THE GEOGRAPHY OF ITATIAIA NATIONAL PARK, BRAZIL

Thesis for the Degree of Ph. D.

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H. Daniel Stillwell

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This is to certify that the

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THE GEOGRAPHY OF

ITATIAIA NATIONAL PARK, BRAZIL

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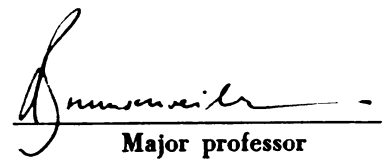

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THE GEOGRAPHY OF

ITATIAIA NATIONAL PARK, BRAZIL

By

H. Daniel Stillwell

AN ABSTRACT

Submitted to the College of Science and Arts
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ABSTRACT

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A national park is an area of outstanding natural interest and beauty which is set aside to assure its survival. This concept is generally accepted throughout the world, but the character of the area and the extent of its development and use vary greatly among nations. Some parks are established primarily for conservation and others for recreation. As of 1960 100 million acres of land and water lie within the confines of 584 parks. Much of this area is in parts of the world still relatively inaccessible to or undisturbed by man, such as in Latin America.

Only five Latin American countries have national parks. However, in these countries, seventy-four areas are so designated. Brazil recognized the need for conservation of natural resources as early as 1797 but only recently established four national parks. Two of these have a mountainous character, and the others display distinctive water and forest resources.

Itatiaia was the first area of Brazil to become a national park. It remains today a most outstanding region both for its natural environment and for its use as a recreational resource. This 30,000 acre park lies in the

southeastern coastal mountains between Rio de Janeiro and São Paulo. The geographic setting of Itatiaia can be regionalized on the basis of altitudinal zones. An igneous massif with a local relief of almost 8000 feet forms the core of the park. Its uppermost peaks are sharp and barren. From the base of this summit zone to about 7000 feet is an almost level, grass and rock covered altiplano. Lower slopes support dense subtropical forests and a great diversity of fauna. The biotic elements reflect varying climatic influences at different elevations.

Land use prior to the park's establishment was limited to homesteading and logging, mostly in the southern part. These activities were related to the development of surrounding regions through various economic cycles, such as coffee culture (1800-1870). Settlement on the higher slopes of Itatiaia was attempted by the government for a temperate fruit culture (1908-1913). This was unsuccessful. The current rapid expansion of touring and resorting in Brazil has emphasized the importance of Itatiaia as a recreation resource. The establishment of the park in 1937 saved Itatiaia from being engulfed in various exploitative activities.

The particular management of a park resource depends on the needs and interests of the people which the park serves. At Itatiaia, three major activities are found: research, conservation, and recreation. To facilitate these uses of course there are numerous roads and trails, cabins

and shelters, a large headquarters, and other structures. Research in geology, flora, and fauna of Itatiaia has been strongly advanced. Conservation activity is limited to erosion control. The overuse of some areas and facilities, and the meager use or neglect of other areas constitute major problems. Less than one-fifth of the 51,000 visitors in 1953 ventured beyond the headquarters and immediate surroundings in the southern part of Itatiaia. There is also a problem of private land ownership within the park.

Plans for the use of Itatiaia must recognize the specific needs of the population of this tropical area. Recommendations for immediate action include: the formation of a ranger service, repairing roads and trails, and various research projects. The most important role of Itatiaia is to educate man in the proper use of his natural environment. As the country develops its resources and as living standards rise, greater stress will be placed on national parks. With some necessary improvements, Itatiaia should continue to be a model for the establishment of other parks and the example for a new land use philosophy in Brazil.

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PREFACE

Itatiaia National Park lies in the southeastern highlands of Brazil near Rio de Janeiro. It exemplifies the basic concept of a national park as an area of outstanding natural interest and beauty which is set aside to assure its survival, an island in the sea of civilization. The mountainous character of Itatiaia results in remarkable contrasts to surrounding regions. Lower slopes support a dense subtropical rain forest while an altiplano at higher elevations shows alpine conditions. Bare, sculptured peaks stand out over 9000 feet above sea level. The cultural development of Itatiaia has been limited to features necessary for park function. However, neighboring areas have exerted some influence on Itatiaia, especially prior to the establishment of a park.

The following study presents the geography of Itatiaia National Park. Two approaches are used: a systematic study of the physical, biotic, and cultural elements of the area, and an evaluation of the park's role as a natural resource. The systematic study offers a basis for the evaluation of park management. The fact that Itatiaia was the first national park established in Brazil for conservation, research, and recreation sheds an important light on the understanding of this rapidly developing tropical country. Itatiaia can well serve as a spearhead for other tropical parks.

This park was chosen for intensive study during a six-month period in Brazil, April to September, 1959. Materials and information were collected during prolonged field work at Itatiaia and other Brazilian parks and also from libraries and universities in Rio de Janeiro and São Paulo. The author wishes to express thanks to Professor L. M. Sommers, head of the Department of Geography, Michigan State University, for aid in securing the fellowship to Brazil and to the Instituto Pan-Americano de Geografia e História for supporting the research. Particular appreciation is given to Professors D. H. Brunnschweiler and E. C. Prophet, also of the Department of Geography, Michigan State University, for helpful suggestions in developing the research and writing the text. In addition, the following acknowledgments should be made: Dr. Wanderbilt Duarte de Barros, former director of Itatiaia National Park and now director of Agricultural Research, Rio de Janeiro, for arranging study at various parks; Dr. Raimundo Girrard, director, and Elio Gouvea, naturalist, Itatiaia National Park, for outstanding cooperation in gathering the data; E. C. de Oliveira and M. P. de Camargo, directors of Serra dos Orgãos and Iguassú National Parks, respectively; Dr. Speridião Faissol, Secretary General of Conselho National de Geografia; and innumerable other Brazilians who made the study and experience in Brazil a memorable one.

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INTRODUCTION AND STATEMENT OF THE PROBLEM

Itatiaia National Park offers the student of geography two main avenues of investigation: a study of a mountain environment and a study of park management and recreational development in the tropics. Here is an area of Brazil in which the original landscape has been little changed by man's occupance in comparison to the surrounding regions. The interplay of natural forces can be observed in the magnificent variety of physical and biotic features which only a tropical mountain system can offer. It is from the viewpoint of mountain geography that the investigator will deal, in the first place, with Itatiaia.[1] Even though the park is relatively small (29,652 acres), it exhibits to the casual observer a remarkable variety of habitats. To the trained observer, this variety becomes meaningful through careful study of physical and biotic elements. It is the relation between altitude on one hand, climate and vegetation on the other, which challenges the student of physical geography and biogeography. From a physiographic point of view, Itatiaia also offers many

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[1]Peattie was among the first to use the term "mountain geography" and indirectly defines the field by the subject matter of his text: mountain climate, vegetation zones, land utilization and economics, mountain populations and their distribution, political matters, and the character of mountain life. See R. Peattie, Mountain Geography: a Critique and Field Study (Cambridge: Harvard University Press, 1936).

intriguing problems. It can truly be said of this part of Brazil that its beauty is the most valuable characteristic, and an understanding of this beauty is most rewarding. The very name Itatiaia, meaning "God of the high peak," reflects the appreciation that the natives had for the beauty of this area.

People of Brazil have long recognized the exceptional character of the Itatiaia area. The conservation of this natural resource was assured when Itatiaia was established as Brazil's first national park in 1937. A geographer working with Itatiaia can not avoid seeing the implications of the fact that the Brazilians now control and use this part of their country in a very special way. Historically speaking, this has not always been so. Small parts of the present park are actually used for other than conservation, research, and recreational purposes, the major park functions today. The regions adjacent to the park show evidence of intensive use and misuse through various periods of occupance. The establishment of the park saved Itatiaia from being engulfed in exploitative activities of any kind, but this alone did not guarantee a successful management of the park land. Brazil has had little experience in any form of nature preservation or "guided recreation."

The problems connected with the management of a national park in Brazil quite naturally began to emerge as a second major area of investigation. The inclusion of these technical aspects of conservation, research, and recreation at Itatiaia National Park in this study dictated the division of subject

matter into two closely connected parts. It was felt that the total geography of Itatiaia consists as much of the nature of the park landscape as of the park's land use and management problems. The functions of conservation and research are closely related to the physical and biotic landscape, whereas recreation is an activity related to the cultural landscape or human geography.

In order to establish a frame of reference for a study of national parks and particularly this one in Brazil, an introductory survey of parks throughout the world and a comparison of Brazilian parks is made (Chapter I and Appendix). Then there follows a discussion of the physical and biogeographic characteristics of the park area. Chapter III deals with the impact of the settling and cultural development in the surrounding regions upon Itatiaia. Therefore, in Part I the emphasis is on describing tangible geographic elements of the park, showing their interrelations, and presenting various problems yet to be solved. In addition, Part I provides a background of the park landscape as the basis for a discussion in Part II of the problem of park management and recreational development. In Part II the emphasis is on analyzing the role of Itatiaia National Park as it exists today, and suggesting how it may be improved in the future.

CHAPTER I

THE POSITION OF ITATIAIA AMONG NATIONAL PARKS OF THE WORLD

Interest in the perpetuation of natural resources is one mark of a civilized nation. Man comes to realize, with the exploitation of raw materials for industry and the pressure of urban living, that he should safeguard some part of his environmental heritage from which can be derived understanding of the truths of natural and cultural history. Moreover, as his working hours shorten and life becomes easier, man finds a need for greater and more varied recreation.[2] From this twofold need for perpetuating natural resources and for public recreation has emerged the concept of National Parks.

The Concept of National Parks

National Parks are special areas set apart to be retained in a natural condition. More specifically, they denote "areas established for the protection and preservation of superlative scenery, flora and fauna of national significance which the general public may enjoy and from which it may benefit when

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[2]Recreation, in its broadest sense, means "pleasurable change" or "creative use of leisure," either for inspiration, education, or just plain enjoyment.

placed under public control."[3] This definition has its roots in the establishment policy for the world's first national park, Yellowstone National Park, in 1872. The purpose of national parks, as reflected in the definition, is "to conserve the scenery and the natural and historic objects, and the wildlife therein, and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."[4] This basic concept and purpose of national parks characterizes most park systems throughout the world. However, some parks are established primarily for conservation and others primarily for recreation.

A national park is a resource and, like minerals, timber, or soil, has value to man only when it is made useful to man. However, the inspiration, education, or enjoyment of national parks are best supplied by the natural scene, the unimpaired wilderness.[5] Wilderness exists where nature is free and man's actions are controlled, a completely opposite relation to that of most other resources. Man is a part of the scene since wilderness has little human value without him, but his use of

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[3]From Article I of the Convention of Nature Protection and Wildlife Preservation in the Western Hemisphere, 1942, as reprinted in D. Butcher, Exploring our National Parks and Monuments (Boston: Houghton Mifflin Co., 1956), p. 274.

[4]Key part of the Act of 1916 that established the National Park Service of the United States. See H. Tolson, Laws Relating to the National Park Service, The National Parks and Monuments (Washington: U.S. Government Printing Office, 1935), p. 17.

[5]Sigurd F. Olson, President of National Parks Association states: "Wilderness has become a cultural necessity to us, and while it does play an important recreational role, its real function will always be as a spiritual backlog...a balance wheel and an aid to equilibrium." See Butcher, op. cit., p. 1.

this natural resource must be modified and controlled. In the park he may find objects of unusual beauty or natural interest, places where he can feel removed from modern civilization, where he might feel the pioneer spirit of self-reliance, sharpened perception, and a renewed perspective on life.

A variety of outstanding landscapes have come under the designation of national park. For example, the United States has areas of virgin forest and mountain glaciation, habitats of desert and cave, and spectacular volcanic and erosional phenomena.[6] In Brazil, the national parks of Itatiaia and Serra dos Orgãos are superlative mountain areas, whereas Iguassú and Paulo Afonso parks possess excellent water attractions (Figure 2).

National Parks of the World

National parks are unevenly distributed over the earth's surface (Table 1). Although almost 600 areas, representing over 100 million acres, are designated as "national parks," there are many other areas set apart for nature protection and recreation; for example, national monuments, national forests, state parks, and wildlife refuges. Obviously, not all countries are in a position to establish national parks. Some have insufficient land at their disposal. Others find that exploitative

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[6]Within the National Park System of the United States are many areas established for specific interest: monuments, historical parks, military parks, battlefield parks, memorial parks, battlefield sites, memorials, parkways, cemeteries, and capital parks. In addition to the National Park System, other recreational conservational areas include: national forests, mountain trail systems, Indian reservations, national wildlife refuges, dams and reservoirs, national recreational areas, and state, county, and city parks. However, national parks alone guarantee the continuation of wilderness for conservation and recreation.

TABLE I. National parks of the world[1]

Location	Number	Park Area, 1000 acres	Population, 1000 (1958)	Persons/ Park Acre	Year[2]
Anglo-America	47	31,695.8			
United States	29	13,136.2	177,702	13.5	1872
Canada	18	18,559.6	17,442	0.9	1885
Latin America	74	10,857.3			
Argentina	8	6,261.0	20,614	3.2	1903
Brazil	4	597.0	64,216	107.3	1937
Chile	10	750.0	7,465	10.0	
Mexico	50	2,569.3	33,304	13.0	1898
Venezuela	2	680.0	6,512	9.6	1937
Europe	107	9,706.3			
Belgium	5	0.5	9,053	18,000.0	
Finland	4	244.0	4,414	18.0	1938
Italy	4	458.0	49,055	107.0	1922
Poland	10	200.0	28,783	144.0	1934
Sweden	15	977.1	7,454	7.6	1909
Switzerland	1	39.0	5,235	134.0	1914
U.S.S.R.	40	4,000.0	208,827	52.0	1919
United Kingdom	10	3,358.7	51,680	15.3	1949
Yugoslavia	18	429.0	18,421	42.9	1928
Africa	56	36,494.5			
Algeria	14	70.0	10,265	146.0	1923
Rep. of the Congo[3]	4	7,432.0	13,291	1.8	1925
French Equ. Africa[3]	5	4,521.9	5,023	1.1	1940
French Somaliland	2	25.0	67	2.7	
French West Africa[4]	2	2,500.0	20,484	8.2	
Kenya	6	5,484.3	6,450	1.2	1946
Morocco	2	85.0	10,330	121.5	
Rhodesia-Nyasaland	10	3,900.0	7,610	1.9	1949
Tanganyika	1	3,684.0	8,919	2.4	1951
Tunisia	1	12.0	3,920	325.0	
Uganda	2	1,280.0	5,868	4.6	1952
Union South Africa	7	7,500.3	14,673	1.9	1926
Asia	60	6,161.8			
India	1	128.0	402,750	3,150.0	
Japan	19	4,360.0	92,740	21.1	1934
Malaya	1	1,075.0	6,277	5.8	1939
Philippines	39	598.8	24,718	41.3	1933
Australia	232	1,700.0	10,061	0.6	1882
New Zealand	8	3,893.0	2,331	0.6	1894
Totals	584	100,600.0			

[1]From C. F. Brockman, Recreational Use of Wild Lands (New York: McGraw Hill, 1959) and Information Please Almanac (New York: McGraw Hill, 1961). Not listed owing to insufficiency of data are parks in the following countries: Honduras, Peru, Greece, Spain, Iceland, Ethiopia, Sudan, Lebanon, New Caledonia.

[2]Date of first established park, when known.

[3]This area is now divided into four republics.

[4]This area is now divided into nine republics.

use of land has gone beyond the stage of possible recovery. Many countries which are underdeveloped or undeveloped feel no concern for setting aside virgin or unused areas. On the contrary, they consider frontier wilderness as an obstacle to progress. As a country opens its wilderness and moves toward economic maturity, an awareness of the need for preserving some of the former virgin land heralds a cultural maturity. A sense of stewardship for natural resources may initiate the establishment of national parks. Often, the only remaining suitable areas are in remote mountains, since distance, ruggedness, and climate are effective guardians of wilderness. Itatiaia National Park is a good example of this situation.

The need for establishing national parks was recognized early by the United States, Mexico, Canada, Australia, and New Zealand (Table 1). However, world park acreage was soon expanded, particularly in colonial Africa. Whether or not these areas in Africa will be maintained, following independence, remains to be seen. Certainly national initiative, as exemplified in Brazil and other South American countries, is responsible for stable park systems.

Multilateral interest in a conservation movement was evident at the International Congress for the Protection of Nature held in Paris in 1931.[7] Two years later, the London Convention for the Protection of African Fauna and Flora gathered representatives from all countries having territories in Africa. Agreement was reached as to the designation and

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[7]Butcher, op. cit., p. 274.

policy for "national parks" and "strict national reserves." In 1942, the Convention on Nature Protection in the Western Hemisphere established a "basic pattern for a scheme of parks, monuments, and reserves throughout the Americas on a basis which experience has proved to be sound."[8] It also enacted protective laws for migratory birds and vanishing species. Conservation education has been stressed by the Pan American Union and the Inter-American Conference on Conservation of Renewable Natural Resources.

World-wide interest in parks became apparent with the organization of the International Union for the Protection of Nature (I.U.P.N.) in October, 1948. It is under the joint sponsorship of France, the Swiss League for the Protection of Nature, and UNESCO.[9] Assemblies are held every two years. The basic policy includes: 1) preservation of outstanding natural environment having scientific, historic, or aesthetic significance by national parks, nature reserves, monuments, and wildlife refuges, 2) spread of conservation knowledge, and 3) scientific research on the protection of nature. Most countries have adopted the general policies of the I.U.P.N., although park administration may differ.[10]

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[8]Pan American Union, Nature Protection and Wildlife Preservation in the Western Hemisphere, 1942 (Washington: U. S. Government Printing Office, 1943), p. 7.

[9]International Union for the Protection of Nature, The Position of Nature Protection throughout the World in 1950 (Brussels: UNESCO, 1951), p. 4.

[10]National Parks of the United States are under the Department of Interior, Brazilian parks are under the Minister of Agriculture, and Japanese parks are under the Ministry of Health and Welfare.

The specific use of a national park may vary greatly according to economic conditions, population density, and cultural background of the people. As previously mentioned, some parks serve primarily as recreation centers. Winter sports are most important at Mount Cook, New Zealand, and at Peñalolen, Chile; two parks in Southern Rhodesia are equipped with artificial lakes for recreation.[11] The protection of specific wildlife is emphasized in other parks; for example, the black-necked swan of Laguna Blanca, Argentina. The former occupance of park land often forces a modification in park policy. Serengeti National Park, Tanganyika, lies within the traditional grazing lands of the Masai. These natives are therefore allowed to continue grazing their livestock. Japan has such limited space for its large population that much park land is still privately owned.[12] However, specific areas are designated for protection.

The position of Brazil and specifically Itatiaia with respect to national parks of the world can be more fully understood by studying Tables 1 and 2 and Figure 1. Since Itatiaia lies wholly within a mountain environment, a situation often characteristic of surviving wilderness, a tabulation and comparison of parks with mountain peaks above treeline seems justified. Although information on the quality, accessibility, extent of development, and volume of visitation at the parks is not given, some observations may be made from the data in

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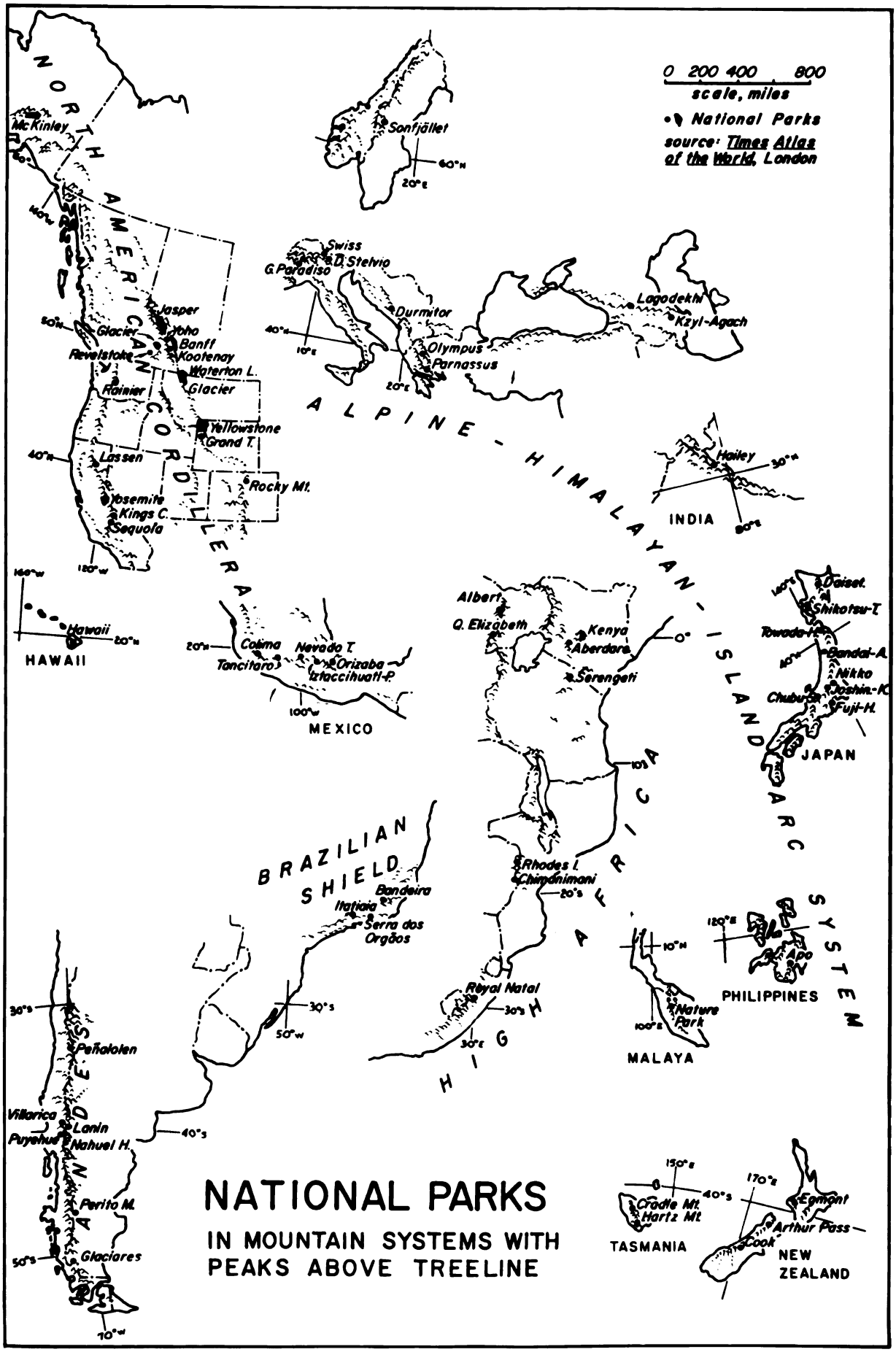
[11] Brockman, op. cit., p. 264.

[12] National Parks Association, National Parks of Japan (Tokyo: Ministry of Health and Welfare, 1956), p. 16.

TABLE 2. National parks with mountain peaks above treeline*

Location and Name of Park	
Anglo-America	
United States:	Glacier
	Grand Teton
	Hawaii
	Kings Canyon
	Lassen
	Mount McKinley
	Mount Rainier
	Rocky Mountain
	Sequoia
	Yellowstone
	Yosemite
Canada:	Banff
	Glacier
	Jasper
	Kootenay
	Mount Revelstoke
	Waterton Lakes
	Yoho
Latin America	
Argentina:	Lanin
	Los Glaciares
	Nahuel Huapí
	Perito Morena
Brazil:	Itatiaia
	Serra dos Orgãos
Chile:	Peñalolen
	Volcan Villarica
	Volcan Puyehue
Mexico:	Iztaccihuatl-Popocatepetl
	Nevado de Toluca
	Pico de Orizaba
	Pico de Tancitaro
	Volcan de Colima
Venezuela:	Serra
Europe	
Greece:	Mount Olympus
	Mount Parnassus
Italy:	Dello Stelvio
	Gran Paradiso
Sweden:	Sonfället
Switzerland:	Swiss
U.S.S.R.:	Kzyl-Agach
	Lagodekhi
Yugoslavia:	Durmitor
Africa	
Republic of the Congo:	Albert
Kenya:	Aberdare
	Mount Kenya
Rhodesia-Nyasaland:	Chimanimani
	Rhodes Inyanga
Tanganyika:	Serengeti
Uganda:	Queen Elizabeth
Union of South Africa:	Royal Natal
Asia	
India:	Hailey
Japan:	Bandai-Asahi
	Chûbu-Sangaku
	Daisetsuzan
	Fuji-Hakone-Izu
	Jôshinyetsu-Kôgen
	Nikko
	Shikotsu-Tôya
	Towada-Hachimantai
Malaya:	Nature
Philippines:	Mount Apo
Tasmania:	Cradle Mountain
	Hartz Mountain
New Zealand:	Arthur Pass
	Egmont
	Mount Cook

*Compiled from Brockman, op. cit., and The Times Atlas of the World (London, 1956).



NATIONAL PARKS

IN MOUNTAIN SYSTEMS WITH PEAKS ABOVE TREELINE

FIG. 1

Tables 1 and 2.

1. National parks comprise about 0.28% of the world land area, or 100,600,000 acres.

2. Australia and New Zealand have 41% of the total number of world parks but only 5% of the total park area. Africa has 10% of the world's parks and 36% of the total park area. Anglo-America ranks slightly below Africa with 8% of the parks and 32% of the park area.

3. Park acreage in the relatively undeveloped tropical region of Africa is large in contrast to the similar region in Latin America.

4. The number of people per acre of park land is low in most African countries, Argentina, and particularly low in Canada, Australia, and New Zealand.

5. Sixty-six national parks lie in high mountain regions. They represent major park areas in western United States and Canada, Central Mexico, southwestern South America, east-central Africa, and Japan.

6. Only five Latin American countries have national parks, but about half of these parks are situated in mountainous regions.

7. Almost all of the mountainous parks lie in young mountain systems. Many of the latter are of volcanic origin, as for example in Mexico and Chile.

8. Mountain parks of Brazil, Mexico, southern Europe, east-central Africa, and Japan are generally within 100 miles of populations with densities over 100 per square mile.

The Development of the Brazilian Park System

Brazil offers a good example of a large tropical country which is starting to recognize the value of national parks. Her eastern coast, long settled and over-populated, contrasts greatly with the underdeveloped interior (Figure 3). Fortunately, the southeast coastal mountain ranges have been largely untouched as the pioneer fringe moved inland. Itatiia National Park was established to protect a portion of this region.

National parks represent only a very small part of the total area of Brazil.[13] However, their acquisition has been a long, hard struggle. It is understandable that early settlers exploited the seemingly inexhaustible natural resources by extensive hunting, cutting of timber (particularly Brazilwood), clearing areas by fire, and mining.[14] The first official recognition of conservation in Brazil was a law, "Carta Regia," by the Portuguese king in 1797 which provided for "severe punishment to those who burned and destroyed the forests."[15] The 19th and early 20th centuries brought exploration by foreign naturalists who described the wide-spread destruction of natural resources.[16] Other laws were passed, particularly

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[13]Brazil has 0.03% of its total area in national parks, compared to 0.67% in the United States, and 0.73% in Canada, two countries of about the same size as Brazil.

[14]W. D. de Barros, Parques Nacionais do Brasil (Rio de Janeiro: Ministerio de Agricultura, 1952), p. 13.

[15]Ibid., p. 14.

[16]See R. Nash, The Conquest of Brazil (New York: 1926). Others include Darwin, Wallace, Derby, Bates, Schomburk, and Saint 'Hilaire.

after the establishment of the Republic in 1889, but no means were provided for their enforcement. From 1890 to 1900, almost two and one-half million acres near São Paulo were cleared for coffee plantations to help in the support of the growing nation. Forest cover in the state of São Paulo was reduced from 64.7% in 1911 to 15.6% in 1919. The Paraíba Valley was likewise denuded.[17] In 1913 an attempt was made to revise conservation policy according to the precepts of Gifford Pinchot.[18] He advocated preserving unused resources and providing for their continuous production, but his ideas received little interest or support in Brazil.[19] Finally in 1934 a law was passed for "controlling exploitation of water, forests, and mines, and protecting the natural beauties and monuments of artistic and historical value." It reflected a trend toward nationalization.[20] According to this law, landowners had to obtain government permission to use the water or subsoil on their land. In the same year a section of the National Historic Museum was formed to protect historic, artistic, and natural features of the country. This evolved into the National Service of Historic and Artistic Patrimony (NSHAP).

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[17] Barros, op. cit., p. 21.

[18] Gifford Pinchot was the first official head of the U. S. Forest Service, and is often referred to as "the father of conservation."

[19] W. D. de Barros, "A Importancia Publica dos Parques Nacionais," Revista Florestal (Rio de Janeiro: September, 1945), 23.

[20] Barros, Parques Nacionais do Brasil, p. 17.

In 1937 the NSHAP took a bold step forward in nature protection with the creation of the first National Park, Itatiaia. This new park served as a proving ground for conservation policies and paved the way for the establishment of other national parks. What is more important, it stood as dramatic evidence that Brazil was attempting "to attain an equal level with civilized nations that consider the establishment and conservation of national parks in its territory the climax of politics for protecting natural resources."[21]

In 1944, the NSHAP became the Section of National Parks (SNP) of the Forest Service under the Minister of Agriculture. The SNP is charged with "directing, supervising, coordinating, and elaborating park works" with the objectives to:

1. Conserve for science, recreation, education and aesthetics the areas under its jurisdiction.

2. Promote studies of flora, fauna, and geology.

3. Organize museums and herbariums.[22]

Potential park areas are studied by a commission comprised of the following: agronomist, geologist, geographer, engineer, architect, naturalist, zoologist, botanist, silviculturist, and ecologist. If an area has exceptional qualities of natural history and for recreation, particularly where man's interference is a threat, it may be established as a national park by government decree.

National park policy in Brazil has been adapted almost entirely from that of the United States and includes the

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[21] Ibid., p. 81.

[22] Ibid., p. 36.

following:

1. Parks are chosen for their national uniqueness and significance in respect to ecology, biology, archeology, history, or scenery, irrespective of their nearness to population centers.

2. Parks must be maintained unimpaired for present and future generations. Every activity must be subordinated to the preservation of the area. Structures must be in harmony with the environment.

3. Strict control by federal government is designed to guarantee the national interest.

4. Scientific research, education, and recreational uses are encouraged by museums, a variety of accommodations, and other structures.

5. Parks are established only by a specific Act of Congress.

Brazil is gradually beginning to recognize that uncontrolled exploitation of forest and soil, especially in tropical areas, brings erosion, floods, and extinction of fauna; that, in the words of Barros, "intensification of nature protection is imperative for the existence of the Nation.[23] Therefore, national parks have been created in four areas: Itatiaia, Iguassú, Serra dos Orgãos, and Paulo Afonso (Figure 2). A brief geographic sketch is given for the latter three parks in the Appendix to facilitate comparison with Itatiaia. Numerous other areas have been proposed as new national parks. They are well distributed throughout Brazil (Figure 2). One is soon to be established northeast of Rio de Janeiro in the mountainous region of "Mantiqueira" where the highest Brazilian peak, Pico da Bandeira (9537 feet), is located. Other potential parks include the beautiful cave formations of Maquine in

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[23] Ibid., p. 11.

Minas Gerais, the sandstone sculptures of Vila Velha in Paraná and the high plateau area of Mount Roraima in the northwest.

In addition to national parks, other areas have been set aside for nature protection in Brazil. They include three state parks, a wildlife refuge, and a national forest.[24]

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[24]Instituto Pan-Americano de Geografia e Historia, Estudos sobre os Recursos Naturais nas Americas, A Report on Brazil (Rio de Janeiro: Servico Grafico, 1953), pp. 193-194.

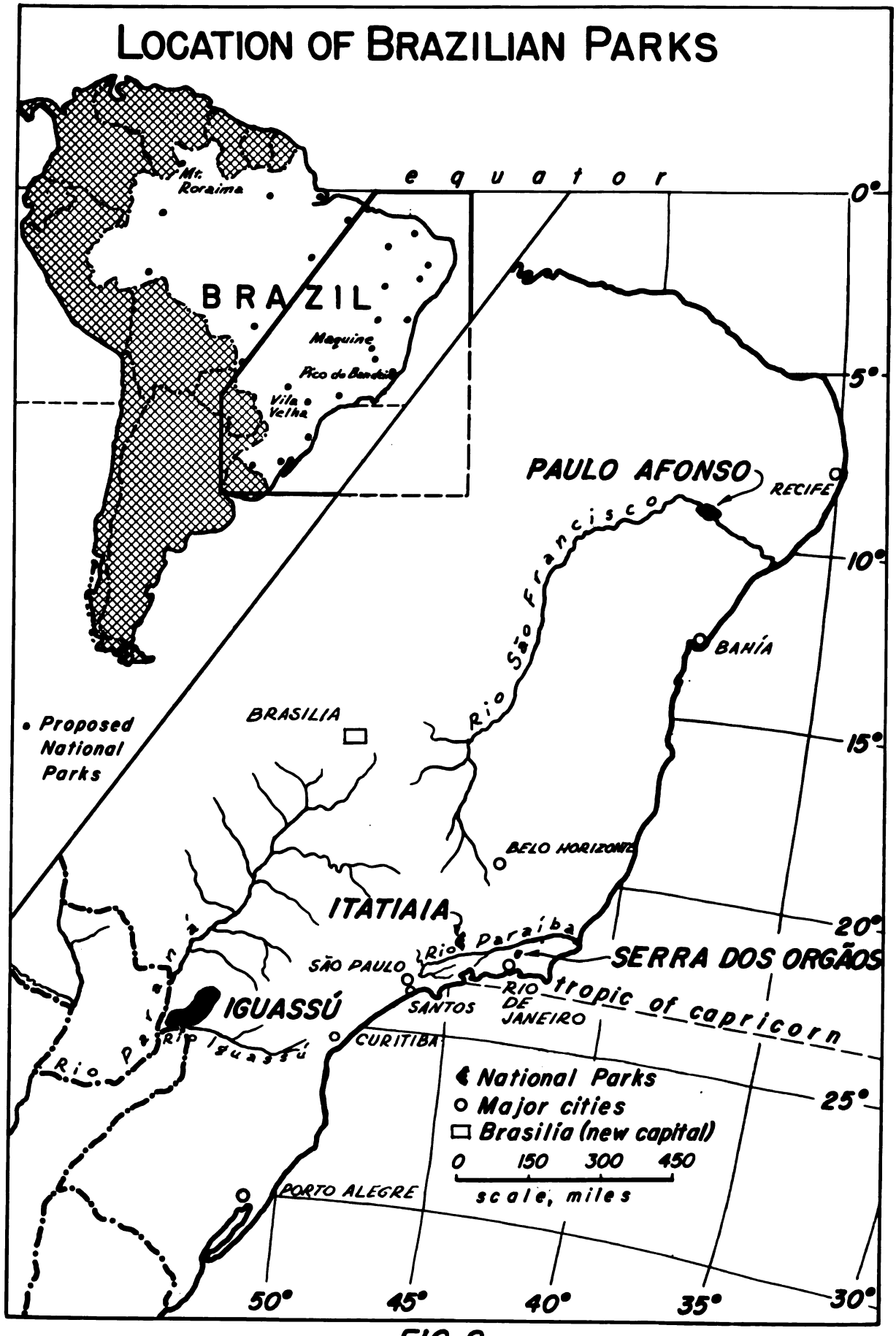
LOCATION OF BRAZILIAN PARKS
equator
0°
5°
10°
15°
20°
25°
30°
50°
45°
40°
35°
Mt. Roraima
BRAZIL
Maquine
Pico da Bandeira
Vila Velha
PAULO AFONSO
RECIFE
Rio São Francisco
BAHÍA
• Proposed National Parks
BRASILIA
BELO HORIZONTE
ITATIAIA
Rio Paraíba
SÃO PAULO
SERRA DOS ORGÃOS
IGUASSÚ
SANTOS
RIO DE JANEIRO
tropic of capricorn
Rio Iguassú
CURITIBA
Rio Paraná
National Parks
Major cities
Brasilia (new capital)
0 150 300 450
scale, miles
PORTO ALEGRE

FIG. 2

Summary

The preceding survey of national parks of the world has offered a brief discussion of their origin, nature, and distribution. The development of the Brazilian park system has also been described as additional background for a detailed geographic study of Itatiaia National Park. The concept of national parks emanates from two basic needs: to preserve outstanding examples of the natural landscape, and to provide types of public recreation possible only in these natural landscapes. The position which national parks occupy in a particular country depends on three factors: how important the need is for conservation and recreation, the awareness of these basic needs, and the willingness and ability to fulfill these needs. There are almost 600 national parks in the world today constituting over 100 million acres. Individual parks differ widely as to relative value and use. A park far removed from populated areas may have low visitation, except in countries enjoying high living standards. However, a certain degree of remoteness is required for the wilderness character which the park is intended to preserve. At least 66 major national parks of the world have some of their areas in high mountains. Thus, a great diversity of climates, landforms, soils, flora, and fauna exists in concentrated areas owing to the influence of altitude. This enhances a park's value both for recreation and for scientific study.

Only five Latin American countries have national parks, but about half of these parks are situated in mountainous regions. Brazil is a large, tropical country with great

contrasts in development. Consequently, there are great differences in the need for conservation and recreation: a pressing need along the populous east coast, and almost no need in the vast interior. Two existing parks and a third one to be established lie in the coastal ranges of the Eastern Highlands. The most outstanding park is Itatiaia, both for its natural environment and for its present and potential use as a recreational resource.

It is in consideration of these facts that Itatiaia seemed to present a well-defined set of conditions worthy of detailed geographic description and analysis. The subsequent two parts of this thesis, therefore, will discuss the geographic setting of Itatiaia and its function as a natural resource of Brazil.

PART I

THE GEOGRAPHIC SETTING OF ITATIAIA NATIONAL PARK

Introduction

Itatiaia National Park offers an excellent field laboratory for the specific study of tropical mountain geography.[25] It was shown in Chapter I that national parks and particularly those of mountain regions are rapidly gaining importance in conservation-recreation use. There is a dearth of work treating the geographic complex of either mountain areas or national parks.[26] The following two chapters will present an intensive study of the physical, biotic, and cultural setting of Itatiaia National Park.

Existing literature

From as early as 1867, aspects of the geology, geomorphology, botany, and zoology at Itatiaia have been studied by scholars.[27] Sketchy and inadequate regional descriptions of the park have been made for tourists and other selected groups. The first descriptive material about the area that was to become the park was a "Map to Serve as a Guide to Itatiaia" prepared by the Brazilian geographer Barão Homen de Melo in

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[25]This field was briefly defined in Footnote No. 1.

[26]However, the Universities of Grenoble and Innsbruck both have institutes of alpine geography.

[27]J. F. da Silva Massena, Quadros da Natureza Tropical ou Ascensão Scientifica ao Itatiaia, Ponto Culminate do Brasil (Rio de Janeiro: publisher unknown, 1867).

1876.[28] An excursion to the area in 1903 was briefly reported by Moreira.[29] The twelfth General Assembly of the Consulho Nacional de Geografia (1952), sponsored an extensive excursion to Itatiaia. A guide book was prepared for this group by Valverde, which emphasized the area surrounding the park.[30] A general booklet by Barros on Brazilian national parks also appeared in 1952.[31] It reviewed the origin, principles, and problems of the parks as well as giving brief descriptions of the following: location, geology, flora, fauna, access, and accommodations. In 1957, Barros, the director of Itatiaia National Park since its establishment, published an illustrated report to create public interest in Itatiaia.[32] He described the wealth of natural history, access facilities, and accommodations of the park with more detail than in his 1952 booklet. This work has been circulated through the Service of Agricultural Information.

A guide which was written for the Eighteenth International Congress of Geography in 1938 described the Paraíba Valley, the Serra da Mantiqueira, and environs of São Paulo.[33]

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[28]W. D. de Barros, Parque Nacional do Itatiaia (Rio de Jeaneiro: Ministerio da Agricultura, 1957), p. 62.

[29]C. Moreira, "Relatório das Excursões Efetuadas na Margem no Itatiaia na Serra da Mantiqueira," Archives Museú Nacional, Rio de Janeiro, XII (1903), 159-186.

[30]O. Valverde, Excursão a Itatiaia. (Rio de Janeiro: Servico Grafico do Instituto Brasileiro de Geografia Estatistica, 1952), pp. 9-33.

[31]Barros, Parques Nacionais do Brasil, op. cit.

[32]Barros, Parque Nacional do Itatiaia, op. cit.

[33]A. N. Ab'saber and N. Bernardes, Vale do Paraíba, Serra da Mantiqueira e Arredores de São Paulo (Rio de Janeiro: Conselho Nacional de Geografia, 1958), pp. 7-303.

Geomorphological problems of the Itatiaia massif were discussed in detail.

CHAPTER II

PHYSICAL GEOGRAPHY AND BIOGEOGRAPHY OF ITATIAIA

The Nature, Distribution, and Origin of Elements in the Physical Environment

The park is situated within the Brazilian Shield, a vast ancient crystalline complex which extends along the eastern coast and throughout much of the interior of Brazil. Paralleling the coast are two major escarpments which define the Serra da Mantiqueira and Serra do Mar (Figure 4). The valley of the Paraíba River separates these ranges (Plates I and IV A). Itatiaia lies in the Serra da Mantiqueria, and even though a part of the shield, it displays some of the most rugged alpine character in the entire country. The main peak rises over 9000 feet above sea level, and abruptly from an altitude of 1400 feet. Itatiaia has been termed a "massif" ("massive").[34] There are three conspicuous divisions of the massif: the lower slopes, the altiplano, and the monadnocks, or zone of summits (Figures 9 and 10). This highest zone, above the treeline, presents a striking topography like towering castles of black rock. The combination of all these features makes the landscape of Itatiaia truly unique.

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[34]Both of these terms signify a principal mountain mass, or a compact portion of a mountain range, containing one or more summits.

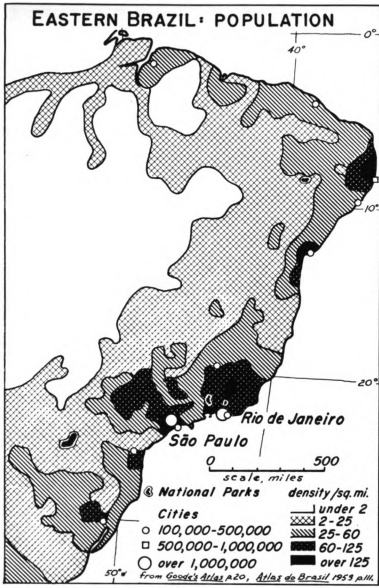
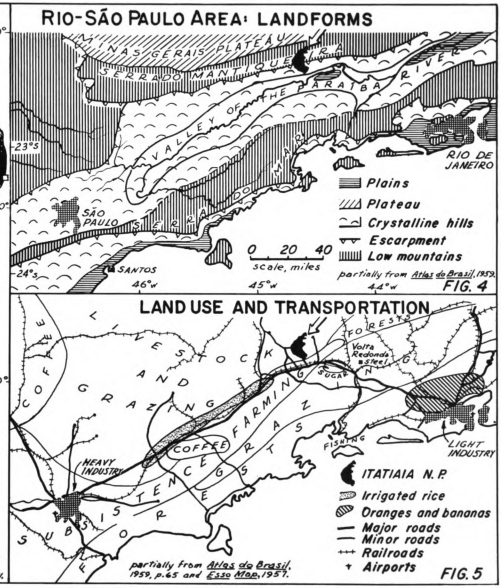
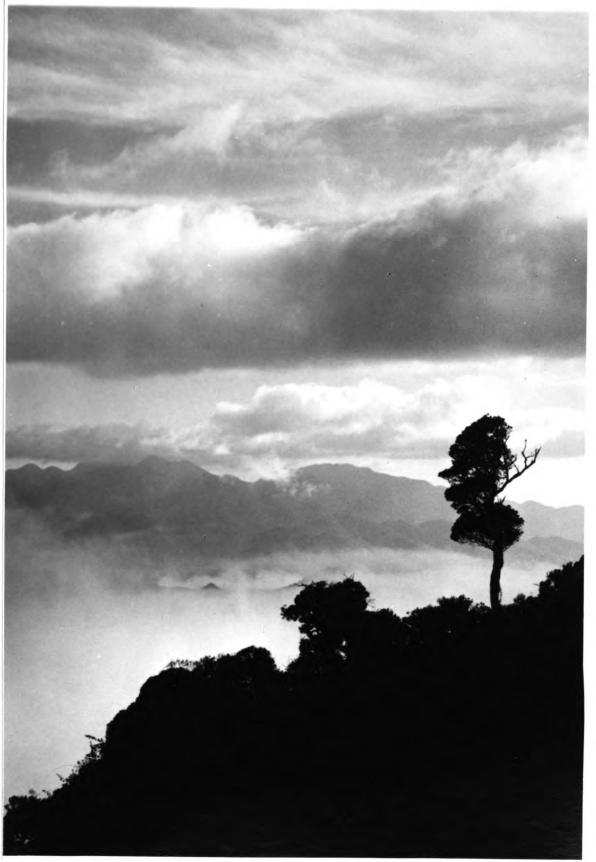


FIG. 3



FIGS. 4 and 5

Plate I. Itatiaia: Valley Fog near Treeline on the Serra da Mantiqueira. At 9:00 o'clock in the morning, high radiation fog fills the Paraiba Valley to the south. The view is from the 7000-foot level. Note the Serra do Mar range in the background. Strato-cumulus clouds are starting to form from an orographic influence of the Serra da Mantiqueira. A lone tree, Cabrella, shows a "Krummholz," or stunted, effect from severe exposure at high altitudes to the prevailing winds.



Geologic Elements

As stated in the preceding paragraph, Itatiaia lies close to the southeastern edge of the Brazilian Shield. It consists mostly of recent intrusive foyaite, a more resistant rock than the interior complex (Figure 6).[35] This different rock material extends over 528 square miles and therefore forms a prominent massif.[36] According to Derby, the massif is probably of Paleozoic age.[37] Oliveira likewise places the origin of the massif during the Hercynian diastrophism.[38] Lamego advanced the hypothesis that the massif was formed during the Cretaceous period (60 million years ago).[39] According to this theory, the main massif and an isolated part to the east of Resende would have acted as barriers for a Tertiary basin lying between them (Figure 6).

Although predominant in the higher elevations of the central Serra da Mantiqueira, foyaite is also found in the

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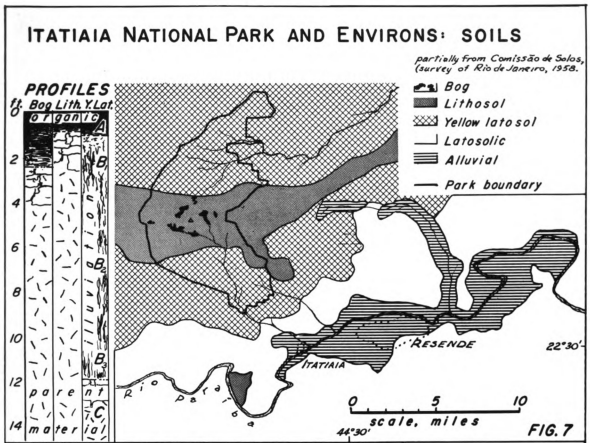
[35]Foyaite is a coarse-grained volcanic alkaline intrusive made up largely of nepheline (an orthosilicate of sodium, potassium and aluminum) and syenite (a non-quartzic, alkaline feldspar).

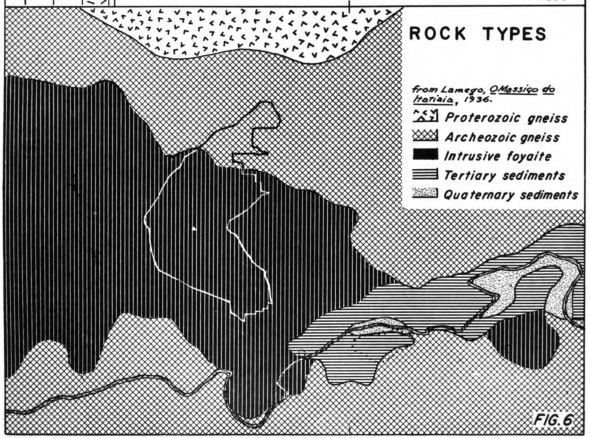
[36]Only the foyaite mass in the Kola Peninsula, U.S.S.R., has a larger extent, 560 square miles. Small isolated patches occur in other areas including 14 square miles in the Fourche Mountains of Arkansas, U.S.A. See A.R. Lamego, O. Massico do Itatiaya (Rio de Janeiro: Servico Geologico e Mineralogico, 1936), p. 18.

[37]O. A. Derby, "On Nepheline Rocks in Brazil," Quarterly Journal of the Geological Soc., XLIII (1887), 472.

[38]E. Oliveira, Epochas Metallogenicas do Brasil (Rio de Janeiro: Servico Geologico e Mineralogico, 1925), p. 124.

[39]Lamego, op. cit., pp. 25-26.


ITATIAIA NATIONAL PARK AND ENVIRONS: SOILS
partially from Comissão de Solos, (survey of Rio de Janeiro, 1958.
PROFILES
ft. Bog Lith. Y.Lat.
organic
A
B
B
B
C
parent material
Bog
Lithosol
Yellow latosol
Latosolic
Alluvial
Park boundary
RESENDE
ITATIAIA
22°30'
Rio Paraiba
0 5 10
scale, miles
44°30'
FIG. 7


ROCK TYPES
from Lamego, O Massico do Itatiaia, 1936.
Proterozoic gneiss
Archeozoic gneiss
Intrusive foyaite
Tertiary sediments
Quaternary sediments
FIG. 6

FIGS. 6 and 7

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Paraiba Valley, the structually related Serra do Mar,[40] and the island of Cabo Frio, east of Rio de Janeiro. The chemical composition of foyaite varies with altitude; there is a decrease in alkali and an increase in silica with increased elevation and the resulting more vigorous weathering.[41] The northern tip of the park and most areas adjacent to the foyaite are composed of Archeozoic gneiss, which is the bedrock of large portions of the Brazilian Shield. Foyaite contains nephelite, a source of aluminum, but it cannot be economically worked here at the present stage of technology. The surrounding areas are rich in other minerals such as magnetite, apatite, zirconium, and phosphate.[42] Mineral water springs associated with alkaline magma also abound.

Tectonically speaking, there has been some local faulting in the park. The most obvious fault forms Maromba Falls at the 4000-foot level (Figure 9). Others are found on the altiplano (Figure 11).

The origin of the Itatiaia massif has been studied intensively by A. R. Lamego. He supports the Backlund theory of magmatic intrusion.[43] According to this theory, alkaline intrusions characteristically pierce through very stable continental

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[40]The author noted outcrops 20 feet square near the road from Rio de Janeiro to Teresopolis.

[41]Lamego, op. cit., pp. 33-37.

[42]Ibid., p. 38.

[43]H. G. Backlund, "On the Mode of Intrusion of Deep-seated Alkaline Bodies," Bulletin of the Geological Institute of the University of Upsala, XXIV (1933), 15-22.


ITATIAIA NATIONAL PARK:
VEGETATION
6000

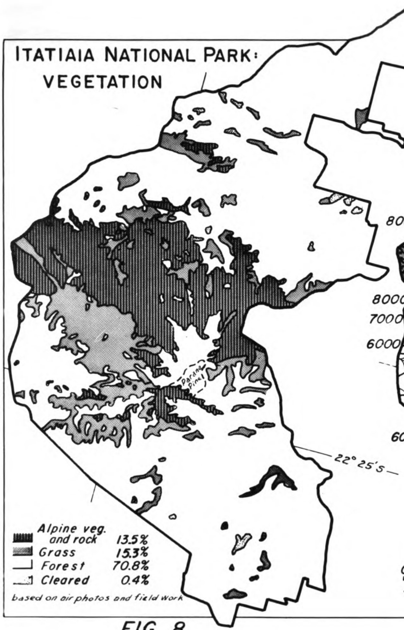
ITATIAIA NATIONAL PARK:
VEGETATION
Parana Pinel
22° 25' S
Alpine veg. and rock 13.5%
Grass 15.3%
Forest 70.8%
Cleared 0.4%
based on air photos and field work

FIG. 8


RELIEF AND DRAINAGE
Park boundary
500-foot contours
Streams
Lakes
Major water divides
Land above 7000 ft.
Rio Santa Clara
Rio Maromba
Rio Itatiaia
Cabeca do Leão
Maromba Falls
Tres Picos
44° 50' W
0 1 2
scale, miles
3000
4000
5000
6000
7000
8000
based on topographic maps by Cruzeiro do Sul, Rio

FIG. 9

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areas, such as the Brazilian Shield, and therefore differ from granitic or basaltic intrusions which form during great crustal movements. At Itatiaia, heat of the magma was able to liquify all except a small mantle of gneiss, although in places there may have been blowouts forming microcrystalline rocks. No vestiges of volcanic necks remain. As a steep-sided stock[44] dome formed, its contact surface cooled unevenly, resulting in layers of varying resistance. Subsequent erosion produced "ring dikes," which are described later (pp. 38-42).

Surface Configuration

The Itatiaia massif presents a salient profile as it rises abruptly from the middle Paraíba Valley (Figure 10).[45] Foothills form great steps or terraces covered with large rocks (Plate IV B).[46] Three major zones occur within the park bounds: the lower slopes, the altiplano, and the zone of summits. Each will be discussed as to general topography, specific features, and morphogenesis.

Lower slopes

This zone lies between the lowest levels of the park (2100 feet) and about the 7000-foot level (Figure 9). It comprises almost two-thirds of the park area and is located mostly

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[44] A "stock" is an igneous intrusion like a batholith with an area of less than 40 square miles. See M. P. Billings, Structural Geology (New York: Prentice-Hall, Inc., 1954), p.319.

[45] This valley is considered a vast asymmetrical syncline by Lamego (op. cit., pp. 45-47), but Valverde (op. cit. pp. 18-24) and others support a fault theory.

[46] These terraces may reflect differential erosion at the base of the massif.

ITATIAIA NATIONAL PARK: PERSPECTIVE VIEW

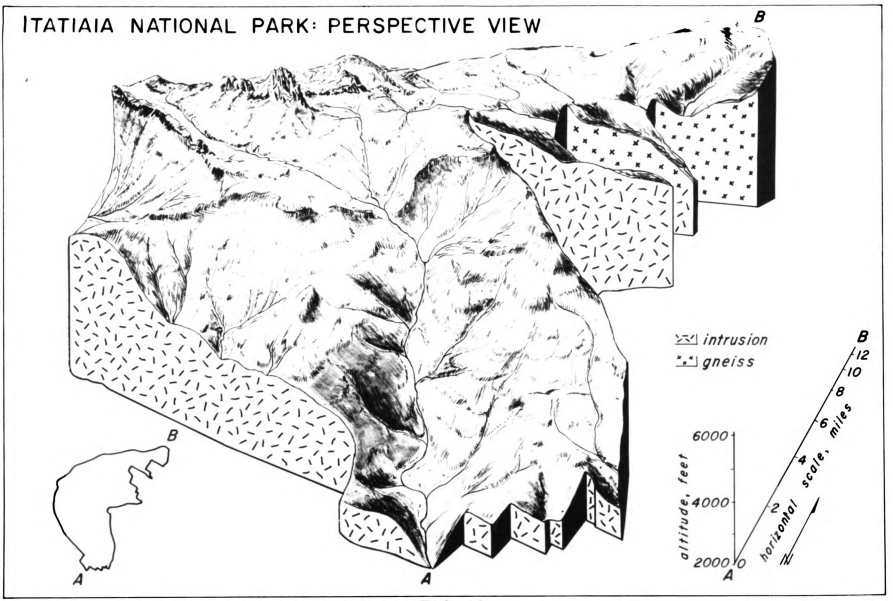
ITATIAIA NATIONAL PARK: PERSPECTIVE VIEW
B
A
B
A
intrusion
gneiss
B
12
10
8
6
4
2
0
horizontal scale, miles
6000
4000
2000
altitude, feet
A

FIG. 10

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Campo Belo.
Saromba Fal
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Altiplano

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in the northern and southern parts. The lower slopes can be divided into three subzones according to gradient:[47] low-mountain subzone (2100 to 4000 feet) with slopes up to 20 percent, mid-mountain subzone (4000 to 5500 feet) with slopes up to 40 percent, and high-mountain subzone (5500 to 7000 feet) with slopes up to 30 percent. The northern section of the park has only mid-mountain and high-mountain subzones; the slopes here are from 20 to 30 percent and gradually merge with the Minas Gerais Plateau (Figure 4).

The general surface configuration is controlled by fluvial erosion of the uplifted massif. Since forests cover most of the lower slopes (Figure 8 and Plates IV A and VI), the landform is subdued. Interfluves appear rounded or even quite flat. However, deep valleys have been formed by the vigorous and perennial mountain streams, particularly the Rio Campo Belo. (See the notch in Plate IV A). The fault at Maromba Falls (4000-foot level) imposes a sharp break in the stream gradient (Figure 9). Rapids and cascades are particularly numerous on the Rio Campo Belo from the 3500-to 4500-foot levels. Streams of the lower slopes display a dendritic pattern and are divided into five major watersheds (Figure 9 and Table 3).

Altiplano

Between 7000 and 8000 feet there is an abrupt leveling off of slope and decrease of forest cover which characterizes

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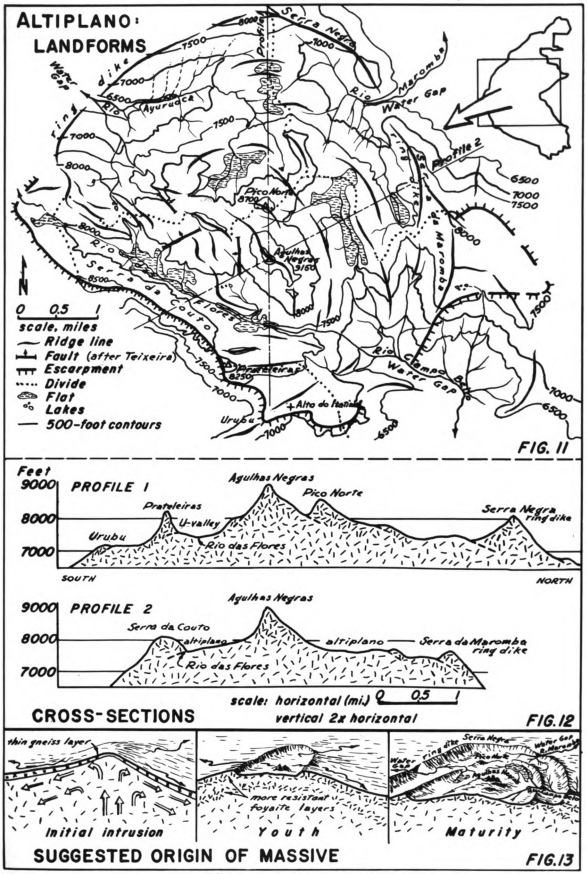
[47]These subzones also correspond roughly to the vegetative zones as described under biogeography.

TABLE 3. Watersheds of the major streams

Name of Watershed	Percentage of Total Park Area
Rios Maromba-Santa Clara	38.5
Rio Campo Belo	36.5
Rios Itatiaia-Branca	13.5
Rio Ayuruoca	9.6
Rio Bonito	1.9

the altiplano zone (Figures 11 and 12, Plates II B and III B). A high planation surface is found in other parts of the coastal ranges, notably in Serra dos Orgãos National Park, but nowhere as extensive as at Itatiaia. The altiplano covers 18 square miles and is bounded by an escarpment to the south and an arc of ridges to the east and northwest. These are ring dikes[48] formed by differential erosion of the foyaite dome (Figure 13). Low, annularly-aligned ridges also occur within the altiplano. To the north are vast cirque-like depressions in which lie the sources of Rio Ayuruoca and Rio Maromba. On the antiplano each drainage system is deranged or indefinite, and is separated from adjacent systems by flat, swampy divides or low ridges (Figure 11). Then the drainage system becomes a trellis pattern, dictated by ring dikes, before its waters leave the altiplano through a water gap. To the south lies a major drainage way, the Rio das Flores, occupying the Valley of Lilies. The uppermost part of this valley shows a distinct

[48] D. Teixeira confirms this hypothesis in his "Contribuicão a Geomorfologia do Macico Alcalino do Itatiaia"(Ph. D. dissertation, Department of Geography, University of São Paulo, 1958).

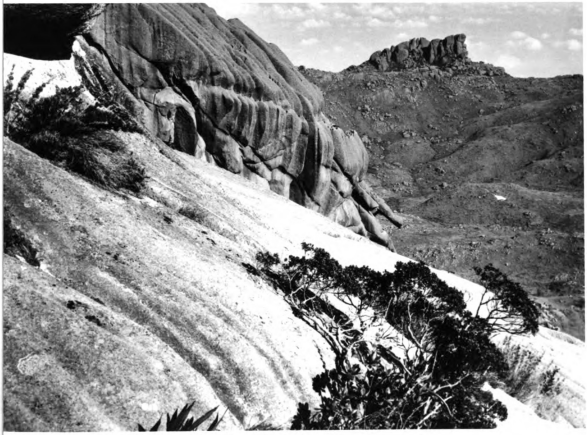


FIGS. 11, 12, and 13

Plate II. Itatiaia.

A. Slopes of Agulhas Negras. View is from the 8200-foot level looking north toward the summit. Note the vertical grooving in the intrusive foyaite on the crests of which grow lichens. Crevices and shallow ledges harbor dwarf bamboo and other xerophytes.

B. Altiplano from Agulhas Negras. View is from the 8500-foot level looking south toward Prateleiras, a monadnock on the edge of the escarpment. The valley of Rio das Flores lies at the right. Scattered boulders, a shallow pond, and bamboo filled ravines are noticeable. Silhouetted to right of center is a 30-foot extension of rock which suggests layering. Dwarf bamboo on the left, shrubs, and grasses occupy crevices.



"V" - shaped transverse profile, but at lower elevations a broader, concave valley floor becomes evident. Tributaries of Rio das Flores emerge from a series of closed depressions filled with water or peat. An abrupt drop into the Rio das Flores gives some of these tributaries the form of hanging valleys (Figures 10 and 11).

Rock accumulations alternating with closed depressions characterize much of the altiplano (Plate III B). Large boulders at the north base of Prateleiras, a monadnock, are rounded by exfoliation and marked with potholes and vertical fluting (Plate II B); they rest on exposed bed rock. Neither residual boulders nor talus are found at the base of Agulhas Negras, nor are solifluctional phenomena apparent.

Many of the features of the altiplano are reminiscent of glaciated landforms. The problem whether the altiplano has been glaciated in the Pleistocence is not yet solved. The highest parts of Itatiaia are considerably below the presumed snow line in the Andes during the last glacial maximum, that is, between 14,700 and 15,000 feet at 15° to 20° south latitude[49]; the present snow line is at about 15,700 feet on the east side and at 18,000 feet on the west side of the mountain system. However, Itatiaia has much greater rainfall, higher humidity, and cloudiness than most of the Andes. These factors contribute to the lowering of the present snow line to 14,450 feet on Mt. Kenya in Africa directly at the equator; U-shaped valleys at

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[49]F. Klute, "Die Bedeutung der Depression der Schneegrenze für Eiszeitliche Probleme," Zeitschrift für Gletscherkunde, XVI(1928), 70-93.

Plate III. Itatiaia.

A. Summit of Agulhas Negras. Note the bench mark (9150 feet) at top center imbedded in quartzitic rock. A large frost crack is evident at lower center. Zygocactus grows in the notch at right. Cumulus clouds hover over peaks in the background.

B. View across Altiplano. The photograph was taken at the 7900-foot level looking northeast to Agulhas Negras. Much exposed rock is noticeable, although talus is absent. A closed depression in the foreground is occupied by sedge (Cladium) at right and dwarf bamboo (Chusquea) at left.

that location extend below 10,200 feet.[50] So it is quite feasible to conclude that glaciation, local and moderate, occurred during Pleistocene times on the altiplano of Itatiaia. This hypothesis was first suggested by De Martonne in 1940[51] and later supported by Ruellan[52] and Rich.[53] Odman[54] attacked their hypothesis and asserted that strong chemical weathering over a long period and erosion during Pleistocene pluvial stages caused the altiplano features. However, he had neither read the previous works nor studied the particular features they described before writing his paper. Chemical weathering has undoubtedly done much in forming the shallow depressions in the altiplano and the vertical fluting on bedrock and large boulders. Fluvial erosion, however, has been active in dissecting the upland, removing rock and soil material, and leveling the altiplano.

Certain features are more convincingly explained by nivation or even by limited glaciation. Nivation is a preliminary stage to glaciation. Where high altitude snow fields

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[50] O. Hedberg, "Vegetation Belts of the East African Mountains," Svensk Botanisk Tidskrift, XL(1951), 152.

[51] E. De Martonne, "Problems Morfológicos do Brasil Tropical Atlantico," Revista Brasileira de Geografia, V(1943), 523-550.

[52] F. Ruellan, "Interpretacão Geomorfológica das Relacões do Vale do Paraíba com as Serras do Mar e da Mantiqueira," Boletim Geografia, II(1944), 1374.

[53] J. L. Rich, "Problems in Brazilian Geology and Geomorphology Suggested by Reconnaissance in Summer of 1951," Geologia, IX(1953), 1-9.

[54] O. H. Odman, "On the Presumed Glaciation in the Itatiaia Mountains, Brazil," Engenharia, Mineracão e Metalurgia, XXL (March, 1955), 107-108.

accumulate and are protected in hollows, alternate freezing and thawing may continue until late summer. Melt waters permeate underlying and neighboring rocks by day and freeze at night; the resulting rock fragments are carried away by rill wash and solifluction. Thus, hollows are gradually deepened and widened and may resemble cirques.[55] However, steep head walls and moraines are lacking on the altiplano. Snow probably accumulated in the Valley of Lilies during a cooler period than the present.[56] Cloud cover and partial shade from Agulhas Negras favored the formation of small snow and ice masses. Nivation and glacial erosion gradually hollowed out a broad concave valley floor and left side valleys hanging. Minor snow and ice accumulations developed depressions in the altiplano in like manner. The melt water streams carved out potholes in boulders near Prateleiras, washed talus from the base of Agulhas Negras, and carried rock debris into the Paraíba Valley.[57]

Zone of Summits

A few conspicuous prominences above 8000 feet form the zone of summits. They have a local relief above the altiplano of from 700 to 1200 feet. Thus their slopes are exceedingly steep and give the peaks the appearance of castles or miniature mountains (Plate II). Closer views show bizarre

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[55]These are termed "nivation cirques" by W. D. Thornbury, Principles of Geomorphology (New York: Wiley and Sons, 1954), p. 367.

[56]Even today, maritime polar air penetrates as far north as Recife (Figure 14).

[57]This is certainly not, by any means, an exhaustive or completely accurate explanation of the altiplano features. Herein lies an opportunity for further research.

sculpturings of the rock surfaces, deep vertical grooves, and potholes.

These prominences (Agulhas Negras, Pico Norte, and Prateleiras) are monadnocks, formed of more resistant, homogeneous material than the altiplano. Differential weathering and erosion have acted on them as on the ring dikes. However, Agulhas Negras and Pico Norte are toward the center of the original domal uplift and therefore stand out at higher elevations today. The unusual needle-like formation of Agulhas Negras (black needles) appears to have resulted from concentrated erosion by violent rains, hail, and strong winds. These forces have acted mechanically and chemically on the steep rock slopes to accentuate slight differences in resistance to weathering. The development of small potholes may have been aided by the action of organic acids of vegetation growing on the rock. At the 8400-foot level of Agulhas Negras, a 30-foot projection of rock dips toward the altiplano (Plate II B). This indicates that differential weathering has removed less resistant layers of the foyaite dome.[58]

Soil Characteristics

Itatiaia contains three soil groups: lithosol and peat occur in the central third of the park, and yellow latosol occupies the remaining area (Figure 7).[59] Yellow latosol, one

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[58]Alkaline feldspar, the dominant material in syenite, is particularly sensitive to hydration and kaolinization so it can decompose readily.

[59]Only soils within the state of Rio de Janeiro have been mapped and studied intensively. However, soil surveys of São Paulo and Minas Gerais are being completed.

of the most widespread zonal soils of the humid tropics, is noteworthy in the cool summer, humid mesothermal[60] climate of Itatiaia.[61] Latosols are formed under conditions of high temperature and abundant precipitation; therefore the soils at lower elevations of the park, where average monthly temperatures remain above 60°F., show the strongest latosolic development. The parent material consists of foyaite except in the northern tip of the park where gneiss predominates. Vegetative cover ranges from dense forests to brush and grass (Figure 8). It is important in minimizing soil erosion. Soil fauna is abundant. Slopes are more gradual in the northern than in the southern part of the park, so deeper soils occur in the north.

Yellow latosol is strongly leached and deep. Its profile (Figure 7), taken at an altitude of 2300 feet, shows a depth of about 12 feet to parent material.[62] New road cuts near the Headquarters and Coöperative expose even deeper soil profiles. All of the horizons are acidic (pH 4.1 to 5.1). Oxides of iron, silicon, and aluminum increase slightly with depth; they average 8, 22, and 24 percent of dry soil weight, respectively. Color and texture vary with depth. A horizons are dark yellow and

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[60] *Cfb* and *Cwb* according to Köppen.

[61] Kruger National Park in the Union of South Africa also has the same combination of climate and soil. Both areas are adjacent to humid tropical (*Af*) climates and podzolic-latosolic soils.

[62] Commissão de Solos, *Levantamento, de Reconhecimento dos Solos do Estado do Rio de Janeiro* (Rio de Janeiro: Servico Nacional de Pesquizas Agronomicas, 1958), pp. 45-46. All specific soil data were obtained from this publication.

of sandy to sandy-clay textures; B_1 and B_2 horizons are dark brown clays becoming more plastic with depth; B_3 and C horizons are red-yellow, with notable decrease in clay content from 63 to 35 percent.[63] These soils derive their color from an incomplete oxidation of the iron content. Iron is hydrated, indicating abundant soil moisture.

The azonal lithosols are typical of the steep slopes and altiplano of Itatiaia, and more broadly, of the coastal ranges at altitudes above 6000 feet. Rock outcrops occur where erosion has not permitted accumulation of soil. Some regolith, an accumulation of decomposed rock fragments, is found on the altiplano where the small gradient and a grass and sedge cover have slowed down processes of transportation. Parent material is the foyaite bedrock. Climate has a particularly strong influence on this soil. Chemical decomposition is slowed by the relatively low average temperature of the altiplano (Figure 17). A markedly dry winter season permits deflation, and heavy summer rainfall favors rapid erosion. Severe climate conditions limit the development of a vegetative cover and of microörganisms which could contribute to the formation of mature zonal soil profiles. Lithosol is found predominantly in shallow depressions and rock crevices to a depth of 12 to 15 inches; the soil has a thin layer of organic litter which rests on bedrock or regolith. Soil texture is variable and a high silica content gives it a light color, particularly at the base of Agulhas Negras and on the slopes of the escarpment.

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[48] Ibid., p. 48.

Climate

General considerations

The park is located very near the Tropic of Capricorn. Tropical, subtropical, and even polar air masses control the climate. Marine influences of the adjacent warm waters of the South Atlantic and prevailing southeast trade winds produce moderate temperatures and heavy precipitation. These are felt along the Serra da Mantiqueira and Serra do Mar which parallel the Atlantic coast (Figure 4). A rapid increase of elevation in these ranges also affects the climate. There is no major topographic barrier inland from the Serra da Mantiqueira, so air masses can move freely.

Atmospheric circulation changes considerably with the seasons. In January warming of the land results in a great low pressure trough near the center of Brazil (Figure 14). The Intertropical Convergence migrates as far south as the Tropic of Capricorn. A very strong and persistent high pressure cell lies to the southeast of Rio de Janeiro over the South Atlantic, so that on-shore winds of monsoonal character are common. Occasionally, cool polar air may penetrate the east coast as far north as Bahia, but unstable maritime tropical air masses dominate the region.[64]

In July most of the land is cooler than the surrounding water masses. The Intertropical Convergence now lies north

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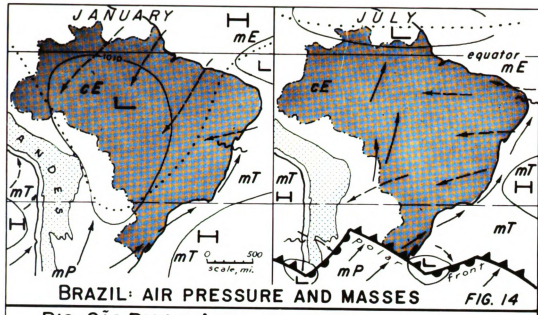
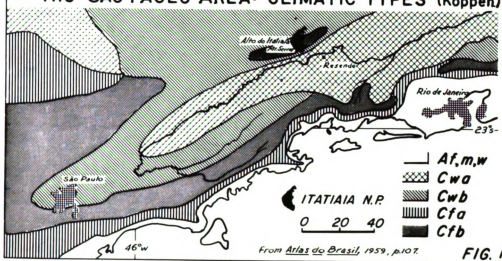
[64]R. Schroeder, "Verteilung und jaehrlicher Gang der Niederschlaege im Staat São Paulo," Petermann's Geographische Mitteilungen, IC (1955), 193.



BRAZIL: AIR PRESSURE AND MASSES FIG. 14



RIO-SÃO PAULO AREA: CLIMATIC TYPES (Köppen) FIG. 15

FIGS. 14 and 15

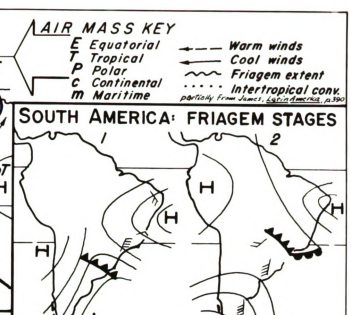


FIG. 16

of the equator, and the continental low has disappeared. The high pressure system over the Atlantic moves north of the Tropic of Capricorn so that its diverging winds with accompanying subsidence may blow parallel to the coast or even offshore between Rio de Janeiro and São Paulo. This is the major reason for winter dryness. Polar front waves, called "Friagems"[65] develop in northern Argentina owing to the contact of maritime polar and maritime tropical air masses. The waves pass north along the east coast and then break up in the interior; episodically, they move as far north as the equator (Figure 16).

Climatic types at Itatiaia

Climatic data of the park cover the years 1912 to 1935 for two first-class meteorological stations:[66] Alto do Itatiaia is an abandoned site on the edge of the altiplano at 7200 feet, and Monte Serrat is the partially cleared site of the Gardens at 2700 feet (Figure 9). Another station in the Paraíba Valley, the town of Resende at 1400 feet, is close enough to be included to emphasize altitudinal climatic differentiation. A pluviometric station was maintained near the base of Agulhas Negras at 8000 feet from 1914 to 1938.

Figure 15 shows climatic types according to Köppen for the area surrounding Itatiaia, and Figure 17 gives comparative temperature and precipitation data for the stations. Since

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[65]M. A. Garbell, Tropical and Equatorial Meteorology (New York: Pitman Publ. Corp., 1947), pp. 114, 126.

[66]Servico de Meterologia, Normais Climatologicas (Rio de Janeiro: Servico de Meterologia, 1941), p. 18.

all stations recorded an average temperature below 64.4°F., but above freezing, for the coolest month, a mesothermal or mild climate (C) prevails. The average temperature of the warmest month in the park is below 71.6°F., so that the "cool summer" or b thermal subtype occurs. Both moisture subtypes f (no dry season) and w (winter-dry) are found at the park.[67] Increased elevation and the resulting lapse rate produce cool summers. In general, greater lapse rates exist during the warm season, on the leeward side of mountain ranges, on equator-facing slopes, and on isolated parks.[68] Table 4 shows the difference in lapse rate encountered at Itatiaia:

TABLE 4. Temperature change with increased elevation

Period	Temperature Decrease per 1000 Feet	
	1400-to 2700 - Foot Levels	2700-to 7200- Foot Levels
February (warmest month)	3.1° F.	2.9° F.
July (coolest month)	3.0° F.	2.5° F.
Yearly average	3.1° F.	2.8° F.

The following relations exist between temperature and increased elevation:

1. The range of average monthly temperature decreases. This is probably due to greater cloud cover in summer and greater insolation during winter over the mountains. Cold

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[67]The Cw climate may be called "upland savanna" or "subtropical monsoon" on a vegetational and genetic basis, respectively. It is found extensively in the highlands of east Brazil, southeast Africa, and southeast Asia.

[68]J. Hann, Handbook of Climatology, 1883, translated by R. de C. Ward (New York: Macmillan Co., 1903), p. 244.

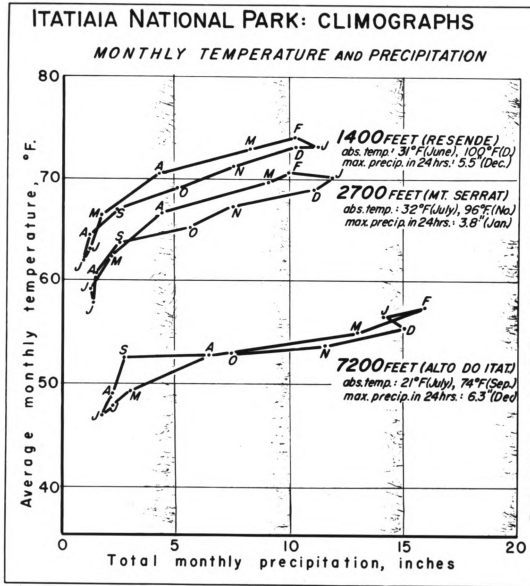
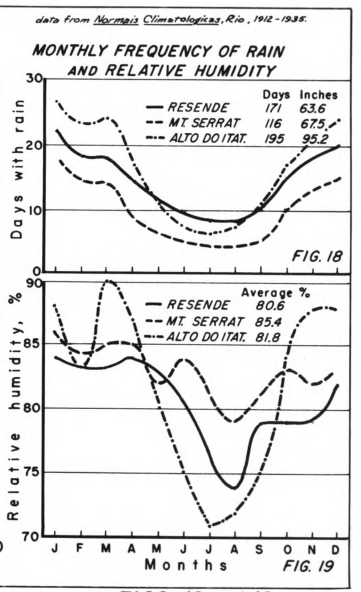


FIG. 17



FIGS. 18 and 19

and hazy air often stagnates in the valley creating temperature inversions. The diurnal range of temperature increases.

2. Freezing temperatures are common in winter at Alto do Itatiaia and higher elevations. Bernardes[69] stated that a microthermal or cool climate (D) exists on the highest slopes of Itatiaia, but the calculated mean temperature for July of 42.1°F. is above the D limit of 26.6°F. In mid-July the author observed two inches of ice on a trail at about 8000 feet, which substantiates the fact of low minimum temperatures. Extreme temperatures are given in Figure 17.

3. Alto do Itatiaia recorded 56 frost days, April through November, and three days of hail in spring per year; snow fell only twice in 23 years.

4. There is a notable temperature lag after the summer solstice due to an increasing number of rainy days in January (Figure 18).

5. The warmest and coolest months remain the same, February and July.

Precipitation is strongly influenced by an increase in elevation and varies with the height and abruptness of mountains. The following rainfall-altitude relations are found at Itatiaia:

1. Yearly total precipitation increases at an increasing rate, 3.0 inches per 1000 feet from 1400-to 2700-foot levels and 6.2 inches per 1000 feet from 2700-to 7200-foot levels. This clearly indicates an orographic effect of the mountain

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[69]L. M. C. Bernardes, "Tipos de Clima do Estado do Rio de Janeiro," Revista Brasileira de Geografia, XIV (March, 1952), p. 57.

mass.

2. From the 7200- to 8000-foot levels, annual total precipitation increases at only 4.1 inches per 1000 feet owing to the loss of water vapor at lower elevations.

3. The range of average monthly precipitation increases as a result of heavy summer orographic and convectional rains at higher elevations. Sixty percent of the yearly precipitation falls from December through March.

4. The 1400-foot station shows its wettest month receiving over ten times the rainfall of its driest month and is therefore a w (winter-dry) subtype. Occasional droughty periods occur during the winter. Higher stations show less seasonal change in precipitation and thus are designated f (no dry season) subtype.

5. The number of days with rain increases below and above the 2700-foot level because more frequent convectional showers occur in the valley and the orographic influence is stronger at high elevations (Figure 18). The maximum precipitation occurring in 24 hours is given on Figure 17.

6. Average annual totals of cloudiness, fog, haze, and lightning increase above and below the 2700-foot station, indicating the microclimatic influence of forests at this level (Table 5).

TABLE 5. Data for cloudiness, fog, haze, and lightning

	Total Days per Year		
	1400-Foot Level	2700-Foot Level	7200-Foot Level
Cloudiness	168 (Oct-Mar max)	127 (Oct-Mar max)	148 (Oct-Mar max)
Fog	103 (Apr-Aug max)	9	218 (Oct-Dec max)
Haze	33 (Apr-Sep max)	0	28 (Aug-Sep max)
Lightning	11	0	19 (Jan-Mar max)

7. The annual average relative humidity decreases below and above the 2700-foot level (Figure 19). A lower relative humidity below the 2700-foot level is, of course, due to the higher temperature and sparcity of vegetation in the valley. A dense forest cover at 2700 feet and above transpires much moisture. The lower relative humidity at the 7200-foot level is due to clear winter days with drying winds and a sparcity of vegetative cover. Fires caused by lightning are possible at this time.

8. The atmospheric pressure decreases 31.4 mb. per 1000 feet causing increased evaporation rates.

Thus, a variety of climatic types can be observed in the mountain setting of Itatiaia. Humid, mild climates characterize all but the highest peaks. Land at altitudes up to 2700 feet receives precipitation mostly during the summer months. Above that level, precipitation is well distributed throughout the year. All areas within the park experience cool summers, a marked change from conditions in the Paraíba Valley.

The Nature, Distribution, and Origin of Elements in the Biotic Environment

The Itatiaia area displays a remarkable variety of plant and animal life. This variety, resulting from intense competition and effects of altitude, was recognized and studied by outstanding naturalists, including Konrad Guenther and Charles Darwin.[70] Guenther captured the essence of the biotic setting;[71] excerpts from notes by the present writer, taken along a trail to Tree Picos, reflect a similar awareness of the environment.[72] To describe the nature, distribution, and origin of plant and animal life in such an environment is the awesome but fascinating task of the biogeographer.[73]

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[70]Darwin particularly observed insect life of the region as discussed later on page 81. See: C. Darwin, A Naturalist's Voyage (London: Murray, 1889), pp. 21-30.

[71]K. Guenther, A Naturalist in Brazil, the Record of a Year's Observation of her Fauna and her People (London: Allen and Unwin, Ltd., 1931). See page 247 for the following: "When we lie at the edge of the forest, when all is so still within us that our souls are conscious of the life and growth of the plants, and when...from a dark thicket, the song of a bird rings out, our eyes and ears admit us to a great Unity, of which we also, in happy self-oblivion, form a part."

[72]"...900 meters; past a steep slope of lace-like tree ferns, pendulant nests of the "guache" oriole hanging from a brilliant red-flowered "mulungu" tree (Leguminosae); the burrow of an armadillo in the deep red latosol; scratchmarks of a wild cat, and a pile of "seven-colored tanager" feathers, a recent falcon kill. At 1600 meters, frost on trail; tiny yellow orchids hang over a cascade; bromeliads cling to moss-covered tree trunks; a flock of screaming parakeets fly overhead drowning out distant whistles of the black monkey; then quiet."

[73]It is obvious that a complete treatment of all the biota at Itatiaia lies beyond the scope of this study. The reader is referred to the studies of Barth, Brade, Holt, Lutz, Pinto, Ribeiro, and Segadas-Vianna listed in the Bibliography.

Elements of the biotic environment are truly of major importance in the park. The following pages will attempt to describe the salient features of the various life zones of Itatiaia, particularly as they are correlated with climate and landforms. Scientific nomenclature is employed to facilitate comparison with other mountainous regions.

Phytogeography

Tropical and subtropical plant life exhibits a great number of species and a variety of forms. The modification of vegetation in definite zones, especially due to climatic differences at higher elevations, increases the variety even more. This section will describe major characteristics of each vegetative zone, particularly as they illustrate ecological principles, and will offer comparisons with other mountainous regions.

Forests cover 70 percent of the park area (Figure 8). Their vertical extent reaches close to the 7000-foot level, above which lies the altiplano (Figure 9). However, the structure and composition of forests vary with altitude. Climate, particularly the element of temperature, plays a key role in the modification of vegetation. With increased elevation, trees are shorter, their leaves smaller and thicker, and the number of species less. Generally above 7000 feet, only grass, low shrubs, and bare rock are found. The average temperature for the warmest month in this zone is less than 58°F. compared to 71°F. for the lowest forest zone.[74]

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[74]Although an average temperature for the warmest month

Altitudinal zonation of vegetation

The first botanist to delineate the floral zones at Itatiaia was Ule.[75] He recognized a lower region up to 2000 feet, a forest region from 2000 to 5600 feet, and a high mountain and field region above 5600 feet. Holt[76] modified this scheme by using climatic criteria. He differentiated a tropical zone to 3000 feet, a subtropical zone from 3000 to 6000 feet, and a temperature zone above 6000 feet. The outstanding Brazilian botanist, A. C. Brade,[77] combined climatic, topographic, and floral characteristics in his zonation scheme: subtropical rain forest up to 3900 feet, transition forest from 3900 to 5900 feet, Brazilian Pine region from 5200 to 7500 feet, altiplano vegetation from 7200 to 7900 feet, and flora of the peaks above 7900 feet. In the latest work by Segadas-Vianna,[78] similar limits are used but with topographic nomenclature: plain level, lower, middle and

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of under 50°F. is generally necessary to limit tree growth, other conditions besides climate may modify the vegetation: fire, slope, exposure, depth of soil and interactions with animals, and man. See page 72.

[75]E. Ule, "Relatório de uma Excursão Botanica Feita na Serra do Itatiaya," Archives Museú Nacional, XI (1895), 185-223.

[76]E. G. Holt, "An Ornithological Survey of the Serra do Itatiaia," Bulletin of the American Museum of Natural History, XXVII (1928), 251-326.

[77]A. C. Brade, A Flora do Parque Nacional do Itatiaia, Bulletin V of Itatiaia National Park (Rio de Janeiro: Ministerio da Agricultura, 1956) pp. 1-85.

[78]T. Segadas-Vianna, "Biogeography of the Itatiaia Range, Southeastern Brazil: I. Altitudinal zonation of Vegetation," manuscript for Ecological Survey of Rio de Janeiro, Museú Nacional, 1958.

upper mountain level, highlands level, and summits level. A modification of the latter two classifications, which most closely follows the author's field observations, is presented in the following discussion.

Plain and piedmont cutover zone: 1400-2100 feet

This zone lies south of the park boundary. It was formerely covered by a subtropical rain forest, similar to that on the Serra do Mar, only more open. Now the area lies as a grim reminder of man's use and misuse of resources (Chapter III and Plate IV B). Fire-induced grass for pasture dominates the lowland scrub and subclimax forest forms a savanna on hill tops where erosion is less intense. The dominant trees, Tibouchina and Cassia, are 50 to 60 feet tall; their flat-topped crowns are covered with purple and yellow flowers during the wet season.

Low-mountain, second-growth forest zone: 2100-3900 feet

Extensive cutting here also removed the subtropical climax rain forest, a remnant of which is found along Rio Bonito. Where succession has progressed, a great variety of flora occurs. There are particularly vivid flowering trees from 100 to 130 feet tall: the red leguminous Erythrina and purple melastomatacious Meriania. Trees with unusual foliage include the sweet palm (Euterpe edulis), the silvery-leafed

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[79]According to Brade, op. cit., pp. 16-24, this zone contains the following numbers of genera: trees-126, lianas and creepers-55, epiphytes-64, shrubs-55, ferns and herbs-131; total-431.

Plate IV. Itatiaia.

A. Low-mountain, Second-growth Forest Zone. The view from park Headquarters (2800-foot level) looking south into the Paraíba Valley (1400-foot level) shows a great contrast in vegetation. Smoke from grass fires, dust, and radiation fog obscure the Serra do Mar range in background. A notch in the Rio Campo Belo Valley silhouetted at center lies at the southern tip of the park. Note the Cecropia tree at left and Meriania at right foreground,

B. Piedmont Cutover Zone. Eroded slopes are criss-crossed by cattle trails. Note the barbed wire fence in foreground. A stand of Cassia in center background and some scattered trees on hilltops occur where erosion is less intense. The sweet palm Euterpe appears at left. The lower part of the photograph shows a terrace strewn with boulders.

Plate V. Itatiaia: Tree Fern. From a moist glen along the road to Maromba (3700-foot level), Alsophila, or "grove-loving" tree fern displays its six-foot fronds. It is a typical component of the low-mountain, second-growth forest zone.

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Cecropia, and the tree ferns Alsophila and Cyathea (Plates IV A and V). Bamboo (Merostachys) forms an impenetrable thicket along forest edges and on drier, well drained slopes. Branches are covered with lianas, notably Philodendron, and epiphytes, such as orchids and climbing ferns.

Understory shrubs, reaching 20 feet in height, are scattered, well branched and of rounded crowns. A continuous carpet of moss, herb, and grass covers the forest floor. The large-leafed Canna indicates the development of a near-climax condition with dominant Cedrela and Cabralea trees, noted for thick, straight trunks and buttressed roots.

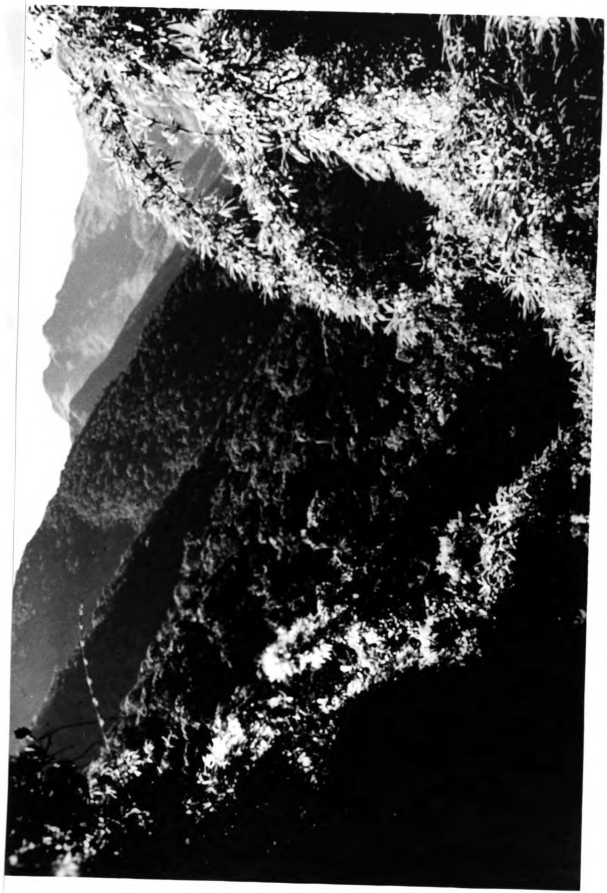
Mid-mountain, subtropical climax forest zone: 3900-5700 feet

At this level almost all the forest remains in a virgin state, a climax type in equilibrium with the environment. Certain genera, such as Euterpe and Cecropia, are no longer present, although there is a considerable increase in the number of individuals as compared with lower levels. Cabralea forms the dominant 65-to 100-foot tree cover with dense shrubs, many epiphytes, and lianas filling in the lower story (Plates VI and VII B). Thin-stemmed bamboo behaves like a liana, climbing up to tree crowns and smothering out saplings. Tree ferns have shorter, thicker trunks than at the previous level. Begonia forms a conspicuous herb cover.

High-mountain, transitional cloud forest zone: 5700-7200 feet

Trees of this forest zone have hemispherical crowns, and rarely attain a height of over 50 feet. Cabralea is again dominant. Masses of bromeliads and moss cover the tree

Plate VI. Itatiaia: Mid-mountain, Subtropical Forest Zone. This view at 5500 shows the dense canopy of dominant Cabralea trees. The peak Cabeca do Leão lies to the east in background and is covered with grass. Thin stemmed bamboo at right foreground climbs over saplings.



branches, a condition which reflects the persistent cloudiness and high relative humidity (Plate VII A). Almost no lianas are found. A very dense shrub stratum consists of the same genera as at the lower elevation. However, a subclimax genus Croton becomes conspicuous. Its reddish leaves and trunk are covered with bright red lichens. There are almost no herbs.

Between 5900 and 6600 feet, small clearings of land, remnants of an unsuccessful attempt at fruit culture (1908 to 1918), are spotted with gnarled pear and apple trees or communities of Senecio and Vernonia shrubs. Near 7200 feet, the forest canopy becomes lower and more open. The undergrowth is thinner, and lianas and epiphytic mosses disappear. The transition to the altiplano is very irregular. It seems to be governed by local moisture and exposure conditions (Plate I). On the steep slopes of the Rio Campo Belo water gap lies an open forest of Paraná, or Brazilian, pine (Araucaria angustifolia, Figure 8). This species reaches a height of 80 to 100 feet and is associated with short-trunked tree ferns. Both plant types are found up to 7500 feet.

Altiplano zone: 6600-7900 feet

Considerable attention has been given this zone, since it is generally treeless and contains alpine vegetation.[80] Not only is alpine vegetation uncommon in Brazil, but it occurs

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[80]In the strictest sense, "alpine" vegetation should refer to flora characteristic of the Alps, particularly to the climatically-controlled vegetation. However, the term has been used broadly to signify any vegetation above the limit of tree growth, and will be so used in this dissertation.

Plate VII. Itatiaia.

A. Interior of High-mountain, Transitional Forest Zone. This view at 6100 feet emphasizes the denseness of upper and lower strata. The center tree is Croton on which bright red lichens, large bromeliads, and mosses grow. However, no lianas are present.

B. Interior of Mid-mountain, Subtropical Forest Zone. At the 4400-foot level, dense lianas hang from old-growth Cabralea at left, while epiphytic orchids cling to the three-foot diameter trunk, Bamboo appears at the lower right. Note the diverse patterns of leaf and light at noon, offering concealment to fauna.

at much lower altitudes here than in other mountain regions at the same latitude (Table 6). There is a great variety in floral composition and structure.[81]

Three major floral communities occur here: bogs, grasslands, and dwarf woods. Graminoid bogs, which occupy many depressions, have the greatest area coverage. A continuous carpet of Sphagnum moss underlies sedge (Cladium), which may grow to a height of six feet (Plate III B). Where better drainage produces a mesic site, sedge is replaced by Andean bunch grass (Cortaderia)[82] in large tussocks, and dwarf bamboo (Chusquea). Well drained flats or slightly inclined slopes are dominated by grasses, about 8 inches high (Andropogon, Briza, Bromus). Extensive areas with a moderate slope and shallow soil support a very dense, almost impenetrable formation of bamboo up to 7 feet tall (Plate II B). A mixture of shrubs and grass is found on steep slopes. Where these slopes form protected valleys, a relic dwarf wood of broadleaf evergreen Roupala occurs, growing from 15 to 20 feet high. Another relic, the needleleaf evergreen Podocarpus of the yew family, occupies a similar site. Trees are covered by masses of lichens, mosses, and occasionally bromeliads.

Hygric vegetation, such as the floating or crawling

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[81]Brade, op. cit., pp. 31-42, lists genera of this zone: ferns-28, gymosperms-2, angiosperms-185; total-215.

[82]The presence of Andean bunch grass is an example of the law of phytogenic traces: the relative geographical positions of plants are good indicators of the trends of migration. This law and others mentioned later are phytogeographical principles having to do with plant distribution. See P. Dansereau, Biogeography, an Ecological Perspective (New York: Ronald Press Co., 1957), pp. 51, 123.

Ranunculus, is common in ponds. Extreme xeric vegetation of crustaceous lichens occurs a few feet above the water on exposed boulders. A cactus (Zygocactus) and a large, red amaryllis (Alstroemaria) are found in rock crevices.

The problem now to be considered is whether or not the vegetation of this zone should be called "alpine." A tree-line exists at the lower levels of this zone, above which only dwarfed trees occur in protected sites. Herbs assume characteristics caused by an inhospitable environment: rosette, whip-like, or creeping forms, woolly covering, and short, late flowering periods. A definite cold, semi-arid season and probable diurnal frost throughout most of the year, severe exposure on the isolated altiplano, and shallow, poorly-drained soils certainly impede the establishment of forest species. Woody species which are well adapted to these conditions do not occur in the park.[83] If the altiplano had been glaciated or at least subject to a much colder climate during Pleistocene times as relic species and certain land-forms indicate, and if natural and man-made fire and cutting destroyed any re-established forest species, an alpine-like vegetation zone could be maintained as at present.

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[83]This situation somewhat parallels that of a "bald," a semipermanent grass area at the transition between deciduous hardwood and evergreen coniferous forests in the southern Appalachian Mountains, except that no trees are found above the altiplano. See A. F. Mark, "The Ecology of the Southern Appalachian Grass Balds," Ecological Monographs, XXVIII (October, 1958), 293-336.

Zone of Summits: 7900 - 9150 feet

The rugged topography, strong and continuous winds, lowered temperature, and sparse soil place extreme restrictions on vegetation of the zone of summits. Only in well protected crevices has a climax flora, dwarf bamboo (Chusquea), been able to develop (Plate II B). It resembles juniper (Juniperus) in temperate regions, growing to a maximum of three feet with short leaves and internodes.

In the notch between Agulhas Negras and Pico Norte, a shady and very humid site, dense shrubs up to six feet high are found (Leandra and Myrcia). Six other shrub genera and numerous ferns, including the Andean fern (Blechnum) and Polypodium, grow in moist chimneys and small crevices. A red or yellow Sphagnum moss occurs where small pockets of water can accumulate, and dense colonies of yellow fruticose lichens cover the crests of parallel grooves in the rock surface (Plate II A). The highest peaks have patches of soil where four-inch thick carpets of herbs (Oxalis and Zygocactus) grow (Plate III A).

Comparisons of vegetative zones.

Since vegetation in the altiplano zone at Itatiaia resembles alpine flora of much higher mountains, an attempt has been made to compare Itatiaia flora with that of selected tropical mountain areas (Table 6). Specific comparisons of the selected areas are unreal since the environments differ in many respects, but certain features, floral associations, and growth forms show definite similarity to vegetative zones

TABLE 6. A comparison of vegetative zones in selected mountain areas*

Area and Latitude	Tall Plants[1] (5-50 feet). Altitude & Characteristics	Short Plants (0-5 feet). Altitude & Characteristics	Similar Plants at Itatiaia. Altitude & Characteristics
Andes Colombia[2] 7° north	3300-7900: tree ferns, subandean palms		2100-3900: low-mountain, second-growth forest: tree ferns, palms
	7900-12,000: Andean open cloud forest	8500-10,000: epiphytes, climbing bamboo	3900-6600: mid- to high-mountain cloud forest: epiphytes, dense liana and climbing bamboo
	12,000-13,000: Paramo: tree herbs	12,000-15,500: bogs, tussock grass	6600-7900: altiplano: bogs, grass, dwarf bamboo
Bolivia[3] 16° south	13,800-15,000: Puna: (semi-arid), tree herbs	15,000-16,000: grass, dwarf Ericaceae	7900-9150: summits: ferns, mosses, yellow lichens, dwarf bamboo, endemics
Sierra Madre Mexico[4] 24° north	5000-92000: mesic forest: pine, oak	5000-9200: large bromeliads	5700-7200: high-mountain cloud forest: dense shrubs, bromeliads
	9200-12,000: subalpine forest: pines	9200-12,000: dense herbs, few shrubs 12,000+: rosette herbs	6000-7500: high-mountain forest to altiplano: Paraná pine, grass
East African Highlands Mount Ruwenzori[3] 2° south	8000-10,000: bamboo cloud forest		5000-6600: mid- to high-mountain cloud forest: climbing bamboo
	10,000-11,000: ericaceous forest	10,000-11,000: epiphytes	6600-7500: high-mountain cloud forest to altiplano: epiphytes, shrubs
	11,000-14,000: tree herbs	11,000-14,000: tussock grass, sedge bog	7200-7900: altiplano: grass, sedge bog

*Sources for this table are given at the bottom of the following page.

delimited at Itatiaia. This illustrates the law of vegetation regime: under a similar climate, in different parts of the world, a similar structural-functional response will be induced in the vegetation. At increased altitudes, especially in the low latitudes, the limit of tree growth is difficult to determine, since some herbs assume arborescent forms (up to 12 feet tall) while tree species may become stunted, low bushes. Only the latter condition is found at Itatiaia.

The flora found at various altitudes of the selected mountain areas in Table 6 are divided into two groups: tall plants from 5 to 50 feet, and short plants under 5 feet. Vegetation is generally absent above the highest altitude given for each area. The zones at Itatiaia which show similar, though not identical, floral characteristics as in the selected areas are also given. Thus, in the Andes Mountains of Colombia an alpine vegetation zone called "paramo" occurs at altitudes of 12,000 to 15,500 feet. It is composed of tall herbs in the lower elevations and tussock grass and bogs in

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The following footnotes apply to Table 6 on the preceding page:

[1]Altitudinal life-form gradients are listed for various areas in the world by S. A. Cain, "Life-forms and Phytoclimate," Botanical Review, XVI (1950), 1-32.

[2]J. Cuatrecasas, "Aspectos de la Vegetacion Natural de Colombia," Revista de la Academia Colombiana de Ciencias Exactas, Fisicas y Naturales, X (1958), 228-249.

[3]C. Troll, "Tropical Mountain Vegetation," Proceedings of the Ninth Science Congress, XX (1958), 37-48.

[4]C. H. Muller, "Relations of the Vegetation and Climate Types in Nuevo Leon, Mexico," The American Midland Naturalist, XXI (1939), 687-729.

the higher elevations. The altiplano zone at Itatiaia, likewise, has grass and bogs but lacks the tall herbs. However, altitudes of the altiplano are only from 6600 to 7900 feet. A partial explanation for this difference in altitude compared to the paramo is that Itatiaia lies at a greater distance from the equator. Therefore, a definite cool season and less cloud cover is found on the altiplano in contrast to the Colombian Andes. Other conditions, already mentioned, such as severe exposure, fires, and lack of hardy species, also help to explain the difference.

It is interesting to note that pines are found at similar high altitudes in the Sierra Madre of Mexico and Itatiaia. Both areas are at approximately equal distances from the equator and have a similar climate. However, the massive volcanic peaks of the Sierra Madre support a growth of scrubby pine up to the 12,000-foot level.

Tree herbs are found on Mount Ruwenzori in the East African Highlands at about the same level as in the Colombian Andes. A cloud forest of tall bamboo at 9,000 feet on Ruwenzori corresponds to the high-mountain cloud forest of Itatiaia at about 6,000 feet.

Origin of certain floristic elements

Itatiaia flora represents about ten different groups some of which have a widespread distribution and others which are extremely restricted.[84] Cosmopolitan genera include the

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[84]Dansereau, op. cit., pp. 51-52.

club-mosses (Lycopodium) and bracken (Pteridium). One found only in tropical regions is Cassia, a dominant tree of the piedmont-cutover zone. The Cecropia tree, amaryllis (Alstroemeria), and the cactus and bromeliad families are confined to the tropics of the western hemisphere. A South Atlantic genus is the yellow flowered, second-growth tree Vochysia. Some xerophytic heath-like shrubs are specific to the Central Brazilian plateau.

The park contains a number of genera common farther south and considered relics of Pleistocene conditions. Paraná pine (Araucária) probably covered large areas of the park at a time when the climate was cooler and moister. Some natural stands are now found in the State of Paraná, the southern Andes, the Eastern Highlands of Australia, New Caledonia, and New Guinea. Podocarpus, the most widely distributed conifer in tropical mountains, is a relic of a cooler, drier climate.[85] Genera from northern temperate zones include the herbs Geranium, Anemone, and Carex. Dwarf bamboo (Chusquea), some ferns, and the tall grass Cortaderia, now conspicuous in the Pampa, all originated in the Andes. Certain ferns and club moss species spread to the park from Patagonia. All of the foregoing plants illustrate the law of zonal equivalence: where climatic gradients are essentially similar, the latitudinal and altitudinal zonation will be equivalent in terms of plant formations.

Endemics, plants with extremely limited distribution,

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[85]Ibid., p. 22.

are numerous at Itatiaia.[86] They develop from long periods of isolation in such locations as islands or mountain peaks where specific adaptations must be made to diverse environments. Oxalis calva grows only on the top of Agulhas Negras in a low carpet form. This exemplifies the law of availability, which states that the geographic distribution of plants is limited by their place and time of origin. Many endemics are given the specific name "itatiaiae" or "itatiaienis" indicating their affinity to this area.

Increase in altitude results in a reduction in the number of species, a modification of life-form, and a substitution of species within the same genus. A good example of modification in life-form is bamboo. In the low-mountain zone, bamboo has a tree-like form and large leaves. At higher elevations, it resembles a liana with thin, crawling stems and small leaves. In the altiplano, its leaves and internodes are extremely short. However, the height of individual plants depends on their exposure.

Zoogeography

The great variety of flora at Itatiaia, particularly in the forest zones, is paralleled by extremely diverse animal life. Darwin visited the region from 1831 to 1835 and suggested that no place on earth had richer and more diverse life forms or patterns of specialization and behavior.[87] Long

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[86]Brade, op. cit., pp. 69-76, lists over 200 endemic species found above 6500 feet, half of which grown only at Itatiaia.

[87]C. Darwin, A Naturalist's Voyage (London: Murray, 1889), p. 49.

periods without gross environmental change, except in the piedmont and altiplano, and an abundance of life which increases the intensity of competition have resulted in effective natural selection.[88]

Faunal elements

Insects and birds, active by day, comprise the most obvious and well-studied faunal elements in the park. There are over 10,000 species of insects, about 50 percent of which are butterflies (Lepidoptera) and 25 percent beetles (Coleoptera)[89] Adaptations for disguise, defense, and mimicry are remarkable. The number of know bird species has increased from early studies to over 300 today.[90] Flycatchers (Tyrannidae) and tanagers (Thraupidae) are most prevalent. Mammals, although dominantly nocturnal, are of great interest not only due to their variety but also from historic-geographic aspects, as discussed later. The park contains 50 known mammals, most numerous of which are the rodents. Others, such as the tapir and jaguar, are almost extinct. A remarkable adaptation to arboreal life is the prehensile tail, a characteristic of the South American monkey, a porcupine, and an anteater.

Although species of turtle and crocodile inhabit the

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[88]Darwin's study of insect life in Brazilian forests was a key factor in his development of the theory of evolution.

[89]J. F. Zikan, a former park naturalist, published exhaustive works on insect life of Itatiaia, including the first park bulletin in 1949.

[90]A. Ribeiro, "Vertebrados do Itatiaia," Archives Museú Nacional, XIII (1905), 163-190; E. G. Holt, op. cit., pp. 251-326; and O. Pinto, Aves do Itatiaia, Bulletin III of Itatiaia National Park (Rio de Janeiro: Ministerio da Agricultura, 1954), pp. 1-87.

Paraíba Valley, the only reptiles in the park are nine species of lizards, including two Iguanidae, and 35 species of snakes, three of which are poisonous. This represents about 14 percent of the total known Brazilian reptiles.[91] Amphibians have been studied intensively by Lutz, an American zoologist.[92] The warm, moist forest holds 54 species, almost half of which are tree frogs (Hylidae). Curiously, no fish occur. A paucity of crustaceans, molluscs, and plancton reflects the lack of calcium in the waters. In contrast to the many insects, only 44 spiders are found, including large wolf and bird spiders. Millipedes, centipedes, and various worms abound in the soils.

Distribution of fauna

Since fauna generally displays mobility and other adaptations to the environment, altitudinal zonation is not as obvious as with flora; effects of temperature and precipitation are less important. However all animals depend directly or indirectly on vegetation for food, so the basic vegetative types, forest and grassland, determine faunal areas to some degree. Barth[93] used the broad areas of artifical grassland (valley and piedmont), forest, and altiplano, which Holt[94] had

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[91]R. Barth, A Fauna do Parque Nacional do Itatiaia, Bulletin VI of Itatiaia National Park (Rio de Janeiro: Ministerio da Agricultura, 1957), p. 86.

[92]Bertha Lutz, "Anfibios Anuros do Distrito Federal," Memorial Institute of Oswaldo Cruz, LII (1954), 155-238.

[93]Barth, op. cit., p. 11.

[94]Holt, loc. cit. Frank M. Chapman in "The Andes: a New World" (Natural History, XXIV (July, 1924)) says of bird study in mountainous regions: "The potential mobility of birds combined with their unusually sensitive, responsive natures makes these animals particularly valuable indices of the effects of

designated in his study of birds, and added a water habitat.

Cutover grassland area (plain and piedmont)

This area south of the park shows the drastic effects of man's interference. Large forest mammals have been replaced by many small Rodentia including the squirrel, cavy, paca, and hare. A few shy tapirs, kin to the rhinoceros, and the capybara or water hog, still browse in secluded parts of the valley; the boa (Constrictor) also remains. Abundant small birds and insects thrive in the grass-shrub cover. A two-foot, almost flightless carniverous bird, Cariama cristata, can be found here as well as in the altiplano grassland, an example of indifference to temperature. Six other small birds move from the valley to the altiplano between nesting periods. At the margins of cultivated areas, the seven-banded armadillo (Dasypus), the most heavily armored mammal, can be seen burrowing for roots, insects, and snakes. Here also is found the South American rattlesnake (Crotalus).

Forest area (mountain slopes)

Most important of all habitats is the forest. Trees are an important element of the environment. They moderate winds and temperature change, increase relative humidity and shade, and provide a great variety of food and shelter for animal life.

During the day, most animals are secretive but at dawn

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those forces and circumstances which are or have been active in producing faunal area." p. 422.

and dusk activity increases, especially among the abundant birds.[95] A sad note of the dove (Leptotila) is interrupted by the screeches of a band of red-bellied parakeets (Pyrrhura) darting through the forest canopy. A shrill whistle, quite different from that of the black monkey (Cebus), comes from a hawk (Spizaetus) searching for small rodents or birds. Thrushes, tanagers, and flycatchers forage constantly for berries and insects. A low grunt of the toucan (Rhamphastos) reveals this large-billed, black, red, and yellow bird cracking open palm nuts.

Of great interest is insect life, specialized through processes of evolution. From prolific mutation, disguises evolved which provided protection from insectivorous birds, monkeys, lizards, and snakes against a diverse background of bark, leaf, branch, and flower (Plate VII). For example, the mottled long-horned beetle resembles bark and lichens; the leaf-blemish katydid and broken-twig moth have their guises. Other insects rely on bad odor or taste for protection, as the foul-smelling moth and heliconian butterfly. Edible butterflies mimic the gaudy Heliconius.

Other diurnal life found often in the trees includes the Brazilian ocelot (Felis), squirrel (Guerlingaetus), racoon-like coati (Nasua), the prehensile-tailed howler monkey (Alouatta), and anteater (Tamandua). This toothless, single-minded gourmet has a perfectly adapted syringe-shaped nose

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95The distribution of bird species (Barth, op. cit., p. 96) is as follows: valley and piedmont 8%, forest 19%, altiplano 2%, every area 22%, valley and forest 49%, forest and altiplano 9%.

and a two-foot tongue. Hanging in the branches, the long, green tree snake (Chironius) appears as a liana vine until a small lizard approaches. On the forest floor run peccaries (Tayassu) while the Brazilian caracara (Polyborus), a carrion-eater, circles overhead.

Night is the hunting time for many animals. The humble paca (Cuniculus) and armadillo (Dasypus), whose tunnels are used as a home by the burrowing owl (Speotyto), forage on the ground, while opossum (Philander), prehensile-tailed porcupine (Coendou), and three-toed sloth (Bradipus) are hunting in the trees (Plate IX B). The sloth, one of the slowest mammals, feeds exclusively on Cecropia leaves. Its long, grooved hair contains living algae, a natural camouflage. Carnivores stalk their prey through the underbrush and even up into the trees. The puma (Felis concolor), the lion of South America, may weigh 165 pounds. Smaller predators, the weasels (Grison and Tayra), raid bird nests, while the poisonous snake Bothrops awaits an unsuspecting mouse or tree frog.

Altiplano

This faunal area is characterized by animals of small size, few species, and the dominance of insects. Without a protective tree cover, animals must hide in the tall grass or rock crevices. A chief predator is the South American dog fox (Cercodocyon). Melanism, the condition of having dark coloration with increased altitude, is noticeable in butterflies. Since dark color absorbs more solar radiation, this may possibly explain why these animals living in higher, cooler altitudes

are darker in color. The partridge-like tinamou (Rhynchotes) is endemic here, whereas Cariama, the only modern relative of the huge predatory cranes, also occurs in the valley grassland. Rodents are scarce, and the pika (Ochotona), so common in the highlands of North America and Asia, is absent. During the summer, a few lizards and snakes may be found among the rocks.

The swiftness, coolness, and lack of calcium in the streams results in limited animal life. A few ponds in the altiplano contain insect larvae and Protozoa.[96] The absence of fish may be caused by high acidity of the water.

Paleo-geographic aspects

Some mammals at Itatiaia represent ancient forms originating far away and surviving today only in isolated places. Others have developed unique features and broadened their distribution. In late Tertiary times the Panamanian land bridge was formed connecting North and South America.[97] The ensuing great Pleistocene migration between the continents mixed their fauna. From the north came the racoon, squirrel, peccary, and puma, which now has the largest range of any western hemisphere carnivore. The tapir, one of the oldest American animals, formerly roamed vast areas in North American, Europe, and Asia but now is found only in isolated parts of Latin America and Malaya. From Brazil the highly

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[96]Barth, op. cit., p. 38.

[97]Simpson, G. G., "History of the Fauna of Latin America," American Scientist, XXXVIII (July, 1950), 361.

specialized anteater, the armadillo, porcupine, and ancient opossum spread northward.

Primitive forms like the tapir, marsupials, Cariama, and Iguanidae find refuge in isolated areas such as the coastal ranges of Brazil and the islands of Galapagos, Madagascar, and Fiji. Of the fifty park mammals, one-third have primitive characteristics and are a living record of the past.[98]

Summary and Problems of Physical Geography and Biogeography

The geography of Itatiaia National Park has been discussed as regards the nature, distribution, and origin of elements in the physical and biotic setting. Particular note should be taken of the abrupt rise in landform from the Paraíba Valley to the altiplano, and the influences of altitude on climate and biota. Elements of the physical and biotic setting can be summarized according to various altitudinal zones (Table 7). Definite zones of vegetation reflect the marked influence of climate on flora. Animal life, however, is more mobile and distributed according to a forest, grassland, or aquatic habitat.

Itatiaia presents a combination of geologic phenomena, surface features, climate, and biota which is truly unique. Many problems are still not fully understood or explained. They deal mainly with genesis: the development of the massif; the existence of a glacial period in the altiplano; the abundance of endemic flora; the establishment of northern species;

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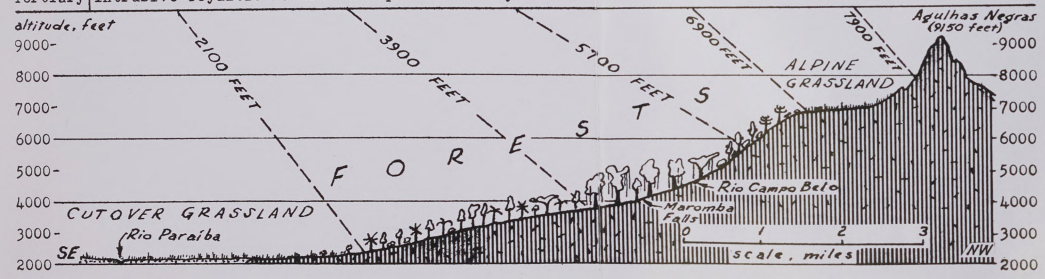
[98]Barth, op. cit., p. 136.

TABLE 7. Transect chart summary of physical geography and biogeography at various altitudinal zones

1400-2100 feet	2100-3900 feet	3900-5700 feet	5700-7200 feet	6600-7900 feet	7900-9150 feet
CLIMATE					
Humid mesothermal warm summer → dry winter → cloudy summer convectional rain Cwa →	Cwb	cool summer: temperature decreases about 3°F/1000 feet moist all year: precipitation increases about 6 inches /1000 feet high relative humidity sunny winter foggy spring orographic and cyclonic precipitation → Cfb →			frost in winter snowfall rare possibly Dfb
FAUNA					
many insects, birds, and rodents; some tapirs, crocodiles, and boa constrictors	in the air: parakeets, toucans, tanagers, and much insect life in trees: ocelet, coati, anteater, sloth, howler monkey, and tree snake on or in the ground: peccary and armadillo			many insects South American dogfox predatory birds	occasionally birds and insects
FLORA					
cutover and burned grassland on the plain; scrub savanna on the hilltops	second-growth forest: extensive cutting palms tree ferns dense bamboo	subtropical virgin forest: less species more individuals dense lianas climbing bamboo	transitional cloud forest: shorter trees Paraná pine dense shrubs epiphytes	alpine grassland: irregular bog and grass communities, endemics dwarf bamboo	isolated patches of vegetation: ferns, mosses yellow lichens endemics dwarf bamboo
LANDFORMS					
plains-piedmont: rolling plains, terraces, hills low gradient	low-mountain: moderate slope deep, V-shaped valley	mid-mountain: moderate slope falls and rapids dendritic stream pattern →	high-mountain: steep slope to escarpment	altiplano: flat to rolling slope deranged-trellis stream patterns	zone of summits: very steep slope deeply weathered channeled runoff
SOILS AND ROCKS					
alluvial soil Tertiary	latosolic soil	yellow latosol →	lithosol and bog soils →		
	intrusive foyaitic massif of nephelite and syenite →				



and the dearth of fish. Since the present study is a regional description of Itatiaia, the solution of these problems is not of prime concern. However, they were introduced to aid in understanding the description.

CHAPTER III

CULTURAL GEOGRAPHY OF ITATIAIA

Itatiaia stands out from surrounding areas not only in its physical and biotic setting, but also in the type of land use--for conservation, research, and recreation. However, the Itatiaia area prior to its establishment as a national park in 1937 experienced a series of quite different land uses in conjunction with development of the surrounding areas and the country as a whole. Therefore, portions of the park, notably in the south, have been modified from a primitive state, and their utilization must differ from virgin areas. This chapter will examine the ways that the Itatiaia area and adjacent areas have been developed and used by man.

Sequent Occupance

Itatiaia is surrounded by areas of diverse land use with diverse histories of human occupance (Figure 5). To the north is the decadent, subsistence livestock area of Minas Gerais, with the legacy of gold and diamond mining days. Westward to São Paulo, coffee plantations and heavy industries, such as a newly completed General Motors Company automobile plant, provide employment and a chance to raise living standards. The middle Paraíba Valley on the south, linking São Paulo with the major commercial and cultural center, Rio de Janeiro, has been

a focus of activity in southeast Brazil and exhibits the scars of numerous cycles.

Pre-coffee period (before the 19th century)

The Serra da Mantiqueira was traditionally a crossing place for bandeiras or pioneers from coastal settlements who opened the interior with their search for gold and slaves. Gazing up at Agulhas Negras tinted with the last rays of afternoon sun, the bandeiras no doubt imagined a solid mountain of gold to fill their lives with luxury. When gold was discovered in 1698 and diamonds shortly afterward in central Minas Gerais, a great rush of hopeful people, many from Portugal, brought permanent settlement to southeastern Brazil.[99] Rio de Janeiro, the center for gold export, became the capital of Brazil in 1763 at the height of gold production. Increased concentration of people in Rio brought the need for meat supplies from the southwest, so a road was developed through the natural route of the Paraíba Valley toward São Paulo.[100] In addition to servicing this communication route, the middle Paraíba Valley provided a variety of crops for the people in Minas Gerais. Some of its forests were cut to supply cheap fuel for sugar and alcohol production in the lower delta area. By the early 19th century gold mining dwindled. Many people moved down from the plateau into the middle Paraíba Valley to initiate a major economic phase, coffee production.

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[99]P. E. James, Latin America (New York: Odyssey Press, 1959), p. 401.

[100]Ibid., p. 442.

Coffee period (the 19th century)

The plateau of Minas Gerais, isolated by the Serra da Mantiqueira and less suited for agriculture, did not have the economic promise of the richer Paraíba Valley and its bordering hills.[101] Therefore, owners of former gold mines in the plateau moved south to these richer areas. They brought capital, slaves, immigrant workers, and what was most important, enthusiasm, thus setting the stage for a great speculative venture in coffee.

Clearing the land for coffee plantations necessitated the destruction of more of the virgin forest. Areas that were too steep or impenetrable were not cleared. Thus we still have virgin forests in Itatiaia National Park above 3900 feet. Below this level to about 2100 feet, selective cutting took place to supply house timbers. Clearing in the middle Paraíba Valley was so rapid that an original forest cover of almost 40 percent of the area was reduced to less than one percent in twelve years.[102] Much of the wood was burned, but some was used to make ties and charcoal for the government-owned Central Railroad, the "Central do Brasil." This vital link between Rio and São Paulo, started in 1858, helped in developing the valley.

Coffee trees were planted as early as 1774 on foothills and accessible slopes south of the park, but from 1800 to 1850 production expanded greatly in response to foreign markets.

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[101]Lamego, op. cit., p. 90.

[102]Barros, Parques Nacionais do Brasil, p. 21.

Resende, with nine warehouses and five estates, became the leading center for coffee export. Shipment to Rio was facilitated in 1877 by a spur of the Central Railroad, but a decline in coffee production was already evident. Some of the causes of this decline included the following: planting trees at right angles to the slopes which resulted in erosion, depletion of the soil by lack of crop rotation or fertilization, competition from more favorable coffee sites in São Paulo State, freeing of the slaves in 1888, and the spread of a coffee parasite.[103] A ghost landscape soon resulted with abandoned homes, poorly kept manors, and rows of dead coffee trees as typical signs for the economic decadence of the Paraíba Valley.

Government colonization period (early 20th century)

The large coffee plantations were broken up and converted into small cattle ranches, a cultural heritage from Minas Gerais. Volunteer grass developed good pastures and was maintained as today by spring burning. The milk and beef market of Rio gave hope of better times to some farmers. Others decided to risk another speculative crop on the terraces of the Paraíba River, namely sugar cane. This too was soon replaced by cattle raising. In 1906 the governor of São Paulo State encouraged the planting of rice in the rich flood plains, an important site for this staple crop since World WarI.[104]

While the Paraíba Valley experienced the decline of

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[103]Lamego, op. cit., p. 88.

[104]Ab'saber, op. cit., p. 115.

coffee cultivation and was attempting an economic comeback, the higher slopes of the Serra da Mantiqueira also witnessed human activity. Emperor Pedro II had long entertained hopes of developing a little Switzerland in the present park area as in the Serra dos Orgãos at Petropolis (Pedros' city). However the need of money, shortly before his abdication in 1889, forced him to sell the land now in the southern and northeastern environs of the park. Seven large fazendas or estates were established,[105] and their owners enjoyed hunting the large mammals and game birds which were abundant. Some of these areas were later acquired for the present park; some were left entirely outside the park bounds as in the northeast, and others were subdivided into plots of 50 to 150 acres (Figure 25). These latter plots are held by 44 different owners and represent a major problem of park management today.

From 1908 to 1918, the federal government attempted an extra ordinary colonization scheme. Groups of immigrants were brought to Brazil and given land in the high slopes of the coastal ranges to establish a temperate fruit culture. German colonists cleared areas on the south slope of land now within park bounds at about the 5900-foot and 6600-foot levels. They planted apple and pear trees. The trees cut in clearing the prospective orchard sites were used to build cabins and provide firewood. Near Serra Negra, on the north slopes, a nucleus of Finns established orchards at 5300 feet. These attempts soon failed due to numerous reasons. Many immigrants

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[105]Source: old property maps at the park Headquarters.

were of non-farm background and desired a standard of living that mountain isolation and its required self-sufficiency denied them. Temperatures were too cold and soils too heavy for good fruit production, and markets for the fruit crop did barely exist. After about five years, most colonists had left for the Paraíba Valley and an urban life. Those who remained longer devoted their energy to cutting trees for lumber, railroad ties, and charcoal which new industries in the valley demanded. A few took up livestock raising and practiced transhumance in the tradition of Minas Gerais herdsmen.[106] During the rainy summers, animals were led to the altiplano to avoid floods and insect pests in the valley. Herdsmen burned the area probably to encourage new succulent grass and, at the same time, prohibit tree development. From October to June, the herds would be kept in the valley where water was more abundant. The only relics of colonization in the park are some gnarled, lichen-covered pear and apple trees near the cabin of Macieiras (Figure 20). A similar failure at colonization occurred in the Serra dos Orgãos where 1600 Swiss immigrants tried to develop a cheese industry.[107]

In addition to the venture of temperate fruit culture, the government maintained a Biological Station at Monte Serrat from 1914 until the park's formation in 1937. The station was operated by the Botanical Garden of Rio de Janeiro and had as

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[106]A. J. P. Domingues, "O Macico do Itatiaia," Revista Brasileira de Geografia, XIV (October, 1952), p. 471.

[107]James, op. cit., p. 458.

its objective the study of the reactions of exotic plants in different environments. Cacti from Mexico, yuccas from Florida, evergreens from the Alps, iris from Siberia, and many other plants were introduced.[108] Many of the plants still add charm to the Gardens of Monte Serrat. Especially thriving are tall cedars, Cryptomeria, or Japanese cedar, and Thuja which line the road into the Gardens and grow with rhododendron at Macieiras. The Biological Station ceased to exist when the region was decreed a national park, but its function has continued under park management.

Modern occupance (since 1940)

The early 1940's ushered in a renascence of development to the Paraíba Valley. Industrialization and recreation hold the key to continued economic growth of the valley and the resultant increased use of Itatiaia. The development of many new small industries such as textiles, tanneries, paper-making, bottling, freezing, and other food processing, encouraged the growth of population and urban areas. Skilled laborers moved in from São Paulo and Rio de Janeiro.[109] In 1942, Brazil secured a loan from the United States to build a steel plant at Volta Redonda (Figure 5), and by 1946 the first large-scale, heavy industry in South America started production.[110] The ultimate capacity of this plant as now planned is one

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[108] M. Foster, Brazil, Orchid of the Tropics (Lancaster, Pennsylvania: Joques Cattell Press, 1945), p. 109.

[109] Lamego, op. cit., p. 89.

[110] James, op. cit., pp. 463-464.

million tons of steel per year. Various chemical companies such as American Cyanamide and E. I. du Pont have built plants in the valley. In 1945, Escola Militar das Agulhas Negras, the Brazilian West Point, was established at Resende.

Agriculture, too, is showing improvement. Orange culture, starting around Rio de Janeiro, has begun to spread to the foothills of the Paraíba Valley. Jute plantings are also noticeable. Through diligent work at the Rural University near Rio, scientists are improving cattle, introducing African grasses of high nutritional value, and encouraging crop rotation of maize, beans, and manioc. This should help to restore and stabilize agriculture. However, the practices of overgrazing and yearly burning of pastures are resisting change.

Some reforestation in the valley with eucalyptus trees, utilized for wind breaks and charcoal, shows promise. This wood, however, has low value as lumber. The impetus of industrialization brings a great demand for charcoal, so that second-growth forests, even extending up to the southern border of the park, have been used for this purpose. Because of inadequate enforcement of the law during the early years of the park, five and one-half acres of forest were unlawfully cut to furnish over eight thousand bags of charcoal.[111]

A growing business of service to vacationers traveling in the valley is providing a market for local products and new opportunities for employment. The present modern road connection between Rio de Janeiro and São Paulo is being

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[111]Valverde, op. cit., p. 32.

expanded as a dual system highway. A circular, drive-in motel, the largest and most modern in Brazil, lies only a few miles east of Resende. Hotels, lodges, and summer cabins accommodate vacationers on the relatively cool slopes of the Serra da Mantiqueira where the greatest attraction is Itatiaia National Park.

Current Evidence of Man's Occupancy

Boundaries

The park perimeter of 43 miles is only vaguely marked. It does not conform to natural bounds except in a small section of its western park determined by a water divide (Figure 9). About a third of the remaining boundary consists of straight run lines adjacent to small private holdings, particularly in the south and northeast.

High ridges of the Serra da Mantiqueira form part of a boundary between the states of Rio de Janeiro and Minas Gerais. Nine miles of this boundary occur within the park, following a divide from the west to Agulhas Negras and irregularly northeast along Rio Maromba. Bounds of private interior holdings are marked in various ways, such as by rock piles, wire fences, or clearings (Figure 25).

Nature and areal extent of roads and trails.

Numerous roads and trails penetrate the park and provide inter-connections among various areas (Figure 20). The highest road in Brazil (8000 feet) enters the altiplano from the west, a well-graded dirt spur of the highway from the Paraíba Valley

to Belo Horizonte. This spur follows the Rio das Flores to a shelter, then continues as a jeep road for another mile. The southern part of the park has a network of roads which reflects the intense use of this area. A six-mile, asphalt paved spur follows up the valley of Rio Campo Belo from the major highway between Rio de Janeiro and São Paulo to Monte Serrat and the park Gardens. From there, a seven-mile, graded, dirt road services homes and extends to the park Headquarters and Maromba bridge. Large buses carrying tourists can easily go as far as the Maromba parking area. Thence, a jeep road winds on up the steep valley of the Rio Campo Belo to a cabin at the 5000-foot level.

Forty-two miles of hiking and bridle trails have been established. In the vicinity of the park Headquarters east to Tres Picos and from Maromba bridge to the falls (Figures 9 and 20), various trails are well maintained. Diversion logs (across the trail to minimize erosion), adequate side ditching, wooden steps, and railings on steep parts of the trails blend into the natural setting. The location of trails takes maximum advantage of interesting forest, rock, or water features. The trails leading to and on the altiplano are in poor condition. In places, deep erosion makes footing treacherous, and few cairns or other trail markers exist. Four bridges of reinforced concrete and others of wood provide safe crossing of the lower Rio Campo Belo and its tributaries as well as vantage points for sightseeing.

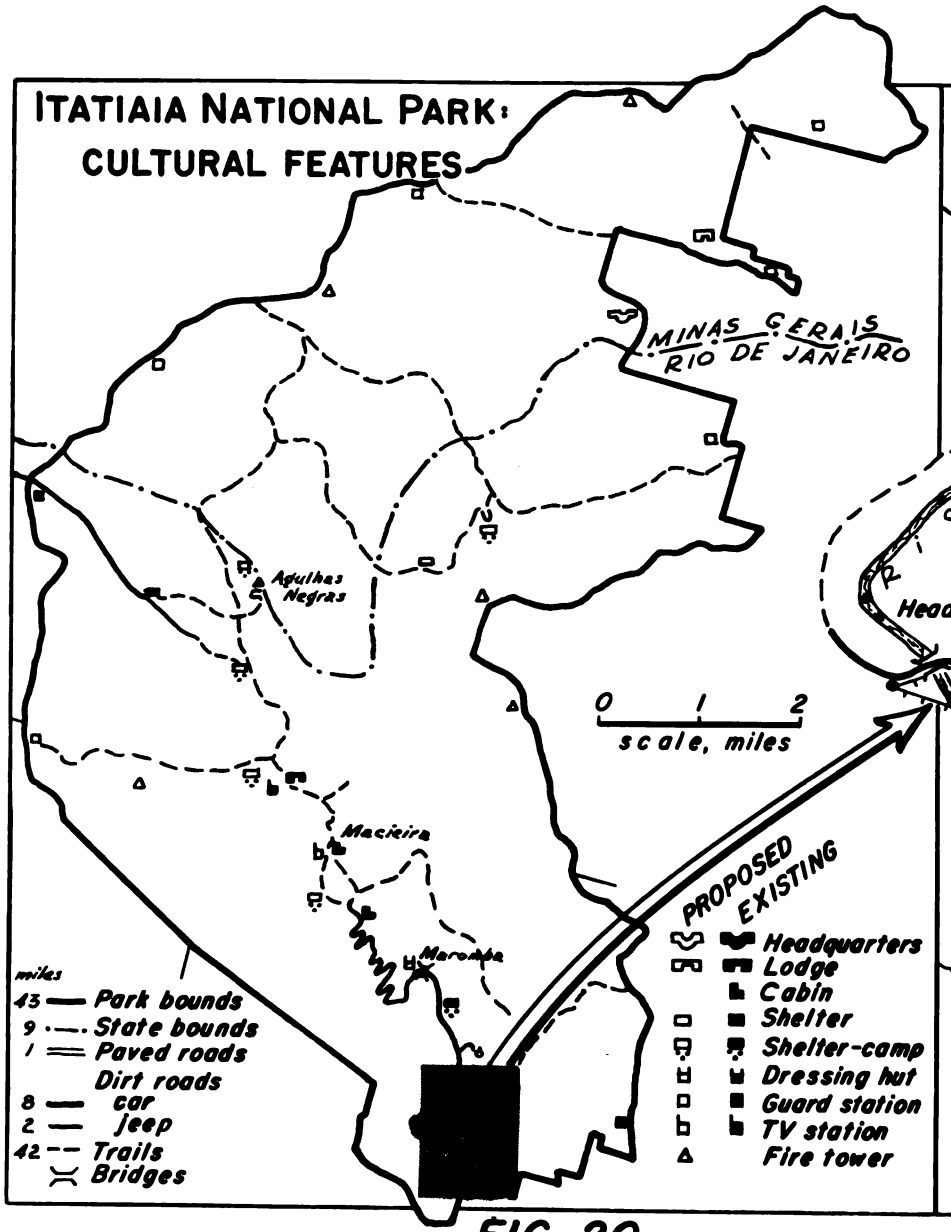
ITATIAIA NATIONAL PARK:
CULTURAL FEATURES
MINAS GERAIS
RIO DE JANEIRO
Agulhas Negras
Macieira
Maromba
0 1 2
scale, miles
PROPOSED
EXISTING
Headquarters
Lodge
Cabin
Shelter
Shelter-camp
Dressing hut
Guard station
TV station
Fire tower
miles
43 Park bounds
9 State bounds
1 Paved roads
Dirt roads
8 car
2 jeep
42 Trails
Bridges

FIG. 20

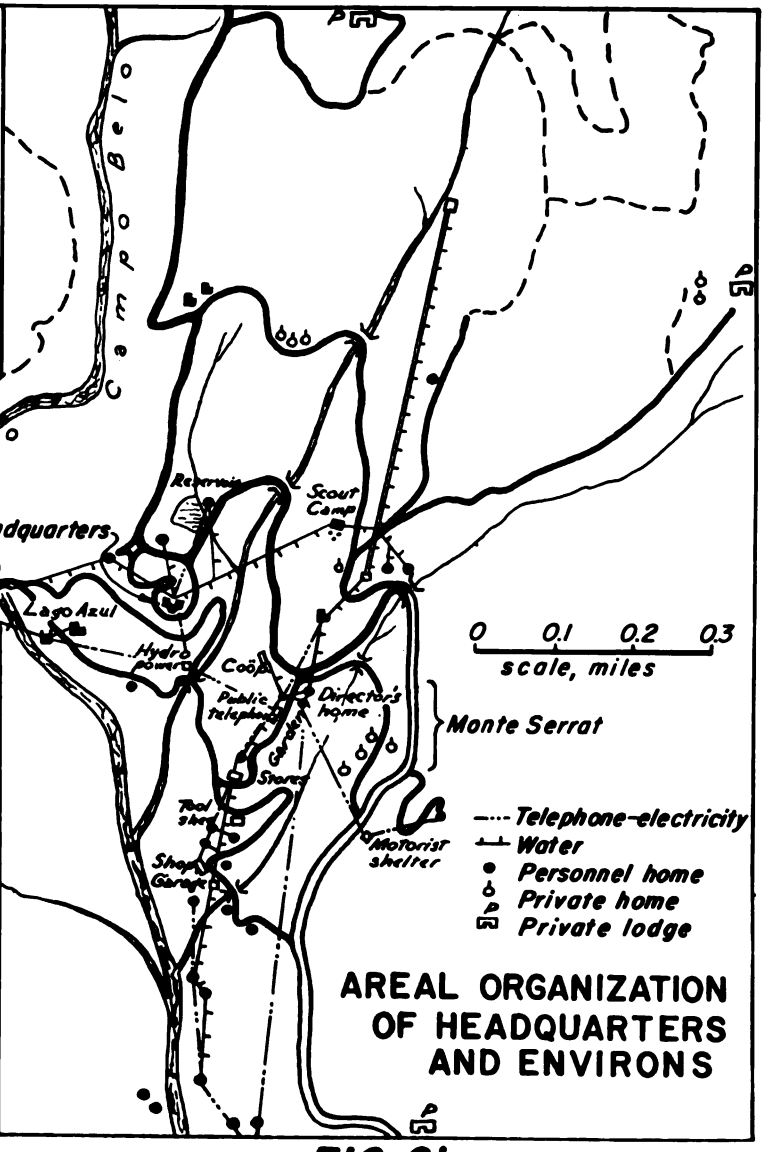
Rio Bonito
Reservoir
Scout Camp
Headquarters
Lago Azul
Hydro power
Coöp
Public telephone
Director's home
Monte Serrat
Store
Post shop
Motorist shelter
Shop Garage
0 0.1 0.2 0.3
scale, miles
Telephone-electricity
Water
Personnel home
Private home
Private lodge
AREAL ORGANIZATION
OF HEADQUARTERS
AND ENVIRONS

FIG. 21

Type and distribution of park facilities

Itatiaia has a notable physical plant in comparison with other Brazilian parks. Outstanding is the park Headquarters located just above Monte Serrat and nestled on a rise surrounded by the lush Rio Campo Belo Valley (Plates IV A and VIII A). The Headquarters contains administrative offices, a large museum, library, projection room, photography gallery, and laboratories for entomology, taxidermy, and cartography, Homes for the director and personnel are located in the vicinity of Monte Serrat (Figure 21). Other structures here include a telephone station, coöperative restaurant and store, greenhouse, picnic shelter, and various maintenance buildings. Utility lines service most of the area from a 50 h.p. hydroelectric plant located below the Headquarters. In 1960, another plant will be installed at about 5000 feet to provide electricity for a television relay station between São Paulo and Rio. Near the park Headquarters, a small tributary has been dammed to form an irrigation reservoir (Figure 21).

Other structures are designed for visitors to satisfy specific needs. Four rustic cabins provide sleeping accommodations for about 20 people. There are many comforts such as a fireplace, electricity, a kitchen, cooking and dining equipment, a bath, beds with inner-spring mattresses, sheets, and blankets. No fee is charged which is quite a contrast with parks in the United States. Two less elaborate cabins with capacity for 16 to 20 persons, a lodge for 60 persons, and a shelter for 18 persons are located at various elevations up

Plate VIII. Itatiaia.

A. Park Headquarters. This beautiful building of white plaster and red tile roof is nestled in the midst of a second-growth forest at 2800 feet. The grounds are well maintained. An extensive museum on the first floor receives much visitor interest. Offices and a library occupy the second floor. Note the columnar sweet palms in the yard.

B. Sample Display from Museum. The opossum (Philander) at left and three-toed sloth (Bradipus) represent typical nocturnal mammals found in the forests of Itatiaia. Note the life like poses and expressions. All taxidermy is done at the park Headquarters.

to the altiplano. All are well built of wood or stone but lack electricity and running water. Two combination shelter-camps provide open air camping during good weather and cooking-emergency shelters (Plate IX A). A two-section bathhouse for swimmers near Lago Azul and a guard station on the altiplano road complete the list of existing park structures.

About seven percent of the area within the park is privately owned and used for individual year-round home sites (Plate IX B). Also, three lodges, with capacities of 50 persons each, have been built by corporations (Figure 21). These establishments supplement the park accommodations while at the same time benefitting from the park's existence. They provide their own utilities but use park roads.

Proposed park improvements

Plans call for an improved access to the altiplano from the south by developing the present trail into a jeep road. This will be much shorter than the circuitous western route. Also proposed is a trail on the east side from Tres Picos to Cabeca do Leão.

Many new structures are planned (Figure 20). A Sub-Headquarters in the northeast will aid in developing that area of the park. Guard stations and fire towers are to be built along the park boundary to increase the control and protection of visitors and environment. Five more shelter camps at higher, more remote places than at present[112] will encourage outdoor camping and a greater use of the park. Another bathhouse at

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[112]Barros, Parques Nacional do Itatiaia, p. 18.

Plate IX. Itatiaia.

A. Scout Camp. This shelter-camp for boy scouts is shown in the center of Figure 21. It consists of a rustic cabin with a large room, fireplace, and kitchen used during inclement weather. In the foreground is a cleared area for outdoor camping.

B. Private Land Holding within Park. This area on the road to Maromba (see Figure 20) is typical of the ill-kept private holdings. As shown on the gate, H. Stumm acquired the area in 1925, twelve years before the park's establishment. Land clearing and erosion, barbed wire fencing for cattle, painted fruit trees, and shacks are of obvious concern to park officials.

Maromba bridge near a deep pool of the Rio Campo Belo is planned to serve hardy swimmers.

In addition to an existing stone crusher, a proposed saw and shingle mill will enlarge the park's physical plant to supply building materials. This will require additional hydro-electricity. A grade school, church, and new houses will be built for park employee.

Summary of Cultural Geography

The park area has had a limited occupance and use in the past due to its rugged, mountainous character and relative inaccessibility. However, regions surrounding the park have experienced great cultural modification as the country developed. A great gold rush (1700-1770) in the interior plateau north of Itatiaia was followed by economic ventures in the Paraíba Valley to the south. Forests were cleared in the valley for an extensive coffee culture (1800-1870). Some wood was cut for building and fueling the Central Railroad, which connects Rio de Janeiro with São Paulo. The decline of the coffee cycle was followed by cattle raising and attempts at other food crops. Since 1940 many new industries, including service to vacationers, have developed in the valley.

Some of the area which is now Itatiaia National Park was divided into private hunting estates before Brazil became a republic (1889). Settlement on the higher slopes of the park area was attempted by the government for a temperate fruit culture (1908-1918). However, this scheme was not based on sound economic geographical analysis and failed. The

government also maintained a Biological Station until the park's formation in 1937. Since then many facilities have been developed to increase the protection and utility of the park.

The current rapid expansion of touring and resorting in Brazil has brought the park into focus as a major asset. However, at the same time, it is resulting in land use problems. The areal distribution of the park facilities and interconnections reflects the use to which these elements are put. For example, the museum and deluxe cabins are near the main entrance; shelters are farther interior. The following part will describe how the physical, biotic, and cultural elements at Itatiaia are interrelated for carrying on specific activities. Various problems resulting from conflicting uses of the park will be discussed and recommendations will be offered.

PART II

THE ROLE OF ITATIAIA AS A NATIONAL PARK

Introduction

The two preceeding chapters have discussed the past and present geographic setting of Itatiaia, emphasizing the areal distribution of both natural and man-induced elements. The problem now emerges concerning the role of Itatiaia as a national park and how successfully that role is being carried out. The basic philosophy of national parks was discussed in the first chapter. Although nature protection is a major function of national parks, it was shown that an emphasis is often placed on specific uses, such as for recreation and research. Certainly recreation is a part of human geography and may involve particular phases of land utilization. Research in a national park, likewise, has importance, since the park area provides a natural, undisturbed setting for study.

Historically, most of the Itatiaia area has remained untouched by the economic activity which characterized the development of the surrounding regions. However, there was a limited use of the area for research, such as the Biological Station, and even for recreation in the form of hunting before the park's establishment. In 1937, Itatiaia was decreed a national park "to perpetuate conservation of its primitive aspects and consider the needs of scientific descriptions and tourism."[113] Thus, a new land use policy was applied to the

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[113]Barros, Parques Nacionais do Brasil, p. 82.

virgin as well as to the modified landscape within the park area. Conservation implies the wise use of a natural resource. If a park can be considered a natural resource as part of the environment which is of use to man, then Itatiaia should function to serve man.

The following chapter will analyze the role and functions of Itatiaia National Park as a natural resource of Brazil. It will show how the natural and cultural elements of the park are interrelated to carry out specific activities for conservation, research, and recreation. A final chapter will offer various recommendations for improving the park so that it may function more effectively and continue to set an example for other national parks.

CHAPTER IV

THE FUNCTIONS AND PROBLEMS OF ITATIAIA

The wise use of a natural resource depends on the needs or demands of a given culture. Thus we have seen that early use of the Itatiaia area was confined to timber cutting and homesteading on the lower slopes. With the rapid depletion of virgin forests and wildlife along the populated southeast coast of Brazil, a growing social consciousness developed. It recognized the need for a modified use of certain outstanding areas for their natural beauty and scientific interest. Setting aside and developing the areas as national parks would aid in satisfying the needs of present and future generations, particularly for recreation and conservation education. Itatiaia was chosen to be thus developed.

Park Organization

In order to carry out the needs at Itatiaia National Park, a park administration was organized. It consists of a director, vice-director, secretary and assistant, librarian, naturalist, and a sixty-man work crew. The park Headquarters serves as a base of operations, and the various interconnections of roads, water lines, and utility lines reflect the importance of this section of the park.

The administration has organizational activities underlying and reflected in all other park activities. It must

provide means for protecting the natural environment and park facilities against unwanted change, both physical and man-induced. In addition to protection or conservation, the administration must provide facilities for scientific investigations. This function has met with success as indicated by many good systematic studies at Itatiaia in the fields of botany, zoology, and geology. Scholars from many parts of the world are encouraged to advance knowledge of the park and its environs. They are given extended-stay privileges in the delux cabins at no cost and provided with a library of over 3,000 books and periodicals (including many of the latest American works), an excellent museum, and laboratories. In addition to facilities for visitors that have been described in Chapter III, the administration also supplies transportation, for a small fee, from the main highway to the park. The naturalist or some other employee may act as a guide for visitors. Protecting the health of visitors is also a major concern of the administration. A medical doctor, living permanently on an interior private holding, is available when needed. He is not, however, on the park staff.

Park Activities

Conservation

It has been shown that the need of preserving part of the once vast subtropical forests in the coastal ranges was a key factor in establishing Itatiaia National Park. However, a decree alone does not assure proper protection of a valuable park resource. Conservation activity is mostly limited to

erosion control along the roads and trails. There are no protective measures against insects or fire. Fortunately, damage from these agents has been negligible, although fire is a threat especially during the drier winter season (June - August). Some fire-fighting tools are available, but no fire towers exist. However, numerous towers will be erected along the park boundary in the near future. The administration is also given authority of surveillance and control over a buffer zone surrounding the park (Figure 26, inset), an important part of the Paraíba watershed.

Protection of the park against man presents a grave problem. Not only is there a need to prevent overuse and abuse of some areas by visitors, but also to prevent timber cutting, hunting, and undesirable developments by neighboring and interior landholders.[114] Visitors' rules, similar to those in parks of the United States, include: no unleashed pets, no picking of flowers or plants, no cutting or disfiguring of trees, and no fires except in authorized places.[115] Only five guards are stationed during the day to keep a record of the number of visitors and to control the use of the Garden, Headquarters, Lago Azul, Maromba, and the altiplano. Therefore, the enforcement of park rules is a difficult task.

Research

Itatiaia has long been a mecca for scientific investigations. Some of these studies were cited in Chapter II. In

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[114]This and other problems are discussed later on pages 120-125.

[115]Barros, Parque Nacional do Itatiaia, p. 59.

addition, research was encouraged by the government at two meteorological stations and at the Biological Station prior to the park's establishment. However, when the Itatiaia area was set aside specifically "to consider the needs of scientific descriptions" (page 108), the support of research received great attention. With the reorganization of the parks system in 1944, a further emphasis was placed on research (page 17). As a result, this activity has been strongly advanced at Itatiaia. Since 1949, six scientific bulletins describing the occurrence of park flora and fauna have been published by the government. These have received wide distribution and acclaim at institutions throughout the world. Collections of plants and animals, made in conjunction with these studies, now enrich the park museum and encourage further study and education. Visitors who stay only a few hours at the park or who seek shelter during inclement weather can readily gain an appreciation of the park's natural history in the museum. Over 18,000 insects are displayed in addition to the excellent series showing insect mimicry, sensory organs, methods of coloration, body forms, life cycles, and arthropods of medical interest. Many habitat exhibits provide natural settings for 240 stuffed animals. Some 800 birds and 60 mammals have been prepared as study specimens, and there is a rock collection (Plate VIII B).

Each year on September 21, the park celebrates the "Festa da Arvore" with a forestry conference. At this time members of the forest service gather for a meeting and field trip. They conduct a number of forestry experiments in the

park, including a study of tree growth rate under various conditions. A complete aerial survey of the park was made in 1957 and a topographic map was prepared at a scale of 1:10,000. Matched photos may be viewed stereoscopically to study forest cover.

A great potential for geographic research exists at Itatiaia. This region, now protected from outside interference and possessing various environmental complexes, could well serve as a long-term field laboratory. Investigations in biogeography might help to explain the occurrence of so many endemic species at Itatiaia. The relationship between predatory animals and the extinct or near-extinct animals must be more fully understood. Research in climatology and geomorphology could solve the problem of a limited glaciation on the altiplano. The effects of various intensities of use in certain areas of the park should be studied.

Visitor Service and Recreation

Itatiaia serves the public for recreation. Visitors seek a change from everyday living and find relief and relaxation from hot, crowded cities or from farm chores. Some people search for tranquility and peace of mind along a quiet forest trail or beside the roaring Rio Campo Belo. The more adventurous may find inspiration after an arduous climb to the heights of Agulhas Negras. Others wish only to have a gay time with family or friends.

Visitor service is the least developed activity at

Itatiaia. The original decree placed "tourism"[116] after both conservation and research, thus indicating the subordinate position of this activity. Although numerous accommodations exist, little service is extended to visitors except around the park Headquarters.

A variety of accommodations, as described in Chapter III, assures satisfaction for groups of diverse size and needs. There is no time limit for the use of camp sites, as in parks of the United States, but accommodations must be reserved during the summer. Some visitors bring equipment for an overnight stay at park lodges, cabins, and shelters, which have a total capacity of 138 persons. Others prefer to stay at one of the three corporatively-owned lodges, which have a total capacity of 150 persons. Thus, only a maximum of 288 persons can be housed or sheltered in the park at one time. In addition, outdoor camping is also possible throughout the park and especially at two areas in the southern part.

The yearly park attendance increased from about 5000 in 1937 to 51,100 in 1958. There was an unexplained drop in 1954 (Figure 22). The recent increase is probably due to a combination of advertising from widely circulated booklets and research bulletins on Itatiaia, and a rise in living standards of the populace. In 1958, about 80 percent of the visitors came from Rio de Janeiro and 18 percent from São

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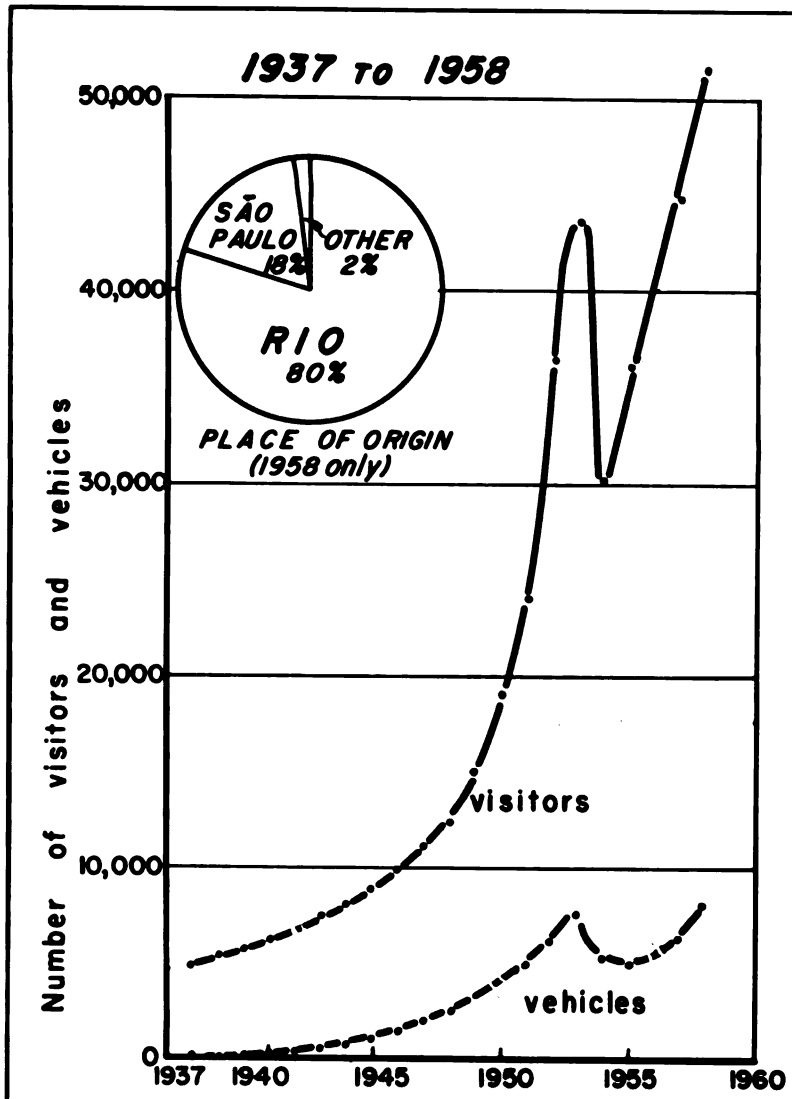
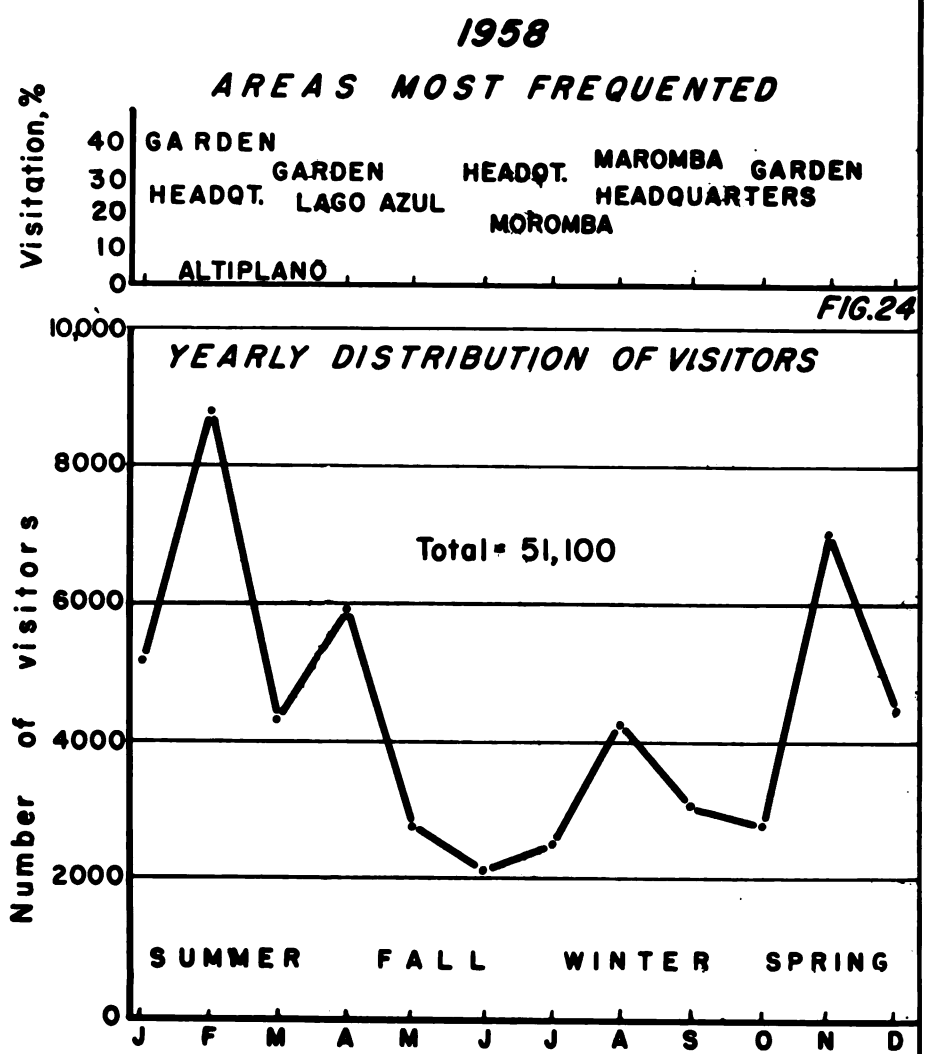
[116] "Tourism" should only refer to sightseeing and short-stay activity; however, in the park decree, "tourism" also includes extended camping and lodging.





ITATIAIA NATIONAL PARK: VISITATION BY YEARS, AREAS, AND SEASONS

FIG. 22

FIGS. 23 and 24

Paulo.[117] Their length of stay was not recorded, but most visitors seemed to remain for a day only as true "tourists;" the rest camped or lodged for at least one week. Resorting[118] is uncommon although, in a sense, some interior landholders living on park land are resorters. Even though the park is open year-round, the spring and summer months (November - February) attract the greatest number of people (Figure 23). A small increase during the sunny, dry winter months (July - September) may be caused by an influx of students between school terms. However, during this period, only the cabin accommodations are used continuously.

Five principal areas lure visitors: the Garden at Monte Serrat, the park Headquarters, Lago Azul swimming area, Maromba bridge and falls, and the altiplano. Figure 23 indicates the areas most frequented during the year as a percentage of the total periodic visitation. The Garden attracts the greatest percentage of visitors throughout most of the year, between 32 and 40 percent from September to May. The Headquarters is also popular, with 25 to 32 percent of the total visitation. These two areas are easily accessible by good roads and require little walking. Beautiful and well-kept exotic plantings, an orchid greenhouse, and a picnic shelter enhance the attractiveness of the Garden area. The Headquarters, at a slightly higher elevation, offers the visitor an excellent museum, photograph

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[117]The distance by highway to Rio is 100 miles and to São Paulo is 155 miles. There are regular bus and rail facilities between these two cities which pass near the park.

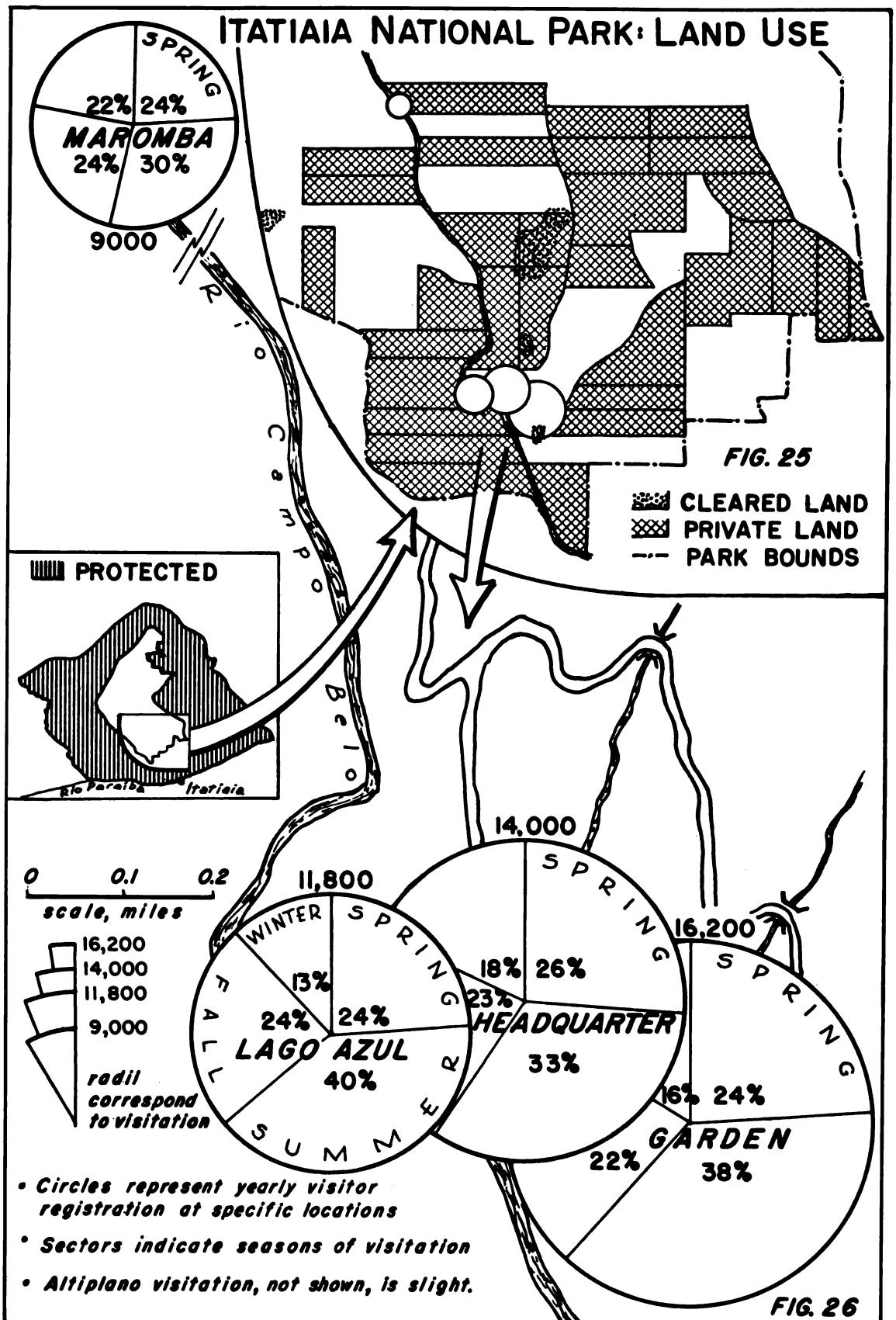
[118]Resorting may be defined as the habitual use of an area as a temporary, fixed abode.

gallery, library, attractive plantings, and a fine view up the Rio Campo Belo gorge as well as south to the Paraíba Valley.

Lago Azul is a deep pool below the bridge crossing Rio Campo Belo near the park Headquarters. A bathhouse next to the pool serves those who are brave enough to swim in the perennially cold water. The rustic Maromba bridge crosses Rio Campo Belo at the 3700-foot level. It provides a spectacular vista of the river and its many rapids and falls, sparkling pools, and deep shadows. From the water's edge up the steep-sided gorge, dense subtropical vegetation competes for every available patch of sunlight. Air plants are attached to huge boulders or hang from trees above the river. Morning haze brings ethereal beauty to the gorge. Following a steep trail for a quarter-mile through virgin forest, the visitor arrives at one of the most picturesque spots in the park, Maromba Falls. Here, a tributary of Rio Campo Belo cascades 110 feet over a local fault at the 4000-foot level.

The altiplano presents a remarkable scene for the visitors to enjoy. It is unusual to find mid-latitude conditions in the tropics. There are also jagged rock formations whose deep shadows excite the imagination. One can take a leisurely walk through the grassy, flower-strewn meadows and past small ponds, or take a strenuous climb to the summit of Agulhas Negras. Visitors may camp in the open or use the rustic shelter for extended stays.

An areal view of the interrelation between features of the park and visitors is given in a land-use diagram (Figure 26).



FIGS. 25 and 26

The size of the circles corresponds to the 1958 visitation at each area. About one-third of the total visitation was at the Garden (16,200) and over 80 percent at the Garden, Headquarters, and Lago Azul. Sectors indicate the relative use of each area during various seasons as the percentage of yearly visitation at the area. The use of Maromba was quite uniform throughout the year: the use of Lago Azul swimming area was concentrated during the warm summer months. Very little use of the park occurred above Maromba Bridge, due to poor accessibility.

Visitors of Itatiaia can find not only natural beauty and a chance to be out-of-doors, but also educational opportunities. At the Headquarters, the museum displays are particularly well presented for general interest, and informative books about natural history may be borrowed from the library. An excursion with the naturalist can be most rewarding. However, few visitors exert themselves beyond a casual look at the Headquarters and at the most accessible areas of the park.

Park Problems and Possible Solutions

When man invaded the natural environments of the Itatiaia area, certain problems developed. Some problems had existed before the park was established, others came to the fore with park organization and public use.

1. As described in Chapter III, the early occupancy of Itatiaia changed the original landscape. Virgin forests were cut, grasslands were burned, and large mammals and game birds were hunted almost to the point of extinction. Habitats were altered so that abnormally high populations of rodents

and insects developed.

Artificial stocking of fauna depleted by man, such as that of the tapir and red brocket deer, would aid in restoring the area so it might resemble its original conditions. Large predators, for example the puma, still exist so there would be no danger of exceeding the carrying capacity of the forest. Reforestation has also been suggested, but with protection assured over a long period of time the natural plant succession will eventually reach a forest climax. Meanwhile, the cutover and second-growth areas provide dramatic evidence of man's need for a greater awareness of conservation. Only by strict enforcement of existing laws through a full-time park ranger service can the renewal and perpetuation of natural features be attained.

2. Private land ownership within the park presents a problem to management but it is not a unique phenomenon. National parks in the United States still have about 182,000 acres, or 1.4 percent of the total area, in private holdings.[119] These are particularly in the east where settlements occurred prior to the establishment of parks, as at Itatiaia. Some of the landholders at Itatiaia are related to the German colonists who were involved in the attempt to establish a fruit culture. The high prices they place on their holdings make it too costly for the government to buy them out. Theoretically, park regulations also apply to these people with the added restrictions of no grazing, burning, or crop raising. Land modification is

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[119] Information Please Almanac, p. 275.

limited to building a home, driveway, and drains only. Actually great latitude in land use is tolerated since the law cannot be made to function retroactively. One resident owns a large home, an outdoor dance pavillion, and a private swimming pool. Less wealthy landholders have built unsightly shacks and chicken coops, graze a few cows and goats, and plant subsistence crops (Plate VIII B). Dogs are allowed to run freely and harass park wildlife. Some hunting and forest cutting occurs. Unfortunately, these conditions exist in the southern part of the park where the most visitation occurs.

About two-thirds of the landowners have organized as the "Association of Friends of Itatiaia." Outwardly they spread good will for the park, but their real purpose seems to be to assure their tenure in the park.[120] Only through strong government pressure and public sentiment can these holdings be secured for the use of the park.[121] Until such action takes place, park laws must be strongly enforced, again emphasizing the need of a park ranger service.

3. A more subtle problem concerns public apathy both within and outside the park. Few visitors show interest in seeing, appreciating, and learning about the great natural attractions of Itatiaia. Few have concern for keeping the park in a condition for others to enjoy; consequently rubbish is dropped on the trails and fireplaces are left unsightly. Of even greater importance is the fact that the vast majority of

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[120]This is the opinion of most of the park staff.

[121]Barros, Parques Nacionais do Brasil, p. 15.

Brazilians do not visit national parks. A number of factors are involved. General poverty prevails among the Brazilians which limits education and recreational opportunity. Some population nodes lack good transportation facilities to the parks. The attempts of many Brazilians in the crowded eastern coastal cities to rapidly assimilate modern civilization tend to resist the appreciation of the park areas, which are symbols of the still untamed wilderness.

Whatever the factors are which cause public apathy, the solutions may lie in the following: (a) changes in the stage of development of the country as a whole, (b) intensive educational efforts on the part of schools, newspapers, and a park ranger service, and (c) learning how to recreate or enjoy leisure time as standards of living rise. The values derived by the individual who visits Itatiaia or other parks undoubtly contribute toward his physical and mental well-being.

4. Improper balance of park activities is reflected in the inadequate control, development, and use of a major part of Itatiaia extending 10 miles north of the park Headquarters, and including about 20,000 acres. Much of this area has steep slopes or exposed highland. A new Sub-Headquarters in the northeast as well as more trails and shelters should improve the visitor service and recreation activities of Itatiaia. Thus a better balance of activities could be achieved.

5. Overuse of a few areas of the park is a corollary of the previous problem and also reflects public apathy. This problem exists in many parks of the United States, particularly

at Yosemite where overuse necessitates such drastic measures as covering some trails with asphalt. Most visitors come to Itatiaia as casual observers and seldom exert themselves to travel beyond the few areas in the southern end of the park. Overdevelopment has taken place in these areas. The administrators of the park have proposed an artificial fish pond and a sports field. These may attract more visitors, but there is a possibility that such improvements would eclipse the appreciation of the natural setting which makes Itatiaia something more than just a city playground.

The solution again lies in developing more facilities in other parts of the park, improving guide and interpretative service, and enforcing park regulations. The establishment of new parks in other areas of the Eastern Highlands would help distribute visitors and relieve pressure on Itatiaia.

6. The problem of an inadequate number of personnel plagues national parks everywhere.[122] A well-staffed ranger service at Itatiaia would alleviate most of the problems already mentioned and provide other benefits, such as better protection to park features and to visitors. An organized search and rescue team is particularly important in areas of dense forest and rugged mountains, such as found at Itatiaia.

Once the government is convinced of the need for a park ranger service, tax appropriations could be used to help support such a program. However, money raising devices, as are common in parks of the United States, could also be used:

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[122]Brockman, op. cit., p. 110.

for example, a 15-day or seasonal automobile permit and fees for the use of cabins.

Another aspect in the problem of personnel involves the welfare of day laborers. Only a few are willing to live in homes supplied by the park. The majority prefer to stay in the village of Itatiaia on the main highway (Figure 6) where their children can be closer to schools. The park has to provide commuter service by truck. In an emergency such as a forest fire, delay in getting fire fighters may have grave consequences.

In spite of the many problems which plague Itatiaia, the park is of value to Brazil. Over 50,000 visitors find recreation here each year and the number is rapidly increasing. Research activities have been outstanding. The park stands as a prototype for Brazil and other tropical regions of a new era in land use and conservation philosophy. Itatiaia can be used as a spearhead for conservation and education. The final chapter will expand on these prospects and summarize recommendations for park improvement.

CHAPTER V

THE FUTURE OF ITATIAIA

Numerous problems resulting from park activities were discussed in the preceding chapter. These problems are similar to those existing in national parks of the United States: competition for use of the land, the destruction of physical resources by man, increased visitation, and inappropriate use. The principles governing "appropriate use" hold the key to the solution of most park problems. Use of the park area is the sole basis for considering it a natural resource. However, activities must be controlled so as not to impair significant natural or scenic values, nor lessen the opportunity for others to enjoy the park.

A complete rehabilitation of national parks in the United States is being carried on under "Mission 66."[123] This ten-year program of park improvement, from 1956 to 1966, is the kind needed at Itatiaia. Its broad objectives are: better use of the whole park, improved interpretative services, and expanded research in problems of use and preservation. Areas already developed are being made effective for visitor needs. New accommodations and roads are being opened to encourage a

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[123]National Park Service, Our Heritage, a Plan for Its Protection and Use: Mission 66 (Washington: U. S. Department of the Interior, n.d.).

dispersal of land use. However, the natural scene must be preserved. This background of undeveloped wilderness, which is not intensively used, forms the character of a national park. The following section of recommended improvements at Itatiaia reflects the underlying spirit of Mission 66 while recognizing the specific needs of this Brazilian national park.

Recommended Improvements

Even a cursory observation at Itatiaia indicates that there are some important problems to be resolved if the area is to continue in the role of a national park and gain stature in the future. The following suggestions are presented not as an exhaustive list but to indicate some areas of the total park program which might be improved. They are divided into two groups according to urgency: immediate actions and long-range planning.

Immediate Actions

The constant need of vigilance to protect the park's natural setting is basic to park policy. This need may be partially fulfilled through a ranger service, whose full-time job would include the enforcing of park regulations. The ranger service would also assure protection to park facilities. Other immediate actions related to conservation should include the repair of roads and trails, particularly the improvement of the unique altiplano road. Erosion would thus be minimized and, at the same time, access to various areas of the park would be facilitated.

Along the lines of research, urgency is not too great, but a number of projects are suggested. A large relief model of the park, using the available topographic sheets, could be easily produced. This would provide a basis for planning the study of certain elements in the park as well as an excellent interpretation of the park for visitors. The development of a phytogeographic map in greater detail than that done by the present author (Figure 8) would likewise be of value. An aerial mosaic map could be constructed from the existing air photos, to provide a good base for planning such improvements as roads and trails.

The installation of an attractive rustic sign at the entrance to the park and also one at the main highway would be good advertisement to visitors. In addition, the visitor could be given a guide pamphlet to Itatiaia. This should include a detailed map, orientation data, an explanation of the major park features, and a review of park regulations.[124] Visitors should be required to register for extended excursions and climbing tours to assure their safety.

Long-Range Planning

Since a national park usually has a permanent status, long-range planning should be considered. Conservation aspects of planning at Itatiaia must first of all be directed toward a complete boundary survey of the park. This should include distinct markings to avoid encroachments on park land. Other

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[124]With the author's suggestion and illustrations, the park director is currently preparing such a pamphlet.

protective measures are now being developed, such as new guard stations and fire towers. An internal radio communication system would make these facilities more effective. The problem of private land holdings within the park is a difficult one to solve. Perhaps, with the passage of time, the government may be able to purchase the most unkempt holdings and rehabilitate them. The more prosperous owners may be prevailed upon to abide by park regulations and respect their position in the national park. This is a situation somewhat comparable to private leasing of land in national forests of the United States.

Specific research projects have been noted in Chapter II. Many other geographic studies could be included in long-range planning. Reinstating the weather station on the altiplano and establishing others at various elevations could aid in understanding the park's climate. More intensive study of landforms and hydrology would likewise be of value. The analysis of land use in various sections of the park would aid in determining where improvements should be made or use curtailed. The facilities of the museum could be expanded with an herbarium and displays of various woods and seeds. More space is needed for the taxidermy laboratory and a photographic darkroom.

Planning for future use of the park by visitors is of prime importance. Many of the suggestions noted thus far also relate to visitor service and recreation. Specific items to consider are directed toward making the park more enjoyable and meaningful to visitors. Roads, paths, and shelters should

be expanded in response to the new Sub-Headquarters in the northeastern part of the park. Interpretative service could include self-guided paths, with exhibits and identifying tags, and frequent lectures and nature walks with the park rangers. College students might be employed during the summer to aid in this work. Various courses could be organized for painting, photography, camping, and mountain climbing. An understanding of conservation will be developed in the visitors through many of these activities, even though they are not aware of it. However, specific publications might be helpful in teaching visitors how to enjoy the out-of-doors and to fully appreciate their national park.

The Importance of Itatiaia as a Geographic Complex

Itatiaia National Park appears as just a dot on the map. Nevertheless, it commands a great deal of attention and respect in Brazil and elsewhere. Here is a tropical mountain area which can be studied as a unit having a considerable diversity of physical, biotic, and cultural elements. Many problems which concern climate, landforms, and vegetation and their interrelations offer themselves for continued study. The comparison of Itatiaia with similar environments in other parts of the world establishes its pecularities as well as its typically tropical characteristics.

The Itatiaia area has displayed a variety of land use reflecting the development of Brazil. Therefore, the study of interrelations between man and the environment allows us to better understand sequent occupance, or the stages in taming

a wilderness. That some of this wilderness should be recognized as valuable to be retained unimpared is also of importance. Itatiaia stands out as the first area in the country to have been selected for the role of a national park. This role, closely following that of parks in the United States, has been carefully designed to meet the needs of present and future Brazilians. At a time when much of the country is still underdeveloped, it is remarkable that Brazilians have had the foresight to advance conservation at Itatiaia. Even more remarkable is that the initiative has been taken to develop a national park system for protecting superb natural areas and encouraging research and recreation.

Just what emphasis should be placed on future activities of conservation, research, and recreation at Itatiaia is a problem which must be solved by the Brazilian people. With the growing need for outdoor recreation, it is likely that visitor service will be given much greater support at the park. Furthermore, Itatiaia is easily accessible to population centers. Basic park philosophy may have to be modified in response to these growing needs. However, if Itatiaia gains popularity through intensive recreational use, Brazilians may develop a fuller understanding and appreciation of conservation and will support the expansion of the park system in more remote areas. Thus, some parks can function primarily as research areas and others for recreation.

Itatiaia is truly an important geographic complex. Its landscape provides typical as well as unique characteristics of a tropical mountain area with many intriguing problems.

Its management as the first and most prized national park in Brazil represents a new concept in land use philosophy and offers an example for other tropical regions to follow.

APPENDIX: A BRIEF DESCRIPTION OF OTHER BRAZILIAN PARKS

Iguassú National Park

Iguassú National Park, created in January 1939, lies along the Iguassú River in southwestern Brazil. To the south is a similar park in Argentina. There are two airline flights per day from São Paulo to the nearby village of Faz do Iguassú, over 500 miles.[125] Taxis provide service to the park.

Iguassú embraces 506,000 acres of primeval, subtropical forest and the magnificant Iguassú Falls.[126] The park lies at altitudes between 800 and 1000 feet. It is underlain by a basic eruptive rock which is covered by well consolidated sedimentary layers. Through these layers, the Iguassú River has cut a deep trough. At one point in the river, a multiple, horseshoe-shaped cataract, almost two miles wide, has formed (Plate X). The cataract consists of eighteen major parallel falls, the highest of which is 260 feet; in comparison, Niagara Falls is only 167 feet high. During spring floods, the Iguassú River discharges twice the volume of water as does Niagara. A humid subtropical

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[125]Round-trip fare is about $50.

[126]Iguassú is the Indian name for "The Great Waters."

Plate X. Iguassú: Upper Falls. The view is south toward the largest falls with a 260-foot drop, "Garganta do Diabo." It has cut back its rim over 1000 feet. Argentina lies in the background. Note the mist forming a constant cloud and vegetation in the center of Iguassú River at left.

climate characterizes the Iguassú area.[127] The average annual rainfall is 61.7 inches, and a maximum occurs during the summer.[128] Winter temperatures may be as low as 40 degrees F. Cloudy days are frequent.

Overlooking part of the falls is the beautiful Hotel das Catarácteas, built by the Federal Government in 1958 (Plate XIB). A modern outdoor swimming pool, tennis courts, fishing, and hiking provide year-round recreation. Over forty visitors arrive per day and stay for an average of three to four days. Considering the great distance from densely populated areas of Brazil, Iguassú is well visited (Figure 3). However, about half of the clientele comes from the United States. The park Headquarters contains facilities for administrative personnel and a small museum displaying flora, fauna, and rocks of the area (Plate XI A). There are well marked trails leading through the forest and along the river to the falls. A small hydroelectric plant, installed on a tributary of the river, supplies power to Faz do Iguassú and the park.

Serra dos Orgãos National Park

Serra dos Orgãos National Park, the smallest in Brazil with 24,700 acres, is located in the Serra do Mar range. It lies only 40 miles north of Rio de Janeiro and near the important summer resorts of Petropolis and Teresopolis. A

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[127] *Caf* according to Köppen.

[128] Departmento Nacional da Producão Mineral, Divisão de Aguas, *Atlas Pluviometrico do Brasil, 1914-1938* (Rio de Janeiro: Ministerio da Agricultura, 1948), p. 22.

Plate XI. Iguassú.

A. Park Headquarters. A museum occupies the first floor. Three park guides look on.

B. Hotel das Cataráctas. The front entrance is dominated by a four-story observation tower for views of the Lower Falls.

modern highway, completed in July 1959, greatly facilitates travel from Rio by car or bus. This highway, perhaps the most beautiful in Brazil, allows the tourist to penetrate easily into the Serra do Mar while enjoying many vistas toward Rio de Janeiro (Plate XI B).

The park has altitudes ranging from 3300 to 7458 feet. Thus, the marked decrease in temperature from lowlands (11 to 24 degrees F.) is a welcome relief to residents of Rio de Janeiro. An average yearly precipitation of 87.1 inches occurs at the park Headquarters (3300-foot level). The rainfall regime has a definite summer maximum.[129] Landforms of the area are outstanding. Crystalline rock has been carved into sharp peaks such as "Dedo do Deus" (Finger of God), or "Agulha do Diabo" (Devil's Needle), producing striking silhouettes (Plate XII A). Vegetation shows the influence of altitude. Below 5000 feet the primary pluvial forest has great variety. Epiphytes such as mosses, ferns, orchids, and philodendron form a dense covering in the upper tree branches. At 5700 feet, vegetation is nearly dominated by broadleaf evergreen trees with spindling trunks and a height of about 40 feet.[130] Above 6500 feet is a scrub forest of small trees less than 20 feet tall, of bushes, and many ferns. No trees are found above 6700 feet, except in protected ravines. From this altitude to the highest peak, an "alpine" vegetation zone occurs, induced by

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[129]Departmento Nacional da Producão Mineral, op. cit., p. 22.

[130]The species is Cabralea eichleriana.

Plate XII. Serra dos Orgãos:

A. Mountain Climbers. On the way up Dedo do Deos, climbers pause at 7000 feet to observe sheer cliffs of exfoliating granite. Note the low, scattered vegetation clinging to the steep slopes. Subtropical forests lie in deeper soil of the protected ravine at right.

B. View toward Rio de Janeiro. Early morning fog seen from 6000 feet outlines the low foothills. High humidity is evident from moss and lichen growing on the 15-foot tree to the right and ground orchids at the left.

fire and topography. It consists mainly of dwarf bamboo, other grasses, mosses, and lichens. Some areas covered with charred stumps indicate that the treeline was formerly much higher than at present. With the exception of bird and insect life, fauna has suffered from the proximity to civilization; therefore, it is not as rich as in the other parks.

The park consists of two different recreational use areas, a short-stay picnic site near the entrance and interior park land, which is used by visitors for longer periods. The first area resembles a city park with public eating shelters, children's playground, a landscaped swimming pool, and exotic gardens. There is also a museum with a good photographic exhibition. The interior area is more typical of a national park. Ten cabins and five shelters are well distributed to satisfy the needs of campers, hikers, and climbers. As at the other parks, no fee is charged for lodging. Hiking trails penetrate the remote areas of the park. Visitation has steadily grown since the park's establishment in November 1939; there were about 180,000 visitors in 1958, and numbers have increased about 8,000 yearly.[131]

Paulo Afonso National Park

Paulo Afonso National Park, established in 1948, straddles the Rio São Francisco in northeastern Brazil. Altitudes range from 600 to 1000 feet. Much of the 41,700 acre park consists of the most extensive systems of cascades

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[131]This information was supplied by the park director.

in South America, largest of which is Paulo Afonso Falls (264 feet). A tropical steppe climate[132] is uncommon in Brazil and produces "caatinga" vegetation, consisting of an open forest of stunted trees and cacti. The park shelters fauna whose numbers have been drastically reduced by uncontrolled hunting.

Paulo Afonso is still in the formative stages of development. Two hydroelectric stations, designed to fit into the environment, a large hotel, and an airport comprise initial construction.[133]

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[132] BSh according to Köppen.

[133] Barros, Parques Nacionais do Brasil, p. 76.

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