



**A STUDY ON THE MANAGEMENT OF FRAGMENTED
RAIN FORESTS OF THE WESTERN GHATS FOR THE
CONSERVATION OF SMALL MAMMALS**

CONTENTS

SUMMARY	i
ACKNOWLEDGEMENTS	iv
PREFACE	v
1. INTRODUCTION AND OBJECTIVES	
1.1. INTRODUCTION	1
1.1.1. Forest Fragmentation	1
1.1.2. Effects of forest fragmentation	2
1.1.3. South Indian Rain Forest	3
1.2. OBJECTIVES	5
2. STUDY AREA, ANIMALS AND METHODS	
2.1. STUDY AREA	7
2.1.1. Geography and climate	7
2.1.2. History	9
2.1.3. Vegetation	10
2.1.4. Fauna	10
2.1.5. People	11
2.1.6. Water resources	12
2.1.7. Forest fragments	12
2.2. STUDY ANIMALS	12
2.2.1. Arboreal mammals	12
2.2.1.1. <i>Lion-tailed macaque</i>	12
2.2.1.2. <i>Nilgiri langur</i>	14
2.2.1.3. <i>Malabar giant squirrel</i>	15
2.2.1.4. <i>Flying squirrel</i>	15
2.2.1.5. <i>Terrestrial rodents and shrews</i>	16
2.3. METHODS	17
2.3.1. Arboreal mammals	17
2.3.2. Terrestrial Rodents and Shrews	18
2.3.3. Analysis of data	18
3. OCCURRENCE AND ABUNDANCE OF ARBOREAL MAMMALS	
3.1. INTRODUCTION	19
3.2. METHODS	19

3.2.1. Survey of Fragments	19
3.3. RESULTS	20
3.3.1. Landscape parameters	20
3.3.1.1. <i>Ownership of fragments</i>	20
3.3.1.2. <i>Area of fragment</i>	22
3.3.1.3. <i>Connectivity</i>	22
3.3.1.4. <i>Matrix around the fragments</i>	22
3.3.2. Habitat parameters	24
3.3.3. Occurrence of arboreal mammals	24
3.3.3.1. <i>The Effect of Landscape Parameters</i>	24
3.3.3.2. <i>The Effect of Habitat Parameters</i>	29
3.3.3.3. <i>Logistic regression</i>	29
3.3.4. Abundance of arboreal mammals	32
3.4. DISCUSSION	35
3.5. SUMMARY	38
4. ACTIVITY PATTERN AND FEEDING ECOLOGY	
4.1. INTRODUCTION	40
4.2. METHODS	40
4.2.1. Study Sites and Groups	40
4.2.2. Ecology and Behaviour	40
4.2.3. Vegetation	41
4.2.4. Analysis Data	42
4.3. RESULTS	42
4.3.1. Lion-tailed macaque	42
4.3.1.1. <i>Time budget: Time spent on various activities</i>	42
4.3.1.2. <i>Feeding ecology</i>	43
4.3.2. Nilgiri Langur	54
4.3.2.1. <i>Time budget: Time spent on various activities</i>	54
4.3.2.2. <i>Feeding ecology</i>	56
4.3.3. Giant Squirrel	61
4.3.3.1. <i>Time budget: Time spent on various activities</i>	61
4.3.3.2. <i>Feeding ecology</i>	65
4.4. DISCUSSION	69
4.5. SUMMARY	72

5. DEMOGRAPHIC STUDIES	
5.1. INTRODUCTION	74
5.2. METHODS	74
5.3. RESULTS	75
5.3.1. Lion-tailed macaque	75
5.3.1.1. <i>Group Size</i>	75
5.3.1.2. <i>Age/Sex Composition</i>	81
5.3.1.3. <i>Birth Rate</i>	81
5.3.1.4. <i>Growth Rate</i>	86
5.3.2. Nilgiri Langur	86
5.3.2.1. <i>Group Size</i>	86
5.3.2.2. <i>Age/Sex Composition</i>	86
5.3.2.3. <i>Birth Rate</i>	88
5.3.2.4. <i>Growth Rate</i>	90
5.4. DISCUSSION	91
5.5. SUMMARY	93
6. TERRESTRIAL RODENTS AND SHREWS	
6.1. INTRODUCTION	95
6.2. METHODS	96
6.2.1. Live trapping	96
6.2.2. Habitat Variables	96
6.2.3. Analysis of data	96
6.3. RESULTS	97
6.3.1. Trapping effort	97
6.3.2. Species Richness	99
6.3.2.1. <i>Variation among Fragments and Seasons</i>	99
6.3.2.2. <i>Correlates of Species Richness</i>	101
6.3.3. Total Abundance	102
6.3.3.1. <i>Variation among Fragments and Seasons</i>	102
6.3.3.2. <i>Correlates of Total Abundance</i>	102
6.3.4. Abundance of Species	104
6.3.5. Microhabitat Selection	105
6.4. DISCUSSION	106
6.4.1. Species Richness	106
6.4.2. Species Composition	107
6.5. SUMMARY	108

7. CONCLUDING DISCUSSION AND RECOMMENDATIONS	
7.1. INTRODUCTION	109
7.2. DISPERSAL	109
7.3. GENETICS	111
7.4. PARASITES	112
7.5. CONCLUSIONS	114
7.6. RECOMMENDATIONS	115
7.6.1. Habitat management	115
7.6.2. Population management	117
7.6.3. Research needs	119
APPENDIX 1	
APPENDIX 2	
APPENDIX 3	
APPENDIX 4	
APPENDIX 5	
APPENDIX 6	
BIBLIOGRAPHY	

SUMMARY

1. The objective of this study was to identify the changes in the occurrence and abundance of arboreal mammals, and terrestrial rodents and shrews, in rain forest fragments in the Western Ghats, and to identify the factors that govern such changes. The animals included in the study were two species of primates (the lion-tailed macaque and Nilgiri langur), three species of tree squirrels (Malabar giant squirrel, large brown flying squirrel, and Travancore flying squirrel), and several species of terrestrial rodents and ground shrews.

2. The field studies, carried out in the Indira Gandhi Wildlife Sanctuary, Tamil Nadu and adjoining private forests, included (a) a survey of 25 rain forest fragments covering nearly 400 km of transects and 350 vegetation plots; (b) nearly 2,200 hours of ecological observations on the two primates and the giant squirrel in four forest fragments; (b) live trapping of terrestrial rodents and shrews for nearly 11,000 trap days; (d) observations on the demography of the two primates; and (e) vegetation and phenological studies.

3. The lion-tailed macaque was the most adversely affected, disappearing from the maximum number of forest fragments, followed by the Nilgiri langur. Area of the fragment is an important factor deciding the occurrence of arboreal mammals only when fragments are very small, probably less than 10 ha. In the larger fragments, habitat variation or quality is more important; the indicator of this was canopy height for the lion-tailed macaque and tree density for the Nilgiri langur. Habitat variation and fragment area were correlated.

4. The abundance of the two primates fluctuated while that of the squirrels increased, with decreasing area and disturbance, within the range of values that are currently present in the fragments. The increase in squirrels is because these are generalists, but might also be due to the absence of lion-tailed macaques with which they overlap in the use of food resources.

5. The three diurnal arboreal mammals showed a reduction in the number of species that they fed on, and greater dependence on shrubs compared to lianas in the larger and less disturbed fragments. There was a reduction in the proportion of invertebrates in the diet of the lion-tailed macaque, which might affect immature growth and survival. The giant squirrel showed no major changes. None of the three species showed major consistent changes in overall time budget, largely because they used the man-made vegetation around the fragment to their benefit.

6. The demographic effects on the lion-tailed macaque included a reduction in birth rate, immature survival, growth rate of groups and a wide fluctuation in the adult sex ratios and other demographic parameters. The decrease in birth rate and survival might be due to reduction in diet quality, the latter might also be due to fall from trees and predation. Lack of dispersal may be the reason for the fluctuation in adult sex ratios and increase in group size. In the Nilgiri langur there was a reduction in birth rate and immature survival but not in sex ratios and group size because of dispersal.

7. Among the terrestrial rodents and shrews, the spiny dormouse seem to have disappeared from the small fragments, probably due to habitat degradation. Several commensal species of rodents have invaded the forest fragments, due to the presence of human settlements and degradation of forest fragments. The total abundance of rodents was highest among the medium sized fragments, due to the greater abundance of the commensal species. There was a decline in the abundance of endemics in the smaller forest fragments.

8. Dispersal between fragments might be most limited in the lion-tailed macaque, because of its inability to use treeless matrix and plantations, and a social system that prevents female dispersal. Dispersal might also be limited in squirrels because of their inability to use treeless matrix. The Nilgiri langur disperse because of their ability to move across treeless vegetation and a social system with male and female dispersal. Thus, the fragmented population of lion-tailed macaque is unlikely to occur as a metapopulation that allows recolonisation, dampening of demographic stochasticity and genetic exchange.

The squirrels might exist partially as a metapopulation, while most of the Nilgiri langur populations might form part of a metapopulation.

9. Greater susceptibility to parasites and pathogens due to environmental stress, and introduction of new parasites and pathogens by invading species make fragmented populations of resident species more prone to extinction.

10. Since the occurrence of the arboreal mammals in fragments is related to 'habitat quality' rather than to area it should be possible to retain the populations that currently exist in fragments. The suggested measures include (a) retention of vegetation around the fragments that are conducive to the survival of the arboreal mammal; e.g. coffee plantations and fruit tree orchards instead of converting these into tea estates; (b) retention of several key stone species of the lion-tailed macaque in the forest fragments (e.g. *Ficus spp.*, *Cullenia exarillata*); (c) an increase in the tree density in forest fragments through assisted regeneration; (d) control of even low level of poaching of the lion-tailed macaque; and (e) translocation of individual males in order to offset unfavourable adult ratios detected through periodic monitoring; (f) and research into genetic and parasitic consequences of habitat fragmentation.