total value of the additional founders, in terms of cost reduction, would be in excess of $175 million. While it may seem distasteful to place a dollar value on wild animals, the idea of founder dividends can provide species managers with a tangible argument for removing individuals from the wild that can be understood by biologists and policy-makers alike.

Some would argue that captive breeding is a misplaced and inefficient use of scarce conservation resources. We maintain that, to the extent that captive breeding programs remain within current zoo carrying capacity, captive breeding allows conservation biologists to take advantage of non-reallocatable resources that would otherwise be unavailable to them. In the case of lion tamarins, the captive breeding programs have been carefully reviewed and are considered essential to an overall conservation strategy. Maximizing the founder size of individual captive populations is one means of minimizing the resource requirements of managed species. In so doing, we can extend the life of existing facilities available to captive breeding and delay the day when *in situ* and *ex situ* conservation efforts in zoos do battle.

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Conservation Units and the Protection of Atlantic Forest Lion Tamarins

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Tropical forests are rapidly being destroyed throughout Brazil, and most particularly those of the Atlantic forest (Teixeira and Câmara, 1988; Câmara, 1991). In Amazonia, the rate of destruction is more than 1,000,000 ha per year, while less than 10% of the Atlantic forest, which once far exceeded 1,000,000 km^2 throughout eastern Brazil along the coast and inland as far west as the basin of the Rio São Francisco, remains today. The large majority is highly fragmented and degraded through logging and destruction. In the long term (centuries or millennia) the preservation of the biodiversity of these biomas will depend almost entirely on conservation units, and most particularly those which guarantee complete protection of the ecosystems they contain (Nogueira Neto and Carvalho, 1979; Pádua and Quintão, 1984; Rylands, 1991; Câmara, 1991; Nogueira Neto *et al.*, 1992). If these areas are properly chosen, based on a knowledge of species' distributions, richness and diversity, and criteria including socioeconomic aspects of land use, it will still be possible to preserve a high proportion of the biological diversity so threatened in these rain forests. There are serious problems still facing the current system of conservation units in Brazil (see, for example, Rylands, 1991), but many are now reasonably well maintained.

There are currently 41 species and subspecies of callitrichids recognized for the Amazon, three north of the Amazon in Colombia and Central America, and 10 species in the Atlantic forest region of Brazil (Mittermeier *et al.*, 1992; Rylands *et al.*, 1993). All except two of the Atlantic forest species are endemic and considered threatened (Groombridge, 1993).

The four lion tamarins, *Leontopithecus*, are endemic to the Atlantic forest, they have very restricted distributions, and the number of protected areas for each is insufficient in both number and size (see Table 1) (Seal *et al.*, 1990). Heltne (1978) argued that an area of at least 10,000 ha is necessary to maintain viable populations of callitrichids, and this is being gradually confirmed through improved knowledge of the population dynamics and ecology of the species, and through the Population Viability Analyses (PVA) and Population and Habitat Viability Analyses (PHVA) now widely used in conservation biology, and which call for an understanding of population parameters, effects of small population size, isolation (migration), and rates and causes of population decline (Seal *et al.*, 1990; Caughley, 1994).

The situation concerning the population sizes and the possibilities remaining for the establishment of further reserves, or for increasing the size of those already existing, is different for each of the lion tamarin species (Table 1). Possibilities remain for *L.chrysomelas* in southern Bahia, where populations still survive throughout a fair portion of its original distribution (Pinto and Tavares, 1994). The area of forest effectively protected in the Una Biological Reserve was recently expanded due to the acquisition of 1,717 ha of adjacent forests (Coimbra-Filho *et al.*, 1993). However, the Reserve, which now totals 7,059 ha, will unfortunately remain as the largest single conservation unit for the species, and is still below the minimum size required for a viable population (see Dietz *et al.*, 1994). Further reserves are urgently needed for this species.

The possibilities for the creation of new conservation units are practically zero for *L.rosalia* in the lowland areas of the state of Rio de Janeiro (Kierulff, 1993), and *L.chrysopygus* in the western and central part of the state of São Paulo (see Valladares-Padua *et al.*, 1994). Although the Morro do Diabo State Park (34,156 ha) is more than three times the size of any other reserve containing lion tamarins, studies have indicated that *L.chrysopygus* have very large home ranges and the population there is very low (between 80 and 450; see Valladares-Padua *et al.*, 1994) not exceeding the potential population size for *L.rosalia* in the Poço das

Antas Biological Reserve (5,500 ha). The principal options remaining for these species include the creation of some few, small private reserves, but will involve mainly active management of the few remaining populations, including the use of reintroductions, translocations, and reforestation (Valladares-Padua *et al.*, 1994: Kierulff and Oliveira, 1994; Pessamílio, 1994).

The recently discovered black-faced lion tamarin, *L.caissara* Lorini and Persson 1990, is relatively privileged in relation to the amount of habitat remaining within and around its known distribution in the extreme north-east of the state of Paraná and south-east São Paulo, along the coastal lowlands. However, it is also extremely rare and populations are minimal (Martuscelli and Rodrigues, 1992; Lorini and Persson, 1994), and it is probably the most endangered primate in South America. This emphasizes the need to consolidate the protection of the Superagüi National Park (see Câmara, 1994) and also the urgent need for the establishment and maintenance of further reserves in areas where populations are still surviving. Marcia Rodrigues, a doctoral student from the University of São Paulo carrying out studies on the distribution and ecology of species, and the Environmental Secretariat of the State of São Paulo, have drafted separate but similar proposals for an Ecological Station in the lowland region of Ariri in the state of São Paulo, both of which have been submitted to the State Government (see Rodrigues *et al.*, 1992). Hopefully this will bear fruit, but further research on the distribution of this species in the state of São Paulo is required in order to confirm its distribution there (especially the northern limits to its range), with the possibilities still remaining of the discovery of new populations. The establishment and protection of conservation units is undoubtedly the key strategy for the species' survival.

Table 1. Protected areas for the Lion Tamarins, *Leontopithecus*. Sources: [1]Kierulff (1993), [2]Dietz *et al.* (1994), [3]Valladares-Padua *et al.* (1994), [4]Lorini and Persson (1990, 1994), [5]Martuscelli and Rodrigues (1992).

Leontopithecus rosalia[1]	
Distribution	Rio de Janeiro
Protected Area	Poço das Antas Biological Reserve (5,500 ha)
	Population = *c.*360 individuals
Other Areas	5 (privately owned) + 12 isolated groups
Leontopithecus chrysomelas[2]	
Distribution	Bahia
Protected Area	Una Biological Reserve (7,059 ha)
	Population = *c.*450
Other Areas	Numerous
Leontopithecus chrysopygus[3]	
Distribution	São Paulo
Protected Areas	Morro do Diabo State Park (34,156 ha)
	Population = 80-450
	Caitetus State Ecological Station (2,178 ha)
	Population = 8-30
Other Areas	3 (privately owned)
Leontopithecus caissara[4,5]	
Distribution	Paraná, São Paulo
Protected Areas	Superagüi National Park (21,400 ha)
	Population = *c.*160
	Jacupiranga State Park? (150,000 ha)
	Population unknown
Other Areas	Uncounted

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Habitat Preservation and the Translocation of Threatened Groups of Golden Lion Tamarins, *Leontopithecus rosalia*

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In 1968, Coimbra-Filho and Magnanini recorded the threatened status of the golden lion tamarin, *Leontopithecus rosalia*, and a subsequent paper by Coimbra-Filho (1969; see also Coimbra-Filho and Mittermeier, 1973) provided the first detailed documentation of the species' distribution in the lowland coastal Atlantic forest in the state of Rio de Janeiro, Brazil (Fig.1). Coimbra-Filho (1969) demonstrated the extreme reduction in the animal's geographic range, and likewise the extreme fragmentation of the remaining forests and the concurrent demise of the species.

The principal factors which threaten the survival of *L.rosalia* in the wild today include the small size and fragmented nature of the populations and the extremely limited amount of remaining habitat available (Fig. 1, Table 1). It is on these two fronts that the principal conservation efforts are concentrated. The resolution of the first problem will depend on the introduction of captive animals (Beck *et al.*, 1991) and also the translocation of isolated endangered groups to safer and larger forests (Table 1). The second problem involves measures to reverse habitat loss and increase the protection of the remaining habitat, comprising to a large extent small privately-owned forest patches. This involves reforestation in protected areas, especially in the Poço das Antas Biological Reserve, where the potential to increase the amount of forest totals 2,000 ha (Pessamílio, 1994), along with environmental education (Kleiman *et al.*, 1986; Dietz, *et al.*, 1994).

During 1991-1992, as part of the activities of the Golden Lion Tamarin Conservation Program of the National Zoological Park, Washington D.C., and following the recommendations of the International Management Committee for the species, a major survey was carried out to examine the status and distribution of golden lion tamarins, *Leontopithecus rosalia*, outside of the Poço das Antas Biological Reserve, and throughout its known and possible range in the state of Rio de Janeiro (Kierulff, 1993a, 1993b). It was carried out using satellite images to locate remnant forests, the large majority of which were visited to check for the existence or otherwise of lion tamarin populations (see Fig.1). One of the results of this survey was the location of 12 single and isolated groups in very small and very degraded forest patches (Table 1). These groups were found to be in serious danger of disappearing. All of the very small and isolated forests where they survive are hunted, logged, and threatened by pasture burning. The groups themselves are threatened by animal dealers, predation by domestic animals, and outright deforestation. Their importance, representing as they do a significant portion of the wild population outside of the Poço das Antas Biological Reserve (Table 1), and in terms of the genetic variability they represent, obviated the need for their translocation to a larger and protected forest. In 1994, a translocation program was set up, having located an area of well preserved and protected forest of 2,400 ha in the Fazenda União, municipality of Rio das Ostras, owned and managed by the Brazilian

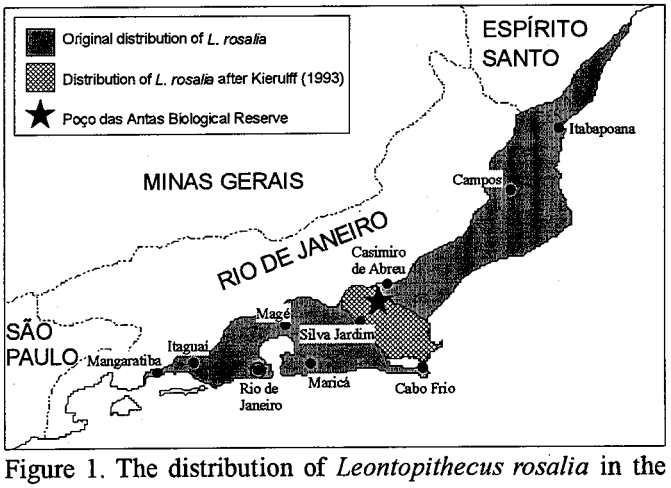

Figure 1. The distribution of *Leontopithecus rosalia* in the state of Rio de Janeiro.

Railway Company (*Rede Ferroviara Federal*) (see Fig. 2). After four months of negotiation, an agreement was signed between the Railway Company and the *Associação Mico-Leão Dourado*, created in 1993 to administer on-site the Golden Lion Tamarin Conservation Program, underway since 1983. The Agreement included the introduction of golden lion tamarin groups and the use of a house, which was restored as lodging and a laboratory for researchers.

The isolated groups were captured, measured, weighed, tattooed, and marked, and radio collars were placed on the adults. One of these 12 groups (A), a pair, found in a forest patch of 24 ha in the municipality of Cabo Frio (see Fig.1), was captured and followed for 15 days. In order to avoid unnecessary stress or interference in their already precarious situation, the pair were located and their sleeping sites recorded just once a day. During these 15 days, the animals were seen leaving their forest patch to enter two others, each of 1 and 5 ha. This involved crossing open grassland, and on the fifteenth day the male was found dead, probably predated by a dog. Traps were subsequently set up to capture the surviving female, but a search using play-back recordings failed to locate the animal, and, according to locals in the region, she had been caught by an animal dealer.

The second group (B) located in Búzios, in the municipality of Cabo Frio (Fig.2), was captured in July 1994, and accompanied during two months until the radio of the collared individual lost its antenna. The forest where they lived was hunted and there was some degree of forest cutting. The vegetation in this group's range was so dense that habituation was impossible, making it difficult to obtain data on feeding and behavior. Information was limited to plotting the group's movements according to the radio signals. The group was formed initially of five individuals which used the entire forest patch as well as an area of scrub and bushes (*macega*), totalling 20 ha. Only one sleeping site recorded. Two infants were born at the end of August 1994, and in October the group was caught and translocated to the Fazenda União. The seven lion tamarins are being followed by triangulation only, in order to minimize disturbing them.

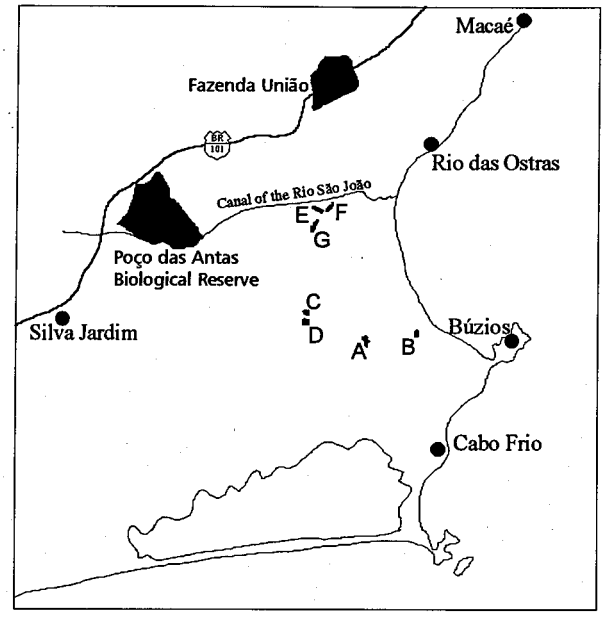

Figure 2. Location of the isolated groups of lion tamarins which will be translocated first to the Fazenda União.

During the first week in the Fazenda the group already occupied an area of 15 ha, and they are increasing their range day-by-day.

Groups C and D were found in the Fazenda Cabista, also in the municipality of Cabo Frio (Fig.2). The two forests of 57 and 81 ha where these two groups are surviving are the only ones left standing in the region, and scrub adjacent to them was cut for charcoal during our observations. It proved impossible to capture these groups using traditional methods. The traps were baited every two days during nine months. Eight

Table 1. Numbers of surviving wild groups of *L. rosalia* and the sizes of the forests where they occur.

Populations of *L. rosalia*	**Forest size**	**Number of groups**
Poço das Antas Biological Reserve	2,760 ha*	48 groups (Seal *et al.*, 1990)
Other wild populations	6,857 ha (4 areas of 340-4,600 ha)	43 groups (Kierulff, 1993a)
Reintroduced population (before May 1994)	1,700 ha**	28 groups (A. Martins, pers. com.)
Isolated groups which will be translocated	865 ha (9 isolated areas of 20-250 ha)***	12 groups (A. Martins, pers. com.)
TOTAL	12,182 ha	131 groups

* Total area of Poço das Antas is 5,500 ha.
** Estimated area.
*** These groups will be translocated to the Fazenda União (2,400 ha of forest).

different fruits were used, including some native to the forest patches. The groups would reply to tape-recorded calls, but never approached. Our continuing efforts to catch these groups will include the use of artificial tree-hole traps.

Groups E, F and G, also in the municipality of Cabo Frio, are isolated by drainage canals. Two of the groups are in two patches of gallery forest, of 48 and 61 ha, along the Rio São João. The other group was located in a forest of 120 ha, isolated by canals and large expanses of pasture. These forests suffer from hunting, fires and selective logging. They are accessible only by boat, but traps are being baited twice a week, and the groups will be translocated by the end of 1994. The remaining groups will hopefully be translocated in the first six months of 1995.

The effort and man-hours involved in translocating these groups is well compensated when considering their important genetic contribution to the wild population and the highly degraded state of the small and isolated forest and scrub where they are surviving now. The formation of a new population at the Fazenda União reserve, besides providing important experience regarding translocation techniques, will without doubt be a significant contribution for the species' survival in the wild. On the other hand the presence of the lion tamarins, the ongoing environmental education program, and the presence of the researchers themselves will certainly contribute to the preservation of the forest at Fazenda União, one of the largest and best preserved areas of Atlantic forest in the lowland coastal region of Rio de Janeiro.

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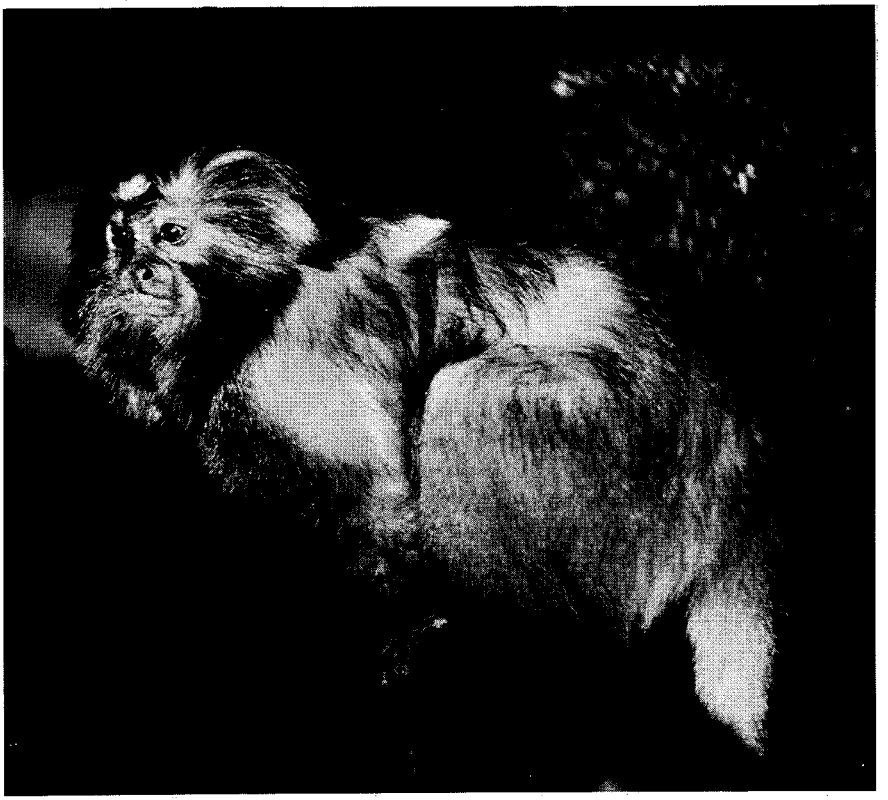

Golden lion tamarin (*Leontopithecus rosalia*). Photo by R. Mittermeier.

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Revegetation of Deforested Areas in the Poço das Antas Biological Reserve, Rio de Janeiro

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Introduction

For some years now, studies of the golden lion tamarin, *Leontopithecus rosalia*, have shown that the Poço das Antas Biological Reserve has insufficient forest to maintain a viable population of the species (Green, 1980; Kleiman *et al.*, 1986; Seal *et al.*, 1990). This is especially serious considering that this is the largest forested area maintaining a wild population of this species. Nearly half of the Reserve's 5,500 ha consists of vegetation which is inappropriate for lion tamarins. For this reason, the Brazilian Institute for the Environment and Renewable Natural Resources (Ibama), responsible for the maintenance and protection of the Reserve (Brazil, MA/IBDF/FBCN, 1981), has been developing a series of projects in conjunction with the Golden Lion Tamarin Conservation Program of the National Zoological Park, Washington, D.C., to promote natural recovery processes as well as direct planting to increase the area of forest in the mid- to long-term.

Research and Reforestation Programs

The first reforestation program was begun by Suzanne Kolb, University of Georgia, Athens, in late 1989, financed by the Golden Lion Tamarin Conservation Program and the World Wildlife Fund - US (Kolb, 1992, 1993). The main concerns of the study included not only increasing the suitable habitat for lion tamarins, but also reforestation as a means of reducing the frequency and extent savanna fires, common during the dry season. The initial stages of the project included investigation on the role of isolated patches of secondary growth in old pastures. It was found that they were important regeneration foci, that they were increasing in size, and that closed canopy patches were more effective for seed germination than open canopy patches. This resulted in a second stage of the Project (1991-1992) examining the more cost-effective strategy of planting islands of native trees rather than uniformly spaced seedlings.

1993 saw the start of the "Revegetation Project for Poço das Antas", following on from the research of Suzanne Kolb, and coordinated by researchers and technicians from the Rio de Janeiro Botanical Garden (administered by Ibama) in collaboration with the Margaret Mee Foundation, Rio de Janeiro. This involves 12 research projects and programs in the following areas: floristics and phytosociology; animal-plant interactions; secondary succession; wood anatomy; the development of an information and service center; phenology and seed collections; seed conservation; population dynamics; ecophysiology; revegetation; mapping of the Reserve; and ecophysiology of vegetation in inundated areas.

This major research and revegetation program is being financed by Shell do Brasil S.A., The John D. and Catherine T.Macarthur Foundation, the Brazil Science Council (CNPq) and the Fundação o Boticário para Conservação da Natureza. In addition, the forest engineering company Biovert Florestal e Agrícola Ltda. has submitted a proposal to the Botanical Garden and World Wildlife Fund - US, which involves the planting of 300 ha of native forest trees free of charge.

Fire Prevention

Successive fires, principally in the peatbogs covering part of the Reserve, have prevented forest regeneration over hundreds of hectares. Combatting fires in these peaty soils is impossible due to difficulties of access and the fact that the fires smoulder up to one meter below ground. To resolve this, a revegetation project is underway involving a strip of 3,000 x 50 m along the Aldeia Velha canal, to act as a barrier to fires which spread from neighboring ranches.

The damaging extent of the fires over recent years, and the threat they pose to the forest habitat of the golden lion tamarins, has resulted in international interest in establishing a fire prevention system, including the participation of the US Forest Service and NASA. The

Reserve now has a meteorological station, and is also well stocked with fire-fighting equipment, including look-out towers and fixed and portable radio-telephones. Reserve personnel have undergone training courses in Brazil and overseas.

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Population Structure and Territory Size in Golden-Headed Lion Tamarins, *Leontopithecus chrysomelas*

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Introduction

With the exception of studies by Rylands (1982, 1983, 1989) conducted for three months on one group at Lemos Maia Experimental Station, Bahia, very little quantitative information has been published on the reproductive success, and population density and structure of free-ranging golden-headed lion tamarins (GHLTs). In addition to intrinsic scientific value, this kind of data is essential to the formulation of an effective conservation strategy for any *Leontopithecus* species (Seal *et al.*, 1990). We have been conducting continuous field observations on GHLTs in Una Biological Reserve, Bahia, since July 1991. The general objectives of our research include a quantitative assessment of the viability of the Una population of GHLTs and a comparison of behavioral and ecological data with that collected on golden lion tamarins (GLT) in the Poço das Antas Biological Reserve, Rio de Janeiro. The results of the first objective have and will continue to generate suggestions about the appropriate size and habitat composition for the Una Reserve (Coimbra-Filho *et al.*, 1993). The comparative approach used in the second objective will allow us to understand better the adaptive significance of behaviors common to both species, for example, the maintenance of territories that are large relative to those of other Neotropical forest primates. Here we report on selected preliminary findings for both objectives.

Study Area

The study area covers approximately 400 ha along the northern and northeastern borders of the 7000 ha Una Reserve. The forest in this portion of the Reserve is characterized by emergent trees about 30 m in height, covered with bromeliads and vines and with a well-developed understorey comprised of small trees, shrubs and bamboos. Although it is likely that selective cutting of economically valuable trees took place prior to the creation of the Reserve, we have no evidence that clear cutting took place in this locale.

Methods

The lion tamarins in the study area were captured using modified Tomahawk live-traps baited with grapes. All individuals were tattooed and fur-dyed for identification. Radio transmitter collars were put on two individuals in each group. The groups were followed until they became habituated to the presence of human observers, at which time systematic focal observations were initiated. The location of the focal group was plotted at intervals of 30 min. Group compositions were monitored at intervals no greater than one week (see methods in Kleiman *et al.*, 1986; Dietz and Baker, 1993). The results presented here are based on at least one year of data for each study group.

Results

Our study included 34 GHLTs in seven groups, presumably all the lion tamarins in the study area (Table 1.). The composition of the study groups was similar to that reported for golden lion tamarins (GLT): a single reproductive (parous) female, 1-3 adult males plus the offspring of 2-3 litters. The mean size

Table 1. Composition of Study Groups

Group	Composition at First Capture
GHLT 8	1RF
VIV	IRF, 2AM
PRI	1RF, 2AM, 2SaF
PIA	1RF, 1AF, 3AM, 2SaM, 1JF, 1JM
FRU	1RF, 2AM
GHLT 10	1RF
JER	1RF, 1AF, 1AM?, 1SaM, 1JF, 1JM

RF = parous female, F = female, M = male, A = adult Sa = subadult, J = juvenile.

for reproductive groups was 5.2 for GHLTs and 5.4 for GLTs. The number of offspring surviving to six months of age/reproductive female/year was 1.1 for GHLTs (estimated from group compositions and birth data) and 1.7 for GLTs (monogynous groups only). Results on GLTs are taken from Dietz and Baker (1993).

With the exception of GHLTs 8 and 10, which were dispersing individuals, all the study groups maintained relatively stable territories defended against all other adult tamarins (Fig. 1). The mean territory area was 75 ha for GHLTs (n= 4) and 42 ha for GLTs (n = 47). The Concave polygon model in MCPAAL software (Conservation and Research Center, Smithsonian Institution) was used to calculate territory areas in both studies. To calculate the density of GHLTs in the Una Reserve we merged the datafiles from the study groups and calculated the total area occupied by the four groups. Based on these calculations, the maximum density of GHLTs in the Reserve is one per 12 hectares. If 5,000 ha of the Una Reserve contain suitable habitat for GHLTs, and our data are representative for the entire area, the estimated population size would be 416 animals in 80 groups. Under these assumptions the effective population size for the Reserve would be about 160, a number far smaller than the minimum theoretically necessary for longterm conservation of genetic diversity in isolated populations (Soulé, 1980). However, both of these assumptions need to be examined carefully before accepting this population estimate as the basis of management recommendations.

Although the social organization and mating system of GHLTs appear to be similar to that of GLTs, group size is apparently smaller and territory size larger. We speculate that the smaller group sizes in the Una Reserve may reflect higher mortality, perhaps as a result of higher predation pressure in this relatively undisturbed forest than in the secondary forests of the Poço das Antas Reserve. Larger territories in Una may be the result of interspecific differences in habitat use, or, may result from a greater resource availability in the forests of Poço das Antas. If the latter explanation is correct, we would predict a decrease in lion tamarin density in Poço das Antas as the degraded forests in that reserve mature.

In conclusion, large patches of relatively undisturbed forest adjacent to the Una Reserve presently contribute to much larger effective population sizes for GHLT's and most forest vertebrates, than would be the case in the Reserve alone. Given the rapid rates of deforestation in the region, we suggest that every effort be made to annex these remaining large forests to the Reserve. Where land acquisition is impossible we suggest intensive work with landowners to encourage the development of private forest reserves. In a few years we will no longer have these options.

Acknowledgements

We wish to thank the Brazilian Institute for the Environment and Renewable Natural Resources (Ibama), the World Wildlife Fund (WWF), the University of Maryland, and the Jersey Wildlife Preservation Trust (JWPT), Jeremy J.C. Mallinson, Zoological Director, in particular, for their generous support of our research.

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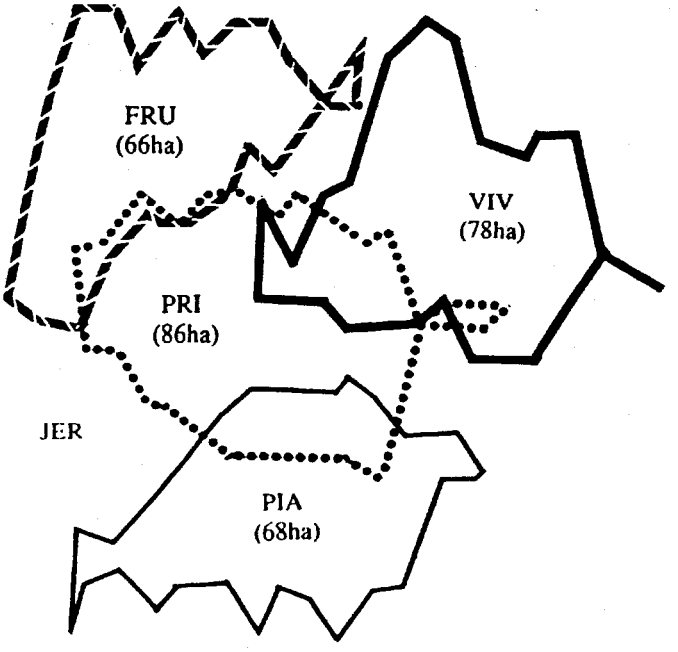

Figure 1. Territory perimeters for four groups of golden-headed lion tamarins in the Una Biological Reserve.

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Inventory and Conservation Status of Wild Populations of Golden-Headed Lion Tamarins, *Leontopithecus chrysomelas*

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The endangered status of the golden-headed lion tamarin has been recognized since the early 1970's (Coimbra-Filho, 1970, 1972). However, only in the last ten years has *L.chrysomelas* been the focus of considerable attention regarding its conservation. The principal stimulus for this arose as a result of concern over the illegal export of 50-60 animals to Belgium and Japan in 1983/84 (Konstant, 1986). Due to this, the Brazilian Institute for the Environment (Ibama) established the International Committee for the Recovery and Management of the species (Mallinson, 1986, 1987). The recovery was highly successful, and the Committee established a breeding program and studbook for the species. The 1993 studbook, now coordinated by Helga de Bois of the Antwerp Zoo, reported 575 animals in 49 institutions, and efforts are underway to reduce the growth of the population (De Bois, 1993). A Population Viability Analysis Workshop for the entire genus, organized by the IUCN/SSC Captive Breeding Specialist Group (now the Conservation Breeding Specialist Group) and the Fundação Biodiversitas, held in Belo Horizonte, Brazil, in 1990, established recommendations and priorities for the Conservation Plan for the species (Seal *et al.*, 1990). On the occasion of this workshop, the International Committee was formerly recognized by Ibama, and its mandate was changed to include all aspects of the species' conservation, including the wild populations.

One of the principal recommendations of the 1990 Workshop, concerning specifically *L.chrysomelas*, was the need for studies on the status and distribution of the species in the wild, considering that the captive population was by then well-established and healthy. This paper reports on an inventory of the wild populations of *L.chrysomelas*, and the information obtained on the status of the species in the context of the status of its natural habitats in northeast Brazil.

From April 1991 to March 1993, we conducted field work throughout an area of approximately 37,000 km^2, including the entire known distribution of the species in the south of the state of Bahia, and a small part of the extreme north of the state of Minas Gerais. This region is within the domain of the Atlantic forest, there divided into two principal forest formations: tropical evergreen rain forest in the eastern, coastal part, and seasonal, semideciduous forest in the parts inland and to the west (Mori and Silva, 1980).

Three main approaches were used in this study. The first involved informal interviews of local inhabitants, enquiring about the primates they recognized as occurring in the region. A total of 418 interviews of 620 people were made throughout the region. The second method involved direct censusing of forest patches using recordings of lion tamarin long calls ("playback") to increase the encounter rate (see Kierulff, 1993). Amplified recordings were played every 200 m along parallel trails (200 m apart) so as to cover all of smaller forest patches, or a known fraction of larger patches, in 33 areas. The third approach involved a survey of the archives of the regional office of the Brazilian Institute for the Environment (Ibama) and the Regional Cocoa Growing Authority (*Commissão Executiva do Plano da Lavoura Cacueira - CEPLAC*), principal supervisors and administrators of the socioeconomic activities of the region. The specific aim was to obtain an understanding of the economic growth of the region over recent years, and with this the trends regarding principal agricultural activities and deforestation. The analysis of this data and the elaboration of distribution maps for the species was carried out using the Geographic Information System (CISIG) developed by Conservation International, Washington, D.C., and installed at the Biodiversity Conservation Data Center of the Fundação Biodiversitas, Belo Horizonte.

The "playback" technique was evidently crucial for the success of the direct censuses. A total of 35 groups were registered during censusing, 26 (74%) of which resulted from responses to the long call recordings. Increasing the likelihood of finding groups, it increases the efficiency of censuses in a large number

of areas. It also means that the observers can spend longer with each group, the animals being attracted by the long calls, and allowing more time for more accurate counts of the composition and size.

The interview program was essential as a complement to the censuses. The lion tamarins are clearly recognizable and easily described, and the interviews provided in most cases reliable information on their occurrence or otherwise in the locality, and therefore a more complete picture of their distribution and total population size than would be possible through direct censusing alone. The interviews also provided valuable information on the capture of primates for pets and on hunting. Positive replies concerning the occurrence of *L.chrysomelas* were obtained for 72% of 181 interviews within the species' range.

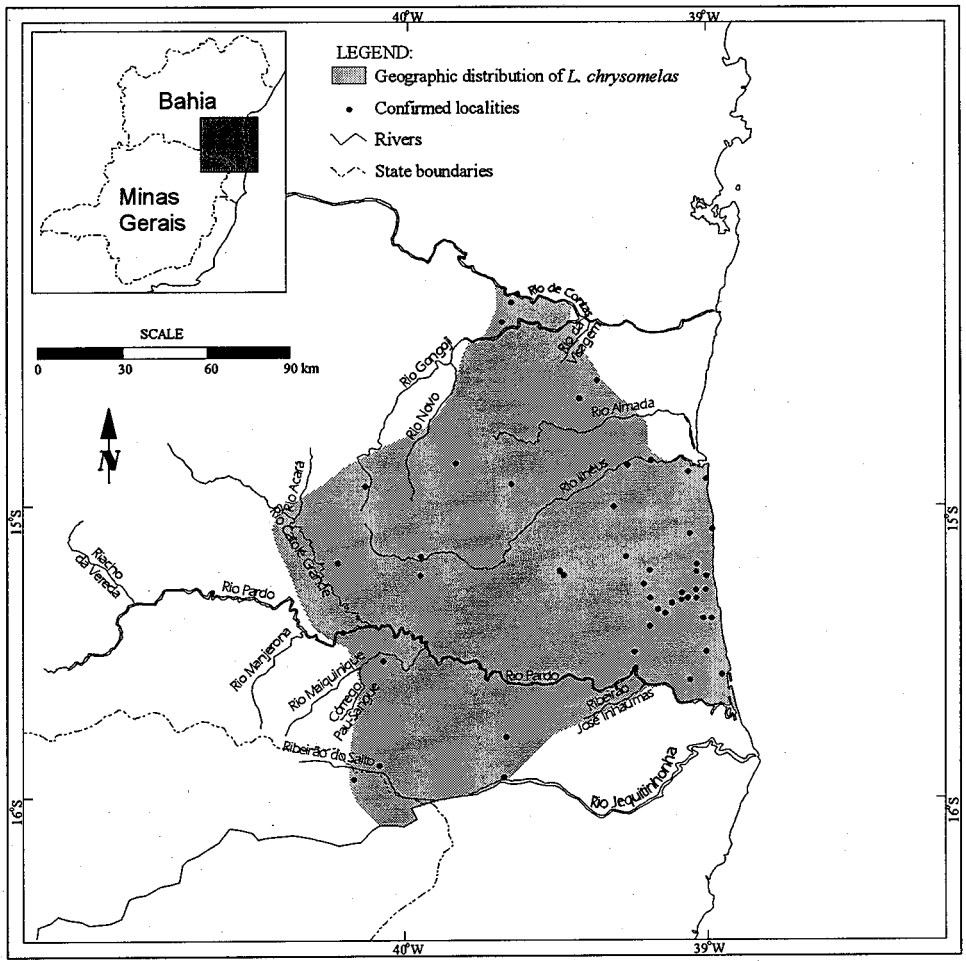

Figure 1. The geographic distribution of *L. chrysomelas*.

Of the 27 areas censused, all within the known geographic distribution, 24 provided direct sightings of *L.chrysomelas* groups, and combining these results with those of the interviews, 94 localities were registered as still maintaining populations of the species. Combining these with results from previous studies (Rylands *et al.*, in press) provides a total of 122 localities where the golden-headed lion tamarin still survives. The geographic distribution, based on these localities, was estimated at 19,462 km^2 (Fig.1); amongst the smallest recorded for any callitrichids.

The geographic distribution of *L.chrysomelas* is divided into two distinct regions in terms of land use. Cattle ranching predominates in the western part, which has resulted in highly fragmented forest. The eastern part corresponds to the principal cocoa growing region of Brazil, where forests are intermixed with cocoa plantations. Cocoa is frequently grown under a system referred to as *cabruca*, where a small number of the forest canopy trees are left standing to provide shade. This provides marginal habitat for numerous vertebrates, including the lion tamarins (Alves, 1990).

Habitat loss, estimated at about 0.5% per year, along with the fragmentation and degradation of forests, and the restricted distribution of the species, indicates that the golden-headed lion tamarin is highly endangered. The largest known subpopulation is in the Una Biological Reserve, now totalling 7059 ha (Coimbra-Filho *et al.*, 1993), where Dietz *et al.* (1994) have estimated approximately 416 individuals, with an effective population size of 160. These factors are sufficient to place *L.chrysomelas* in the endangered category, following the Mace-Lande Criteria, adopted by the World Conservation Union (IUCN) (Mace and Lande, 1991; Mace and Stuart, 1994). Urgent measures are required to guarantee the maintenance of

adequate habitat for this species, and others such as the yellow-breasted capuchin (*Cebus apella xanthosternos*), and the northern masked titi (*Callicebus personatus melanochir*) (see Santos *et al.*, 1987; Oliver and Santos, 1991). Since the public sector lacks the wherewithal for such a proposition, fundamental will be the participation of private landowners. This will require environmental education programs, and particularly the use of the Private Natural Heritage Reserve (RPPN) category of conservation unit now provided for in the Brazilian legislation.

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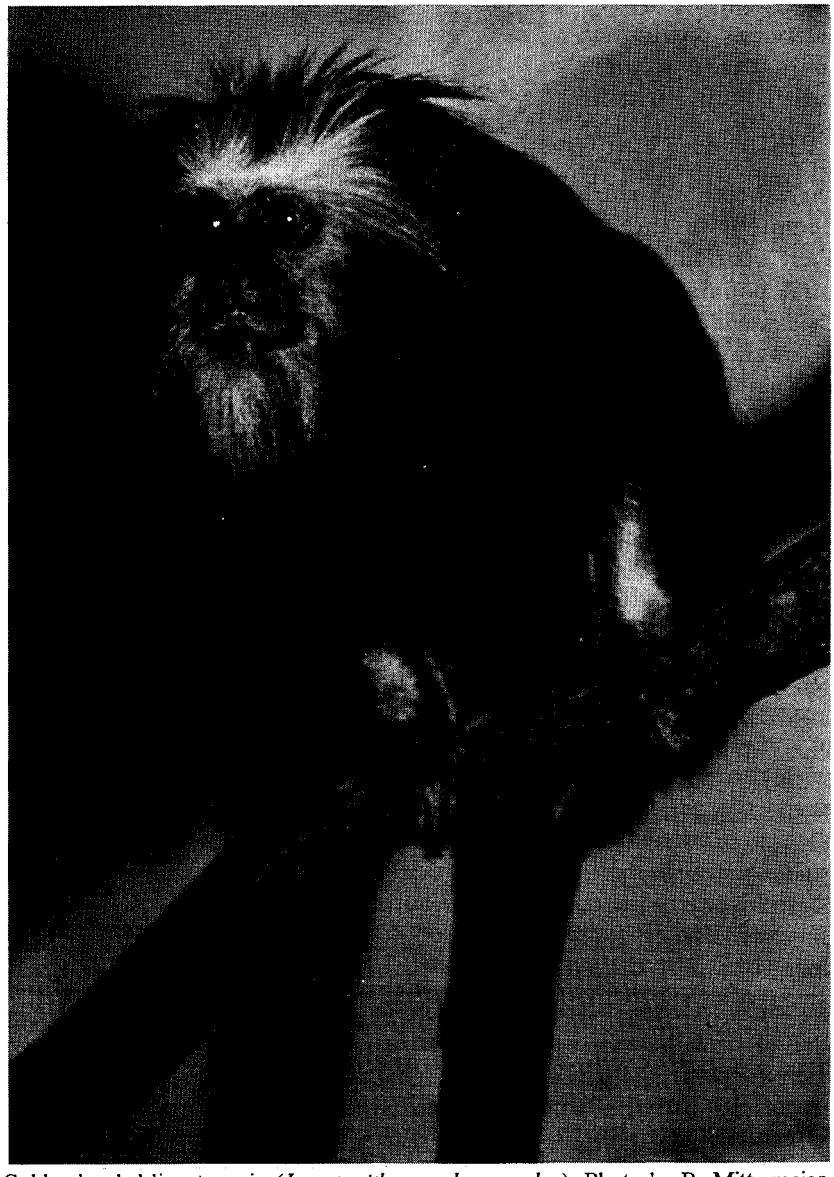

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Progress Report on the Captive Population of Golden-Headed Lion Tamarins, *Leontopithecus chrysomelas* - May 1994

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Background

Managed captive breeding of the golden-headed lion tamarin, *Leontopithecus chrysomelas*, has a relatively recent history (Ballou, 1989). In 1979, the captive population consisted of less than 20 individuals, all at the Rio de Janeiro Primate Center (CPRJ/FEEMA). The captive breeding programme was begun in the early 1980's, when illegally exported animals were discovered in Belgium, France and Japan (Mallinson, 1987). The Brazilian Institute for the Environment (Ibama), seriously concerned about this, established the International Recovery and Management Committee, chaired by Jeremy Mallinson (Jersey Wildlife Preservation Trust) and Adelmar Coimbra-Filho (Rio de Janeiro Primate Centre), which was extremely successful in returning the animals to Brazil, and at the same time in organizing a worldwide captive breeding program and studbook. By 31 August 1989, a captive population of 285 animals in 22 institutions was registered in the species' studbook (Mace, 1989). As pointed out by Ballou (1990), the founding of this captive population is "an interesting case history and an excellent example of how pressure brought to bear by international governmental and non-governmental conservation organizations can achieve successful conservation strategies".

Captive Population Today

The 1992 golden-headed lion tamarin studbook reported 472 (238.178.56) living animals in 47 institutions (Mace, 1992). On 31 December 1993, the living captive population of the golden-headed lion tamarin, managed by the International Recovery and Management Committee (IRMC), consisted of 575 (293.232.50) animals, distributed over 49 institutions in Brazil, Asia, North America, and Europe (Table 1) (De Bois, 1994a, 1994b). Comparing this with the status of the species on 31 August 1992, the population increased by more than 22% in 18 months. Population growth differed significantly between the regions. The North American population remained stable during this period, while in Europe and Brazil the number of *L.chrysomelas* in captivity increased by nearly 30%, and in Asia by more than 50%.

Considering space availability for callitrichids in general, and taking into account the minimum requirements to ensure long-term demographic and genetic health of the captive golden-headed lion tamarin population, it is evident that the most important management procedure now is to aim for zero population growth. At present, this is being achieved only for the North American population (Fig.1), thanks to the intensive management of the lion tamarin regional coordinator, Jonathan D.Ballou (National Zoological Park, Washington, D.C.), and the cooperation of the participating institutions. Four institutions in Europe have now provided females with contraceptive implants and established non-breeding groups (see Van Elsacker *et al.*, 1994), but many more animals should be restrained from breeding in the near future.

Breeding can be limited through such as contraception, sterilization and the formation of single-sex groups. However, there are still many questions and problems to be solved regarding the practical application of population control. I list here some examples concerned with the health of the female and possible social problems in non-breeding groups which should be considered captive research priorities in the coming years:

- What are the long-term consequences of hormonal implants on the health of the female?

Table 1. Golden-headed lion tamarins in captivity.

	Numbers 31 Dec 1993	Growth since 31 Aug 1992
Brazil	235	29%
North America	101	1%
Europe	208	27%
Asia	31	55%
TOTAL	575	22%

- What is the effect of hormonal implantation of the dominant female on the reproductive status of her daughters in the group?
- If breeding is stopped, how will the youngest animals in the group obtain breeding experience?
- What types of non-breeding social groups are stable, and how is this influenced by the size and design of the enclosures?

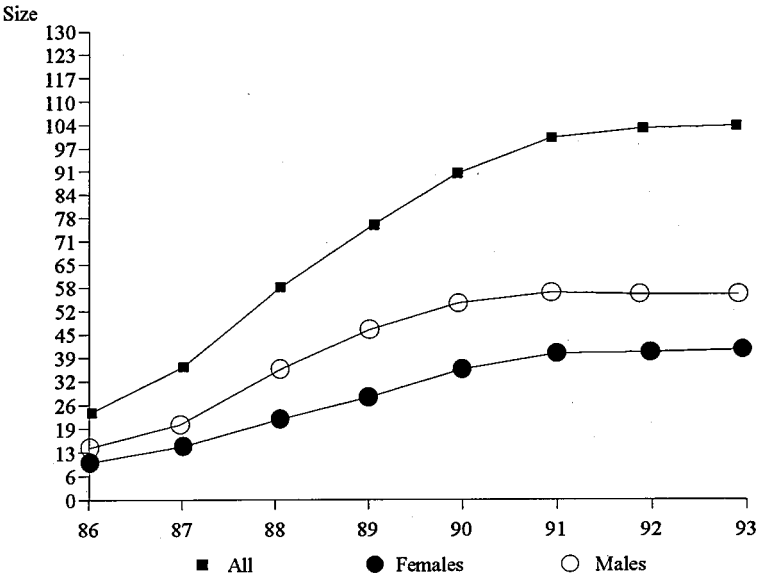

Figure 1. Evolution of population size of golden-headed lion tamarins in North America.

The present captive population has many founders (154), only a small number of which still lack descendants (Table 2). However, even with this large number of founders, it will be important to continue management for more equal founder representation. This can be illustrated by a comparison of the genetic situation of the North American and European populations. Although Europe has twice as many founders as North America, analysis shows that both regions have lost about equal amounts of genetic diversity (North America 4.4% and Europe, 4.0%). This is because the variation in genetic representation of the individual founders is much higher in Europe, resulting in a relatively higher loss due to random drift when compared to the North American population.

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Table 2. Genetic status of the regional golden-headed lion tamarin populations on 31 December 1993.

	No. of founders*	Loss of genetic diversity (heterozygosity)
Brazil	115 (30)	1.4%
North America	21 (0)	4.4%
Europe	47 (2)	4.0%
Asia	11 (0)	10.5%

*In parentheses: Number of founders without living descendants.

Preliminary Results on the Evaluation of Contraceptive Implants in Golden-Headed Lion Tamarins, *Leontopithecus chrysomelas*

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Introduction

A summary of the research on golden-headed lion tamarins (*Leontopithecus chrysomelas*) underway at the Royal Zoological Society of Antwerp, Belgium, was presented by De Bois and Van Elsacker (1993). Each of the behavioural research projects aim to find practical solutions to zoo-related problems, as well as supplying basic data on the animals. This is important in terms of gaining the interest and support of academic researchers as well as zoo managers for projects which are of interest to each but for differing reasons (Van Elsacker *et al.*, 1993).

One of the practical problems concerning the breeding programme for *L.chrysomelas* is the urgent need to stabilize population growth (De Bois, 1993, 1994a, 1994b). A number of techniques are possible, but in the Antwerp Zoo we have chosen the use of melengesterol-acetate (MGA) implants. We have been evaluating the effect of this contraceptive on the reproductive status of implanted females and their eldest female offspring since December 1993. At the same time we are studying the effect of the implant on the female's behaviour, particularly concerning the sexual behaviour of the breeding pair, to examine if and how the mother-daughter and father-daughter relationships are influenced.

In callitrichids, spontaneous social contraception prevents offspring from reproducing within their natal group (Abbott and Hearn, 1978; Abbott *et al.*, 1993). It is not unlikely, however, that changes in the formerly reproductive female resulting from an implant, be they physiological or behavioural, may prevent further suppression of reproduction in the offspring. In this case, one of the daughters may replace the mother as the group's breeding female, and even reproduce with her own father. Needless to say, the inbred offspring would be disastrous in terms of the management of the captive breeding stock.

Methods

The Study Animals: Two groups of golden-headed lion tamarins were studied. In both only the breeding female was given the hormonal implant. The reproductive status of the implanted females and their eldest daughters was monitored. Table 1 gives the composition of the two groups.

The implant: The silicone implants are the size of the tip of a cigarette filter (0.5 cm high). They are supplied through Dr E.D.Plotka, Wisconsin, USA. The implants were carried out three to four days after the female had given birth. The female was caught immediately following a suckling bout and the transfer of the infants to another group member. The implant was inserted under the skin between the scapulae. The incision required three to four stitches, and the female was returned to her group two hours later.

Observations: Social and sexual behaviour of the breeding male, the female, and the eldest daughter were observed on a daily basis using the method of focal animal and continuous recording. Observation was begun prior to the birth of the offspring (10 days before for Fabiola, and 35 days before for Josepha), and are still continuing. Urine samples from the mother and daughter were collected daily to record ovarian cycles.

Table 1. The composition of the two golden-headed lion tamarin study groups.

	Group 1	**Group 2**
Mother's name	Fabiola	Josepha
Age	>8 years	>8 years
Father's name	Boudewijn	Bonaventure
Age	>8 years	>8 years
Eldest daughter's name	Trees	Tina
Age	20 months	18 months
No.of other offspring	5	8

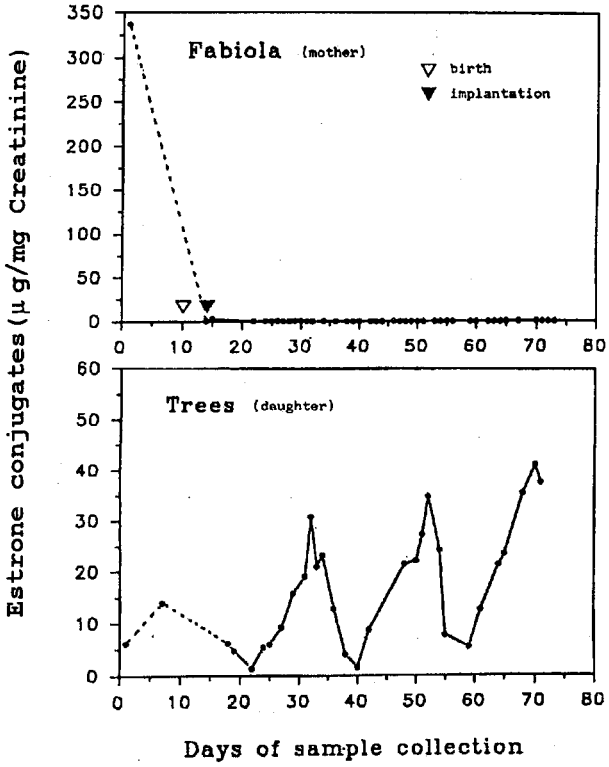

Figure 1. Estrone conjugate profiles for two female *L. chrysomelas,* Fabiola (>8 years) and Trees (20 months).

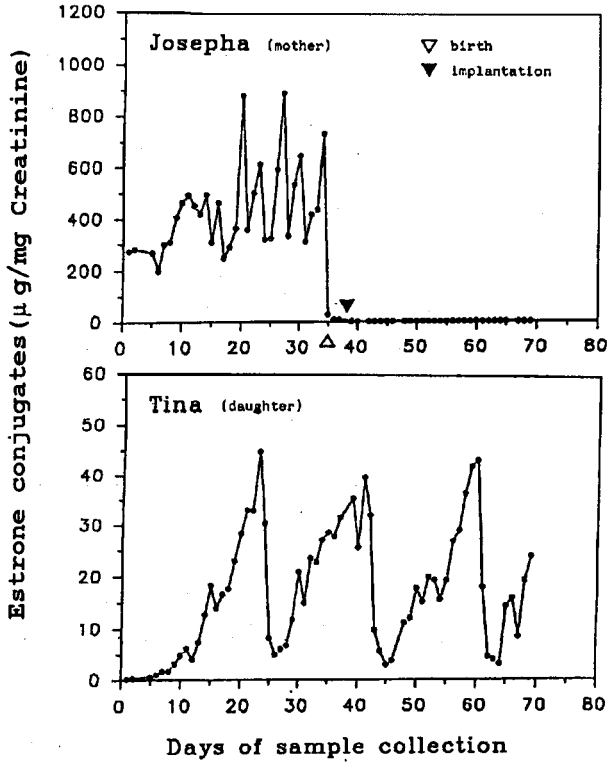

Figure 2. Estrone conjugate profiles for two female *L. chrysomelas*, Josepha (>8 years) and Tina (18 months).

Analyses: Hormone analyses of the urine samples were carried out at the German Primate Center, Göttingen. Measuring the changes in the concentrations of oestrone-conjugates has proved to be efficient in monitoring reproductive status in *Callithrix* (see Eastman *et al.*, 1984), *Cebuella* (see Ziegler *et al.*, 1990), *Saguinus oedipus* (see Ziegler *et al.*, 1987), *Saguinus fuscicollis* (see Heistermann and Hodges, 1994), *Leontopithecus* (see French and Stribley, 1985; French *et al.*, 1989) and *Callimico* (see Carroll *et al.*, 1990). In the absence of any information on hormone excretion in golden-headed lion tamarins, urinary oestrone conjugate E1C excretion was also expected to reliably reflect ovarian function in this species, and was therefore used to investigate reproductive function in the four study females.

Results and Discussion

The behavioural studies and hormone analyses are still underway, and the results presented here are. therefore, only preliminary.

Hormonal data: As can be seen in Figs. 1 and 2, both the former breeding females had a very high E1C level during late pregnancy which fell following parturition. Both females then showed consistently very low E1C concentrations during the remaining sampling periods (4-8 weeks), and did not resume ovarian cycles post-partum. Whether or not this is a direct result of the hormonal implant remains to be seen. However, the two non-breeding daughters showed E1C levels (presumably reflecting follicular phase values) which at their lowest were 10 times higher, which suggests that the implants were being effective in suppressing normal ovarian fuction. Further research will examine the post-partum hormonal profiles of non-implanted females.

Another interesting result is that both daughters showed regular cycles during the entire sampling period. The cycles had a duration of approximately 18-20 days, very similar to that reported for *Leontopithecus rosalia* by French and Stribley (1985). As for golden lion tamarins, therefore, it would appear that at least the eldest daughters remain physiologically fertile and are not hormonally suppressed by the presence of the breeding female (French and Stribley, 1987), as has been reported for other callitrichid species (Ziegler *et al.*, 1987, Epple and Katz, 1984; Heistermann *et al.*, 1989; Abbott *et al.*, 1993).

Behavioural data: As with the hormonal study, the research is ongoing and the results are preliminary. Although the mothers were hormonally suppressed during the period of implantation, the general behavioural pair-bond between them and their mates continued to exist. Completed copulations never occurred however, with mating attempts by the males being frustrated by the females who, although permitting mounting, were otherwise not fully cooperative. Although the daughters were cycling, we never witnessed any sexual interactions with their fathers, and there were no obvious changes in the relationship between mother and daughter.

Although the results are as yet inconclusive with respect to the effects of the implant, they are providing us with the first information on endocrine reproductive parameters for the species. The results should help us to interpret the behavioural data with respect to the mother-daughter relationship, and in particular to examine if and how the mother will manage to maintain her dominance in terms of preventing her daughters from breeding. If, as is becoming evident, *Leontopithecus* breeding females, unlike other callitrichids. do not maintain physiological dominance but only behavioural dominance over subordinate females (for review see Abbott *et al.*, 1993), one might expect that the implant will have no effect, although the lack of breeding in itself might be a "behavioural" aspect which eventually brings about a change in the subordinate role of the daughters. It would be of great interest to carry out similar studies on callitrichids showing physiological inhibition of subordinate females.

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Evaluation of Community-Based Conservation Education: A Case Study of the Golden-Headed Lion Tamarin Education Program in the State of Bahia, Brazil

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Introduction

This study was designed to evaluate the effectiveness of the community-based conservation education program "Projeto Mico-Leão-Baiano" (Bahian Lion Tamarin Project) in changing the knowledge, attitudes, and behavior of people in the region around the Una Biological Reserve in the south of the state of Bahia, Brazil (Nagagata, 1994). More specifically, the aim was also to determine if a conservation education program should be developed which targets the landowners and farmers in the Una region. Initiated in 1989, and concentrating primarily on the communities of Ilhéus and Itabuna, the "Projeto Mico-Leão-Baiano", run by Maria Cristina Alves, uses the endemic and endangered golden-headed lion tamarin (*Leontopithecus chrysomelas*) as a symbol and focal point to encourage the conservation of the rapidly dwindling Atlantic coastal forest of the region (Alves, 1991).

Methods

A questionnaire was used to compare target (community) and non-target (farmers) groups. Seventy-five community people and 145 farmers were interviewed. Data were obtained on knowledge, attitudes, and behavioral intent towards the golden-headed lion tamarin (GHLT) and the local forest. An "ex post facto" quasi-experimental design was chosen to compare between the groups (Tull and Hawkins, 1990).

Results and Discussion

Knowledge: The golden headed lion tamarin was found to be well known in the region. A high percentage of respondents in both groups (78.7% of the community and 77.9% of the farmers) recognized the GHLT from a photograph. However, only 37% of the community and 19.6% of the farmers also recognized the GHLT as the most endangered local animal. Thus, although more than three-quarters of the interviewees recognized the GHLT, considerably fewer were cognizent of its endangered status. There was evidently a "knowledge gap" between recognizing the animal and knowing that it is an endangered and endemic species. The gap was more pronounced amongst the farmers.

Attitudes: Both groups showed fairly positive attitudes toward the GHLT and the forest, although the community rather more so than the farmers. Eighty-nine percent of the community and 68.8% of the farmers thought that the forest has benefits for man (Table 1). This difference is statistically significant.

Approximately 68% of the community and 70% of the farmers thought that deforestation in the region was a serious problem (Table 2). In contrast, 6.7% of the community and 27.4% of the farmers thought that the amount of deforestation was *not* serious, while 25.3% of the community and 2.2% of the farmer's "did not know". There is a significant difference between the groups, resulting from the difference in the "not serious" and "do not know" categories.

Table 1. Comparison between the community and farmers regarding benefits from the forest. "Do you think the forest has any benefit?"

	Frequency Observed (%) Frequency Expected*			
	Yes	No	Don't know	Total
Community	67 (89.3)	3 (4.0) 56.8	5 (6.7) 11	75 (34.2) 7.2
Farmers	99 (68.8) 109.2	29 (20.1) 21	16 (11.1) 13.8	144 (65.8)
Total	166 (75.8)	32 (14.6)	21 (9.6)	169 (100.0)

* $X^2 = 10.52$, $p = 0.005$

Table 2. Comparison between the community and farmers regarding the amount of deforestation in the municipality. "How serious do you think the amount of deforestation is in the municipality?"

	Frequency Observed (%) Frequency Expected*			
	Not Serious	Don't know	Serious	Total
Community	5 (6.7)	19 (25.3)	51 (68.0)	75 (35.7)
	7.9	15	52.1	
Farmers	37 (27.4)	3 (2.2)	95 (70.4)	135 (64.3)
	14.1	2.7	93.9	
Total	42 (20.0)	22 (10.5)	146 (69.5)	210 (100.0)

* $X^2 = 31.56$, $p = 0.0001$

Behavior: Few respondents in either group claimed to have participated in some type of conservation activity (Table 3).

Recommendations

1. Information from this study indicates that the "Projeto Mico-Leão-Baiano" could benefit from at least two additions. First, the project could place greater emphasis on the fact that the golden-headed lion tamarin is endemic and endangered, and as a "flagship species" for the local forests. Second, the project could incorporate more participatory conservation activities into its program. Evaluations of the project in future years could address how long-term changes in knowledge and attitudes affect behavior and values regarding conservation of local natural resources.

2. The principal finding of this study is that the community-based program is not reaching the farmers. This argues strongly for the need for a conservation education program designed specifically for them. Different kinds of farmers (poor farmers v. wealthy farmers, small landholders v. large landholders) will require different kinds of education programs. The author's personal experience further suggests that the most effective program should be delivered on a personal basis (the educator working directly with individual farm owners). In addition, farmers are more likely to be positively influenced by other local farmers who already have positive attitudes about conserving the forest and who have already participated in conservation activities (Reading and Kellert, 1993).

3. A conservation program for farmers should incorporate the following features:

a) *Self-reference.* An effective rural conservation education program should include many specific references to the farmers and their problems (Rogers, 1977). In this case the principal problem is the need to integrate agricultural production (their livelihood) with forest production. The educator should obviously also have a clear understanding of the problems specific to the region and to the crops farmed, and hence the economic aspects of conservation-oriented practices. In Una, the predominant crop is the perennial cocoa, which over recent years has been suffering from epidemics of witch's broom disease, and low international market prices. Likewise, there are a number of methods for the cultivation of cocoa in terms of the shade plants used, which include *Erythrina*, canopy trees of the original forest (*cabruca*), and numerous others such as bananas and even rubber trees (see Alves, 1990).

b) *Problem-solving.* An important characteristic of a good conservation education program is a focus

Table 3. Conservation activities participated in by members of the community and farmers.

	Frequency	%
COMMUNITY (N = 14)		
Presentation in school	4	5.3
Planting seedlings	4	5.3
Cleaning the beach	2	2.7
Conservation of the forest	2	2.7
CEPLAC seminar[1]	1	1.3
Member of Green Party	1	1.3
FARMERS (N = 23)		
Planting with CEPLAC[1]	6	4.1
Forest conservation	2	1.4
Cocoa cultivation	2	1.4
Advisor on conservation	2	1.4
Agricultural technician	2	1.4
Planting seedlings	2	1.4
Planting trees	1	0.7
Defending nature	1	0.7
Research	1	0.7
Motorsaw licence	1	0.7
Helping Ibama[2]	1	0.7
Conservation foundation	1	0.7
EMAQ activities (military)	1	0.7

[1] *Comissão Executiva do Plano da Lavoura Cacueira* (CEPLAC), the Regional Cocoa Growing Authority.

[2] *Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis* (Ibama), the Brazilian Institute for the Environment.

on specific problem-solving. If the farmers are given an opportunity to help solve some of the problems they are causing, they are more likely to be interested in participating in conservation.

c) *Audience analysis.* Different problems are caused by and affect different groups (audiences). It is important to determine and understand which problems need to be addressed for each. Audience analysis should take place before the conservation education program is begun, but should also be carried out during and after the program as well (McDonough, 1984).

d) *Evaluation.* An evaluation protocol should be developed and implemented *prior* to initiating the conservation education program.

e) *Clear objectives.* An important element for the success of a rural conservation education program *and* for its accurate evaluation is to establish clear objectives from the start. Formal evaluations are usually designed to assess whether the predetermined objectives are being met. The objectives must clearly state whether knowledge, attitudes, and behaviors, or some combination of them will be changed (McDonough, 1986).

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The Conservation Biology of the Black Lion Tamarin, *Leontopithecus chrysopygus*: First Ten Years' Report

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Introduction

The black lion tamarin conservation biology project began ten years ago. The long term research on this species has resulted in information on its genetics, behavior, ecology, demography and habitat characteristics. It has also provided additional benefits such as the protection of forest fragments which belong to private landowners. The involvement of ranch owners in this species' conservation has enhanced the protection of forest fragments within the original range of the black lion tamarin. The protection of remnants of their habitats which are scarce nowadays, enhances the protection not only of this primate, but of all other species found in the same ecosystems.

Other important aspects of the black lion tamarin project have been the training of field professionals and environmental education activities. University students and field assistants, Brazilians and from abroad, are constantly being trained and absorbed in this study or in other field studies, resulting in an effective training program for the conservation of endangered species. Similarly, educational activities are conducted in all research sites as an important part of the species conservation strategy.

The recent phase of the long term conservation management plan for the black lion tamarin resulted from the *Leontopithecus* Population Viability Analysis Workshop, held in 1990 (Seal *et al.*, 1990), which showed that the survival of the black lion tamarin was threatened in the middle to long term. Based on these findings we proposed that the conservation of the species must rely on the effective protection of officially protected areas, privately-owned habitat fragments and captive colonies. These different populations or sub-populations should be integrated in a metapopulation plan which involves translocation, managed dispersal and the continuity of the long term comparative studies underway.

Project Description

Definition of the Problem: In a world increasingly affected by humans, where large tracts of relatively undisturbed habitats are being shredded and fragmented, one of the major challenges for conservation biology is ameliorating the long term consequences of population fragmentation. As indicated above, the black lion tamarin is an extreme example of this habitat fragmentation requiring management for its long term survival (Seal *et al.*, 1990). In the wild, there are around 1000 animals in five confirmed sub-populations; two in protected areas (Morro do Diabo State Park and the Caetetus Ecological Station) and three in privately owned forest fragments (Valladares-Padua and Cullen, in press) (Fig. 1). A Population Viability Analysis carried out

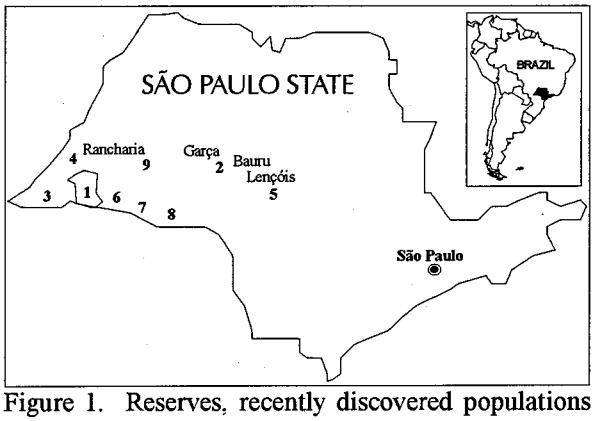

Figure 1. Reserves, recently discovered populations and potential localities for reintroduction or translocation of black lion tamarins. Numbers on the map correspond to the following areas. Reserves: 1. Morro do Diabo State Park, 2. Caetetus State Ecological Station. Areas with recently discovered populations of black lion tamarins: 3. Tucano/ Rosanella Ranch, 4. Ponte Branca Ranch, 5. Rio Claro Ranch. Potential areas for reintroduction/ translocation: 6. Santa Rita Farm, 7. Mosquito Ranch, 8. Vista Bonita Farm, 9. Bartira Farm.

for the black lion tamarin suggested that, if not managed, its survival probability for the next 100 years is very remote even with the most optimistic scenarios for the species.

Previous Information on the Black Lion Tamarin Project: The success of the long term conservation project for *L. chrysopygus* is highly correlated to the amount of knowledge acquired on the species. The Black Lion Tamarin Project has developed one of the largest existing data bases for any neotropical mammal species. It includes information on: 1) distribution and status; 2) genetics; 3) demography in the wild and in captivity; 4) ecology and behavior; 5) captive breeding; 6) habitat restoration; and 7) environmental education.

Current Situation: Presently the Black Lion Tamarin Project is confronting the challenge of designing management plans based on updating the concept of metapopulation (the series of isolated sub-populations of a species) developed by Levins (1969, 1970). To understand the conservation approach we are proposing, it is important to know that when Levins coined the term "metapopulation", what he had in mind was an infinite number of sub or local populations of one species. His main interest was not conservation, but the development of a mathematical model to optimize biological control of crop pests. The idea was to balance local extinction of pest-predators by re-migration from other populations. Thus, in his view, a metapopulation could be regarded as the net result of the establishment, survival, and extinction of local populations.

The approach we are using was developed subsequently, mainly by Gilpin (1987) and Hanski and Gilpin (1991). They proposed an adaptation of Levin's model to conservation biology using a finite number of sub-populations. Their concept identified the minimum viable size of a population as not solely dependent on its size, but also on the patchiness of the existing habitats and on the movement of each individual between habitable patches. The extreme version of their model is the case where discontinuous habitats may result in the total impossibility of natural migration among local populations. These fragmentation processes create small isolated sub-populations enhancing their probability of extinction due to genetic, demographic and environmental forces acting within patches (Soulé, 1980; Ralls and Ballou, 1983). Even if the sub-populations survive, isolation itself might cause differentiation and consequent speciation (Wright, 1977; Franklin, 1980; Otte and Endler, 1989). In the cases where fragmentation precludes natural migration, metapopulation management entails artificially moving animals from one patch to another. Translocation and managed animal migration must also take into consideration previous knowledge about the species so the animals can survive and reproduce in the new area (Foose, 1990).

Since the black lion tamarin is reduced to small fragmented sub-populations (Fig. 1), we believe it is close to the extinction scenario, which can be reversed if we adopt metapopulation management as the central conservation strategy for the species. We have begun to implement this strategy, and in 1995 we intend to complete the following three major steps:

1. A study of potential translocation habitats for the species. Areas with habitat significantly similar to the habitat found in the areas occupied by black lion tamarin subpopulations;

2. A long term monitoring of a series of neighboring groups in one of the black lion tamarins sub-populations;

3. Translocation of one or two of these monitored groups to a protected and uninhabited, pre-selected habitat area.

Methods/Action Plan: To determine the habitat areas appropriate for translocation we are using multivariate analysis to statistically compare potential areas with areas effectively used by the species. The potential areas are the Fazendas Mosquito, Santa Rita and Vista Bonita in the western part of the State of São Paulo and the "palmital" (palm heart plantation) section of the Fazenda Rio Claro. We surveyed these areas in 1991, and found no tamarins. These areas are being compared to those at Morro do Diabo where we conducted a long term study on the ecology and behavior of the tamarins between 1987 and 1990. If the data collected for the habitat of a potential area are not statistically different from those found at Morro do Diabo where the tamarins inhabit, the area will be considered as appropriate for the species and may receive translocated animals.

Together with the translocation, we will develop a long term monitoring of the group to be translocated as well as its neighbors. This will furnish information on habitat selection among lion tamarins. In practical terms, we will be able to analyze how the newly vacant

home range will or will not be occupied by the surrounding individuals or groups of lion tamarins. The resulting data will be very important in a theoretical view point where little is known on habitat selection. However, the most important aspect is the information obtained on minimum and maximum home range sizes and the carrying capacity of a given area which will allow us to calculate the minimum viable habitat for the species.

Personnel Involved: The following professionals are involved in this project, full or part time:

- Claudio Valladares Padua, General Coordinator
- Laury Cullen Jr., Field Coordinator
- Cristiana S. Martins, Field Coordinator
- Carolina Mamede, Local Coordinator at Duraflora
- Evandro L. Gonçalves, Local Coordinator at Morro do Diabo
- Eduardo Ditt, Local Coordinator at Caetetus
- Fabiana Prado, Researcher at Caetetus
- Marilene M. Silva, Researcher at Duraflora
- Jose Maria de Sousa, Field Assistant
- Luiz Homero Gomes, Field Assistant
- José A.G. Garcia, Field Assistant
- José Maria Aragão, Field Assistant
- Suzana M. Padua, Environmental Education Coordinator

There are also a number of trainees and other professionals who have been involved part time with the field work.

The Project's Most Important Results

Black Lion Tamarin Project Continuity: The following activities have been developed in the past ten years, or are being conducted currently:

Already concluded:

a. Preliminary survey of the current distribution of the species;
b. Genetic study of some wild and captive populations;
c. Demographic study of wild and captive populations;
d. Long term study on the ecology and behavior of the species at the Morro do Diabo State Park;
e. Environmental education program at the Morro do Diabo State Park;
f. Survey for new populations in the State of São Paulo;
g. Pre-selection of potential areas for translocation and reintroduction;
h. Census at the Caetetus Ecological Station.

In Progress:

a. Periodic census of the newly discovered sub-populations;
b. Field study on the ecology and behavior of different sub populations;
c. Comparative study on habitats;
d. Pilot project on habitat recovery in Morro do Diabo;
e. Environmental education program for the Caetetus Ecological Station.

To be developed in 1994-1995:

a. A pilot project on translocation;
b. A new survey for wild populations;
c. Field study on the ecology and behavior of different sub-populations.

Training and Environmental Education: One of the most important aspects of this project has been the training of students and field assistants. We have been training people in the field since 1988, when the Morro do Diabo study began. More than 20 people, varying from university students to field assistants, have participated. Environmental education has become a crucial part of the Black Lion Tamarin Project. The Morro do Diabo education program which began in 1989, was receiving in 1991 an average of 1,500 students per month (Padua, 1994). The field staff have begun a similar project at the Duraflora site (Lençois Paulista), with the students living at the Fazenda Rio Claro, one of the research sites. This education program still needs to be structured and evaluated so it can expand and benefit other communities. The idea is to multiply the experience of the Morro do Diabo to the other sites where *L. chrysopygus* is found.

Acknowledgments

We would like to thank the Forestry Institute of the State of São Paulo (IF), the São Paulo Electricity Company (CESP) and the Secretary of the Environment of the State of São Paulo for supporting this program. We are grateful to the communities of Teodoro Sampaio and other towns in the Pontal region which welcomed our conservation initiatives. We also thank individuals and institutions who have supported our work, such as Apenheul - Holland, the Canadian Embassy, in Brazil, Conservation International, the Brazil Science Council (CNPq), Duraflora S.A., Fanwood Foundation, the Fauna and Flora Preservation Society, Fazenda Rosanella, Fazenda Ponte Branca, the Brazilian Institute for the Environment (Ibama), the International Committee for

the Preservation and Management of the Black Lion Tamarins, the Jersey Wildlife Preservation Trust, Lincoln Park Zoo, Whitley Animal Protection Trust, Wildlife Preservation Trust International, World Wildlife Fund - US and the University of Florida, Gainesville.

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Behavior of the Black Lion Tamarin, *Leontopithecus chrysopygus*, in Different Forest Levels in the Caetetus Ecological Station, São Paulo, Brazil

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Introduction

This paper reports on one of the aspects under study in a project underway examining the ecology and behavior of the black lion tamarin, *Leontopithecus chrysopygus*, in the Caetetus Ecological Station. Little is known of the behavior of lion tamarins concerning their use of different vegetation levels in the forest. It is emphasized, however, that further data are being collected, and the results reported here are preliminary.

Material and Methods

The Caetetus Ecological Station (22° 23'S, 49° 41'W) is a small forest reserve of 2,179 ha, administered by the São Paulo Forestry Institute. The study group, of six individuals in December 1993, was by March 1994 composed of just four: an adult female, two adult males, and an infant female. The group has been accompanied since December 1993, using radiotelemetry. Basic data is obtained using scan-sampling (Altmann, 1974), recording the following four activities: feeding, moving, resting and foraging, each of which are divided into descriptive subcategories. Feeding includes the manipulation and ingestion of foods, whereas foraging is recorded when the tamarins are evidently searching for animal prey. The forest height is recorded for each behavioral record: understorey 0-8 m, middle layers 8-16 m, and canopy above 16 m, in order to obtain a picture of the association between their behaviors and the forest layers.

Results

To date, 1,410 behavior records have been obtained during 119 hours of direct observation: feeding N=505 (35.8%), moving N=465 (33.0%), foraging N=237 (16.8%), and resting N=203 (14.4%). All four of these behaviors were carried out mainly in the middle layers of the forest (8-16 m) (Fig.1).

A little more than half (51.5%) of the feeding records were in the middle layers, largely due to fruit-feeding (N=242). Feeding on fruits in the canopy was registered for a further 36.6% (N=184) of the feeding records, due to such important trees as *Celtis pubescens*, *Cordia superba*, *Rhamnidium elaeocarpum* and *Ficus* sp. Feeding in the understorey (11.6%, N=60) was restricted to animal prey and exudate feeding. With regard to locomotion, again a little more than half of the records for moving were in the middle layers (55.5%, N=258). However, different from the pattern seen for feeding, 34.0% (N=158) were in the understorey, and only 10.5% (N=49) were in the canopy. The use of the middle layers was most accentuated for resting. 72.9% of the resting records were in the middle layer, 19.7% (N=40) in the understorey, and 7.4% (N=15) in the canopy. Foraging showed a similar pattern to that observed for locomotion: 57.0% (N=135) in the middle layers, 29.9% (N=71) in the understorey, and 13.1% (N=31) in the canopy.

Discussion

A preference for the middle layers of the forest was marked for all of the behavior categories sampled.

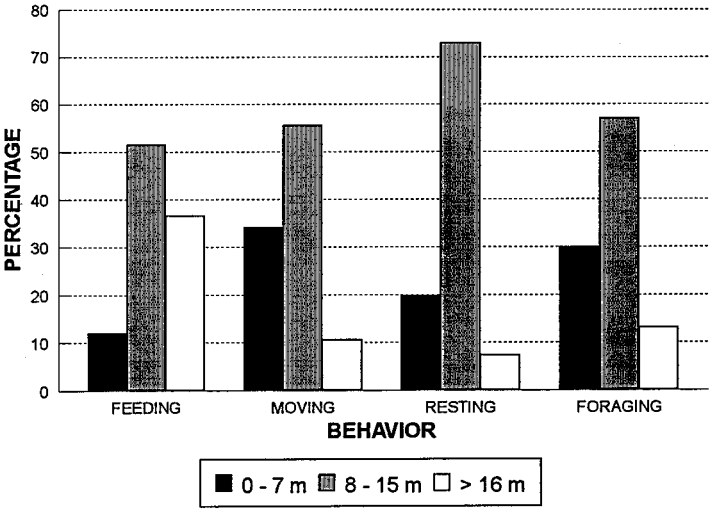

Figure 1. Behavior of black lion tamarins in different forest levels in the Caetetus Ecological Station, Gália, São Paulo.

Feeding on fruits was the principle reason for their use of the canopy, and moving and foraging for their use of the understorey. Information on the use of different forest levels has also been obtained for four groups studied by Valladares-Padua (1993) and his colleagues in the Morro do Diabo State Park. The height at which they recorded the lion tamarins was most frequently between 7 and 8,5 m, and on occasion they were observed going to the ground to obtain food, also seen at Caetetus (Keuroghlian, 1990; Passos, 1992). No studies on the vertical use of space have been published for the golden lion tamarin, *L.rosalia*. However, observations by Coimbra-Filho and Mittermeier (1973) suggested that they spend much of their time between three and 10 m. Rylands (1989) observed *L.chrysomelas* spending more of their time higher in the forest, above 12 m in the majority of records (80%), with foraging occurring generally between 13 and 19 m. The foraging level corresponded to that containing the highest abundance of large bromeliads, one of their preferred foraging sites, but non-bromeliad foraging was also largely restricted to these levels. Rylands (1989) also obtained data on the syntopic marmoset, *Callithrix kuhli*, which foraged at lower levels than *L.chrysomelas*. The majority of sightings (78%) were below 15 m, and slightly more than half of all the records (53%) were between 8 and 15 m (Rylands, 1989).

A number of factors determine the use of different levels of the forest in these animals, which undoubtedly differ between sites and most particularly for the different populations of each species. They include the relative importance of aerial and terrestrial predators, the vertical distribution of fruit and animal prey, and the forest structure, notably the height, degree of stratification and the vegetation density at each level. Sympatric primate species can also be expected to influence the use of different levels, and the presence of *C.kuhli* at Rylands'(1989) study site may well be contributing to a greater use of higher levels than has been found for other species. The lion tamarins at Caetetus are probably suffering competition from the high density of capuchin monkeys, *Cebus apella* (see Coimbra-Filho, 1976). A comparison of the vertical use of the forest in the four lion tamarin species along with an understanding of the habitat differences for each population would be of great interest to understand better the factors influencing the relative use of the different heights of the forest, and hence to understand better the adaptive behavior of these species.

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A Contribution to the Study of the Arboreal Vegetation of the Caetetus Ecological Station, São Paulo, Brazil

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Introduction

The Caetetus Ecological Station is in the north-west of the state of São Paulo, in the municipalities of Gália and Alvinlândia. With an entirely forested area of 2,178 ha, it is forms the largest single block of forest in the region. The forest is semi-deciduous, at altitudes ranging from 550 to 700 m. The climate is seasonal, with a hot rainy season, and a cooler dry season. Much of the Reserve is dissected by streams and swampy areas.

Here we report on the first study of the phytosociology of the forest in the Ecological Station, in a region where most has already been destroyed, reflecting the situation throughout the state of São Paulo where only about 3% of the forests still stand. Although being an important study in itself, the primary objective of the survey was to evaluate the distribution and abundance of food resources for the black lion tamarin, *Leontopithecus chrysopygus* (see Passos, 1992).

Material and Methods

The quadrant method (Martins, 1991) was used for the vegetation survey due to the rapidity and ease of data collection, and its adequacy in terms of supplying the information needed for an understanding of food availability for the *L.chrysopygus* groups in the Reserve. Data was obtained on the density, dominance and absolute frequency of the tree species. Quadrants (N = 157) were marked at 40 m intervals along eight trails, totalling about 6 km. All tree species in each quadrant which had a diameter at breast height $\geq$25 cm were marked and identified. The study was carried out from August 1993 to February 1994. The plant species are being identified by specialists at the Herbarium of the State University of Campinas, the Forestry Institute of São Paulo, and the Botany Institute of São Paulo.

Results

A total of 628 trees (528 identified to species), with heights ranging from 1.5 to 30 m, have been marked. The maximum circumference recorded was 2.7 m. One hundred species have been identified to date, distributed among 36 families. The most abundant families in terms of individuals recorded are, in order, Euphorbiaceae (N = 170 individuals), Myrtaceae (N = 49), Lauraceae (N = 47), and Rutaceae (N = 42) (Fig.1). In terms of species richness, the most speciose families recorded were Myrtaceae (10 spp.), Rutaceae (8 spp.), Fabaceae (7 spp.), Euphorbiaceae (6 spp.), Mimosaceae (5 spp.) and Moraceae (5 spp.) (Fig.2).

The most abundant species were two representatives of the Euphorbiaceae: *Securinega guaraiuva* (N = 113) and *Croton floribundus* (N = 35). These were followed by *Aspidosperma polyneuron* (Apocynaceae, N = 19), *Piptadenia gonoacantha* (Mimosaceae, N = 17), *Astronium graveolens* (Anacardiaceae, N = 16), and *Alchornea triplinervia* (Euphorbiaceae, N = 15). All of these species were used by the lion tamarins for sleeping holes.

A number of other species which were recorded in the survey have been found to be important as food resources for the lion tamarins. Those providing fruits include: *Chrysophyllum gonocarpum* (N = 11), *Syagrus romanzoffiana* (N = 10), *Protium widgrenii* (N = 10), *Inga* spp. (N = 7), *Duguetia lanceolata* (N = 6), *Cordia ecalyculata* (N = 6), *Rhamnidium elaeocarpum* (N = 5), and *Tapirira guianensis* (N = 3). *L.chrysopygus* differs from the other lion tamarins in its more extensive use of tree exudates (Passos and Carvalho, 1991; Rylands, 1993). Species they use to obtain gums were also represented: *Croton floribundus* (N = 35), *Piptadenia gonoacantha* (N = 17), *Euterpe edulis* (N = 11), *Pilocarpus pauciflorus* (N = 11), and *Esenbeckia leiocarpa* (N = 9).

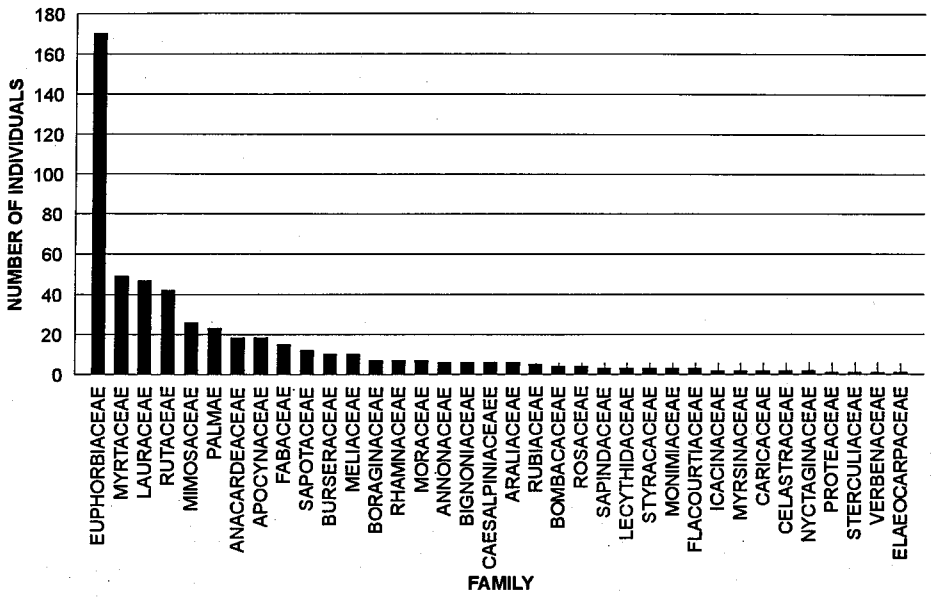

Figure 1. Relative abundance of trees in terms of the number of individuals of each family identified in the Caetetus Ecological Station, São Paulo, Brazil.

Discussion

Although the results presented here are only partial, they indicate a forest with a high degree of similarity to others studied in the state of São Paulo (César and Leitão-Filho, 1990; Pagano and Leitão-Filho, 1987). There are of course local and regional variations in floristic composition (Pagano *et al.*, 1987), but the overall pattern conforms to the conclusion of Leitão-Filho (1987) that the semi-deciduous forests of the upland plain of São Paulo typically demonstrate a marked presence of Fabaceae, Rutaceae, Euphorbiaceae, Lauraceae, and Myrtaceae.

The continuation of this study will permit a better understanding of the ecology and behavior of the black lion tamarin, notably in terms of understanding its group size, ranging behavior and seasonality in reproduction. A knowledge of the floristic composition, and the distribution and abundance of the food resources available to and exploited by *L. chrysopygus* is also an invaluable tool for the translocations and meta-population management proposed by Valladares-Padua *et al.* (1994), and will hopefully provide us with a better understanding of the differences in the ecological and behavioral parameters of the four species (Rylands, 1993).

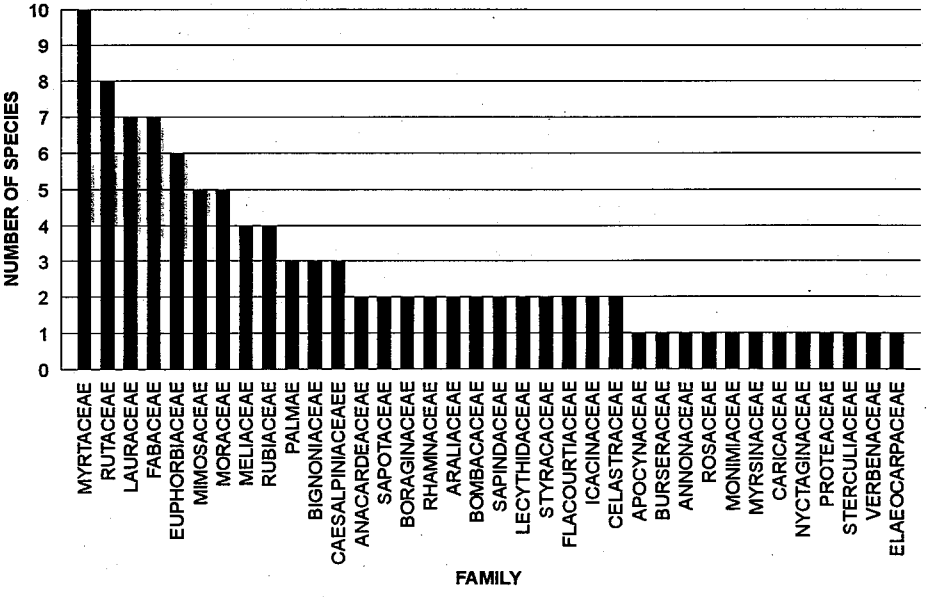

Figure 2. Tree species richness for the families identified in the Caetetus Ecological Station, São Paulo, Brazil.

Acknowledgements

We are grateful to the São Paulo Forestry Institute (IF-SP), and the Brazilian Institute for the Environment (Ibama) for permission to carry out this study. Dr J. B. Baitello, Dr H. F. Leitão-Filho, and Dr Inês Cordeiro kindly identified the plant specimens. Dr Anthony B. Rylands kindly translated the manuscript. The research is being financed by the Brazilian Higher Education Authority (CAPES), the Brazil Science Council (CNPq), the World Wide Fund for Nature (WWF), the Fundação o Boticário de Proteção à

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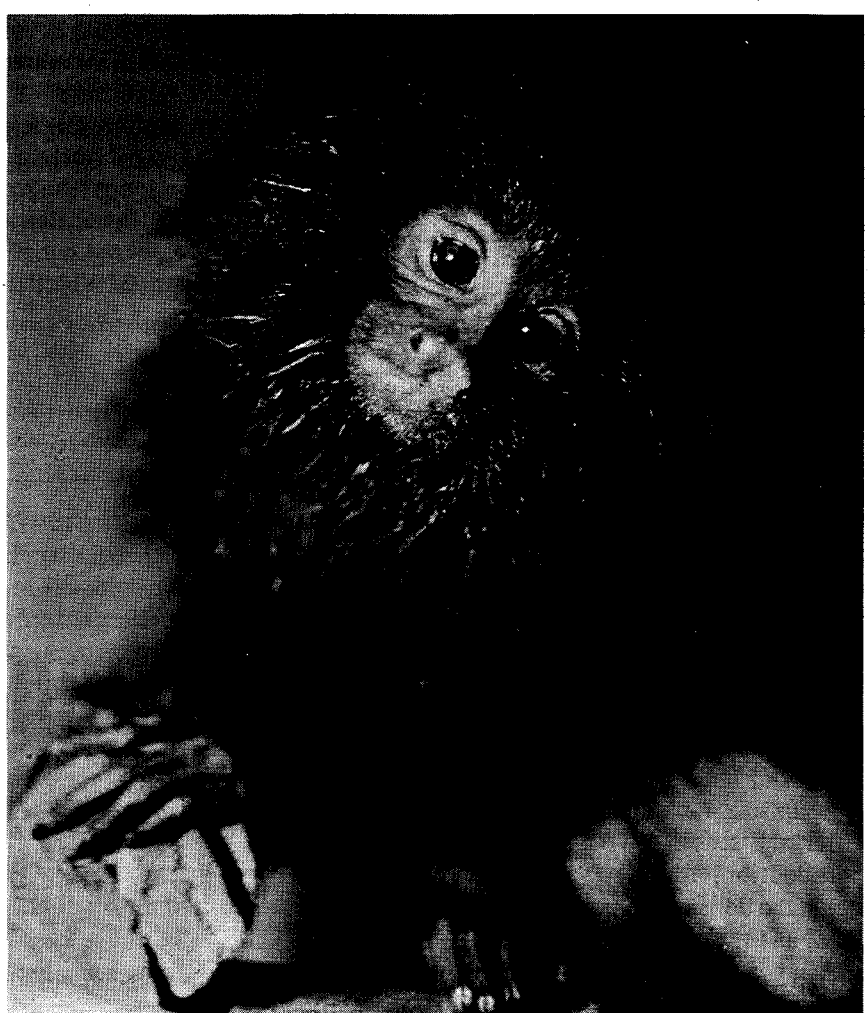

Black lion tamarin (*Leontopithecus chrysopygus*). Photo by R. Mittermeier.

Environmental Education and the Black Lion Tamarin, *Leontopithecus chrysopygus*

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Introduction

People are unaware of the importance of natural areas because they are so rarely used for education purposes. This is especially true for Brazil, while significant exceptions can be found in the education projects designed for the conservation of lion tamarins, *Leontopithecus* (*v.* Dietz et al. 1994). The first, set up on behalf of the golden lion tamarin, *L.rosalia*, began in the early 1980's (Dietz and Nagagata, 1986; Kleiman *et al.*, 1986; Deitz *et al.*, 1994), and opened up a whole new conservation scenario, providing the basis on which subsequent programs were established for the golden-headed lion tamarin, *L.chrysomelas*, in Bahia (Alves, 1991; Nagagata, 1994) and the black lion tamarin, *L.chrysopygus*, in São Paulo (Jacobsen and Padua, 1992, in press a and b; Padua, 1991, 1994, in press a, b; Padua *et al.*, 1990; Padua and Jacobsen, 1993). These programs, although varying in their context, are in general designed to involve local communities in the conservation process and disseminate scientific findings in a simple and direct language so that the information can be understood by all. As the lion tamarins are charismatic, beautiful, and highly threatened, they have been highly effective in attracting attention and stimulating pride in the communities within their geographic ranges, and as such enhancing the protection of the forests they live in (Padua *et al.*, 1990; Dietz *et al.*, 1994). In addition, some of these education projects have applied research methods important for improving the strategies employed, in assessing their overall effectiveness, and in pinpointing those which have been effective and those which have not, so that other educators and education programs can benefit.

The environmental education program for the conservation of the black lion tamarin began in 1988/89, and was centered on the Morro do Diabo State Park, which harbors the most significant surviving population of the species. The Park is administered by the São Paulo State Forestry Institute (IF). Education initiatives have likewise been carried out in other sites where *L.chrysopygus* is found. In June 1992, a course for teachers was held at the Caetetus Ecological Station (also of the São Paulo Forestry Institute). It served as a starting point for a continuous school program maintained by the Station's new administration. Another program centered on the Fazenda Rio Claro of the Duartex Co., where *L.chrysopygus* was recently discovered (Valladares-Padua *et al.*, 1994). Activities with local students included a study of the extent to which information was passed on to their parents (Padua *et al.*, in press). The results of this study were adapted and translated into Portuguese for the journal *Educador Ambiental* (Padua *et al.*, 1994).

The education program for the black lion tamarin has been carried out according to specific methodologies, the most thorough of which was that centered on the Morro do Diabo State Park, and which I will summarize here. It was continuously and systematically evaluated following the PPP model (Planning/Process/Product), designed by Jacobsen (1991), and adopted by Padua and Jacobsen (1993) and Padua (in press a). This model helps ensure effectiveness in each step of the program, from conception to completion, through the planning stage, implementation (process) and the evaluation of the results (product).

Planning Stage

The needs, goals, objectives, target public, constraints, and available resources are defined during the planning stage. A preliminary survey conducted among the local population showed that people had very little environmental knowledge. Although they showed great interest, the majority knew little about the local flora and fauna. The need to instil a broader knowledge and understanding was evident.

The goals and objectives of the program were also defined based on information gathered through preliminary surveys. Since the Park is the largest surviving remnant of the Atlantic forest in the west of the state of São Paulo, and threatened as such, the main goal was the preservation of the integrity of the Park itself. The objective, therefore, was to foster among local people an appreciation of the Park and its rich wildlife.

A specially designed school program introduced students to the Park and furnished means for them to increase their knowledge of ecological concepts, and stimulate positive attitudes towards nature. Strategies that would impact the value and increase the knowledge of individuals were systematically applied during all stages of the program: research has shown the importance of these aspects to increase awareness and change people's behavior (Swan, 1974; Iozzi, 1989; Hungerford and Volk, 1990; Stapp, 1974). Although the environmental education program was targeted mainly at local students, many activities were specially designed for a broader public.

The involvement of the communities surrounding the Morro do Diabo State Park was of great importance due to the increasing rate of destruction of the natural environments of the region. Students alone may not have the chance to halt this destructive process since little may be left for them to fight for when they eventually become the decision-makers. For this reason, the environmental education program sponsored several out-reach activities targeting the entire community, from local authorities to businessmen and laborers.

The planning stage also included seeking institutional support and participation, crucial for the program's implementation. The Park's employees were encouraged to collaborate, and as a consequence nature trails were set up and educational activities in the Park were carried out with little extra expense. Although the São Paulo Forestry Institute was very supportive of the program, and provided help in a number of ways, additional sponsorship was obtained from several institutions concerned about the conservation of the Park (see 'Acknowledgements'). This was most important in giving the program an impetus and pace that enabled the full realization of its objectives and goals.

Process Stage

The program's content, its implementation strategies, and the evaluation procedures were defined in the Planning Stage. The content of the black lion tamarin environmental education program was selected based on the information gathered in the planning stage and on the scientific findings of a long-term study of the species (Valladares-Padua, 1993; Valladares-Padua *et al.*, 1994). Program strategies were designed accordingly and included the elaboration of educational materials for local teachers who lacked information on the Park, its natural resources, and history. Visitors watched a slide presentation before their visit to the Park. Three nature trails were set up for students, each focusing on a different aspect of the Park. A Visitor's Center included an area for exhibits and one where objects could be handled during activities which were specially designed to stimulate curiosity and learning. There students play games and have contact with live animals. As snakes were especially feared in the region, three were kept and presented to students to turn their feelings of fear into admiration. Class contests were sometimes held, and after the visits the students received hand-outs with information and games.

All activities were designed to encourage appreciation of the black lion tamarin and the Park. Each activity was pilot-tested and constantly evaluated using straightforward questions as advocated by Nowak (1984). This process evaluation furnished helpful information for the improvement of the program during its

implementation. Among the many community-oriented activities were art exhibits, art or sports competitions and workshops. The local radio station played an important role in broadcasting special activities and supplying information on the environmental education program in general.

Two Park employees and some local high school students were trained as nature guides. They helped design the program by contributing with new ideas and activities. These were pilot-tested and, depending on the results, adopted by all as an educational strategy. As most of the program's participants were members of the local community, they were important in helping to solve specific implementation problems, and facilitated the local community's acceptance of the program as a whole.

Product Stage

The Product Stage assessed whether the goals and objectives were being achieved, as well as the direct and indirect effects of the program. A formal evaluation procedure helped assess its effectiveness, and the results were used to improve, change or abandon the various strategies. Results based on systematic data collection were also used to obtain institutional and funding support.

The black lion tamarin environmental education program was able to count on considerable public interest, acceptance, and participation. By the end of the first year, 6,000 students had visited the Park, and the average annual visitation in the following three years was 8,000. A systematic evaluation with 144 students assigned to experimental and control groups were tested on three occasions: a *pre-test*, prior to exposure to the program; a *post-test*, immediately after visiting the Park; and a *retention test*, one month later. The tests were written questionnaires which measured the student's knowledge and attitude. Statistical analyses showed that there were significant differences between the experimental and control groups ($F=98.29$, $p \leq 0.05$) indicating the program's effectiveness (Padua, 1994, in press b).

Other indicators of the program's success were: the increase of families visiting the Park during weekends; university students spending weekends at the Park's lodging house; local teachers requesting environmental education courses; and the nature guide's increasing interest to improve their performance. Several events demonstrated people's interest in the Park's conservation. Some were related to festivities, such as floats for the town's anniversary celebration, end-of-year parties of the Rotary and Lion's Club and other public initiatives. However, the most important indications of community involvement referred to the protection of the Park itself. After a radio interview in which the education staff explained the threats to the Park and its wildlife resulting from the relocation of the garbage dump of the nearby town of Teodoro Sampaio, people wrote and telephoned to the Town Mayor requesting an immediate solution. The garbage was removed in less than a week. The community also voluntarily helped the Park employees to extinguish a forest fire. Fires had occurred in previous years, but the community's collaboration was unprecedented. A third instance of community willingness to participate in nature conservation occurred outside the Park. A nearby farm was being illegally logged, and through public pressure this was stopped and the farmer was fined.

In order to improve the socioeconomic conditions of the poorer sections of the communities, local businessmen formed a group with the purpose of establishing development plans which gave priority to problems of pollution, as well as using local underprivileged and unskilled labor: concerns which would have been lacking in solutions imported from the outside. Finally, the community became active in demanding the continuity of the program itself. Letters were sent to the Park's administration in São Paulo and to the Town Mayor requesting a local director to guarantee the continuity of the education program during a temporary hiatus in the program's activities.

Conclusions

The environmental education program for the lion tamarins, together with other conservation measures should serve as examples of integrated and effective efforts towards species and habitat protection. Through public programs of this sort, people increase their knowledge concerning local environmental problems and shift their values and attitudes to an extent that encourages them to act. Giving power to local communities in terms of their understanding of environmental problems can greatly contribute to the conservation of natural areas. In Brazil, this is especially important due to the richness of its natural environments and the lack of resources to protect them. The lion tamarin example should be shared and disseminated so that other species and ecosystems can benefit from the lessons learned.

Acknowledgements

Fundamental for the successes of the black lion tamarin environmental education program has been the support of the local communities and the enthusiasm of the education team. We are also grateful to the following institutions: the Forestry Institute (IF) of São Paulo, SMA, Apenheul, Holland, the Canadian Embassy in Brazil, the Fanwood Foundation, the U.S. Fish and Wildlife Service, Wildlife Preservation Trust International (WPTI), the Whitley Animal Protection Trust, the World Wildlife Fund (WWF), the Brazil Science Council (CNPq), and the Center for Latin American Studies, the Program for Studies in Tropical Conservation, and the Tropical Conservation and Development Program, all of the University of Florida, Gainesville.

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Conservation Status of the Black-faced Lion Tamarin, *Leontopithecus caissara*

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In May 1993, the International Committee for the Management of the Black-faced Lion Tamarin (*Leontopithecus caissara*), created by the Brazilian Institute for the Environment and Renewable Natural Resources (Ibama) in September 1992 (Edict No.106-N, 30 September 1992), met on the occasion of the 1st International Symposium for the Lion Tamarins at the Poço das Antas Biological Reserve, Rio de Janeiro, to draw up an emergency action plan for the species. This Emergency Action Plan was based on a previous and similar document presented at the *Leontopithecus* Population Viability Workshop held in Belo Horizonte in June 1990 (Teixeira, 1990). It was finalized and sent to Ibama in June 1993 (Câmara, 1993a, 1993b). The principle proposals and priorities can be summarized as follows:

- the creation of new conservation units within the known distribution of the species;
- transformation of the entire or substantial part of its continental distribution into a fully protected area;
- improvement of the protection afforded to the already existing conservation units;
- research programs to study the ecology and behavior of the species;
- the elaboration of an environmental education program;
- studies on the feasibility of translocating individuals between the Island of Superagüi and the continent. following appropriate genetic research;
- establish a captive breeding program, involving at least two institutions, one in Brazil and a second overseas, using preferentially animals arising from confiscation;
- the preparation of management plans for the existing protected areas, notably the Superagüi National Park.

The International Committee met again in April 1994 to analyze the current status concerning the measures proposed in the July 1993 Action Plan, and discuss methodologies currently being used by two teams which are studying the distribution, habitat, and status of *Leontopithecus caissara* from: a) the National Museum in Rio de Janeiro and the "Capão de Imbuia" Natural History Museum in Curitiba (Vanessa Persson and Maria Lucia Lorini, see Lorini and Persson, 1990, 1994a, 1994b; Persson and Lorini, 1993, 1994) and the University of São Paulo in collaboration with the São Paulo State Forestry Institute (Paulo Nogueira Neto, Paulo Martuscelli and Marcia Rodrigues, see Martuscelli and Rodrigues, 1992).

The following conclusions were reached at this meeting:

- none of the priorities or proposals contained in the Action Plan had yet been attended to by the Brazilian Institute for the Environment and Renewable Natural Resources (Ibama);
- research on the distribution and habitat of the species was continuing, and beginning to provide estimates with some degree of confidence regarding their accuracy as to the status of the species, although this is made difficult by the rarity of the species and the finding that a number of at least more northerly populations are isolated;
- attempts to capture a group for an ecological/ behavioral study (the project of Marcia Rodrigues, University of São Paulo) had till then proved unsuccessful;
- the São Paulo State Government had received a formal proposal for the creation of a reserve in the northern part of the species' range, but to date nothing had resulted;
- there is an urgent need for a captive breeding program;
- action needs to be taken concerning the recent finding that indian groups had settled in the Superagui National Park, the most important protected area for *L.caissara*, and that the National Indian Foundation (FUNAI) was intending to establish an Indigenous Area within the Park.

Concerning this last point, the Committee members agreed on the serious consequences for the survival of *L.caissara* should the integrity of the Superagüi National Park be compromised by the superimposition of an Indigenous Area. The Ministry of the Environment and Legal Amazonia, of which Ibama is part, was contacted alerting to the situation.

Finally, the Committee discussed the vital need for Ibama to act on the Action Plan submitted to them. Conservation measures must be taken immediately if the future of the black-headed lion tamarin is to be guaranteed even in the short term.

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Status of Field Research on *Leontopithecus caissara*: The Black-Faced Lion Tamarin Project

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Introduction

During five years of field research on mammals in the state of Paraná, our attention was consistently drawn to the presence of a third primate species on the northern coast of the state, which was distinct from *Cebus apella* and *Alouatta fusca*. Records go back to the XIX century, when Vieira-dos-Santos (1850) indicated the presence of a *Callithrix* species in the region of Paranaguá. Nearly a century later, this primate caught the interest of the mammalogist Carlos C.Vieira (1944) of the Museum of Zoology of the University of São Paulo, who ascribed the record to the buffy-tufted-ear marmoset, *Callithrix aurita*. At his request, the Paranaense Museum (now called the "Capão de Imbuia" Natural History Museum) carried out an expedition to the area to look for the species, but without success. Further rumours of this third primate arose in the 1980's, this time coming from the municipality of Guarequeçaba. As a result, the Sociedade de Pesquisa em Vida Selvagem (SPVS), based in Curitiba, Paraná, organized a survey in the Guaraqueçaba Environmental Protection Area (APA) from 1987 to 1989. This survey resulted in the conclusion that the third species was identifiable as the masked titi, *Callicebus personatus*, with no evidence for the presence of a callitrichid (Oliveira and Pereira, 1990). However, the rumours persisted, and we were informed of the presence of a "sagüi" (the Brazilian common name for marmosets and tamarins) on the Island of Superagüi, and which in no way corresponded to any description of a titi monkey. We consequently set up an expedition in early 1990 to search for the animal along the northern coastal area of Paraná and adjacent São Paulo. To our surprise, we were able not only to confirm the presence of a callitrichid, but found that it was an undescribed species of *Leontopithecus*. The new species, the black-faced lion tamarin was named *Leontopithecus caissara* (Lorini and Persson, 1990) as a tribute to the inhabitants of the Island of Superagüi called "caiçaras", who participated and helped in our search with such enthusiasm.

At the time of its description, we lacked information which could result in any evaluation of its conservation status, although it was evident that it was locally rare, and that its distribution was very limited; facts which alone were cause for concern. On this basis, we presented an Action Plan for the preservation of the species on the occasion of the *Leontopithecus* Population Viability Workshop, organized by the Fundação Biodiversitas in collaboration with the IUCN/SSC Captive Breeding Specialist Group, in Belo Horizonte, Minas Gerais, in June 1990 (Seal *et al.*, 1990). This plan included five proposals: 1) a survey of the geographic distribution and an evaluation of the populations of *L.caissara*; 2) research on its behavior and ecology; 3) measures for the protection of its habitats; 4) an environmental education program; and 5) a captive breeding program (Teixeira, 1990). Amongst the conclusions drawn up in the final document of the Workshop was the urgent need for basic research on the species, above all examining its distribution and habitat preferences (Seal *et al.*, 1990). In keeping with this recommendation, the Black-Faced Lion Tamarin Project was set up in July 1990 specifically to attend to the first of the proposals in the Action Plan. The Project included the following objectives: 1) delimit the geographic distribution and characterize the habitats available; 2) estimate population sizes; 3) bring together all available information on the biology of the species; and 4) identify threats to its survival and evaluate its conservation status. The project was financed by Conservation International (CI) and the Fundação o Boticário de Proteção a Natureza, and supported by the Brazilian Institute for the Environment and Renewable Natural Resources (Ibama).

Geographic Distribution and Habitat

In order to delimit the distribution, we surveyed a strip of 200 x 50 km along the coast, extending from the

Baia de Guaratuba in Paraná to the mouth of the Rio Ribeira de Iguape, in São Paulo (Fig.1). The first stage of the Project involved a program of interviews adapted specifically for the region, of local people who knew well the forest and fauna where they lived. Any skins or bones found were collected and captive animals (pets) were registered and photographed. In the second stage, surveys were carried out using "play-back" of recordings of *Leontopithecus* long-calls (see Kierulff, 1993; Pinto and Rylands, 1992; Pinto, 1994), some of which were kindly supplied by Devra Kleiman (National Zoological Park, Washington, D.C.). The information obtained to date indicates that the distribution of *L.caissara* is very restricted (Fig.2), totalling approximately 300 km^2, and divided into the Island of Superagüi and adjacent parts of the continent in the states of Paraná (municipality of Guaraqueçaba) and São Paulo (municipality of Cananéia) (Persson and Lorini, 1991, 1993, 1994). The region is comprised of predominantly flat lowlands with a mosaic of vegetation types. These are being studied and described with the help of botanists and forest engineers from the Federal University of Paraná, the "Capão da Imbuia" Natural History Museum, and the Georg-August University of Göttingen, Germany. Locations suitable for reintroduction or translocation of the lion tamarins are being catalogued. A number of different vegetation types are occupied by *L.caissara*. They include: coastal pioneer sub-xerophilous forest on sandy soil (*restinga*); swamp forest with a predominance of *Tabebuia cassinoides*

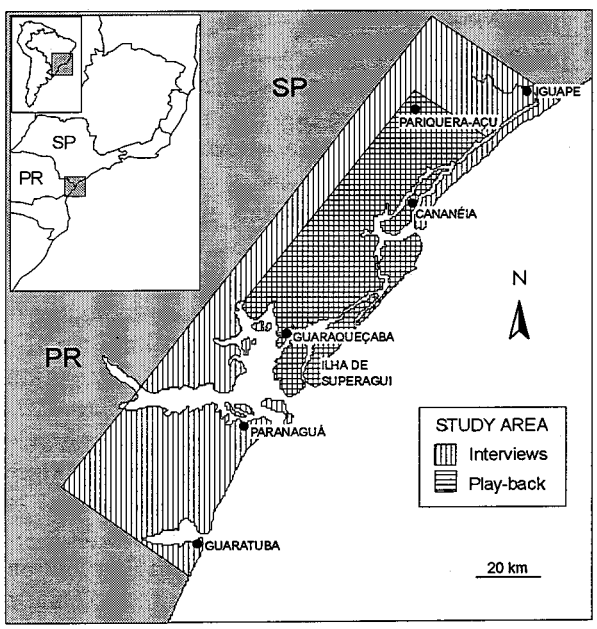

Figure 1. The study area showing the regions included in the interview survey and the playback study.

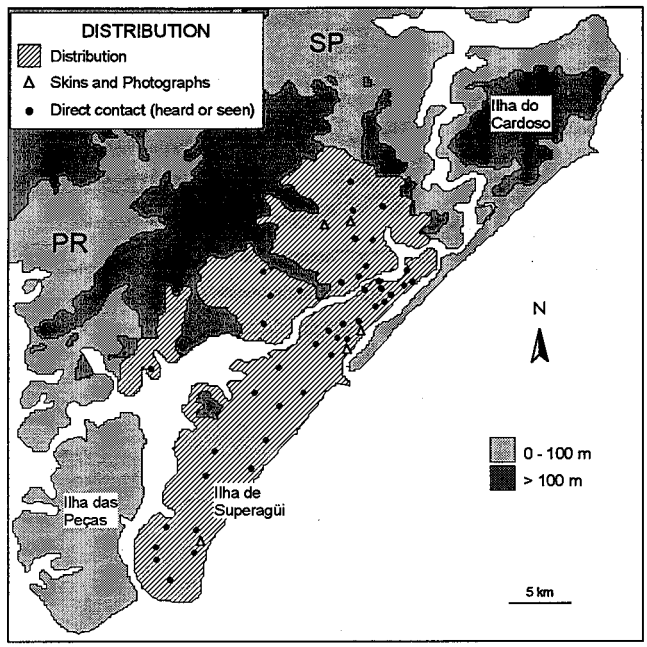

Figure 2. The geographic distribution of *Leontopithecus caissara*.

(Bignoniaceae), referred to as *caxetal*, a pioneer formation of 8-10 m in height near to rivers; and dense, coastal lowland, humid forest on the Quaternary plains (Persson and Lorini, 1991, 1993).

Population Estimate

Besides the geographic distribution, population estimates are fundamental for the elaboration of a conservation strategy for the species. For this reason, we carried out preliminary surveys by the conventional method of linear transect censuses, which resulted in density estimates of 0.3 groups/km^2 or 1.5 ind./km^2; values below those recorded for other *Leontopithecus* species (Lorini and Persson, 1994a). With the available habitat totalling about 17,300 ha throughout its geographic distribution, this gives an estimate of a wild population of about 52 groups or 260 individuals divided into two or three sub-populations. This population size is small enough to indicate that the species is seriously threatened. We are also beginning a survey of the population on the Island of Superagüi using the playback method adopted by Kierulff (1993). This will enable direct counts of all groups in a population, reducing as such the biases inherent in the transect method.

Biological Aspects

Due to the fact that nothing was known of the biology

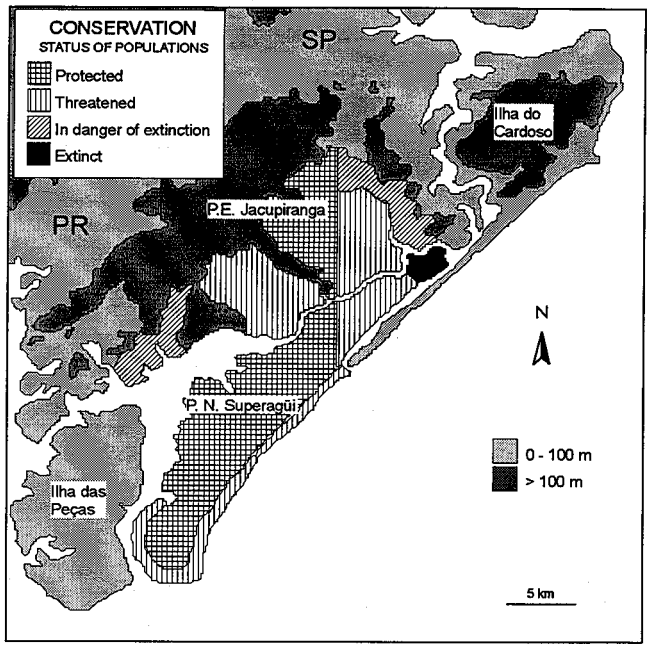

Figure 3. The distribution of *Leontopithecus caissara* (cross- hatched), indicating the conservation status of the populations on the basis of the degree of isolation and threats to each.

of *L.caissara*, we collected any information we could on the species during our censuses. Alhough scant and preliminary, our findings suggest that it is, like other lion tamarins, a frugivore-insectivore: including to date 27 plant food items and eight species of invertebrates recorded in its diet. The invertebrates resulted from the analysis of one stomach (MN28861, the holotype; Person and Lorini, 1991), in which we found 12 items (one mollusc, two spiders and nine insects). The number of insects in one stomach, the results of one morning of feeding, confirm its categorization as a specialized predator (see Coimbra-Filho, 1981). Fruits are important in the plant part of the diet, with Myrtaceae being predominant, but we have also recorded them eating the leaf bases of small bromeliads (for example, *Vriesia* sp.), and the nectar of the inflorescences of *Norantea brasiliensis* (see Lorini and Persson, 1994b). Shelters used by *L.caissara* include bunches of bromeliads, moss-covered dens among root tangles, and holes in trees. We have no evidence to suggest other than once-yearly breeding, with newborn infants being carried in November and December, and juveniles being present in the groups in April and May.

Conservation and Status

The most serious threats faced by *L.caissara* result from its small geographic distribution and very small population size, estimated at less than 300 individuals. The total population is divided into three isolated sub-populations: the Island of Superagüi (121 individuals), and the continental valleys of the Rios Patos and Branco (35 individuals) and the Rios Varadouro and Araçaúba (100 individuals). It range is approximately 300 km^2, smaller than the known distribution of any of the *Leontopithecus* species (Persson and Lorini, 1993, 1994). Only one-third of its distribution is within protected areas (Fig.3), represented by the Ilha de Superagüi National Park (21,400 ha), Paraná, and the Jacupiranga State Park (150,000 ha), São Paulo. The remainder falls within the Environmental Protection Areas (APA) of Guaraqueçaba (291.500 ha), Paraná, and Cananéia-Iguape-Peruíbe (160,000 ha), São Paulo; conservation units which do no more than provide for the regulation or prohibition of activities prejudicial to the environment. Such activities in the region include buffalo farming, extractivism (*caxeta*, firewoood and timber, and notably palmheart), agriculture (manioc, bananas, rice), uncontrolled tourism, road construction (notably the planned federal highway, BR-101), and most recently the occupation of the area by indigenous tribes (principally in the Superagüi National Park) (Lorini and Persson, 1991; Câmara, 1994). The local population do not hunt the lion tamarins, although they do capture them occasionally for pets. We have recorded at least 25 cases as occurring in the last 50 years (Lorini and Persson, 1991), but one cannot rule out the possibility of illegal traffic on a greater scale, as has occurred recently for another local endemic, the highly threatened blue-cheeked parrot, *Amazona brasiliensis*, when more than 100 were captured (Lorini and Persson, 1991). It is important to emphasize that environmental controls and supervision in the region are extremely precarious, lacking sufficient personnel and equipment compatible with the size and characteristics of the conservation units involved.

With the information currently available, *L.caissara* is clearly an endangered species, following the traditional categories of The World Conservation Union (IUCN) *Red Lists of Threatened Animals* (Groombridge, 1993). The more recent Mace-Lande System (Mace and Lande, 1991; Mace, 1993; Mace and Stuart, 1994) places the status of this animal as "Critical", the highest threatened category, on the basis of its population size and geographic distribution alone. We intend to continue our research to obtain a more detailed and accurate appraisal of its status, along with the development of management strategies,

using also computer models to analyze extinction probabilities and the loss of genetic variability. The black-faced lion tamarin is undoubtedly the most threatened of the Neotropical primates and initiatives to promote its survival and well-being should be considered the highest priority for primate conservation in South America.

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The Superagüi National Park: Problems Concerning the Protection of the Black-Faced Lion Tamarin, *Leontopithecus caissara*

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The Superagüi National Park is located on the northern coast of the state of Paraná. It was created by Decree No.97688 on 25 April 1989. It includes two coastal islands, the Ilha de Peças and the Ilha de Superagüi and, excluding areas in the proximity of fishing villages, totals 21,400 ha. The principal ecosystems include Atlantic forest, *restinga* (coastal forest and scrub on sandy soil), mangrove swamps, dunes and beaches. Superagüi was formerly part of the mainland of the state of São Paulo, and the island was created only in 1953 when the Canal do Varadouro was constructed in order to facilitate navigation for small boats between the neighboring states of São Paulo and Paraná.

The Park lies within the estuarine-lagoon complex of Iguape-Cananéia-Paranaguá, within the boundaries of the Environmental Protection Area (APA) of Guaraqueçaba, in the municipality of the same name. This APA was created by Decree No.90883 on 31 January 1985, with an area of 313,400 ha. Besides the Park, there is also the Guaraqueçaba Ecological Station (14,000 ha) created on 31 May 1982 by Decree No.87222 for the protection of the mangroves and areas of *restinga*, and the Area of Relevant Ecological Interest (ARIE) of the Ilha de Pinheiro and Ilha do Pinheirinho (109 ha) created on 5 November 1985 by Decree No.91888, specifically to protect roosts of the endangered blue-cheeked parrot, *Amazona brasiliensis*.

The Guaraqueçaba Environmental Protection Area, therefore, serves as a buffer zone for these protected areas, and it should be emphasized that the Superagüi National Park is not, as such, isolated. However, despite this, and despite the wealth of environmental legislation governing the Park and its surrounding protected area categories, its effective protection is no way guaranteed. The black-faced lion tamarin, *Leontopithecus caissara*, was discovered in the Park only in 1990 (Lorini and Persson, 1990), one year after it was created. Distributional studies have since shown that the species occurs throughout a large part of the Park as well as on the mainland in both Paraná and southernmost coastal São Paulo (Persson and Lorini, 1993; Lorini and Persson, 1994).

When the Superagüi National Park was created, a decision was to made to allow for the permanence of the local and traditional human populations, the principle occupations of which involved fishing, by excluding them from the Park limits. There are six on the island: Barra do Superagüi, Barbados, Canudal, Vila Fátima, Ararapira and Barra do Ararapira, with a total population of 747 people. The existence of these fishing villages is not in itself a threat to the integrity of the Park. Incursions into forested areas are infrequent. However, a real threat arises from the pressures on the part of tourists to sell their land for the construction of holiday homes, as well as their serving as bases for palm-heart gatherers. The northern part of the island is near to the town of Ariri, already in the state of São Paulo and a popular tourist resort. It is there that the pressures are greatest, and where there is also a minor industry involving the supply of sand for construction. Likewise the entire coastline on the east of the island is excluded from the Park, and there is a serious threat in the short term of the establishment of housing lots and a tourist infrastructure along the beach area which would be highly prejudicial.

Patrolling of the area is carried out by the Brazilian Institute for the Environment (Ibama), the Paraná State Environment Institute and the Forest Police. However, the number of personnel is minimal and insufficient for the large areas under their jurisdiction. There are besides, some problems which current legislation is incapable of resolving. This is the case with groups of Mbya-Guarani indians occupying parts of the island in the north and south. Besides cutting

and burning the forest for small-scale agriculture (they usually destroy areas larger than they need), they also hunt directly and using traps. They also make extensive use of a palm, locally known as Jerivá, and which is an important food resource for the lion tamarins. They have also been observed attempting to sell lion tamarins and the blue-cheeked parrots to tourists.

Discussions are underway between Ibama, responsible for the maintenance of the Park, and the Indian Foundation (FUNAI) to resolve this conflict (see Câmara, 1994). FUNAI is, however, demanding the delimitation of indian reservations within the Park. Although sympathizing with the indians, it must be emphasized that there are numerous other areas in the region of Guaraqueçaba providing identical living conditions which they could occupy, whereas Superagüi is the only protected area within the tiny distribution of the already scarce lion tamarins.

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Black-faced lion tamarin (*Leontopithecus caissara*). Photo by Zig Koch.

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NEOTROPICAL PRIMATES

A Newsletter of the Neotropical Section of the IUCN/SSC Primate Specialist Group

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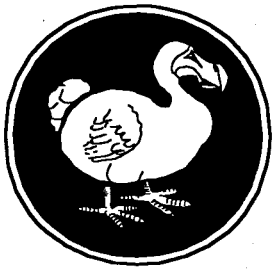

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