

**TEXT FLY WITHIN
THE BOOK ONLY**

UNIVERSAL
LIBRARY

OU_166511

UNIVERSAL
LIBRARY

PROCEEDINGS
of the
NINTH PACIFIC SCIENCE CONGRESS
of the
PACIFIC SCIENCE ASSOCIATION
1957

VOLUME 7
CONSERVATION

Published by the
SECRETARIAT, NINTH PACIFIC SCIENCE CONGRESS
DEPARTMENT OF SCIENCE
BANGKOK, THAILAND
1959

OSMANIA UNIVERSITY LIBRARY

Call No. 506 | P 11 P

Accession No. G-15174

Author Pacific Science Association. Science
Congress, Ninth, 1957.

Title Proceedings. Conservation 1959.

This book should be returned on or before the date last marked below

--	--	--	--

SECRETARIAT, NINTH PACIFIC SCIENCE CONGRESS

DEPARTMENT OF SCIENCE
BANGKOK, THAILAND

1959

PUBLICATION COMMITTEE
and
EDITORIAL STAFF

Chairman: DR. CHARNG RATANARAT

Vice-Chairman: M. R. CHAKRATONG TONGYAI

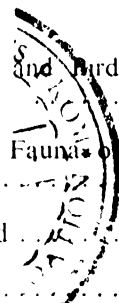
MR. WELLINGTON BRINK PROF. NOPAKHUN TONGYAI

MR. D. V. SASSOON MRS. CATHERINE F. SIFFIN

MRS. M. ISABELLE FARRAR, *Secretary*

CONTENTS

<i>Editor's Note</i>	i
<i>Abbreviations</i>	ii
<i>Participants</i>	iii
 <i>Standing Committee Reports</i>	
COOLIDGE, HAROLD J., Report of the Chairman of the Standing Committee on Pacific Conservation	1
SIRVENTY, D. L., Fauna Conservation in Australia and Conservation in Australian-Controlled New Guinea	5
HARRISSON, TOM, Conservation in the Island of Borneo	11
COWAN, I. MCT., Conservation in Canada 1953-1957.	13
ANDERSON, ELEANOR S., Summary Report of Work by the Conservation Council of Hawaii. . .	15
SETYODIWIRYO, KUSNOTO, Nature Protection in Indonesia	18
YAMASHINA, YOSHIMARO, Conservation in Japan.	21
RAND, A. L., Conservation Notes on New Guinea and Southeastern Asia.	22
FAILLA, R. A., Conservation in New Zealand	24
RINEY, THANE, Land Use as It Affects the Definition of Wildlife Problems and the Planning of Research on Large Mammals in New Zealand	26
FOSBERG, F. R., Conservation Situation in Oceania.	30
DEPARTMENT OF AGRICULTURE AND NATURAL RESOURCES, Conservation on Natural Resources in the Philippines.	32
BURKILL, H. M., A Survey of Nature Conservation on Singapore Island	34
COOLIDGE, HAROLD J., Notes on Progress in Wildlife Conservation in the United States. . .	38
 <i>Symposium on Proposed National Parks and Reserves in Southeast Asian Countries</i>	
SETYODIWIRYO, KUSNOTO, Some Remarks About the Management of Game Reservations in Indonesia.	41
SETYODIWIRYO, KUSNOTO, The Exportation of Live Animals Belonging to the Fauna of Indonesia.	45
LEKAGUL, BOONSONG, Proposed Game Preserves and National Parks in Thailand	47
HÜRLIMANN, H., Needs for a Conservation Park in New Caledonia	50



Symposium on Effects of Shifting Cultivation on Natural Resources with Special Reference to Problems in Southeast Asia

SPENCER, J. E.,	Introduction	51
BARRAU, JACQUES,	The "Bush Fallowing" System of Cultivation in the Continental Islands of Melanesia.	53
LAFONT, PIERRE-BERNARD,	The "Slash and Burn" (<i>Ray</i>) Agricultural System of the Mountain Populations of Central Vietnam	56
CONKLIN, HAROLD C.,	Shifting Cultivation and Succession to Grassland Climax.	60
CONKLIN, HAROLD C.,	Population-Land Balance Under Systems of Tropical Forest Agriculture	63
LEACH, E. R.,	Some Economic Advantages of Shifting Cultivation.	64
FREEMAN, J. D.,	Shifting Cultivation Among the Iban of Borneo (<i>Abstract</i>)	66
SCHLIPPE, PIERRE DE,	Systems of Land Tenure Among Shifting Cultivators (<i>Abstract</i>)	67
TUBB, J. A.,	Shifting Cultivation and Inland Fisheries.	68
FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS,	Shifting Cultivation—FAO's Position and Course of Action.	71
POPENOE, HUGH,	The Influence of the Shifting Cultivation Cycle on Soil Properties in Central America.	72
BARTLETT, HARLEY HARRIS,	A Bibliographic Review of the Literature on Shifting Agriculture and Fire as Ecological Agencies in the Tropics	78
 <i>Miscellaneous Contributions on Conservation</i>		
MURPHY, R. C.,	The Guano Industry of Peru as a Practical Conservation Project (<i>Abstract</i>).	80
OTHER CONTRIBUTIONS		80

EDITOR'S NOTE

At the meeting of the Committee on Publications of the Ninth Pacific Science Congress, it was agreed that the increasing number of communications and papers presented at each Congress has become a very difficult problem for the Publication Committee and the editorial staff to cope with and that too much time is required to complete the publication of the Proceedings; therefore, it was recommended that the following principles governing publication be followed:

- a. That invited contributions to the scheduled symposium be published in full;
- b. That reports of the Standing Committees be published in full;
- c. That other papers submitted to the Congress during its sessions be published in abstract only, the abstract not to exceed 500 words;
- d. That papers which, though listed on the program or included in the pre-Congress abstracts published in advance but not actually submitted to the Congress at its sessions, should be disregarded;
- e. That authors be asked to indicate by a definite and early date¹ whether they prefer to publish their papers in sources other than the Congress Proceedings; that if this is done, the Congress should be acknowledged;
- f. That all proof reading be the responsibility of the editorial committee, and that this committee shall consider the manuscripts in their hands by a definite date as final;²
- g. That authors be held responsible for submitting their material in good English;
- h. That on matters arising during the course of publication and not specifically covered in the statement of policy the editorial committee is empowered to act.

In accordance with the resolutions of the Committee, the editorial board has edited the reports and manuscripts where necessary to bring uniformity and consistency to the format. Typographical and grammatical errors as well as errors in phraseology, spelling, or technical terms have been corrected, wherever possible, but in cases where the exact meaning of the original copy was not clear, the text has been left as submitted by the author.

In order to reduce the cost and bulk of the publication, appendices, illustrations, and exhibits whenever considered not vital to the text have been eliminated.

If an author requested to publish elsewhere, his paper has been mentioned in the footnote under the respective titles, but if an author who presented a paper at the Congress failed to submit his manuscript either in full or in abstract, his paper and the discussions thereon have been eliminated entirely.

It was also decided that, in order to complete the publication of the Proceedings as soon as possible, each division be published in a separate volume. Short volumes or the ones that do not require too much editorial work will be released first. Therefore, among the twenty volumes planned, any volume may appear first. They will not appear in consecutive order.

The editorial board wishes to thank all authors who were prompt in submitting their revised manuscripts in good form and, in particular, members of the Standing and Organizing Committees, too numerous to be named, who have helped in collecting the manuscripts pertaining to their respective divisions.

The Board wishes in particular to thank Dr. F. Raymond Fosberg for going over and correcting the Special Symposium on *Climate, Vegetation, and Rational Land Utilization in the Humid Tropics* under Unesco;

Mr. Saman Buravas of the Royal Mines Department for helping by redrawing charts and maps in order that they might reproduce clearly when printed:

Mr. J. Alan Tubb of the FAO Regional Office, for his assistance in going over and clarifying some of the papers in the Fisheries and Oceanography volumes and in translating some of the French papers;

¹ January 1, 1958, in the case of the Ninth Congress.

² March 1, 1958, in the case of the Ninth Congress.

Dr. Pradisth Cheosakul of the Department of Science for editing the Chemistry in the Development of Natural Resources volume;

Last but not least, the Board wishes to thank the *Thai Watana Panich Press* for their cooperative efforts, far beyond the requirement of the contract, in devoting all their resources to printing these volumes.

ABBREVIATIONS

APFC	— Asia-Pacific Forestry Commission
CAA	— Civil Air Administration
CSIRO	— Commonwealth Scientific and Industrial Research Organization (Australia)
ECAFE	— Economic Commission for Asia and the Far East
EQUAPAC	— Equatorial Pacific (oceanographic survey)
FAO	— Food and Agriculture Organization
IACOMS	— International Advisory Committee on Marine Sciences
ICA	— International Cooperation Administration
ICAO	— International Civil Aviation Organization
ICSU	— International Council of Scientific Unions
IGY	— International Geophysical Year
IPFC	— Indo-Pacific Fishery Commission
IRC	— International Rice Commission (FAO)
JCRR	— Joint Commission on Rural Reconstruction (Taiwan, China)
NORPAC	— North Pacific (oceanographic survey)
PHILCUSA	— Philippine Council for United States Aid
PIOSA	— Pan-Indian Ocean Scientific Association
SEATO	— South-East Asia Treaty Organization
SPC	— South Pacific Commission
UN	— United Nations
UNESCO	— United Nations Educational, Scientific and Cultural Organization
UNICEF	— United Nations International Children's Emergency Fund
USDA	— United States Department of Agriculture
USIS	— United States Information Service
USOM	— United States of America Operations Mission
WHO	— World Health Organization
WMO	— World Meteorology Organization

PARTICIPANTS †

- AUBERT DE LA RÛE, EDGAR, Geologist, Centre National de la Recherche Scientifique, 18, rue Ribera, Paris XVI^e, France.
- BANDYOPADHYAY, PRABODH CHANDRA, Director, Unesco Science Exhibition, N.S. Department, c/o Unesco, 19, Avenue Kleber, Paris XVI^e, France.
- BLUMENSTOCK, DAVID I., United States Weather Bureau, P.O. Box 3650, Honolulu, Hawaii.
- BOONJAVATANA, CHAROEN, Supervisory Unit, Teacher Training Department, Ministry of Education, Rajdamnoen Avenue, Bangkok, Thailand.
- BROWN, GEORGE STEWART, State Forest Office, Sungei Patani, Kedah, Federation of Malaya.
- BURKILL, HUMPHREY MORRISON, Director, Botanic Gardens, Singapore.
- CONKLIN, HAROLD C., Assistant Professor of Anthropology, Columbia University, New York 27, New York, U.S.A.
- COOLIDGE, HAROLD JEFFERSON, Executive Director, Pacific Science Board, National Academy of Sciences, 2101 Constitution Avenue, Washington 25, D.C., U.S.A.
- COWAN, IAN McTAGGART, Head, Department of Zoology, University of British Columbia, Vancouver 8, B.C., Canada.
- DAVIES, DAVID MICHAEL, Lecturer, Faculty of Arts, Chulalongkorn University, Bangkok, Thailand.
- DEIGNAN, HERBERT GIRTON, Associate Curator of Birds, Smithsonian Institution, Washington 25, D.C., U.S.A.
- FOSBERG, F. RAYMOND, Botanist, U.S. Geological Survey, Pacific Vegetation Project, National Research Council, Washington, D.C., U.S.A.
- FREEMAN, JOHN DEREK, Reader in Anthropology, Australian National University, Box 4, G.P.O., Canberra, A.C.T., Australia.
- FUKTHONGPAN, BISVONG, Science Instructor, Pratumwan College of Education, Ministry of Education, Bangkok, Thailand.
- GOODENOUGH, WARD HUNT, Associate Professor, Box 14, Bennett Hall, University of Pennsylvania, Philadelphia 4, Pennsylvania, U.S.A.
- HALPERN, JOEL MARTIN, Field Service Officer, USOM/Laos, Luang Prabang, Laos.
- HARRISSON, TOM, Curator, Sarawak Museum, Kuching, Sarawak.
- HEIM, ROGER, Directeur, Muséum National d'Histoire Naturelle, 57, rue Cuvier, Paris V^e, France.
- HÜRLIMANN, JOHANN H., Botanist, CIBA S.A., Friedensgasse 51, Basle, Switzerland.
- KARNASUT, PRIDA, Chief, Inland Fisheries Division, Department of Fisheries, Ministry of Agriculture, Rajdamnoen Avenue, Bangkok, Thailand.
- LAFONT, PIERRE-BERNARD, École Française d'Extrême-Orient, P.O. Box 10, Vientiane, Laos.
- LEACH, EDMUND RONALD, Lecturer in Anthropology, Faculty of Archaeology and Anthropology, University of Cambridge, Downing Street, Cambridge, England.
- LEKAGUL, BOONSONG, Physician, Sahakarnbhaet Clinic, Bangrak, Bangkok, Thailand.
- LINSENMEYER, ROY F., Assistant Professor, Swarthmore College, Swarthmore, Pennsylvania, U.S.A.
- LOETSCH, FRITZ, Professor, Bundes forschungsanstalt Forstwirtschaft, Reinbek bei Hamburg, Germany.
- McCLURE, H. ELLIOTT, Medical Ornithologist, 406 Medical General Laboratory (U.S. Forces, Japan) APO 343, San Francisco, California, U.S.A.

† Initials or names in italics represent Thai titles.

MAJID, ABDUL, Assistant Conservator of Forests, District Forest Office, Taiping, Federation of Malaya.

MILLOT, JACQUES, Directeur, Recherche Scientifique, P.O. Box 434, Tananarive, Madagascar.

MILTON, OLIVER M. B., Conservation Specialist, Peabody Museum, Yale University, New Haven, Connecticut, U.S.A.

MURPHY, GRACE E. BARSTOW, Writer, Briarlea, Old Field, Setauket, Long Island, New York, U.S.A.

MURPHY, ROBERT CUSHMAN, Research Associate (Curator Emeritus), American Museum of Natural History, New York 24, New York, U.S.A.

NATHALANG, SOMBOON, Director, Rubber Division, Department of Agriculture, Ministry of Agriculture, Bangkok, Thailand.

NICHOLSON, DONALD IAN, Ecologist, Forest Department of North Borneo, Sandakan, North Borneo.

PELZER, KARL J., Professor, Department of Geography, Yale University, New Haven, Connecticut, U.S.A.

POPENOE, HUGH, Research Associate, Department of Soils, University of Florida, Gainesville, Florida, U.S.A.

PRAKORB-WANAKICH, *Luang*, Technical Forest Officer, Royal Forest Department, Bangkok, Thailand.

PREMRASMI, THANOM, Forest Products Research Division, Royal Forest Department, Bangkok, Thailand.

REAM, HOWARD W., ICA/Joint Commission on Rural Reconstruction, c/o American Embassy, Taipei, Taiwan, Republic of China.

RUAMRAGSA, SANAN, Chief, Fish Section, Department of Fisheries, Ministry of Agriculture, Rajdamnoen Avenue, Bangkok, Thailand.

SANSUKH, SOMSAK, Department of Teacher Training, College of Education, Ministry of Education, Bangkok, Thailand.

SETYODIWIRYO, KUSNOTO, Director, Botanic Gardens of Indonesia, Djl. Bubulak 25, Bogor, Indonesia.

SMITINAND, TEM, Chief, Section of Botany and Zoology, Forest Products Research Division, Royal Forest Department, Bangkok, Thailand.

SPENCER, JOSEPH E., Department of Geography, University of California, 405 Hilgard Avenue, Los Angeles, California, U.S.A.

SRI SMARTH-VIJAKICH, *Luang*, Professor, Department of Botany, Chulalongkorn University, Bangkok, Thailand.

STAMP, L. DUDLEY, Professor of Social Geography, University of London, London School of Economics, London, W.C. 2, England.

SUVARNASUDDHI, KHID, Deputy Director-General, Royal Forest Department, Bangkok, Thailand.

TANGCHAI, THIERAPHONG, Teacher Training Division, Bansomdej Teacher's Training School, Ministry of Education, Thonburi, Thailand.

THIRAWAT, SUKHUM, Chief, Division of Forest Control, Royal Forest Department, Bangkok, Thailand.

TRINANDWAN, SA-KORN, Science Teacher, Prasarnmitra College of Education, Ministry of Education, Bangkok, Thailand.

TUBB, JOHN ALAN, Regional Fisheries Officer, FAO Regional Office for Asia and the Far East, Bangkok, Thailand.

WATANABE, AKIRA, Chief, Mapping Division, Geographical Survey Institute, Ministry of Construction, Ichikawa City, Chiba Pref., Japan.

CONSERVATION

Standing Committee Chairman: D.L. SERVENTY

Standing Committee Secretary: HAROLD J. COOLIDGE

Organizing Committee Chairman: *Luang* SRI SMARTH-VIJJAKICH

Standing Committee Reports

REPORT OF THE CHAIRMAN OF THE STANDING COMMITTEE ON PACIFIC CONSERVATION†

HAROLD J. COOLIDGE

Executive Secretary, Pacific Science Board, National Academy of Sciences, Washington, D.C., U.S.A.

In the absence of Dr. D.L. Serventy, Chairman of the Standing Committee on Pacific Conservation, I have the honor to present to you a summary of several appended sectional reports prepared by members of the Committee or by appropriate government departments at the request of the Committee.

I have little to report in the way of activity, other than two visits to Bangkok where the plans for the conservation program for the Ninth Pacific Science Congress were discussed with Prof. *Luang* Sri Smarth-Vijjakich, our organizing chairman.

I wish to thank those members of the Committee, as well as officials of various governments, who prepared the following reports: Fauna Conservation in Australia and Conservation in Australian-controlled New Guinea by D.L. Serventy; Summary report of work by the Conservation Council of Hawaii, compiled by Eleanor S. Anderson; Nature Protection in Indonesia by Kusnoto Setyodiwiryo; Conservation Notes on New Guinea and Southeastern Asia by A.L. Rand; Conservation in Canada 1953-1957 by I. McT. Cowan; Conservation Situation in Oceania by F.R. Fosberg; Conservation on Natural Resources of the Philippines by the Department of Agriculture and Natural Resources; A Survey of Nature Conservation on Singapore Island by H.M. Burkill; Notes on Progress in

Wildlife Conservation in the United States by Harold J. Coolidge. In addition, we have received a report on Land Use as It Affects the Definition of Wildlife Problems and the Planning of Research on Large Mammals in New Zealand by Thane Riney of the New Zealand Forest Service which is of special interest to the Committee.

The Philippine report points out that shifting cultivation practices are largely responsible for forest destruction and hillside erosion. The general public is not aware of the dangers of forest misuse and forest destruction. While soil and water problems are receiving some attention, the role of wildlife is not generally appreciated. Its protection requires more rigid enforcement of game laws. There is need for a program of conservation backed by money appropriations, personnel and equipment to be worked out with full cooperation from land owners, as well as the general public. An educational campaign dealing with soil, water, vegetation, and wildlife is needed, as well as increased government support of these activities.

The Indonesian report indicates that progress in conservation in the past ten years is the result of joint efforts of the Forest Service and the Botanic Gardens of Indonesia. Wildlife protection matters are worked out in consultation with the Institute of Nature Protection of the Botanic Gardens of Indonesia, which supervises and

† Secretary of the Standing Committee on Pacific Conservation presented the report for the Chairman who was unable to attend the Congress.

manages the nature reserves and controls the export of wild animals. Game laws for Java and Madura are enforced under the 1940 ordinance, but in the outlying areas there is illegal shooting and capture of orang-utans in violation of the 1931 ordinance. Exports for scientific purposes has to be conducted through Indonesian Zoological Gardens to make them legal. The Indonesian Government is asking for the cooperation of all governments by prohibiting the import of oranges without export permits issued by the Botanic Gardens. The Malayan rhinoceros is well protected at Udjung Kulon Reserve by the Forest Service where 40-45 animals still exist, and two patrol motor boats help to protect the area. Another rare species, the giant Komodo lizard has greatly increased in numbers, especially in the Rintjah nature reserve. Only 15 or 20 are allowed to be exported over a 5 year period, but no ecological studies of them have been made due to lack of specialists. The only plants that are specially protected are a few species of orchids and several timber species. Fortunately, existing parks and reserves protect most wild life and vegetation. These number 115, covering an area of 2,225,000 hectares. A new conservation law put into effect in July, 1957, will enable the Ministry of Agriculture to set aside areas around existing reserves to help protect these reserves. In Indonesia there is need for instilling a love of nature in the hearts of children, and the teachers must be made nature-minded.

Mr. Burkil, the acting director of the Singapore Botanic Garden, gives us the following summary of his report:

"Man's destructiveness and a growing population have created an immense land hunger. Agriculture began in Singapore about 1822. By 1883 Government had become seriously alarmed at the devastation of the country's forest. It commissioned a report, following which Forest Reserves were gazetted. In Singapore these ceased to be economic in 1937 and were degazetted. The Botanic Gardens took charge of three areas as Botanical Reserves for the purpose of preservation of indigenous flora and fauna.

"The areas survived the 1941-45 hostilities without much damage but reconstruction and development programmes called for immense quantities of granite which was quarried on the perimeter of one Reserve and gravely threatened it. A commission was set up to report on granite resources and nature conservation. It was recommended *inter alia* that the botanical reserves maintained by the Botanic Gardens be formally constituted Nature Reserves under a Board of Trustees. Two further areas were created Nature Reserves.

"The objects of nature conservation and the duties of the Board are clearly stated in an Ordinance. Steps have been taken to develop the Reserves and to publicize them as a measure to meet the threat of commercial exploitation and destruction which even now hangs over them."

In the report on Oceania, Dr. Fosberg points out the unique problems of island habitats where species of plants and animals that have developed may be very restricted in distribution and numbers with the result that hunting or habitat destruction, even on a scale not serious elsewhere, may lead to the extinction of unique and interesting forms of life. He points out the value of basic studies to contribute to our ecological knowledge of island environments, but sees no sign of the educational program that is needed to point out to island peoples the dangers that go with some of the transplanted mainland land use practices. The setting aside of five conservation areas in Guam for long term studies is a progressive step, as are the efforts to establish effective measures to preserve vanishing Galapagos species under the auspices of the International Union for Conservation. On the other hand he deplores such practices as the introduction of predators to control the Giant African Snail in Hawaii, the flooding of the Plain des Lacs in New Caledonia by a power dam development, and the introduction of goats into Henderson Island, the last truly virgin high island in Polynesia.

The report on the progress of the Conservation Council of Hawaii shows encouraging conservation developments in the saving of the Nene or Hawaiian goose from extinction, the study of its habits in the wild, and program of rearing them in captivity for return to the wild state. The Council's Flora Committee has, with the cooperation of landowners and ranchers and government officials, set aside small stands of disappearing species, and periodic surveys are made of indigenous plants now only found in few numbers. Better land use practices are being promoted, and Territorial leases modified to insure against overgrazing. Ground water studies of the Pearl Harbor area and Kona district are being supported, as is the establishment of a Geophysical Institute at the University of Hawaii. Progress in restoring, marking, and preserving historic and legendary sites is being furthered by the Sites Committee.

The awareness of various conservation groups in Hawaii of their problems and their ability to work together through the Conservation Council, a non-governmental agency, for the improvement of the controlled use of Hawaii's resources for the purposes of conservation is a gratifying example of healthy progress in a joint effort.

The Chairman's report has given us a well-balanced and encouraging picture of the progress of conservation in Australia during the past four

years. The enforcement of conservation laws are rendered effective because of the community feeling of interest and good will towards the indigenous fauna which is a part of national pride in all things Australian. This has been accelerated and directed along positive conservation channels by various forces, among which are the development of study curricula by State Education Departments. This is also aided in some states by the Gould Leagues similar to the U.S. Audubon Societies.

The emphasis in Australia is passing from the protection of individual animals towards the preservation of habitats where the organism lives. In protecting animals against destruction the most active steps are being taken in Tasmania. For example, a resolution of the 1953 Congress asked the governments of Victoria and Tasmania to protect the Gannet (*Sula serrator*) colony at Cat Island in eastern Bass Strait from depredation of cray fishermen. This has been done by stationing a warden there since January, 1955. In protection of habitats, progress has been made with the passage in 1955 of a National Parks Bill in Victoria, which provides for a National Parks Authority with a university-trained zoologist as a full time director. In the bill the duties of the Authority include maintaining every National Park in its natural condition and conserving there in ecological associations and species of native plants and animals. This marks a first recognition of ecology in Australian protective legislation.

In 1956 in South Australia the government incorporated a National Trust by Act of Parliament to preserve lands and buildings of beauty, historic, scientific, artistic, or architectural interest and the preservation of natural factors in land and the protection of animal and plant life.

In New South Wales the fauna protection authority can directly control fauna reserves, and Crown lands designated as faunal reserves are close to an ecologist's concept of primitive areas. A plan to establish such reserves to cover all types of habitats where distinctive fauna is found is being developed.

In West Australia the Fauna Protection Advisory Committee is empowered to control certain reserves and nearly 11,000 acres of Crown land has been so set aside. It is hoped to follow the plan of New South Wales. Tasmania has 2.9 per cent of the overall area of the State under the authority of the Fauna Board and is well endowed with National Parks. Its west coast has a large undeveloped area.

It must also be pointed out that the Mulga Association of the drier parts of the Australian mainland, with its large cattle and sheep stations, has no primitive area or national park to maintain its virgin state.

It is recognized that the Victoria National Parks Authority is facing up to the need to curtail grazing in National Parks and the same applies to New South Wales. A recent investigation shows the need of excluding grazing animals from high mountain catchments about 4,500 feet in the Snowy Mountains and Mt. Kosciusko areas.

On the problem of fire, Dr. Serventy calls attention to his statement at Manila that fire, as a factor in altering environment may not be as fundamental a danger to the fauna as commonly supposed. Several recent publications by Bornemissza, Gardner, and Jacobs support his views as applied to Australia. Repeated burnings off by graziers has had deteriorative effects in wet sclerophyll country. Vegetation can cope with casual and natural fires but not repeated grazer burnings.

On the impact of exotic fauna on native animals, the greatest menace was the introduction of the European rabbit and the fox. In 1952/53 reduction by myxomatosis increased the value of the sheep industry by more than 30 million pounds. The effect of the rabbit reduction on native fauna is being studied.

The Commonwealth Scientific and Industrial Research Organization is mainly responsible for research in animal ecology and especially the Wildlife Survey Section. Research is also sponsored by the State governments to obtain data on which to base their conservation activities. The Queensland Department of Stock is mapping and listing all sanctuaries and will then examine each area and its faunal classification. It is also making an ecological study of ducks using a banding program. Banding is also used in other states; it began in 1951 in Victoria and in 1952 in West Australia.

Australian Controlled New Guinea — Conservation problems are most urgent in densely populated areas like the Wahgi Valley where the government approach is to select and purchase conservation strips in the form of ravines staggered throughout the valley. This, with education, can help protect vertically distributed species. Such a measure may help to save a localized species like the Blue Bird of Paradise (*Paradisornis rufolophus*).

Officers of the Administration supervise the permits for taking and export of animals and birds. There are no established parks and reserves.

In A. L. Rand's conservation notes on New Guinea and Southeast Asia he draws an interesting contrast between an area emerging slowly from a long period of primitive conditions with few local conservation problems and an area of wide-spread population, old civilization, and long standing conservation problems where great and sudden changes are taking place. He makes a strong plea for saving at least samples of endangered species for future generations through habitat preservation in parks or preserves where original conditions are maintained before it is too late, and postulates the future return of some individuals of Pére David's deer, which have been perpetuated in the Duke of Bedford's private game park, to a park in their China homeland.

These reports indicate that an awareness of conservation needs is growing in the Pacific, and that in Australia and Hawaii there have been significant advances in conservation practices. The Australian record is especially encouraging.

It is also gratifying that the Indonesians are making progress. The Eighth Pacific Science Congress at Manila recommended increasing education at all levels in furthering the concepts of conservation, and progress along these lines is being made in several countries.

Here at the Bangkok Congress throughout the meetings we shall all have an opportunity to become somewhat familiar with various aspects of conservation problems in Southeast Asian countries, and as a result I hope that we can develop recommendations that may be of assistance to them in dealing with these important problems. Where a well established system of parks and reserves has been established by a previous colonial regime as in Burma, Malaya, Indonesia, and Indo-China it is essential not to lose the basic value of such areas for the future benefit of the countries concerned, although it is recognized that the new governments are often not in a financial position to meet the expenses involved in their maintenance. The Indonesians are to be especially commended for their action in this regard.

FAUNA CONSERVATION IN AUSTRALIA AND CONSERVATION IN AUSTRALIAN-CONTROLLED NEW GUINEA

D. L. SERVENTY

Wildlife Survey Branch, C.S.I.R.O., University Grounds, Nedlands, Western Australia.

FAUNA CONSERVATION IN AUSTRALIA

GENERAL

In my report to the Eighth Pacific Science Congress, 1953, I stated that the situation in Australia was, in general, very satisfactory as far as the legal and actual protection of animals against direct killing. The enactments of the various State Legislatures on fauna protection were rendered fairly effective, not only by the activities of enforcement officers, but because of the development in the community of a feeling of interest and good-will towards the indigenous fauna.

This benevolent outlook on the fauna is part of a general attitude of national pride in all things Australian which has been developing in the community simultaneously with the drive for self-government in the various colonies several generations ago. It has been accelerated and directed along positive conservation channels by various forces. Important among these is the emphasis on protection in the nature study curricula of all of the State Education Departments. In many States this is reinforced by national organizations known as Gould Leagues (resembling the analogous movements in the United States, the Audubon Societies, which originally inspired the local efforts). These commemorate John Gould, "the father of Australian ornithology." In New South Wales, the government authority administering the fauna protection act, has included a vigorous education policy in its activities. It assists in planned teaching in natural history in the public schools curriculum, conducts a film service, and stimulates the formation of local fauna and flora societies. Usually, however, such amateur natural history societies, especially those of national scope, have been of spontaneous origin, and they have done much in Australia to extend the conservation influence into adult life. Incidentally it may be remarked that the number and strength of such bodies in various countries appear to be a good index of the reality of the concept of animal and plant conservation within their borders.

It was further stated in my 1953 report that the emphasis in fauna protection in Australia had passed the stage of protecting individual animals and was now mainly directed towards preserving the habitats in which the organisms lived. The situation in this respect was then much less satisfactory. However, since the presentation of the 1953 report to the Manila Congress some notable advances have taken place and though practical achievements have not been outstanding as yet, the situation is so promising that the reporter for the 1961 Congress may be in a position to announce substantial progress.

PROTECTION OF ANIMALS AGAINST DESTRUCTION

Very little modification is necessary to the information supplied in the 1953 report on the organization of official animal protection agencies in Australia and its territories.

In the Northern Territory, administered by the Commonwealth Government, birds only enjoy legal protection. Under a Birds Protection Ordinance, policed by officers of the Animal Industry Branch, complete protection is extended to almost all species. The exceptions are crows (*Corvus ceciliae*) and Wedge-tailed eagles (*Uraeetus audax*) which are considered as agricultural pests. Recently protection has been removed from certain duck species, principally the Pied goose (*Anseranas semipalmata*), which are seriously menacing efforts to grow rice in the Territory. At present mammals and other terrestrial vertebrates in the Northern Territory have no legal protection but legislation to cover them is at present under consideration. Those that are actively destroyed at present include the Sandy wallaby (*Protemnodon agilis*) which occurs in pest proportions in some northern pastoral areas. Hunting for sport and profit is virtually confined to the introduced water buffalo (*Bubalus bubalis*) and the Saltwater crocodile (*Crocodilus porosus*). Both are still very plentiful. The smaller marsupials and native Eutherian mammals are not interfered

with by the small white community in the Territory and are only collected by visiting scientists. The activities of such expeditions are controlled either by Administration officers accompanying them or examining the collections before their departure.

The most active steps in protecting threatened fauna, other than the routine inspections and patrols by fauna wardens, fisheries inspectors and police officers (carried out in all States), are being taken in Tasmania. At the 1953 Congress of this Association a resolution was passed appealing to the governments of Victoria and Tasmania to take steps to protect the Gannet (*Sula serrator*) colony at Cat Island, in eastern Bass Strait, from depredations by cray fishermen. These had reduced the colony from about 2,500 breeding pairs to under 50 pairs. The Fauna Board of Tasmania made representations to the Government for funds to station a warden on the island and at the end of 1954 this was agreed to. From January, 1955, onwards a warden has been living on the island during the critical period, and in the current season (1957-58) his stay there has been extended. The provision of this special guard, unique in Australian faunal control measures, has considerably strained the financial resources of the Tasmanian Board and so far financial assistance from the Commonwealth government or the Victorian State government has not been forthcoming.

The gravity of the situation concerning the hunting of the Humpback whale (*Megaptera nodosa*) in Australian waters, referred to in the 1953 report, appears to have eased. The two stocks fished in local waters seem to be holding their own reasonably well, though operations on the Western Australian one still need careful watching. The analysis of the data by the C.S.I. R.O. Division of Fisheries and Oceanography suggests that this stock will not withstand continuous fishing above the intensity of 1956.

PROTECTION OF HABITATS

Administrative Progress. Almost all of the State fauna protection administrations are now giving serious attention to problems affecting habitat preservation, and in some States notable advances have been made in the general field of national park control.

There has been an important development in Victoria. As a result of years of preparatory work by the Victorian National Parks Association and the various combined societies' committees which preceded it, the Victorian Government was moved

in 1955 to introduce a National Parks Bill, which was eventually passed by Parliament. Though the Act has many shortcomings it at least puts the national parks in Victoria on a firm legislative foundation. Basically, it provides for a National Parks authority, of whom the full-time Director, is a university-trained zoologist, and the membership includes the heads of a number of relevant government departments plus some non-official members representing fauna, flora, and other interests. One of the official members is the Director of Fisheries and Game, and thus will be eliminated the anomaly which existed in the past of the native fauna it was charged to protect. Specially interesting points in the Act are certain provisions specifying its objects, which are "to protect and preserve indigenous plant and animal wild life . . ." and "to maintain the existing environment of national parks," and the duties of the authority "to maintain every National Park in its natural condition and to conserve therein ecological associations and species of native plants and animals . . ." This appears to be the first time that ecology, by name at any rate, has been recognized in Australian protective legislation.

Analogous progress has been made in South Australia. In 1956, after many years of agitation, the South Australian Government was persuaded to introduce legislation for the formation of a National Trust. This body, now incorporated by Act of Parliament, has for its aims the preservation of lands and buildings of beauty, historic, scientific, artistic or architectural interest and the preservation of natural features in land and the protection of animal and plant life. Several properties near Adelaide have already been donated to the Trust, and these areas are to be proclaimed as fauna reserves. In 1956, also the powers of the National Parks Commissioners of South Australia were extended to allow them to control flora reserves. This will allow a better control of the rare fauna (including Mallee fowl, *Leipoa ocellata*, and kangaroos).

The New South Wales system permits the fauna protection authority to control fauna reserves directly. The Fauna Protection Panel, in the Chief Secretary's Department, under the direction of the Chief Guardian of Fauna, can recommend the dedication of Crown Lands lands as faunal reserves. On these grazing, timber-getting and mining are prohibited except with the Panel's consent. The "Faunal Reserve," as administered now by the Panel, approximates the ecologist's conception of a primitive area, since the man-

agement usually means leaving the area undisturbed but supervised. At present there are only five such reserves, ranging in size from 22 to 3,600 acres, but another area of 28,000 acres will be dedicated in the near future. Recommendations for others are under consideration, and the Panel plans to establish such reserves in all parts of the State to cover all types of habitats where distinctive fauna occurs. Apart from these reserves of primarily biological importance, there are a number of National Parks and reservations controlled by other authorities where the landscape is permitted to remain unaltered and consequently the fauna enjoys protection. Some of the problems in the administration of one such National Park will be discussed later in this report.

Something similar to the New South Wales set-up exists in Western Australia. Here the Fauna Protection Advisory Committee is empowered to control certain reserves, in various types of habitat, and already nearly 11,000 acres of Crown Land has been placed under its administration. The Committee's plans, are, like those of the New South Wales Panel, to have primitive areas retained in all the major habitats in the State. A great many additional reserves in Western Australia are controlled by various agencies, many of them by the National Parks Board (formerly the State Gardens Board), and about 2½ million acres are reserved for flora and fauna in the State, in various categories. This does not include extensive areas reserved as State Forest, Water Catchments, etc., where the habitat remains virtually undisturbed and the fauna has sanctuary.

Tasmania is generously provided with sanctuaries for fauna. Those proclaimed under the authority of the Fauna Board total 475,752 acres, or 2.9 per cent of the overall area of the State. The State is also well-endowed with National Parks and the National Parks Board adopts the policy of preserving the natural landscape rather than introducing artificial improvements. Tasmania has a relatively vast area of undeveloped and unpopulated land on its west coast, comprising high mountain ranges, river valleys and plains which, even if ultimately opened up, will provide many years of sanctuary for its mammals and birds owing to practically unsurmountable difficulties regarding development and accessibility.

On the other side of the picture, the point must be made that an important habitat is degenerating over great areas of mainland Australia and,

strangely enough, practically nothing of it has been retained in the virgin state as a national park or a primitive area. This is the Mulga association of the drier parts of Australia where the larger sheep and cattle stations are situated. The Mulga constitutes a complex of *Acacia* species, of which *A. aneura* is the most important. A conference was held in Western Australia in 1955 on the problem in that State, at which it was claimed that overstocking by sheep, in conjunction possibly with the increase of kangaroos in certain areas and the cutting of mulga for mining timber in others, had led to a cessation of, or greatly reduced, natural regeneration. Unfortunately no sample of the original vegetation association was preserved before sheep were depastured on it.

Inimical effects of the domestic sheep on the ecosystems in which it has been introduced in Australia have only been dimly realized by Australian naturalists, but visiting zoologists have pointed out its harmful impact. Riney (in a paper presented to this Congress) states that in general the smaller the daily or weekly area covered by an animal, the greater is the use on the plants of that area. He finds in New Zealand that the sheep has the most restricted movements of any animal there measured to date (as compared with chamois, red deer, and fallow deer). The position is probably similar in Australia in respect to the sheep and other introduced and native herbivores. The exclusion of sheep grazing from fauna reserves in Australia, particularly any that may be established in the mulga and other areas in semiarid Australia, is a paramount necessity. The general problem in existing parks is treated in the next section.

The Problem of Grazing in National Parks. Mention was made in my 1953 report that some national parks in Victoria permitted grazing to take place in the reserves, the revenue from such leases being an important, and in some cases the sole source of income for the controlling body. The new National Parks Authority in Victoria is facing up to this issue, but the practice cannot be eliminated suddenly. This undesirable practice also exists in some national parks in New South Wales. An important review of grazing as a factor in habitat despoliation in high mountain areas in New South Wales and Victoria has recently been published by the Australian Academy of Science (12). The investigating committee found that the major deterioration of the vegetation was due to a combination of grazing and burning and it recommended that grazing animals be

completely excluded from the high mountain catchments (in the Snowy Mountains and Mt. Kosciusko areas) at heights above 4,500 feet, and that burning off in the interests of grazing, or for any other purpose, be prohibited.

The Problem of Fire. When my 1953 report was discussed at the Manila Congress, several delegates, mainly from the United States, questioned the validity of my statement that "in general it may be said that fire, even as a factor in altering the environment, may not be as fundamental a danger to the fauna as commonly supposed. Fires were a hazard even before white settlement, and probably those elements in the fauna which were vulnerable to fires were eliminated long ago. There has been no satisfactory demonstration that any animal species has declined in numbers or had its existence threatened as a result of bush fires."

Since then a number of publications have appeared on the subject which justify my remarks. Bornemissza (2, p. 4) in a study of forest insects showed that the fauna would return to its original composition after any kind of fire. Gardner (5, p. 166) stated that there was sufficient evidence to show that fire as a factor affecting plants was one that had been in existence from remote times and that the flora of Australia, in part, was pyrophilous. This was particularly so of the dry sclerophyll formations. Jacobs (6, p. 132) stated that most of the Australian woodland had a long fire history, and the botanical evidence suggested that regular burning may have influenced the very evolution of the modern flora. Modern fire-control practice, he thought, had resulted in some woodlands becoming fire-protected for perhaps the first time in the course of their recent evolution. This is also suggested by the observations of Gardner (5, p. 168) on a fire-protected mallee thicket in Western Australia which showed definite degenerative features. A belief to the contrary has been general in Australia, however, and probably more harm has been caused to certain woodland areas and parks by over-zealous fire control measures than would have been occasioned by leaving the woodland alone (7, p. 45). An older report by Cleland (3, p. 43) gives a good idea of the surprise felt by an orthodox botanist at the regeneration which quickly followed a particularly devastating fire. Recent studies (1956) in the Californian chaparral regions by Sweeney (11) show that such fire tolerance, and in fact dependence on fires, is not confined to the Australian flora.

However in the wet sclerophyll country, particularly, and the mountain regions, repeated burning off by graziers to improve the growth of fodder grasses has definitely been on a scale which has had deteriorative effects. Thus in the report of the Australian Academy Committee already referred to (12), the point is made that though "fire, of course, has always been with us, and most Australian plants are, to some extent fire-resistant. It is the frequent recurrent fire which is so damaging to the vegetation." And that "while occasional summer bushfires in the mountains must be expected, we cannot agree with the specious argument that burning off in alpine country is necessary to reduce the fire hazard in that region." The inference is that the vegetation can cope with casual and "natural" fires but the repeated burning by graziers does serious harm.

The Impact of the Exotic Fauna on the Native Animals. Among the greatest menaces to the native fauna was the introduction of the European rabbit and the fox. The latter appears to have depended on the former for its staple diet over large areas. When, from 1950 onwards, the virus disease Myxomatosis dramatically eliminated the rabbit from vast stretches of country, or drastically reduced its numbers, the effect on its community ecosystem must have been significant. Ratcliffe (in press) has stated: "The sudden wholesale eclipse of a key herbivore, like the rabbit, in a country's fauna is bound to have far reaching ecological consequences, which could well be very complex." The effect of rabbit reduction on pastures and stock has been of a most spectacular order and it has been estimated that "during 1952/53 in the sheep industry alone . . . myxomatosis resulted in increased production to the value of more than 30 million." As far as the native fauna is concerned the effects have not yet been assessed, and it is too early to formulate any generalizations. However inquiries are in train. In the eastern states there appear to be no readily observable results of the rabbit eclipse. In partial explanation, Ratcliffe has pointed out that in the main rabbit-infested districts the varied and originally abundant herbivorous marsupials had long previously been eliminated by competition from grazing stock (mainly sheep), and therefore a recovery could not be expected as a result of the myxomatosis campaign.

The situation in Western Australia is obscure. A resurgence of many species of native fauna has become apparent in recent years (10 and 1953 Conservation Report), but this began before

myxomatosis could have had any effect. The species involved included carnivorous and herbivorous marsupials and ground-frequenting birds such as Mallee fowl (*Leipoa ocellata*) and bustards (*Eupodotis australis*)—all of which were peculiarly susceptible to fox and feral cat predation and some of which had found in the rabbit a formidable competitor.

The C.S.I.R.O. Wildlife Survey Section has begun investigations into the problem, and in New South Wales an officer is engaged full-time on a field study of the present status of the marsupials in that region.

Scientific Research in the Conservation Field. Commonwealth research in animal ecology is mainly conducted by the Commonwealth Scientific and Industrial Research Organization. The Wildlife Survey Section of the C.S.I.R.O. concerns itself with research on birds and terrestrial mammals, mostly on pest species and fauna of commercial importance, but its activities are widening into the general conservation field. In 1954 it began a bird banding service for the use of ornithologists generally, though several State governments (including Queensland, Victoria, and Western Australia) conduct independent banding schemes for their own special needs. The C.S.I.R.O. Division of Fisheries and Oceanography is concerned with investigations mainly on marine fishes and whales. The C.S.I.R.O. has no executive responsibilities even in the Commonwealth administrative field. Its functions are purely research and advisory. Ecological research in Commonwealth executive departments is principally conducted in the territories, and has only recently begun. The Animal Industry Branch in the Northern Territory has recruited biologists to assist conservation and pest control administration in that territory.

Research is also being sponsored by the State governments to obtain fundamental data on which to base their administrative functions in the conservation field more effectively. The Queensland Department of Stock (which administers fauna protection in that State) has initiated investigations along two lines. The first project involves the mapping and listing of all sanctuaries throughout Queensland. This will be followed by an examination of each area and its faunal classification, which will allow an assessment to be made of additional areas needed as sanctuaries and the improvement of existing ones. The second Queensland project is an ecological study of the ducks, which will be partly based on a

banding programme. The State of Victoria has always been to the fore with research as an important instrument in improving the administrative efficiency of its Fisheries and Game Department. It has the largest research staff of any State department, and its banding scheme on duck and other game birds was begun in 1951 (4). Western Australian research in this field started with a duck-banding programme in 1952, and the research staff is being increased.

Ecological research into the causes of fluctuations and the decline in native mammals is being undertaken at the Zoology Department of the University of Western Australia. This is reinforced by physiological studies on marsupials for a better understanding of their ecosystem. Some of the studies are in co-operation with the Wildlife Survey Section of the C.S.I.R.O.

CONSERVATION IN AUSTRALIAN-CONTROLLED NEW GUINEA

The following information was obtained through the Minister for Territories (the Hon. Paul Hasluck) from the Administrator of Papua and New Guinea (Mr. D. M. Cleland).

ACTUAL CONSERVATION GAINS

Areas Set Aside.—Selections are being made. The need for conservation measures is fully appreciated but our approach must be different from that in Australia. Wide areas of the Territory are uninhabited; in other areas population is sparse and life primitive. Because of these factors, there is considerable latitude within the limits of time before such areas need attention. However, in more densely populated areas there are threats to the continuity of local populations of some species. Concentrated attention is being directed to these areas of which the Wahgi Valley is the most typical case. Although, in such a case, overseas observers have recommended the proclamation of the National Park, our better knowledge of relevant factors shows that unless the people of the Valley have an appreciation of conservation purposes and policies, the mere proclaiming of the area will not in itself achieve much.

The current approach is to select and purchase conservation strips in the form of ravines staggered throughout the Valley. This procedure coupled with education of the people should make effective control more possible and allow for attention to vertical distribution of species.

Similar action will be taken in other threatened areas following investigation by the appropriate officers.

New Government Policies and Regulations. Regulations which have been drafted, though not yet in force, will give effective legal control including control of the movement of endemic species within the Territory. It is hoped to preserve the unique research potential here in systematics; phylogeny and population genetics.

Recovery of Threatened Species. It is almost impossible at present to assess fluctuations in population densities of species because of lack of previous data and facilities. An evident example of a decrease is the case of the Blue Bird of Paradise (*Paradisornis rudolphi*) in the Wahgi Valley where it appears to be an extremely localized species. There is cause for concern in the decrease, and it is hoped that the proposed measure indicated above will halt the trend in this case as well as in that of less conspicuous forms obviously subject to the same destructive processes. The proposed remedial steps should improve the overall conservation picture.

International Agreements. There are none.

Announcement of New Conservation Organizations. There are no conservation organizations in the Territory, apart from Administration Officers, whose duties include the conservation and protection of fauna.

Brief Outline of Activities of Established Ones. Officers of the Administration play a part in conservation of fauna, by supervising the issue of permits to take animals or birds, and also by supervising the export of such animals or birds.

Specific New or Aggravated Conservation Problems that have Arisen. See the case of the Wahgi Valley mentioned above.

Threats to Established Reserves or Parks of Any Sort. Nil, because there are no established parks or reserves.

REFERENCES

- (1) Anonymous, 1957, An analysis of Recent Catches of Humpback Whales from the Stocks in Groups IV and V, C.S.I.R.O. Divn. Fish. & Ocean. Report, No. 4.
- (2) Bornemissza, G., 1955, Proceedings Pan Indian Ocean Science Association. *Proc. Pan Indian Ocean Sci. Congr.*, Part 1 (B,D), 4.
- (3) Cleland, J.B., 1940, Rejuvenation of Vegetation after the Bushfire in National Park, South Australia. *South Austr. Nat.*, 20: 43-48.
- (4) Downes, M.C., 1954, Waterfowl Conservation in Victoria, *The Emu*, 54: 169-180.
- (5) Gardner, C.A., 1957, The Fire Factor in Relation to the Vegetation of Western Australia, *W. Austr. Nat.*, 5: 166-173.
- (6) Jacobs, M.R., 1957, History of the Use and Abuse of Wooded Lands in Australia, *Austr. J. Sc.*, 19: P 132-P 141.
- (7) Main, A. R. and Serventy, D.L., 1957, Kings Park as an Indigenous Park, *W. Austr. Nat.*, 6: 25-53.
- (8) Ratcliffe, F.N., 1956, *The Ecological Consequences of Myxomatosis in Australia*. I.U.P.N. Conference, Edinburgh, June 1956.
- (9) Riney, T., 1959, Land Use as it affects the Definition of Wildlife Problems and the Planning of Research on Large Mammals in New Zealand, *Proc. Ninth Pac. Sci. Congr.*, 7: 26.
- (10) Serventy, D.L., et. al., 1954, The Recent Increase of the Rarer Native Mammals, *W. Austr. Nat.*, 4: 128-141.
- (11) Sweeney, J.R., 1956, *Univ. Calif. Publ. Bot.*, 28: 143.
- (12) Turner, J.S., et. al., 1957, *A report on the Condition of the High Mountain Catchments of New South Wales and Victoria*. Canberra: Australian Academy of Science.

CONSERVATION IN THE ISLAND OF BORNEO

TOM HARRISSON

Curator of the Sarawak Museum, Kuching, Sarawak.

The conservation situation in the island of Borneo on the whole is not bad, but with several very worrying exceptions.

Four separate territorial governments with four separate sets of game laws are involved. Seventy-five per cent of Borneo is still virgin jungle and the great numbers of species still enjoy a vast, natural reserve. Serious diminution is not yet in sight, except with species that are large, conspicuous, or otherwise valuable. Among mammals, the two-horned rhinoceros and the orang-utang are, however, in serious trouble.

Rhinoceros. Only 15 to 25 are left on the island: 2 in Sarawak, 5 in North Borneo, perhaps 1 in Brunei, and 10 to 20 in the far interior of Indonesian Borneo. In no case in British territory are two rhinos known to be near each other, so no breeding pairs may remain. The Chinese demand for rhinos for medicinal purposes in the past has been the main factor causing their reduction from a common animal 50 years ago. They are now protected—but much too late.

Orang-utang. Once as numerous as humans, today only a few thousand remain on the west side of the island confined to a few localities in southwest Sarawak and northeast North Borneo, mostly in swamp and pandanus habitats. There are none in Brunei. Still fairly plentiful in parts of Indonesian Borneo. The main trouble is border smuggling to and from Indonesian Borneo, in which there is no effective game law enforcement at present. Border laws are by-passed. Rich rewards are paid by zoos, museums, and wealthy

individuals who show little regard for proper accrediting of collectors. Until export and import is controlled by license, especially at Singapore, continued decrease is to be expected.

Sea and Estuarine Birds. Species with special, restricted habitat are not safe. In 1956, laws were passed in Sarawak to protect them and are reasonably enforceable. Week-end "sportsmen" bag birds merely for fun. Malays collect the eggs for food. The Darter, Adjutant and Storm's storks, conspicuous delta birds, were widespread before 1940; there are no breeding records for the past two years. The magnificent Sea eagle is also in danger, as also the Reef heron locally.

Pheasants and Hornbills. These are conspicuous, good-eating, and with feathers, and other produce—like the casque of the Helmeted hornbill (*Rhinoplax*) that excite Dayak attention. Still plentiful except in populated areas. Bulwer's pheasant is the nearest to possible extinction?

Marine Animals. Dugong are now very rare because of new "improved" fishing methods. The Green turtle (*Chelonia mydas*) at present is still safe though fishing methods imported by Singapore Chinese may become a serious factor. Sarawak has three turtle islands where only eggs (over 1,000,000 a year) are taken under my supervision.

National Parks. The first on the island was established in 1956, at Bako, southwestern Sarawak. It is already proving extremely successful.

DISCUSSION

H.J. COOLIDGE: Is any effort being made to correlate conservation efforts between the different territories? Are there any game wardens?

T. HARRISSON: No. The difficulty arises from diversity of interests in the four territories. Nor is there any between Sarawak and Singapore. All have British game laws of a standard type, but there is only one museum and few zoologists. Conservation generally comes under forestry departments that are interested only in trees. The reason for lack of game wardens is a shortage of cash. In British territory, everybody can and does own a shotgun. Shooting statistics put out by governments are of little consequence.

There is NO liaison, not even communication of any kind with Indonesia. It would be helpful if the Congress would pass some kind of resolution urging cooperation between the countries involved.

L.D. STAMP: This is a real political difficulty. Countries with newly found independence have a tendency to want to wipe out game laws, reserves, etc., as evidence of their freedom from their previous estate. Any resolution, the only kind that would be effective and appropriate, is to get it out of the field of politics and to base it on the conservation for its own sake. The paper of Colin Marshall for the Botany symposium really points this out.

H.J. COOLIDGE: Thailand is probably the most backward of Asian countries in this respect. It lacks parks and reserves. There is even a revulsion against conservation measures because people have never been educated for conservation needs from the grass-roots upward. In former colonial areas, the education has always been from the top down. It should be emphasized that Thailand can take the leadership in conservation movements, working through a program based on a dynamic popular education program that reaches all classes.

I. MCT. COWAN: Is it impractical to try to dry up sources of demand or sale in order to wipe out the cash value of bigger animals?

H.J. COOLIDGE: It is illegal to import animals into the United States from a country in which its export is prohibited.

G.C. RUHLE: That may not stop import through an intermediary country which has no controlling legislation because it is not applicable or of interest to them, for example, from Sarawak via Singapore.

L.D. STAMP: Zoos might well be the sole hope of keeping in existence animals that are exterminated in their habitat. This has been true of the bison in Poland.

T. HARRISSON: That cannot apply to many species that cannot be bred successfully in captivity or outside their native habitat. The orang is in this category.

In a later discussion between Dr. Tom Harrison and Dr. Kusnoto Setyodiwiryo, arrangements were made to direct conservation communications to Indonesia to Dr. Kusnoto so that they will receive action. A conference will be arranged in the near future between conservationists in the separate territories to attain accord and cooperation on mutual problems.

CONSERVATION IN CANADA 1953-1957

I. MCT. COWAN

University of British Columbia, Vancouver, B.C., Canada.

Through the years that have elapsed since the meetings of the Eighth Congress there has been a notable increase in the general awareness of conservation needs in Canada. It is often difficult for a large country with a small population to realize that resources can be seriously damaged by unwise use practices. Canada has become aware of this fact.

The drought years of the 1930's on the Canadian wheatlands brought this into the public eye and led to the establishment of the Prairie Farms Rehabilitation Administration. This organization has continued to expand its water and soil conservation programs in the drought vulnerable areas of the prairies. It has completed many water impoundments and built extensive systems of irrigation canals.

The same organization has extended its activity outside the prairie region and has undertaken several water development programs in British Columbia. Recently the pattern has been expanded by the creation of the Maritime Marshland Rehabilitation Administration operating in the Atlantic Seaboard Provinces. Ontario too has attacked soil conservation directly in a broadly conceived program under the River Valley Authority. It has undertaken flood control, soil conservation, forest restoration and wildlife encouragement on river basin units with spectacular results.

There has been an increase of fact finding and policy making activity during the period. These are reflected in such reports as the Farmers Federation Report on streambank erosion and the extensive investigations of the Senate Committee on Land Utilization in Canada that is attempting to establish a land Utilization Policy for the nation that emphasizes improved soil management practice to increase pasture and crop yields, restoration of cover on now arable lands and flood control.

British Columbia has implemented a new legislative soil conservation act.

Despite the vast area of Canada, there is relatively little first class agricultural soil outside the prairie grain growing region. A matter of concern is the expansion of urban development

over much of the best crop land that happens to be close to large markets. This results from lack of planning and lack of authority to prevent development under present systems of land ownership. The matter is under study.

In a somewhat similar frame of reference increased attention is now given to the levels of stocking of ranges with domestic livestock, though there is still room for improvement in our range utilization.

In wildlife conservation probably the main achievement has been the widespread adoption of the concept of limited range capacity for the wild ungulates. This has led to laws permitting the shooting of both sexes of most big game species. Almost every province in Canada now has its staff of game management biologists to obtain the data necessary for efficient management.

Populations of most big game species are in a satisfactory condition, waterfowl stocks are at a high level. Fur animal stocks are at a high level, but market conditions have been poor and trapping effort has been reduced. The annual yield of game meat to Canada is about 50 million pounds annually.

One serious trouble spot has arisen. The barren-ground caribou of Arctic Canada has suffered a serious decline in number from about 675,000 six years ago to only 150,000 today. Large sums have been spent on research to determine the cause of the decline and to devise management measures.

There has been little change in the status of rare species of birds and mammals. Musk oxen are increasing slowly, antelope have decreased slightly. The Trumpeter swan and Ross goose remain in small numbers but not in danger. The Whooping crane has been the subject of public concern. Through cooperative research and publicity between Canada and the United States its breeding grounds have been discovered and its migratory routes protected. The population has not changed materially. Every effort is being made to protect the species from disturbance but natural hazards seem to keep reproductive rates low.

The most serious concern is the conservation of fish stocks which arises from the threat of power developments on the Fraser River, the greatest salmon carrying river in the world. To date conservation interests have succeeded in keeping the developments to the power sites that do not interfere with salmon runs. Research is proceeding in the attempt to develop infallible technique for guiding both small and large fish around dams in preparation for the time when power demands outstrip the productivity of the salmon free sites, and direct competition for the waters of the Fraser River becomes more severe.

The International North Pacific Fisheries

Commission has come into being during the last four years as an expression of the joint efforts of Japan, United States, and Canada to solve high seas' fisheries problems of mutual concern. Under its auspices intensive studies have been undertaken on the oceanography of the North Pacific and its migratory fish stocks. The Fraser River Salmon Commission is another example of effective cooperation between nations with shared interests in a common resource. The North Pacific Sealing Treaty has been under renegotiation during the last year.

The four year period has seen solid progress in the International Problems of resource use.

SUMMARY REPORT OF WORK BY THE CONSERVATION COUNCIL OF HAWAII

ELEANOR S. ANDERSON

Honolulu, Hawaii.

The primary function of the Conservation Council of Hawaii is to arouse and maintain community interest in the potentiality of Hawaii's natural resources, and thereby initiate ways and means of striking a balance between their exploitation and their conservation. In order to do this most effectively, the Council has been organized into five committees, each one concerning itself with a specific area of conservation.

FAUNA

During recent years, measures to conserve Hawaii's native fauna have been marked by several positive and successful efforts.

One of Hawaii's most urgent problems concerning conservation of its native fauna has been that of saving the Hawaiian goose, or Nene, from extinction. These unique geese have been classed as one of the world's rarest species of bird life. A restoration project for them, operated by the Territorial Board of Agriculture and Forestry, has been successful in the rearing of these birds every year since it was established in 1949. There are now a total of 35 Nene at the project, starting from a single pair. A year-long ecological survey of the Nene in their volcanic habitat was begun in 1956 by an outstanding waterfowl specialist from the University of Missouri. A program is being developed to release birds reared through the restoration project in suitable, protected habitat, by utilizing techniques that will assure maximum survival of the released birds. Hawaii's program to restore the Nene is believed to be the only one whereby an endangered native species has been propagated in captivity to be released in the wild while, at the same time, the bird is exhaustively studied in the wild to learn the factors that contributed to its decline. The Committee on Fauna, through the Conservation Council, recommended to the Territorial Legislature that the Nene be declared the Official Bird of Hawaii. This was done in 1957. This will focus additional attention on the Nene and thus aid in gaining greater public support for the program of increasing its numbers in the wild.

The Hawaiian duck, or Koloa, is another rare native species of waterfowl, which is being pen-reared and then released in parts of their habitat from whence they had disappeared.

The Hawaiian Monk seal (*Monachus schauinslandi*) is an endemic seal found only in the Leeward Chain of the Hawaiian archipelago. They were heavily hunted for their oil and hides about a hundred years ago, but have been very little disturbed since. Several years ago, the Conservation Council recommended to the Territorial Legislature that a law protecting this native mammal be enacted. The Legislature passed this law, and recent surveys indicate that the seal population has increased to several hundred.

FLORA

The need to be on the lookout for threatened indigenous species of plants is great along with the aid in their preservation. Many native species, present when the first foreign settlers came to the Hawaiian Islands, were destroyed without thought for the future, as residential and ranch lands were cut out of the native rain and dry forest areas, or lands along the seashore were taken over for recreational purposes. Creating a forest reserve system throughout the higher elevations covered by the rain forests, and incorporating some of the native forest regions in the Hawaii National Park has helped to preserve some of the indigenous species of flora, but there are constant threats of extinction. To some species of which only a few specimens remain, on private holdings of land.

The Flora Committee has been chosen to represent agencies and institutions in a position to learn of threats to such species and to call for action. As a result of direct action taken by this committee, and with the cooperation of ranch owners, other private land owners, the Territorial Board of Agriculture and Forestry, officials of the Hawaii National Park, and other government agencies, small stands of disappearing species have been fenced in, sanctuaries for tree and smaller species have been created, and the support of arboretums in which native species have been planted has been given.

The committee cooperated with other organizations in preventing the introduction of Axis deer for the purpose of sport, because it is felt that these animals pose a threat to native vegetation.

Periodic surveys are made of those indigenous plants which are now found only in few numbers, and a list has been prepared and kept up-to-date, noting locations, state of growth, and other pertinent information.

LAND

The activities of this committee have dealt with problems concerning the use of mulches, in modifying leases of Territorial lands to include soil conservation requirements, in urging protection from wind erosion through windbreak plantings, and in supporting appropriations for the study of reclamation procedures of strip-mined areas.

The study of the use of mulches by the Hawaii Agricultural Experiment Station has resulted in the adoption of these practices by many farmers of Hawaii.

The Commissioner of Public Lands has modified the Territorial leases to insure against over-grazing. Provisions for a conservation program are prepared by the lessee for approval.

The development of irrigation water on the island of Molokai has prompted appeals to the Hawaiian Homes Commission and the Board of Agriculture and Forestry to encourage the planting of windbreaks to conserve the soil of the wind-swept areas of central Molokai.

The current interest in a bauxite mining industry in Hawaii has prompted the establishment of safeguards to prevent damaging erosion from strip-mining operations. The Land Committee supported the request for an appropriation of \$50,000 from the Territorial Legislature to study necessary reclamation procedures.

WATER

The chief conservation measures recommended by the Water Committee are the initiation of a Pearl Harbor ground-water study, the establishment of the Hawaii Institute of Geophysics, and appropriation for a study of water resources for the Kona area on the island of Hawaii.

The initiation of a special hydrologic study of the Pearl Harbor ground-water area on Oahu was formally recommended in 1956 as a result of

the growth of importance of the ground-water in that area for the supply of irrigation, industrial, and domestic water, not only for that area but also for Honolulu as well, and of uncertainty as to the safe ground-water yield of that area. Appropriations totalling \$100,000 have been made by the City and County of Honolulu, the Territorial Economic Planning and Coordinating Authority, and the U.S. Geological Survey for a three-year study, now being made by the Geological Survey.

The establishment of a geophysical institute at the University of Hawaii was recommended by the Water Committee in 1957 because of the growing need for hydrologic knowledge, and the knowledge of supporting branches of geophysics, in the continuing growth of use and need for conservation of the water resources of the Hawaiian Islands. The Hawaii Institute of Geophysics is now in existence; an appropriation of \$50,000 has been made by the Territorial Legislature for the initial expenses, several research contracts have been granted, and the National Science Foundation has recommended the appropriation by the Federal Congress of nearly \$3,000,000 for a building and equipment for the Institute.

An engineering-hydrologic study of the water resources of the Kona District on Hawaii was recommended in 1957 because of the need for an expansion of the public water system in that area and the desirability of providing for the expansion in an economic and conservative manner. The Territorial Legislature has appropriated \$50,000 for a study to be made by the Hawaii Water Authority.

SITES

The Sites Committee, while not directly concerned with natural resources, is an integral part of Conservation Council. The preservation of historic sites in the Territory is important, not only for their historical value, but also because of their economic value as an added attraction to tourists.

The Sites Committee supports and assists the Territorial Sites Commission in its work (without funds) of preserving historic and legendary sites from destruction is the face of public apathy and hunger for land to exploit for modernization. It has been instrumental in helping to have historic sites marked on the various islands and it has also given information to the Territorial Tax

Map Division as to the approximate locations of historic sites to be placed on tax maps.

A medicinal *heiau*, partly restored under the jurisdiction of the Board of Agriculture and Forestry, has been replanted with many medicinal herbs and is used as a park. (A *heiau* was the ancient Hawaiian's place of worship).

Petroglyphs on Oahu have been protected against destruction by iron bars, and the site proposed as a possible natural park.

The Territorial Department of Public Works has provided a parking area in a newly constructed road for access to an agricultural *heiau*.

Kamehameha III's Summer Palace, one of the oldest buildings in Hawaii, has been marked by

a plaque through efforts of the Territorial Historical Sites Commission.

The Sites Committee assisted in locating the homesite of John Young, Kamehameha I's chief advisor, so that it could be preserved from quarrying activities in the development of a harbor.

Although the Conservation Council of Hawaii is a non-governmental agency, through the activities of its committees, which are made up of representatives of many organizations, both governmental and non-governmental, as well as interested individuals, it has fostered and assisted programs which have been responsible for the controlled use of Hawaii's resources with the ultimate result of their conservation.

PROCEEDINGS OF THE NINTH PACIFIC SCIENCE CONGRESS

NATURE PROTECTION IN INDONESIA

KUSNOTO SETYODIWIRYO

Director, Botanic Gardens of Indonesia, Bogor, Indonesia.

Indonesia is growing conservation-minded although not yet to the same extent as the well-developed countries, such as the United States and Western Europe.

The progress — when compared to the situation before the war — is largely the result of the joint efforts and information of the Forest Service and the Botanic Gardens of Indonesia during the past ten years. In this difficult and heavy task, the Forest Service played an important part tackling such problems as the conservation of soil, water and vegetation, and the afforestation of barren mountain regions by means of artificial planting as well as by natural regeneration in accordance with the advice of the Forest Research Institute and of the Botanic Gardens of Indonesia.

With regard to wildlife protection, the Forest Service works in close contact with the Institute for Nature Protection of the Botanic Gardens of Indonesia which, besides supervising and managing the nature reserves, also directs the catching and export of wild animals in this country.

The planting of mountain regions is always done by the local forestry officials under the supervision of the Central Forest Service. For this afforestation, a special budget is administered by the Ministry of Agriculture, which has its objectives all over the Archipelago, and attained its maximum between 1950 and 1955.

The local effort on the part of the Forest Service with the assistance of the Civil Service is another important factor which encourages the village farmer to plant arid fields with trees in order to prevent erosion in threatened areas. In addition, the bitter experience of the different areas which have been repeatedly struck by floods these last ten years has made the people realize the importance of forest protection in mountainous regions, although the danger of inundation has not entirely disappeared.

Detailed knowledge of the perils of forest devastation is being given by those government bodies which have the task of informing the public, such as the Ministry of Information, the Institute for Nature Protection, and the Information Branch of the Forest Service. It may also be mentioned that the Land-Use Institute

of the Ministry of Agriculture has gradually completed a rational identification and classification of soils following the indications of the General Institute for Agricultural Research on soil fertility, and of the Forest Research Institute on hydrological and orological matters.

Wildlife protection is still in the hands of the Government (i.e., the Institute for Nature Protection) in accordance with the Law and Regulations on Wildlife Protection of 1931, which are in force all over Indonesia, and with the Game Law of 1940, which mainly deals with hunting in Java and Madura.

Although these laws and regulations are imperfect and not up-to-date, they at least help to reduce large-scale killing of animals by people hunting for profit.

A hunting-license is given in Java and Madura to every adult (minimum age 21) who is in possession of a shooting-license required for all kinds of wild game. This shooting-license can be bought at every police station or country office for 50, 100, 200, 300, and 500 rupias a book which is valid for one hunting season and for a certain species. The hunting-license, on the other hand, is granted by the Resident of each residency outside Java and Madura, and may or may not be given free of charge. Before World War II and in 1950 a hunting-bill was introduced by the Botanic Gardens of Indonesia for the provinces outside Java, but it has not been passed up to now. Such a law is very much needed for the prevention of unlimited deer and wild buffalo hunting in various regions, and preparations are already made in this direction by the Institute for Nature Protection in cooperation with the Nature Protection Bureau of the Forest Service.

Supervision of protected wild game has the special attention of the Institute for Nature Protection of the Botanic Gardens, but in the remote areas of Sumatra and Borneo illegal catching is still a frequent occurrence, especially of orang-utans. Reports indicate that much shooting of elephants in South Sumatra is committed by hunters killing for profit.

The regulation on wild game hunting and on the export of wild animals are in accordance with the above mentioned law, which stated

among other things:

a. It is forbidden to hunt, catch, kill, trade, or keep dead or live wild animals mentioned in the Law on Wild Game Protection 1931, i.e., orang-utans certain felines, all kinds of tailless monkeys, rhinoceroses, tapiruses, pangolins, birds of paradise, certain species of storks and herons, elephants, monitor lizards, etc.

b. The export embargo is not operative for wild mammals and non-protected wild birds if not more than 2 of one mammal species and/or 4 of one bird species are jointly exported to one destination.

It is evident that protected animals may not be hunted or exported at all except for scientific purposes. The Institute for Nature Protection has determined that only Indonesian zoological gardens are allowed to catch or export the above mentioned animal species in a limited number by way of exchange with foreign zoological gardens and institutes on a non-profit basis, and that a permit is required from the Botanic Gardens of Indonesia. This should prevent any commercial dealings which will affect the law-protected animals.

Recently reports were received about the illegal trade in *Simia satyrus* at Singapore, which was said to be the source of supply for zoological gardens in West Germany, U.S.A., Japan, etc. The Institute for Nature Protection then contacted the Singapore veterinary surgeon, soliciting his support for our efforts to prevent clandestine trade in these rare animals. The surgeon was found willing to give us every help. Through this Conference we wish to appeal to all Governments and Associations for Nature Protection in every country to assist us in the fight against illegal trade in order to prevent the extinction of this unique animal (found only in Sumatra and Borneo). Close cooperation among the international associations and governments concerned is the only means to make this possible, e.g., by prohibiting the import of orang-utans and other unique Indonesian animals into their respective countries without an export permit from the Botanic Gardens of Indonesia.

Rigorous measures have been taken for *Rhinoceros sondaicus* in Java. It is strictly forbidden to catch or hunt this animal, which considering the very limited number still alive (some 40-45) is threatened with extinction. The refuge of this big animal, the nature reserve at Ujung Kulon, has the special protection of the Forest Service, firstly by closing the area to the public, secondly

by an intensive guarding system directly under the Central Forest Service at Djakarta. For the upkeep of the patrol roads and the grazing fields of wild cattle and deer an annual allowance of 200,000 rupias is granted. In order to facilitate and accelerate inspection along the coast from island to island, two motorboats of 20 H.P. are available.

Another species that needs protection is *Varanus komodoensis*, also found only in Indonesia, i.e., Western Flores and Komodo Island. Many requests from foreign zoological gardens could not be complied with because the number of animals that may be caught is very limited and may not exceed 15-20 during the period of five years. In the last ten years the number of Komodo varanuses has greatly increased, especially in the Rintjah nature reserve; this island proves to be a perfect biotope for the species. Investigations on the life of that animal, especially its propagation, could not be conducted for lack of experts.

While there are legal provisions for the protection of wild animals (though not complete), nothing has yet been done for the protection of plants. Save for a few species of orchids (*Dendrobium*, *Vanda*, *Phalaenopsis*, etc.) and a number of species of construction timber as *Eusideroxylon melangangai* and *Elmerillia ovalis*, two to three species of *Dipterocarpus*, the Indonesian flora is not in such a perilous state as many of the animal species. The supervision and protection of the flora is in the hands of the Forest Service which is sufficiently staffed in the provinces to prevent any local depredations.

The cutting of timber trees for construction purposes is governed by instructions from the central government. While for *Tectona grandis*, a 10-year plan has been worked out by the Forest Planning Bureau, which has to be carried out by the Forest Service in the provinces. This plan, which is renewed every ten years, is one of the most important objects of the forest management in Java, and we may say that considerable progress has been made during the last sixty years.

Considering present conditions, there is a great need to protect such plant species as *Rafflesia patma*, *R. arnoldii*, *Amorphophallus titanum*, *Intsia bijuga*, *Vitex cofassus*, *Metrosideros* spp., etc., of which the last tree produce first-rate timber, durable on land as well as in water. Fortunately, the regions which are important for the preservation of wildlife and vegetation have already been made into nature reservations and nature parks. There are 115 of such reservations in Indonesia, covering a total area of 2,250,000 hectares.

CONCLUSIONS

In conclusion we may say that the future of the fauna and the flora of Indonesia is not too dark in comparison with conditions in some other countries, considering that in the past ten years the love for nature and all it embraces has increased among the public. Moreover, the new Nature Protection Law, made by the former Government but not operative until July 1, 1957, (due to World War II and its aftermath), will make supervision of wild animals and plants more efficient. In addition, it will enable the Government — in this case the Ministry of Agriculture — to proclaim the coral islands and territorial waters around nature reservations as nature reserves if this is necessary to prevent devastation and/or to facilitate supervision in those

areas. This possibility is not found in the regulations of the old Nature Protection Law (1932).

But if nature protection is to become a living force in the world, it is not enough to enforce it by laws and regulations. It must spring from a desire of the people. The people must realize that their patrimony is in jeopardy, the beautiful inheritance they owe to a bountiful Creator. In order to instill this demand for nature protection into the hearts of the people, not only Indonesia but in all countries, it is necessary to make the children nature-minded, and in order to kindle the love of nature in the hearts of the children, we need the help of the teachers. Therefore, it is to the teachers that we look in the first place. And we ask the educational authorities to make the teachers nature-minded.

CONSERVATION IN JAPAN†

YOSHIMARO YAMASHINA

Yamashina Institute for Ornithology and Zoology, Tokyo, Japan.

The great importance of the problems of conservation of wildlife for the benefit of mankind is hardly necessary to mention. In Japan right now, we are making every possible effort to solve difficult conservation problems in various ways: in conjunction with the Japanese Association for the Protection of Birds, the Ornithological Society of Japan, the Wild-Birds Society of Japan, and other scientific organizations, as well as appropriate governmental agencies.

We are concerned particularly over the problems of protection of migratory birds and sea-fowls, and we think it extremely important and necessary to secure the fullest cooperation of the neighbouring countries touched by the birds on their migration routes.

It is my understanding that the nations in Europe and on the American continents have already taken this matter up seriously and are helping each other protect birds coming and going on the migration route. It is very regrettable that such efforts have not been carried into execution among the nations in the Far East as yet.

We are at present fighting extremely hard to have our government enact a strict measure prohibiting the merciless killing of migratory song birds. For many years these birds have been hunted by countless poachers using mist-nets, in order to supply the food shops or restaurants, in provinces of this country through which the migratory birds pass.

† Extracted from a letter to Dr. Harold J. Coolidge for inclusion in the country reports.

CONSERVATION NOTES ON NEW GUINEA AND SOUTHEASTERN ASIA

A. L. RAND

Chicago Natural History Museum, Chicago, Illinois, U.S.A.

The following is a brief survey of some facets of conservation problems in two very different areas. One, New Guinea, is emerging slowly from a long period of primitive conditions with few and local conservation problems. The other is southeastern Asia, an area with an old civilization, widespread population and conservation problems of long standing, and an area where great and sudden changes are taking place.

NEW GUINEA

New Guinea is still a primitive country, mostly mountainous, forested, and sparsely populated. There are still large areas with culture little beyond that of the stone age. The political future of the western half of the island, Dutch New Guinea, is still being disputed; but that of the eastern half, the territory of Papua, New Guinea under Australian control, is being administered with a view to safeguarding native interests. This would seem to mean progress will be slow.

Centers of native population are (a) along the coast, when also most of the Australian settlement is located; and (b) in the mid-mountain areas where there is little land being released for Australian settlement.

Along the coast, products of the sea and those of coconut palms, sago palms, and bananas provide important native foods. Under Australian management are extensive and commercially important coconut plantations and some rubber plantations that are replacing the original forest. In the mid-mountains the native's main crop is sweet potatoes, and it is here that new ventures by Australians, notably cattle raising, full of promise but of little economic importance as yet, are starting. But Australian settlement and new lands being made available is carefully regulated by the administration with an eye to native interests. An index to the land use is given by the value of the chief exports for the year 1956-57: coconut products, 8 million pounds; rubber, 1 million pounds; gold, 1 million pounds; and shell, about $\frac{1}{2}$ million pounds.

This points up the fact that New Guinea has its flora and fauna almost intact, and this state will

probably continue for some time. The following points need mention:

(a) Mid-mountain oak forests and grasslands. Certain oak forests grow only in the mid-mountains and the extent of the stands seems to have been co-extensive with lands suitable for sweet potato agriculture. This has resulted in the large scale disappearance of these oaks mentioned above, as in the Grand (Balem) and Waghi Valleys. The natives in these areas have a timber supply problem solved in part by casuarinas which grow as second growth weed and which locally are planted for a fuel and timber supply.

(b) Plume-hunting. Frequently the destruction of birds-of-paradise for the sake of their plumes to be used in native dances is cited as a threat to the species. If the plumes were an item of export, if the hunting was commercialized, this would be a danger to the bird. But this was abolished many years ago. Plumes taken by natives, mostly without guns, for their ornamentation in tribal ceremonies cannot be considered a dangerous drain on the species.

(c) Food birds and mammals. Until populations are much denser than they are, I do not see that the taking of wallabies, cuscus, cassowaries, goura pigeons, and other smaller pigeons for food can affect the overall status of the species. Of course, in the vicinity of settlements the wallabies, cassowaries and gouras could be wiped out, but these are local problems.

(d) There is no big game, and no bird shooting to attract sportsmen from abroad, so that New Guinea is spared one of the problems of some other areas.

(e) New Guinea fauna's interest, in its more conspicuous elements, is in the echidna and the marsupials, and in the endemic birds such as the birds-of-paradise, kingfishers and pigeons. Their continued existence depends on that of their habitat. Though the day when that will be endangered seems far distant, it will gradually approach. As preparations for it, it would seem wise and logical to establish nature preserves, after adequate studies as to where the needs are likely to be most pressing. That the Australians in New Guinea are aware of the needs for studies

in the area is indicated by the suggestion (*Pacific Island Monthly*, March, 1947) that the 34th Congress of the Australian and New Zealand Association for the Advancement of Science be held somewhere in the Papuan-New Guinea area, and that a branch of the A.N.Z.A.A.S. be set up there.

SOUTHEASTERN ASIA

What a contrast is southeastern Asia where there is a long-established civilization pulsing with the life of sudden violent changes. There are such political, sociological and economic changes that "bread-and-butter" conservation matters, which will add so materially to the welfare of the people, should have only to be mentioned to be followed up wherever possible: water shed improvement, flood control and irrigation projects, soil erosion and forestry problems. The results of all these will affect everyday living.

But what of the future of what appear less pressing matters? What about preserving areas of habitat and of endangered species? In their preservation, which is protection, there may be no immediate prospect of brightening human lives, or helping human suffering. Rather their aim is a longtime one, to save for posterity samples of what the country has been like; to rescue from oblivion creatures living now that without attention may become extinct. To accomplish this is to prevent the complete and final disappearance of forms of life, and of association that future ages will bless us for.

There will always be crisis everywhere in the world, when it will seem necessary to exploit natural resources to the end. But when the last tree is cut down, and the last animal killed and eaten, no problems have been solved. Their solution has been postponed only slightly. Let us save some samples at least of what there was in the land while there is yet time.

Some species of southeastern Asian animal have probably gone beyond recall, like Kuroda's Crested sheldrake of Korea. Others, like the Kouprey of Indochina, are decreasing in numbers, and the Japanese murrelet has not recovered from the use of its principal breeding island (Sambondake) as a bombing target. However, others continue to survive at least, like the Japanese Marsh warbler (despite their capture by the use of mist-nets), and the Steller's or Short-Tailed albatross, which was thought to be extinct for 20 years until a few pair were found alive occupying the species' old breeding areas on Torishima Island.

With habitat preservation, in parks or preserves, where original conditions are maintained, endangered species can be protected and preserved. In the future perhaps, when there are preserves for them, some individuals of Père David's deer which for fifty years has been perpetuated only in foreign zoos, may be returned to populate parks in their homeland in China.

There never will be a better time than the present to inaugurate conservation projects, and to implement and further measures now in existence in some stage. Delays may allow irrevocable changes and irreplaceable losses.

PROCEEDINGS OF THE NINTH PACIFIC SCIENCE CONGRESS
CONSERVATION IN NEW ZEALAND

R. A. FALLA

Dominion Museum, Wellington, New Zealand.

CONSERVATION AGENCIES

Legislation designed to protect natural habitat and vegetation communities of all kinds are administered by the Lands Department and by the Soil Erosion and Rivers Control Council attached to the Ministry of Works. The Lands Department has no active internal division with conservation as its sole objective; the administration and field work is carried out by the officers of the department as part of their normal duties. The Soil Erosion Council does have a number of professional officers broadly concerned with conservation policy and practice. The Animals Protection Act is administered by the Department of Internal Affairs through its Wildlife Division. Both research and field staff are actively engaged in the work of the Division. The Department also coordinates the district responsibilities of Acclimatization Societies, which are non-governmental fish and game groups. In addition, the Minister of Internal Affairs has appointed a Fauna Advisory Council to which many matters involving departmental policy are referred. Personnel of this Council are selected and appointed as individuals, but they represent both government and non-governmental agencies.

Of non-governmental agencies active in the field of conservation, the Forest and Bird Protection Society has the largest membership and publishes monthly bulletins devoted entirely to conservation matters. The Royal Society of New Zealand has a Conservation subcommittee which gives periodic attention to matters of national policy in conservation. A number of smaller societies concerned with branches of botany or zoology are also actively interested, and they are loosely federated in the Nature Protection Council, which is convened by the Forest and Bird Protection Society.

It should be clear from the above summary — if compared with the state of affairs reported in Auckland, 1949, and Manila, 1953 — that there has been an increase in the number of agencies interested and some improvement in coordination. Mention should also be made of the National Parks Authority set up in 1953. This is

attached to the Department of Lands through its chairman who is by law the Director-General of Lands. The Authority is responsible for the administration of the large areas of National Parks for which New Zealand is now noted and is currently engaged in formulating and expanding policy. The situation may be regarded in many ways as very satisfactory, but there is never any room for complacency in conservation matters. Several aspects should be noted in which improvement can be made.

1. In spite of the great responsibilities carried by the National Parks Authority, there are comparatively few field officers employed by the authority; and there is no trained national park service.

2. In spite of some direct and overruling authority vested in both the Soil Conservation Council and the National Parks Authority, it is still possible for significant decisions, indirectly affecting wildlife and vegetation, to be made by other departments and agencies. Considerable modifications of landscape are involved in many of the engineering and earth-moving plans, drainage and so on, before any opportunity occurs for full discussion of the secondary effects, especially on animal and plant life. The time would seem to be opportune, indeed overdue, for some kind of screening or coordinating advisory council with a small active staff scrutinizing the plans and projects.

3. Research directed primarily toward conservation of natural resources and of wildlife, is still not sufficiently coordinated. It is actively carried out by the Departments of Agriculture, Forestry, Scientific and Industrial Research, and Internal Affairs (Wildlife), but apart from some provision for interdepartment exchange of views and information, there is no person, committee, or agency to scrutinize the direction and dovetailing of research projects. There is, in the opinion of your reporter, some overlap and duplication and even more serious, a lack of any regular forum of scrutiny and critical discussion of the trends of research and the evaluation of it. Some of the departments concerned have advisory committees, but they still work independently

one of another. Some centralizing and strengthening of biological survey seems to be much needed.

GENERAL

The special sanctuaries for the preservation of rare species are all being maintained and supervised, and conditions appear to be satisfactory in all of them. This is a feature of conservation work in New Zealand which has considerable value not only for its own sake, but because

it can be used as an example and even to some extent as experimental. Only reasonable restrictions are placed on access by visitors to outlying island sanctuaries where a great deal of useful work can still be done by observation. Access to the Takahe Valley, where the *Notorhis* survive, is still restricted. Some relaxation under close supervision has been permitted in the oceanic bird reserves at Otago Peninsula where the Royal albatrosses, Yellow-Eyed penguin, and other species are breeding.

LAND USE AS IT AFFECTS THE DEFINITION OF WILDLIFE PROBLEMS AND THE PLANNING OF RESEARCH ON LARGE MAMMALS IN NEW ZEALAND

THANE RINEY

New Zealand Forest Service, Wellington, New Zealand.

The following paper is based on this assumption: that specific wildlife problems exist mainly because some animal is adjusted in such a way with its environment that human interests are affected (5). As K.R. Allen has pointed out, subsidiary wildlife problems can be resolved into one generalized problem largely based on questions of human values: . . . "how are we to adjust our relationships with wildlife so as to obtain the maximum benefit, both physical and mental, which is economically practicable?" (1). This represents a logical extension of our thinking about wildlife problems, and it is similar to and closely related to the growing awareness of ecologists of the need to recognize and to use the ecosystem as the basis unit in ecology (3). The ecosystem in fact constitutes the basic unit within which all wildlife problems develop.

There has been a period in New Zealand in which the animal problem has been popularly conceived as a simple one of rectifying "mistakes," a problem of reducing or eliminating animals believed to be "injurious" so that some approximation to "virgin" conditions can be restored, at least in some areas. The extent to which this view is held has direct and at times confusing influences on official policy. Its validity and practicability, however, must be examined against all the relevant factors of a background that is inevitably changing in spite of, as well as because of, human activity.

Since changes in human attitudes can be a major influence on the ecosystem, it is appropriate to review problems involving large mammals in terms of human values. In describing our attitude toward a wild animal species we normally make one of three choices: (1) we want a species increased in number, (2) we are satisfied with the species present status and want it maintained, or (3) we want its numbers decreased or eliminated. Situations referred to as wildlife problems can arise as a result of each of these three basic attitudes. The present discussion deals only with the last mentioned category and is restricted to examples of classification of specific problems involv-

ing animals in direct or indirect conflict with various categories of land use in New Zealand.

New Zealand mammal problems are unique in that they all concern mammals introduced by man, for the most part between forty and eighty years ago. The entire list of native mammals consists of but two insectivorous bats. Several introduced mammals are still spreading into virgin areas and into areas modified by man. In many areas mammals have reached a measure of stability with their environment which equals or approaches that found in other countries. Present day categories of land use provide a basis for comparing New Zealand wildlife problems with problems in other countries.

CATEGORIES OF LAND USE WITHIN WHICH PROBLEMS DEVELOP

Categories of land use in New Zealand which influence wild mammal populations or within which problems involving large mammals develop are: arable farm lands, forested areas, and grazing lands. Combinations of two or more of these are normally found in any given drainage system.

URBAN AREAS

There are no problems involving large land mammals in urban areas in New Zealand as in certain other countries. Since there are no periods closed to hunting, and no licenses required to shoot any large wild or feral mammal, a householder in a residential district effectively deals with deer, goats, and pigs by shooting.

ARABLE FARM LANDS

The majority of arable farm lands are untroubled with large wild mammals; consequently such problems are small in scale, and at present are of little economic consequence nationally.

Examples of types of wildlife problems in farm lands are the depredations by deer, goats and pigs in orchards, farm woodlots, pastures, and in crops such as turnips which are used as winter feed for sheep. Problems of management often develop which require practical field trials of fencing, deterrents, or poisoning. Such problems

usually develop on those arable lands adjacent to marginal or unoccupied forested lands.

FORESTED AREAS

Forests managed for the production of timber. In forests managed for production it is important to clearly define the following three general questions: (1) What are the requirements for future growth and milling of certain tree species? (2) What is the comparative cost of repellent spray, fencing, or other animal deterrents, or the cost of eliminating the animal populations, or of reducing them to a satisfactory level? (3) What is the value of the animals to total forest management: in reducing root competition beneath the forest canopy; or by sustaining other forest values, as a source of meat, sport, and supplementary income to forest workers. An understanding of these three types of question is essential to determining the desired policy of animal control in any production forest.

Compared with other classes of land use, the relation of animals to forest managed for timber production is normally a simple one. Locally deer, goats, rabbits, hares, Australian possum, and feral pigs interfere with regeneration of some of the early growth stages of desirable timber trees, in some cases deform and/or lower the quality of the trees by interfering with the terminal shoots. This major problem gives rise to subsidiary practical problems of fencing, repellent spraying, or reduction or elimination of animals; of knowing the limits of use beyond which the production forest is safe from animals; and of understanding and controlling factors that facilitate increases in animal numbers.

Forests Managed for Conservation Purposes. At present, in forests whose principal function is conservation, the major concern over forest mammal relations consists of questions of "damage." The most common way of referring to "damage" is in terms of either (1) the changing composition of plants due to the presence of animals, (2) the prevention of regeneration of the forests, or (3) in terms of accelerated erosion. Many specific problems are involved when one considers the "damage" problems in a given area. Not the least of these is the business of defining the problems or potential problems that exist. At present, problem definition is in itself one of the major administrative and research tasks in areas whose principal use is conservation of watershed values.

GRAZING LANDS

Some of the most complex wildlife problems

in New Zealand develop on partially forested or unforested grazing lands. Among the most important are problems of competition between two or more species of wild feral or domestic animals: the description of the nature of the competition, the use of total animal numbers as a measure of animal pressure to obtain if not an estimate of, at least an index to the carrying capacity of the area. Where competition is shown to exist this knowledge should facilitate the planning of differential types of management for the several species. It is equally important to learn if certain species co-exist but are not competitive.

Another problem arising from consideration of the nature of competition between species jointly using grazing lands involves the determination of the best class of domestic and/or wild animal to be used on the land in question, for each introduced animal is different in behaviour, and some species have a markedly different kind of impact on the environment than others. For example, in rugged mountainous country chamois in small groups will move a certain distance in a day; Red deer will move about half this distance; Fallow deer, still less; and sheep, normally in larger groups than any wild introduced animal, have the most restricted movements of any animal measured to date. Other things being equal, the smaller the daily or weekly area covered by an animal, the greater is the use on the plants of that area. Furthermore, even closely related species differ in their environmental requirements and so prefer certain parts of the environment to others. For example, Javan rusa and Sambar freely use swamps never penetrated by Red deer or Fallow deer. The pattern of trails by Fallow deer, Red deer, cattle and sheep are not only different but often diagnostic.

There are two present trends in thinking about grazing on high forested country in New Zealand.

One view emphasizes the need to extend upward in elevation the management practices such as oversowing, aerial top dressing, and techniques for improving stock distribution. This would have the effect of changing some categories of land use from ungrazed forested lands to partially forested grazing units and eventually bring more marginal lands into production (4).

The other view places highest emphasis on the establishment of standards for permissible animal use, particularly in marginal lands bordering high forested country, and at higher elevations, regardless of which species or combination of species are present.

These two views are not necessarily incompatible, providing priority is placed on maintenance of conservation standards. Basically this emphasizes a fundamental assumption underlying any kind of productive land use: that a pattern of land use including specific management practices can be sustained only as long as vegetative cover and soils are maintained or improving.

On a New Zealand-wide basis it has been shown that the highest densities of deer are not necessarily associated with areas most critical for soil and forest conservation (7). A preliminary report of another more intensive study — in an area including Red deer, chamois, and sheep — indicates that sheep were more closely related to the critical parts of the drainage than were the deer and chamois (8). This in no sense implies that deer have not, locally, become problem animals, but serves to emphasize the need for dealing with such problems as can be demonstrated to exist within a drainage in terms appropriate to the category of land use most suitable to that drainage. Because of the high intensity of use by sheep and cattle in some areas (under present grazing practices which involve free-ranging domestic stock) it may be impossible to retain domestic animal production on certain classes of marginal land and at the same time maintain minimum requirements for conservation. On the same lands, wild animals of more than one species may safely be tolerated and used for recreational purposes because of the natural controls operating to keep their numbers in check, and the lighter use of the area due to marked differences in behaviour between wild and domestic animals.

Combination of Two or More Categories — Normal for Most Drainages. In simplified terms the topography of New Zealand consists essentially of mountain ranges and coastal plains. The floors of mountain valleys are often too narrow and are otherwise unsuitable for cultivation, and the upper reaches of many of the valleys are so precipitous and remote that they are not grazed by domestic stock. Many watersheds are suitable for and in fact normally contain several different forms of land use: and in terms of the total drainages, wild mammals often assume a minor role.

The problem of balancing the multiple needs of an entire drainage is a normal one and may in itself be the most complex and difficult administrative task. For example, any protection forest may be influenced by logging, fires, cattle, sheep, or deer in adjacent areas managed under a different system of land use — one that is usually based

on maximum production or exploitation.

RESEARCH

In New Zealand at least twenty-four separate public or private national organizations are directly or indirectly concerned with animal problems (5). Of these organizations, eleven (seven private organizations and four government departments) are directly concerned, and the majority of the research work on birds and mammals is conducted by the following four government departments: Agriculture Department, Department of Scientific and Industrial Research, New Zealand Forest Service, and Internal Affairs Department.

Specific research programs are strongly influenced by the major aims of the organization conducting the research and by the type of land use with which it is principally concerned. Thus the primary responsibilities of the Agriculture Department involve farm lands, and animal problems of most concern to this department are those interfering with farming interests. The department has started range management studies on higher elevation grazing lands in the South Island, and has published on techniques for control of feral pigs. The Animal Ecology Section of the Department of Scientific and Industrial Research, while nominally interested in all introduced animals, has initially concentrated its combined research efforts on animals in direct conflict with or occurring primarily in agricultural lands; for example, the rabbit and the rook. The New Zealand Forest Service has, within the past two years, assumed responsibility for research on introduced big game animals, and the Australian Brush-Tailed possum: that is, those species considered of greatest importance or potential importance to the management objectives of the forest service. And the Wildlife Division of the Internal Affairs Department, with the largest staff of biologists, spreads its research activities over a variety of subjects including studies of waterfowl and introduced upland game birds, the management problems associated with these birds, and preliminary studies of two rare birds, the Notornis, and the Kakapo.

From time to time other organizations contribute to research on problem animals in New Zealand. Especially important contributions have been made by staff members of museums and universities.

This concurrent existence of different aims and approaches in organizations dealing with prob-

lem wild or feral animals in New Zealand places even more importance on the need to view animal research and the planning of this research against a background of present and potential land use. Knowledge of land use policy is important in helping to set the framework within which current basic problems and long term aims can be defined. It can thus be useful in a general way by providing part of the basis for the formulation of research and management activities, and in a specific way by facilitating the assignment of a specific research job.

CONCLUSION

The analysis of problems caused by large mammals in terms of categories of land use has a special value to the government organizations responsible for research as it facilitates the assignment of priorities of research. Such analysis should provide these research organizations with a perspective with which the problems of other countries can be compared and assessed. In principle such an assessment should provide a common ground for speeding the adoption of proven techniques in other regions and may encourage an increase in continuing exchange of ideas between different wildlife research organizations.

A Guess Into the Future. Future fundamental wildlife research studies may concentrate on an approach involving an increasing number of parts of the total environment. This will not necessarily involve several years study, or large scale works such as the "West Highland Survey," a pioneering work accomplished by F.F. Darling (2) and a team of colleagues in Scotland, or the small scale synthesizing approach suggested by Riney (8) in New Zealand, but will include any approach which tries to develop an enlarged perspective for the total environment and not just a selected piece of it.

In general, future studies of large wild mammals throughout the world, and in particular, management of wild and domestic animals must trend increasingly toward assessing the environmental potential of the lands they attempt to manage on the one hand and the potential range of response the animals in question are capable of on the other hand. Progress in this direction will be facilitated as we understand more details especially of those mechanisms of animal environment inter-adjustments which result in homeostatic trends within ecosystems. This should increase our skill at directing the ecosystem in

question in order to insure maintenance of maximum production and conservation values.

The trend in the organization of wildlife research, whether financed by public or by private funds, is to place increasing emphasis on the value of basic ecological research, and to recognize that the understanding of the animals we study, the problems with which we are concerned, and the solutions which we propose and apply can have long term value only as they operate within the limitations of the total environment — the particular ecosystems with which we work. And if the environments we study are or will be used by man, then the character of this present or proposed use sets the scope within which all of our wildlife research and management activities develop.

REFERENCES

- (1) Allan, K. R., 1955, The Wildlife Problem: A Question of Values, *New Zealand Sci. Review*, **13** (3-4): 30-35.
- (2) Darling, F. F., (ed.), 1955, *West Highland Survey: An Essay in Human Ecology*. London: Oxford University Press. 438 pp.
- (3) Evans, F. G., 1956, Ecosystem as the Basic Unit in Ecology, *Science*, **123** (3208): 1127-8.
- (4) Love, R. M., 1957, Some Thoughts on Plant Ecological Research and its Relation to the Solution of Tussock Problems, *New Zealand Sci. Review*, **15** (7-8), (in press).
- (5) Riney, T., 1952, New Zealand Wildlife Problems and Status of Wildlife Research, *New Zealand Sci. Review*, **10** (3): 26-32.
- (6) ———, 1952, An Approach to the Application of Field Techniques in Wildlife Research, *Proc. New Zealand Soc. Animals Production*, **12**: 89-92.
- (7) ———, 1956, Comparison of Occurrence of Introduced Animals with Critical Conservation Areas to Determine Priorities for Control, *New Zealand J. Sci. and Tech.*, **B. 38** (1): 1-18.
- (8) ———, 1956, A Zoecological Approach to the Study of Ecosystems that Include Tussock Grassland and Browsing and Grazing Animals, *New Zealand J. Sci. and Tech.*, **B. 37** (4): 455-472.
- (9) Williams, R. W. M., 1955, Study of Deer Fencing and Changes Induced in Vegetation — Alton Valley, *New Zealand J. Forestry*, **7** (2): 56-62.

CONSERVATION SITUATION IN OCEANIA

F. R. FOSBERG

Pacific Vegetation Project, National Research Council, Washington, D.C., U.S.A.

Oceanic islands have, in addition to all of the conservation problems faced by continental areas, various special difficulties of their own. These, in one way or another, result from the limited extent of island habitats and from their individual uniqueness. Distribution of resources in islands, as elsewhere, is uneven, frequently resulting in scarcities and over-exploitation. Population increases are less likely to be relieved by voluntary removal to new places. Shipping costs make necessary the utilization of marginal resources that are subject to rapid depletion or would better be saved for other purposes. Most serious of all, however, is the fact that species of plants and animals developed on islands may be very restricted in distribution and numbers, so that hunting or habitat destruction, even on a scale that would not be serious elsewhere may here result in extinction of unique and interesting forms of life. This process, which is going on ever more rapidly, is leading toward a dreary monotonous world, deprived of much that gives to living its interest and savour, as well as toward depletion of resources that may have unanticipated ecologic and economic consequences.

Island biotas and vegetation types, evolved in the absence of many of the destructive influences of continental areas, are especially vulnerable to the bad effects of agricultural patterns and other cultural features developed on continents. The same can be said for soils and water supplies. Water supplies on islands are subject both to depletion, as in larger areas, and to salinification, almost peculiar to islands. Island topography is commonly rugged, resulting in accelerated erosion when lands are handled in ways appropriate to the Middle Western United States. In discussions of the impact of Western cultures on island people, the supposed benefits have usually been emphasized with little attention to the dangers. This must be corrected if islands are not to be reduced to uninhabitable wastes in the easily foreseeable future.

In Oceania, even more than elsewhere, one of the reasons for the slowness of the conservation movement to get under way is scarcity of information, both technical and popular. Inventories

of plants and animals are incomplete for most islands. Understanding of ecological relationships is in its beginning stages. Ecological thought is almost non-existent among the populations in Oceania. The remedies for these conditions are, of course, investigation and education. Such programs of investigation as the study of western Samoa by Auckland University College, the Coral Atoll Program of the Pacific Science Board, the geological surveys of several Micronesian islands by the U. S. Geological Survey, and the soil surveys in French Oceania under sponsorship of the Institut Français d'Océanie provide basic information essential to an intelligent conservation effort in the islands. The corresponding educational programs do not appear to be well advanced. Individual efforts of certain teachers are not negligible, but no concerted actions by educational administrations have come to our attention.

A number of important achievements in the conservation field in Oceania during the past four years may be noted.

In Guam five "conservation areas" have been set aside by action of the Governor, preserving samples of as nearly original forest and grassland as are available, as well as of eroded areas, for the long-term study of vegetational stability and change. In the Marshall Islands a recommendation has been made by the District Administrator that the High Commissioner of the Trust Territory of the Pacific Islands set aside the uninhabited atolls, Pokak (Taongi) and Bikar, as bird and turtle reserves. The Trust Territory has also been carrying on investigations of the life history of *Trochus* with the object of providing more rational regulations for its conservation. Investigations and clean-up activities concerning the coconut beetles have continued.

Efforts are being made by various individuals and agencies under the leadership of the IUCN to create a reserve in the Galapagos Islands.

In Hawaii conservation activities in all fields are being carried on by several agencies, represented on and stimulated by the Conservation Council for Hawaii. An overall view of the conservation situation in this territory is provided by the

annual reports of this important organization. In the recent issues, such as the seventh such report issued on February 7, 1957, some very encouraging progress is reported, such as a great increase in the numbers of the rare Laysan teal, an ecological study of the almost extinct Nene or Hawaiian goose, fencing of certain small forest patches containing rare trees, legislative protection of the Hawaiian Monk seal, and many other less spectacular activities. The record is marred, however, by introduction on Lanai and Kauai of mouflon, or wild sheep, and introduction of various fishes and other water animals, as well as by an almost hysterical program of importations of predators in an attempt to control the giant African snail. These will almost surely bring about destruction of many members of the extraordinary Hawaiian land snail fauna.

Major defeats in conservation may be noted in the decision of the French administration in New Caledonia to go ahead with construction

of the dam which will flood the famous Plaine des Lacs, with its remarkable aggregation of rare and endemic plants; the use of Christmas Island for testing of nuclear weapons; the decision of the Administration of the Gilbert and Ellice Islands to change three small islands in the Phoenix group from bird refuges to coconut plantations; the encouragement of colonization and sheep ranching in the Juan Fernandez Islands National Park, Chile; and in the introduction of goats into Henderson Island, the last truly virgin high island in Polynesia.¹ These are unnecessary and regrettable blots on the record of our time.

¹ Following his paper, Mr. Fosberg commented that the situation in Oceania emphasized the vulnerability of the biota of small islands to introduced species such as goats and rats. The Sub-committee on botany has forms available for reports of the existence of species rare, vanishing, or reported as exterminated.

CONSERVATION ON NATURAL RESOURCES IN THE PHILIPPINES

DEPARTMENT OF AGRICULTURE AND NATURAL RESOURCES

Manila, Philippines.

VEGETATION (FORESTS)

In the Philippines, forest and watershed management is primarily concerned with the conservation of approximately 3,729,100 hectares representing 66.8 per cent of the 5,580,000 hectares of commercial and non-commercial forests which should be kept at all times under forest cover as protection forests. About 7,000,000 hectares under logging, reforestation and other uses, need to be maintained and managed under sustained yield as production forests.

A. Problems on Watershed and Forest Management:

1. *Kaingins*. The shifting system of cultivation generally practiced by the people is largely responsible for the destruction of the forests and the continuous erosion taking place on the hillside in the watersheds.
2. *Destructive logging*. Clear cutting and the use of high powered logging machines leave the forests bare, and exposed to the agents of erosion.
3. *Lack of forest conservation-consciousness of the public*. The greater part of the population is not aware of the dangers of land misuse and of forest destruction, despite the occurrence now and then of floods, droughts, etc.

B. Steps undertaken by the Bureau of Forestry in Forest Management and Conservation:

1. Intensive campaign for forest conservation.
2. Artificial reforestation of logged-over areas.

SOIL AND WATER

Soil and water conservation work in the Philippines is rather slow compared with other countries. The following has so far, been accomplished:

1. Soil surveys on over 22 million acres.
2. Soil conservation surveys on 2.5 million acres.

3. Land capability surveys on more than 3.5 million acres.
4. Erosion surveys on about 7.5 million acres.
5. Cooperative soil conservation work on about 60,000 acres.
6. Numerous demonstrations conducted of the different soil conservation practices and many fertilizer field experiments.

A. Problems in Soil and Water Conservation:

1. Inherent difficulties encountered in the promotion and application of the soil and water conservation principle.
2. Predominance of small land holdings which would not offer an opportunity for change on land use, much less allow drastic changes in farming operations.

WILDLIFE

Wildlife is the most abused and the least considered resources of the country today. Lack of understanding, on the part of the populace on the important role wildlife plays in our society, is the basic reason. Our people have been so used to bountiful wildlife that they do not observe proper harvesting methods to maintain natural balance, resulting in rapid depletion of the wildlife stock.

A. Problems in Wildlife Conservation:

1. Indiscriminate hunting.
2. Restoration and preservation of the depleted wildlife species.
3. Proper enforcement of the game laws.

B. Steps Undertaken by the Parks and Wildlife Office on Wildlife Conservation:

1. Rigid campaign requiring all shotgun and rifle owners to secure hunting licenses, thereby limiting their bag limit.
2. Through the recommendation of the Parks and Wildlife Office, Congress enacted Republic Act No. 1086, for more rigid prohibition on killing the Tamaraw.
3. More rigid enforcement of the game laws with the cooperation of other law-enforcing agencies.

4. Partial evaluation of the wildlife population in the major islands.

For the present, there is no fear of depletion or extinction facing most Philippine wildlife forms. However, unless controls are properly implemented, there will be a scarcity of most of the wildlife forms throughout the Islands within a ten-year period.

RECOMMENDATIONS

1. A program of conservation, backed up by

sufficient appropriation, personnel and equipment, should be initiated whereby the fullest cooperation of the people who own land in any form as well as the general public could be utilized for the proper conservation of the soil, water, vegetation, and wildlife.

2. Intensification of soil, water, vegetation, and wildlife educational campaigns to awaken public interest in favor of natural resources conservation.

3. Greater government support and incentives should be given.

A SURVEY OF NATURE CONSERVATION ON SINGAPORE ISLAND

H. M. BURKILL

Botanic Gardens, Singapore.

In all man's pursuits, nature conservation has come as an agonizing reappraisal of his destructiveness. In Singapore it came at the eleventh hour as the last few remaining acres of the indigenous vegetation stand was imperilled by a growing land-hunger. Many thousands of acres¹ have in the past been ruined by agricultural malpractice and now there is an increasing urban population pressure which results in the land disappearing under housing estates, roads, and the like. A growing rural population wants land for market gardening. To understand what has happened in Singapore, it is necessary to recall the salient historical events.

European rivalry for trade in the East led The East India Company of London to found a trading post at Penang in 1786. In 1819 Sir Stamford Raffles in the service of the Company established another trading post and settlement at Singapore. Crops of economic value, chiefly nutmegs, cloves, and cocoa were introduced to the two settlements. In the following decades gambier and pepper were added to the crops grown, all lucrative and before which the natural forests were ruthlessly cleared for land for their cultivation. In Malacca and the Malay States much the same process had been going on. Of the crops, probably gambier caused the greatest toll of destruction.

The first botanic garden was started in Singapore in 1822, but closed down in 1829. It was reopened seven years later and eventually abandoned in 1846. The present botanic gardens were begun in 1859 as a venture by an Agri-Horticultural Society, but the Society went bankrupt and in 1875 the Government took over the responsibilities of running the gardens under the charge of a systematic botanist whose duties included a study of the vegetation of the Malay Peninsula.

In 1883 the Government became seriously alarmed at the extent of the ruination of the forests in the Straits Settlements, and it commissioned Nathaniel Cantley, a Kew-trained horticulturalist who was then Superintendent of the Botanic Gardens, Singapore, to make a

survey of the forests of the three settlements. As a result of his report, the first forest reserves in the Straits Settlements were created. Thus were sown the first seeds for conservation of resources in Malaya. Though forest reservation connotes management for exploitation, it connotes also the introduction of a policy aimed at regeneration and permanence. Though these ideals have not always been obtained in Singapore, our present nature Reserves have stemmed from this origin.

All the Forest Reserves in Singapore were worked for timber except the Bukit Timah Reserve. In 1937 they were deemed to have been worked out and to be no longer economic. Thus, although the policy of management failed to give permanence, it did at least permit a lengthy running-down period.

At about this time biologists all over the world were becoming seriously perturbed at the spreading destruction of plant and animal life. Singapore, owing to its small size and rapidly increasing population, was probably as badly affected as the worst.

With an almost complete clean-clear of its forests, there was little left of its original flora, and with the loss of its natural vegetation went the loss of much of its fauna, ably assisted on its way out by a multitudinous band of trigger-happy "sportsmen". Messrs. R.E. Holttum and E.J.H. Corner, Director and Assistant Director respectively of the Botanic Gardens realized that Singapore was in imminent danger of becoming a biological vacuum with no flora left but alien immigrant plants, nor fauna either. They were instrumental in obtaining control of certain of the released forest reserves for the express purpose of preserving what little remained of the indigenous flora and of affording sanctuary to the remnants of Singapore's fauna. Singapore is fortunate to have had servants of such vision, who brought to the fore the necessity of keeping samples of the country's vegetation and animal life to facilitate the teaching of biology in the schools and conducting biological research, as open spaces for recreation, and as sample

¹ The acreages I quote may seem quaintly small, but it must be recognized that Singapore Island is only 220 square miles in area, i.e., 140,800 acres.

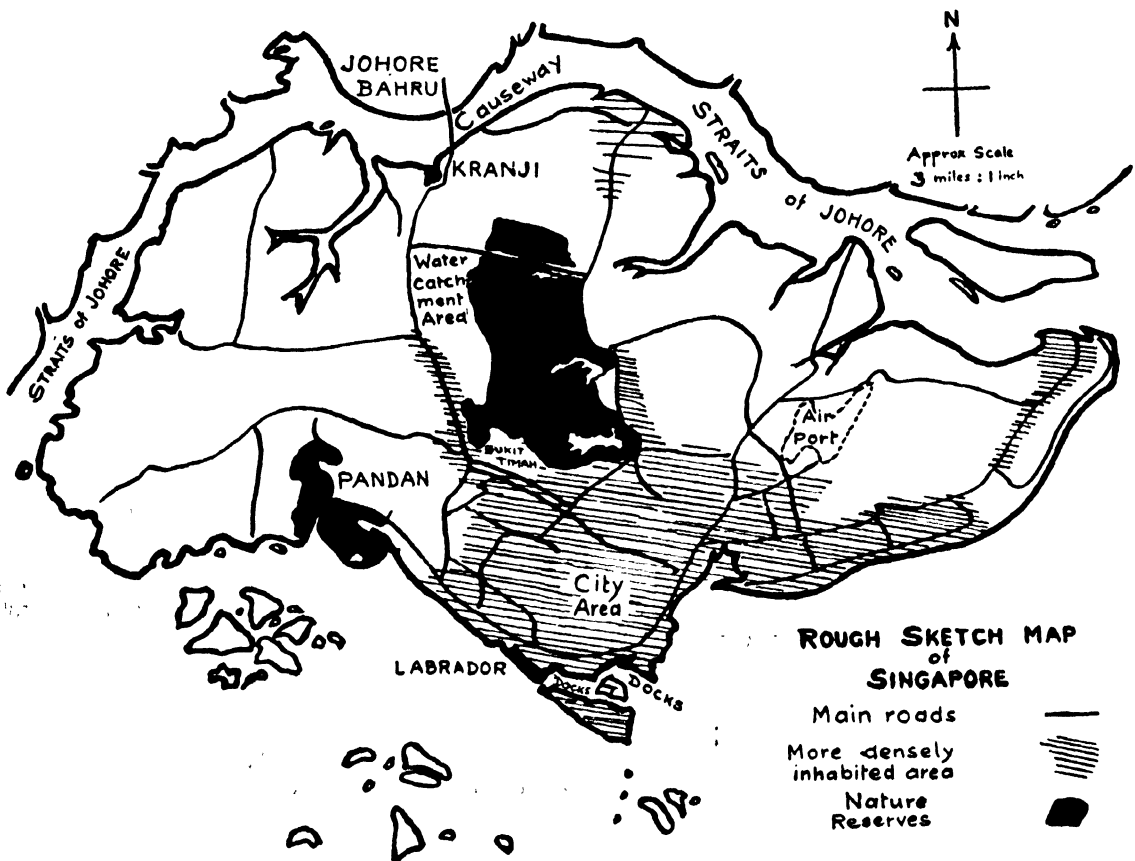
products of the biographic history of the country and its heritage.

In 1939 there were regazetted three of the old forest reserves under the Director of Gardens who for the purpose of administration was appointed Conservator of Forests. Their management, by virtue of their being Forest Reserves, was regulated by the Forests Ordinance which gave protection to plants and soil at the discretion of the Conservator of Forests. They were thus essentially botanical reserves since under the management of the Botanic Gardens there was no intention to exploit.

In 1941 protection was afforded to vertebrate animals by enactment of the Wild Animals and Birds (Amendment) Ordinance, No. 14 of 1941. I have been unable to ascertain why legislation stopped short at the vertebrates, but it seems a curious anomaly.

At this time the Reserves consisted of:

Bukit Timah Reserve. A block of 184 acres of lowland forest clothing Bukit Timah (Malay for Hill of Tin. It is granite and quite without any tin deposits). Its altitude, 581 ft. at the summit with a second peak at 560 ft., is the highest ground on Singapore Island. From 1822, when Sir Stamford Raffles brought Nathaniel Wallich from the Calcutta Botanic Gardens to the new Colony of Singapore to advise on botanical matters, to the present day, Bukit Timah has been a happy hunting ground for botanists. A very large part of Malaya's flora was first collected on its slopes. It is the type locality for a great many species, and probably on a density area basis more new species have been found there than anywhere else in the world. Though it has been so thoroughly explored botanically, it still even now yields up



an occasional secret. It is one of the first Forest Reserves made after Cantley's report and has never been exploited for timber. The Forest Department has been primarily interested in it because of the gutta-percha planted in the southern section. Professor Kwan Koriba who came from Japan to the Botanic Gardens during the war was instrumental in preventing damage to the reserve by the Japanese military.

Pandan Reserve. A block of 1373 acres on the banks of the Jurong and Pandan Rivers on the southwest side of Singapore Island. The vegetation is typical of the pioneering and tidal mangrove association. The Forest Reserve, which at one time was almost double in size, was worked for poles and timber for charcoal. In 1931, it was practically cleared. Further cutting was done to the regenerated timber during the late war. Much of the original Forest Reserve has given way to prawn ponds. The remaining Nature Reserve is threatened with the same fate, though there is evidence suggesting that a successful prawn farming industry is dependent on the presence of undisturbed mangrove where a proportion of the prawn population may grow and remain at large to become the breeding stock.

Kranji Reserve. A block of 50 acres on the Straits of Johore on the north side of the Island. The Straits which separate Singapore from Johore are a deep water channel typical of the larger mangrove areas of the west coast Malaya. Phytographically the northwestern, northern and northeastern mangrove areas of Singapore are units of the extensive mangrove area lining the Straits of Johore, the Johore River and the southwest corner of Johore. The Kranji Reserve is typical of a climax mangrove vegetation where the pioneering and land building characteristic of the complex is in the process on its inner boundary of bowing itself out to a succession of dryland plants. In this respect the Pandan and the Kranji Reserves form a series, but since the latter is a considerable distance from open sea it also has a slightly different population of species.

During the Japanese occupation of Malaya, the Japanese authorities released Holttum and Corner from internment in order that they might look after the Raffles Museum and the Botanic Gardens. They were instrumental in bringing these two institutions through the occupation and liberation periods more or less intact. Equally so, Corner was able to persuade the Japanese authorities of the value in maintaining the Reserves. At Bukit Timah a few caves were dug

into the hill at various points and a few trees were felled, but there was relatively no damage done. Kranji was untouched. More extensive damage was done at Pandan, but it was all the time subject to restraint. A Chinese who had worked it for charcoal in the days when it was a Forest Reserve proper maintained guards to prevent illicit felling in return for a suitable commission in kind. In addition he was permitted to make three prawn ponds in the Reserve and part of the proceeds of the sale of prawns was smuggled into the Gardens and used to augment the wages of the staff and labourers.

During the period of rehabilitation in Singapore after the war there was an immense demand for granite. On the perimeter of the Bukit Timah Reserve four granite quarries were operated and their encroachments, sometimes it would seem not entirely accidental, and the increasing calls for granite lead to a commission to enquire into Granite Resources and Nature Reserves on Singapore Island. The Commission concerned itself primarily with the resources and extraction of granite and the conflict of this with the Bukit Timah Forest Reserve.

At the same time though there was a growing opinion that the Forest Reserves needed putting onto a firmer basis as areas where nature as a whole could be protected. The Commission report (No. 6 of 1951, Colony of Singapore) which was approved by the Governor-in-Council recommended that the existing quarries at Bukit Timah be closed down and other sites opened up. This, alas, is yet far from being implemented. The Commission also proposed that Nature Reserves be legally established.

In 1951 the Singapore Government enacted the Nature Reserves Ordinance, No. 15 of 1951. To the existing three areas of Forest Reserve, now designated Nature Reserves, were added:

Labrador Nature Reserve. A block of 11 acres of cliff-face just outside the western entrance to the docks. This is one of the most scenic spots of Singapore's coast and is a favourite picnic site. The cliff composed of laterite, soft shale and clay grows *Dipteris conjugata*, seldom found in Malaya below 3,000 ft. altitude, *Nepenthes rafflesiana* and *N. gracilis* and hybrids between them and an assortment of more common foreshore plants.

Water Catchment Area. A large block of 4,006 acres adjacent to Bukit Timah and composed of some interesting freshwater swamp forest and small blocks of virgin lowland forest

but mostly of secondary forest in the process of regeneration. This area comprises the water-shed of the three City Water Service reservoirs and management is directed towards soil conservation for the production of clear water. When the requirements of the Water Department have been met, which in effect are the maintenance of a ground cover and the prevention of timber felling and thieving, then the conditions of the Nature Ordinance are operative.

The Ordinance States:

- (i) "The lands shown in the Schedule (i.e., those referred to above) to this ordinance are hereby dedicated, set aside and reserved for the purposes of the propagation, protection and preservation of the indigenous fauna and flora of the Colony and for the preservation of objects and places of aesthetic, historical or scientific interest."
- (ii) "Such lands shall be controlled and managed not only for the purpose of protection and preservation aforesaid but also for the purpose of providing under suitable conditions and control facilities for the study of and research into matters relating to the fauna and flora of the Colony and physical conditions in which they live."

The Ordinance established a Board of Trustees for the management of the Reserves under the Chairmanship of the Director of Botanic Gardens. Its composition after minor amendment in 1955 now consists of seven members, two appointed by the Legislative Assembly, two by the Minister for Local Government, Lands and Housing, and one each by the Singapore City Council and the Rural Board. Appointment is usually for three years and regular meetings are held. The Director of Botanic Gardens is ex-officio chairman.

The Board is empowered to employ its own personnel and has in fact at the present time a head ranger, 3 rangers, and 9 labourers. A separate staff of rangers is maintained by the City Council in the Water Catchment Areas. The Board may undertake construction work, make roads and paths, put up public amenities and equip vantage points. Bukit Timah is well supplied with paths which are named and signposted and sheltered seats at vantage points. The path name boards originally on thin metal rods gave a certain amount of trouble as monkeys took a fancy to jumping and springing on them. Names are now displayed on granite blocks or concrete slabs too heavy to shift. A recent development has been the making of flat-topped

cement tables at the vantage points indicating by direction lines conspicuous features in the view. It is expected that similar facilities for public enjoyment will be extended in time to all the Reserves.

The most urgent present task is to "sell" the Nature Reserves to the public, to inculcate the idea of nature conservation and protection, and to encourage an appreciation of the fact that though these areas are designated nature reserves they are as much for public enjoyment as for scientific purposes and that all persons who respect the spirit of them are welcome visitors.

In recent sociological planning of communities, stress has been laid on the need for the easy availability of open spaces (green belts) for the town dweller. In a densely populated city like Singapore this is highly necessary. In the immense land utilization survey conducted in the last few years by the Singapore Improvement Trust, a so-called Master Plan has been drawn up in which the Nature Reserves feature as open spaces together with parks, playing fields and the like for the purpose of recreation. Once the public realizes that it has a collective stake in the Reserves, then there is a strong defense against individual catch-penny commercialism which at present is a grave danger hanging over Singapore's Reserves.

DISCUSSION

H.J. COOLIDGE: How can the Conservation Committee help hold the dike?

H.M. BURKILL: Our educators want these parks conserved for instruction, research, and recreation. But city people must also get out into the countryside. This is unimportant in the eyes of the government. The master plan drawn up by the Singapore Improvement Trust recognizes the mission of the parks. Supporting the SIT master plan would be most helpful.

L.D. STAMP: Singapore, like Hong Kong, differs from other countries inasmuch as it is small in area and has an absence of big game. Is the master plan suitable for the purpose in mind?

H.M. BURKILL: It is exactly what we want.

H.J. COOLIDGE: In the history of previous Congresses when similar problems have been referred to the Council, it has been difficult to treat specific problems of this nature. The Council has no way of being informed on merits of different plans and on local politics involved.

There was agreement that some general kind of supporting resolution would be appropriate.

NOTES ON PROGRESS IN WILDLIFE CONSERVATION IN THE UNITED STATES

HAROLD J. COOLIDGE

Executive Secretary, Pacific Science Board, National Academy of Sciences, Washington, D.C., U.S.A.

Conservation of Natural Resources is becoming an ever increasingly important problem for the islands as well as the countries of the Pacific area. Much information on this subject in the United States is available in reports of governmental departments charged with the specific responsibilities for our national parks, forests, fish and wildlife, and soil and water conservation programs. In addition, there are an increasing number of private organizations such as the Nature Conservancy, National Parks Association, Wilderness Society, Wildlife Management Institute, Sierra Club, working together to counteract the government pressures that are being brought to bear on our parks, reserves, and wildlife refuges by special interest groups concerned with mining and public utilities. For example, a bill that would allow for the establishment of a large dam that would have flooded much of Dinosaur National Monument was defeated this year only by the united effort of many conservation organizations and conservation-minded Congressmen.

A new threat has developed through the indiscriminate use of powerful insecticides and fungicides. These are often sprayed from the air and leave damaging effects on beneficial insects, as well as upsetting the natural balance by destroying animal life in fresh water ponds and killing many birds. Measures to establish a firmer control on such practices, as well as to increase research on the effects of insecticides, are now being developed and supported by a rising tide of public opinion. At a Congressional hearing on a bill directing the Department of Interior to undertake comprehensive pesticide research, the Assistant Secretary of the Interior for Fish and Wildlife pointed out that 65 million acres of one sixth of the Nation's farmland devoted to crops and more than 3 million acres of forests were treated with 3 billion pounds of pesticides. A comprehensive study of the effect this is having upon fish and wildlife is needed for the protection of these valuable natural resources. Such abuses are unfortunately not confined to the United States although many of the young countries expect us to set an example in our handling

of such matters.

Information furnished by the U.S. Fish and Wildlife Service states that:

- (a) From 1953-56 about 106,759 acres of lands have been acquired for waterfowl refuges under the Migratory Bird Conservation Act while in 1953 alone, states purchased 116,459 acres and leased 200,898 for refuges and management areas. Waterfowl—marsh acquisition has been receiving major attention.
- (b) An international conference of more than a score of migratory bird and wildlife experts from Canada and the U.S. was held in October, 1956 to consider management plans aimed at helping to assure perpetuation of the Whooping crane, America's largest and one of its rarest migratory birds. Legislation has been introduced which would provide authority to acquire an addition to Aransas National Wildlife Refuge in Texas, to establish more adequate wintering grounds for the whoopers. Plans to acquire refuges along the cranes' migration route are being considered. Two young Whooping cranes were hatched and raised in 1957 at the Audubon Zoo in New Orleans. Mr. George Scott, Fish and Wildlife Service collaborator and consulting aviculturist of the New York Zoological Society, was in constant attendance at the zoo from the time of incubation until the young whoopers were big enough to be considered "safely raised." These are the first Whooping cranes to be raised in captivity.
- (c) The Alaska Fur seal herd, which numbered only 130,000 animals in 1911, has been restored to its present strength of about 1½ million under the protection of treaties and through the rational management program of the United States Government. In this interval of 45 years more than two million skins have been harvested from male Fur seals surplus to the breeding requirements of this highly polygamous

species. An average of 65,000 skins valued at 6,000,000 dollars has been taken annually in recent years.

- (d) Within the past 4 years the Bureau of Commercial Fisheries has completed a detailed population study of the herd and a joint investigation with Canada and Japan of the distribution and food habits of Fur seals of the North Pacific. On February 9 of this year the Governments of Canada, Japan, the U.S.S.R., and the United States signed an interim convention for the conservation of the North Pacific Fur seals. The stated objective of this treaty is to achieve the maximum sustainable productivity of these resources with due regard for other living marine resources. This objective is to be realized through international cooperation and through the coordination of research programs by a North Pacific Fur Seal Commission.
- (e) Mortality of Fur seal pups from hookworm is great, amounting in 1954 to nearly double the 63,882 animals taken for pelts. To reduce this loss, soil treatment to kill hookworm larvae is being sought. A $5\frac{1}{2}$ acre test of creosol and cresylic acid compounds decreased the number of larvae, but pup mortality was not appreciably reduced. The problem has not been solved.
- (f) Sea otter, considered extinct, or nearly so, as recently as the 1920's have been flourishing under strict protection. A few years after World War II it was estimated that there were 8,000 Sea otters on the Aleutian Islands. Today's estimates of Sea otter populations run as high as 20,000. An attempt has been made (1955) to reestablish Sea otter at Otter Island in the Pribilofs. Results of the plant of 16 animals is not known. The Congress has given recognition to the needs of the diminutive Key deer by authorizing establishment of a Key deer refuge on the Florida Keys.
- (g) If any one activity in the United States can be said to characterize the times, it is research. Billions of dollars are being poured from both public and private sources into the search for new materials, devices, and compounds to improve and protect the American standard of living. New uses for old materials, and new materials and methods for solving old problems are appearing with startling

frequency. Industrial research facilitating an expanded economy has had great impact on wildlife and its habitat, and has thus created need for increased wildlife research. A case in point concerns the widespread use of chemicals.

Chemical treatments hold promise for the farmer, forester, and rancher, of providing the cheapest and most effective methods of crop protection. An outstanding example is chemical protection of tree seeds for direct seeding of forest areas. Experimental plots planted with chemically treated seeds have succeeded better than plots planted with untreated seeds; one chemical in particular shows promise of being effective against birds, forest rodents, and rabbits. Success of this program is attested by the planting in Louisiana in 1955 of more than 10,000 acres with repellent-treated longleaf, loblolly, and shortleaf pine seeds. Chemicals are used to protect both seeds and seedlings. In field studies in Washington, the first-year damage by rabbits to Douglas fir seedlings was reduced by more than 75 per cent, at a cost for the repellent of less than 50 cents a thousand. Repellent treatments of young hardwoods and conifers in other regions have been similarly effective.

Chemicals are also important in the control of rodents, especially house mice and rats, which cause annual losses of millions of dollars to food supplies, packaged materials, and electrical installations, and constitute an ever-present health hazard. Thousands of chemicals have been tested at the Service's Patuxent and Denver laboratories, and several promising materials have been isolated for use as rodenticide or repellents that should contribute significantly to better use of natural resources. Insecticides have experienced outstanding development within the past few years. DDT, which was viewed with alarm by wildlife biologists a decade ago, has now been largely replaced by more effective insecticides, much more toxic to warm-blooded animals. Use of these materials must be evaluated and field-tested to enable recommendation of applications safe for wildlife. Studies are made on penned game birds to determine lethal doses. It has been found, also, that

sublethal amounts affect reproduction of game birds and survival of their young.

- (h) An interesting development is the establishment of a new research unit, Ocean Research, located at Stanford University, which was begun in September, 1955. It will make a broad-scale study of relations between climatic and ocean conditions and the sudden fluctuations of commercial fish stocks—such as the recent failure of the California sardine fishery—with the ultimate purpose of discovering natural laws governing such fluctuations.
- (i) While this report is not concerned with fisheries it is of interest that in 1953 the International Convention for the High Seas Fisheries of the North Pacific Ocean (Japan, Canada, and the United States) was established to study problems “arising from the interests of the three nations in the North Pacific Ocean.”
- (j) Research and investigations of the U.S. Fish and Wildlife Service’s Pacific Oceanic Fisheries Investigations, with headquarters at Honolulu, are providing quantities of data about several hitherto little-known Pacific fisheries. These findings should

prove of inestimable value to future Pacific fisheries management.

In my report to the Eighth Pacific Science Congress in Manila in 1953, I indicated that there was a growing interest in conservation education at the graduate and college level as well as in the schools. This trend is happily increasing and is being aided by instructional films and text books. This was the subject of a resolution at the Manila Congress.

I also mentioned the growing interest in furthering the work of the International Union for the Conservation of Nature and Natural Resources which has active commissions in such fields as Ecology, Conservation Education, Information, and the Survival of endangered species. It has recently cooperated with the wellknown firm of Elsevier in the publication of an Atlas of National Parks and Reserves on a world-wide basis. Editions in Dutch and French have already appeared. Twenty of our leading U.S. conservation organizations belong to the Union and are actively working with it. It is hoped that similar groups in other Pacific countries might seek membership, and join with us in strengthening its conservation activities in the whole Pacific region, and especially the young newly established countries of Southeast Asia.

Symposium: *Proposed National Parks and Reserves in Southeast Asian Countries*

SOME REMARKS ABOUT THE MANAGEMENT OF GAME AND BIRD RESERVATIONS IN INDONESIA

KUSNOTO SETYODIWIRYO

Director, Botanic Gardens of Indonesia, Bogor, Indonesia.

Considering that very little is known about the many problems that arise in connection with the management of game and bird reservations, it does not seem superfluous to tell about such problems as they present themselves in the island of Java. It should be made clear from the start that the experiences related below refer to the rainy province of West Java namely to the game reserve Ujung-Kulon and to the bird sanctuary Pulau-Dua, both situated in the westernmost part of the said province. At other places where there is less precipitation, the experiences will probably be different.

Each of the two reservations will be discussed separately and only the activities directly connected with the basic needs of the fauna will be dealt with.

UDJUNG-KULON GAME RESERVE

The reserve embraces the westernmost tip of Java. It consists almost exclusively of lowland and has an area of approximately 30,000 hectares (75,000 acres). It was proclaimed a reserve for the purpose of protecting all species of game living in Java, and especially the rare *Rhinoceros sondaicus*. The following particulars concern the improvement of the food supply and the perpetuation of the ruminants living within the reserve, more particularly the Banteng cattle (*Bos sondaicus*) and the Java deer (*Rusa timorensis*).

The proclamation declaring the area to be a nature reserve dates from 1912, but wildlife management did not start until 1938 and had to be interrupted from 1944 to 1952 as a result of war revolution.

From the tales of hunters of former days we know that around the turn of the century large areas of alang-alang (*Imperata cylindrica*) and other grasses along the north coast of Ujung-Kulon were the main food supply of the ruminants that lived there. These areas, in this article to be designated as pastures, were

intentionally kept intact by hunters and poachers, who instructed the local population to set fire to the low brush a few weeks or a month before they were coming to hunt, generally during the latter part of the East Monsoon, the period when little or no rain falls.

After the area was proclaimed a nature reserve, hunting was forbidden and poaching decreased. Slowly but surely the picture changed completely, but not to the advantage of the ruminants. This only became apparent much later. The opinion was held at first that in order to preserve an area for posterity it was sufficient to set it aside as a nature reserve. This was one reason why in the present instance nothing was done after the reservation had been established. Another reason was that at that time field biology was almost unknown in Indonesia, and there was consequently a lack of experts. Thus it was not realized that the method followed was not conducive to the accomplishment of the end in view.

It may be taken for granted that poachers did visit Ujung-Kulon during the next 25 years, but it was obviously not their business to report on their experiences. It was not until 1930 that official reports were forthcoming.

These reports were partly based on the observations of hunters and game experts, but did not touch upon the crux of the problem, the almost complete disappearance of the pastures. Some of the observers reported a surplus of tigers; others painted the picture as perfectly normal.

Finally, in 1937, the real situation was disclosed by an officer of the Bogor Botanic Gardens who under orders of the Director made a six weeks' visit to the reservation and stated in his report that the grazing area was covered almost entirely by forest or heavy scrub, that the condition of the game was poor, and that there were few calves.

Consultation of specialists in various fields showed the necessity of intensive management,

primarily aiming at the restoration of the pastures. Thus started a hit or miss period during which it became clear that the creation of pastures involved going back to the old situation, and this was not a simple matter.

In 1938 the first pastures and patrolling trails were started in accordance with the recommendations contained in the report. A veterinary survey held during the same year showed that part of the bantengs (wild cattle) were suffering from *Distomatosis* and were infested with *Paramphistomum*, a parasite of the stomach and intestine. These diseases are present in more than 80% of all the tame cattle in Java but practically never have catastrophic results as long as the food situation remains normal. The situation in Ujung-Kulon was not considered disquieting.

It struck the author of the report that the game were concentrated at certain places in the reservation. Due attention was paid to this matter in selecting the locations for pastures. Other locations selected were those where traces of alang-alang and other grasses remained and those which might be assumed that "they" would not become marshy even during the rainy season (so as to reduce the risk of *Distomatosis* infection).

The first thing necessary was to cut the young forest, but certain palms and other trees were saved to give the game some shady places in which to rest and ruminate. It was not necessary to save shrubbery as a cover, because all the surrounding land was wooded.

The conditions under which the work had to be done were so primitive that there was no other way to dispose of the cut trees than by burning. All this lumber was therefore collected in piles which were subsequently burnt. Moreover it was considered advisable to interfere as little as possible with the way of cutting practiced by the workers, since these were all nomadic farmers whose abandoned gardens usually formed an excellent habitat for ruminants.

In this way we succeeded in a few years in obtaining a grazing area of about one hundred hectares (250 acres), partly new, partly improved. But elsewhere we had little success in establishing pastures, because we often failed to get new growth of alang-alang or other grasses. Instead of these there appeared stands of weeds that had no value as food for game, for instance *Stachytarpheta jamaicensis* (or *indica*?), *Melastoma polyanthum*, *Blumea balsamifera*, and a taller vegetation consisting of such plants as *Lantana camara*, *Ficus septica*, *Calotropis gigantea*, *Ardisia*

elliptica, and *Lagerstroemia speciosa*.

Experiments made on areas that had not been burnt over had about the same result: the grasses stayed away. Still another method, namely pulling up the weeds, root and all, resulted again in the same disappointment: the vacant spaces were taken up by seedlings of the old weeds, or a new worthless weed appeared on the scene, but no grasses. Thus a large part of the work remained without result, in spite of the fact that all experts, hunters as well as planters, had predicted that our methods would be crowned with success within a short time: waving alang-alang fields, or a field of grass.

We also found that almost every pasture had its own particular weed. There were areas in which *Lantana camara* was the murderer of the grass, almost to the exclusion of other weeds; elsewhere *Stachytarpheta* played the part, still in another place it was *Melastoma* or *Blumea*, and finally there were tracts that became covered with *Ardisia*.

Only at certain spots where the activities of poachers had resulted in the preservation of a large pasture of alang-alang or other grasses did our attempts at extension bring quick results, and could we, by burning, obtain a field of plants that the game could feed on. With most of the weeds a running fire could not be kept up, but *Stachytarpheta* was an exception, provided the attempt was made at the end of the dry season after many of the plants had dried out. We then dived into our pockets for matches and set fire to the many hectares covered by the weed. But we had to cash in another failure. There appeared a complete lawn of *Stachytarpheta* seedlings, closer than ever before, and the few grass plants that had maintained a foothold before, were now squeezed out of existence. We therefore had proof that our method, burning, could not be applied, so that all we could do was to pull up or cut weeds and shrubs.

Finally Nature herself brought a solution, for in the later years *Stachytarpheta* somehow came to grief, and the grasses increased progressively. It was now necessary only to destroy the higher plants. Fire had to be avoided, because it might entail the risk of a new "outbreak" of *Stachytarpheta* that would nullify the results obtained.

Areas on which the latter weed does not play an important part could be kept in condition by pulling up the higher weeds by the roots (*Lantana*, *Melastoma*, and *Blumea*), and by cutting young trees at ground level (*Calotropis*, *Ficus*, *Ardisia*,

Lagerstroemia), but complete results may only be expected by these methods if the work is done at least three times a year and if the growth of the vegetation is watched closely. The latter point is anyway essential, even when the pasture is a closed field of alang-alang or a perfect green-sward. This was brought home to us when the best pasture at Ujung-Kulon totalling 30 to 40 hectares and showing good young growth was invaded within one year by another worthless weed, *Leonotis nepetifolia*, which is now growing man-high there and has quickly disposed of all alang-alang and other grasses to such an extent that the ground below is completely bare. In a case like this it is essential to nip the evil in the bud, and this can only be done by ordering a large shift of hard-working weeders to exterminate the pioneers of the invading vegetation, root and all.

In the Ujung-Kulon reserve we have not yet used any manufactured weedkillers. It goes without saying that the use of such chemicals is not justified unless the greatest care is taken in accordance with the advice of specialists, to avoid poisoning the game. Moreover the population looks upon alang-alang as a weed, but for the game it is excellent food, so that it must not be exterminated. And finally there is always the possibility that alang-alang seedlings are coming up.

The planting of high-value pasture plants would be eminently desirable, but of course any plans in this direction could be carried out successfully only if intensive management could be effected, and in the Ujung-Kulon reserve this is not the case: witness our poor progress in providing new or improved pastures and our failure to control the *Leonotis* invasion.

In a reservation like Ujung-Kulon all efforts should therefore be concentrated on bringing back the original condition described at the beginning of this article. This goal is within reach, but it can be realized only if we have a team of workmen at our disposal whose activities in the reservation are of a permanent nature and who proceed according to a programme carefully worked out. Up to the present we have recruited our workers from among persons who during extended periods have little or no time available, and we have ample proof that this method is inadequate.

We are publishing our experiences here firstly to give an idea of the enormous difficulties in the way of realization of the aims of well intended

conservationists in the tropics, and secondly to encourage specialists to make their experiences known in order to assist us in eliminating those difficulties.

PULAU-DAU BIRD SANCTUARY

The management of this reserve, the breeding-ground of about 14 species of herons and storks, besides ibises, cormorants, and other birds, involves problems of lesser magnitude that have largely been solved. The reserve consists of only an 8 hectare (20 acre) atoll covered by a low to medium vegetation and situated off the north coast of Java.

This island did not draw the attention of conservationists until 1936 when it was still regularly visited by people from the opposite shore for the purpose of collecting eggs or young birds or of cutting wood. Shortly afterwards it was proclaimed a nature reserve and it was found that the presence of watchmen would not be sufficient to increase or even maintain the value of the island as a breeding ground, because the trees and shrubs offering good nesting opportunities, such as *Diospyros maritima*, *Allophylus cobbe*, *Aglaia odoratissima*, *Morinda citrifolia*, *Schleichera oleosa*, *Premna obtusifolia*, *Hibiscus tiliaceus*, *Thespesia populnea*, *Erythrina variegata*, and *Sterculia foetida*, were being smothered by quickly growing climbers like *Flagellaria indica*, *Canavalia maritima*, and many others, which had been joined by some plants that as a rule are harmless, for instance *Wedelia biflora*, *Lantana camara*, and even *Barleria prionitis*.

It was necessary to give regular attention to the progress made by this vegetation, which was threatening both the lower scrub constituting 80% of the plant cover of the island, and the trees to a height of 8 to 10 metres. The nesting capacity was thus endangered, because the space was reduced and also because certain birds do not like this rank vegetation to nest in. Moreover shrubs and trees overgrown with climbers would ultimately die and the plant cover of the island would be leveled down to a 1 to 2 metre high layer of weeds without any nesting value for the tens of thousands of pairs of birds that breed there now.

Already the danger had nearly materialized when we visited the island in 1942 after it had been left to its fate for only one year. We returned to the island in 1951 after it had been neglected for several years. A gang of study workers spent several days in cutting the climbers that had

already smothered a number of shrubs and treelets. Most of the original scrubby vegetation could however be saved. And up to the present day it has remained necessary to keep the climbers in check, as they take advantage of every opportunity.

On the other hand it may be necessary in the future to limit the height of trees and shrubs, because it is almost certain that some species of birds, including herons, do not wish to make their nests in trees that are too high. In order to avoid the disappearance of these species the cutting of trees may therefore become necessary. At present we have not yet enough experience to say definitely that this will be the case; continuous observation of the breeding bird population is required in order to obtain certainty in the matter.

The above instances show that the method of non-interference in a Game Reserve or Nature Monument will not always produce desirable results, and probably never will if the area in question had been subjected to anthropogenous influences to a considerable degree at the moment it was proclaimed a reservation, as was the case with the two areas discussed above.

SUMMARY

The Ujung-Kulon game reserve affords proof that human intervention remains necessary in the case of areas which due to anthropogenous influences harboured an optimum game population.

Letting Nature take its course, threatened to lead to complete failure as far as the preservation of ruminants is concerned. After a quarter of

a century without interference nearly all grazing areas had been covered by trees or shrubs, so that the food supply of the species mentioned became insufficient, the number of game animals decreased, their physical condition declined, and the number of calves was reduced.

It is essential in cases like these to maintain continuous supervision of the way in which the vegetation develops, to weed at least three times a year, and to have a proper shift of workmen available who can be employed immediately when a new invasion of weeds threatens to destroy the results achieved. Chemical weedkillers have not been introduced. Should this method be resorted to, it will be necessary to consult experts in order to avoid killing the game and to prevent grasses important for the game from being destroyed along with the weeds.

A very different problem, and one which has been solved, was presented by the bird sanctuary on the island of Pulau-Dua.

The danger in this case was a rank growth of climbing plants that threatened to suffocate the woody vegetation. Care had to be taken to combat the smothering of plants, otherwise the whole vegetation of the island would ultimately have been leveled down, and Pulau-Dua would have become useless as a breeding ground for the birds. In the future it may be necessary to cut the tallest trees also because certain birds now nesting there probably do not like to breed in tall timber. Pulau-Dua, too, had been under the influence of man when it was proclaimed a reserve, so that there was no question of a climax vegetation having evolved. Continuous observation of plant and animal life will be required in order to avoid our overshooting the mark.

THE EXPORTATION OF LIVE ANIMALS BELONGING TO THE FAUNA OF INDONESIA

KUSNOTO SETYODIWIRYO

Director, Botanic Gardens of Indonesia, Bogor, Indonesia.

The exportation of legally protected wild animals belonging to the fauna of Indonesia is forbidden, except by licence, and the exportation of non-protected animals is forbidden in quantities of more than 4 birds or more than 2 mammals belonging to the same species, forwarded by the same shipper and addressed to the same consignee abroad.

During recent years the interest in exportation has been increasing progressively, but the number of firms or persons who may be considered experienced is exceedingly small, and they have hardly any love or sympathy for the animals to be exported. It has appeared practically impossible to collect particulars on these points that would enable us, for instance, to refuse a licence on the basis of lack of expert knowledge. This applies to national and foreign exporters alike. It was therefore necessary to adopt other measures to keep the protected fauna out of the hands of unscrupulous exporters and to restrict the exportation of non-protected birds and mammals.

As a step in this direction we may regard the rule that with respect to all important protected animals, such as the orang-utang, gibbons, tapir, anoa and babirusa, export licences shall be issued only on behalf of zoological gardens or other cultural institutions (licences for the exportation of rhinos are never issued). When however, this rule proved to be ineffectual because certain zoos or other institutions sometimes appeared to cooperate with animal dealers, the measures were made more stringent by providing that the animals in question could be exported only when *exchanged* for exotic animals by zoological gardens in this country and institutions abroad, without any financial transaction involved.

Notwithstanding the fact that practically all zoological gardens in Indonesia are greatly in need of exotic animals, such as giraffes, hippos, antelopes, wildebeests, zebras, chimpanzees and gorillas, the interest in exchange is very limited.

This indifference on the part of the zoological gardens is however no reason to change the rule now in force, as it is not Indonesia's business whether animals belonging to the protected fauna are available abroad. But it is the task of

those in authority to leave no stone unturned to preserve the protected fauna for posterity.

The measures discussed above are, however, not efficacious, because the commercial value of the animals is rising and they are becoming an attractive object for smuggling. It is for this reason that I desire to appeal to the governments of the countries represented at this Congress to assist in defeating the purposes of the smuggling trade.

According to figures received from the Chief of the Veterinary Service at Singapore, a total number of 112 orang-utangs were transported via that city to foreign countries during the years 1953/56 without a licence from the Indonesian authorities either for being in possession of those animals or for exporting them. It is a pleasure to be able to state here that the Chief of the Veterinary Service at Singapore recently took a far-reaching decision by prohibiting the exportation of any orang-utang not covered by the licence required. But the illicit trade will not be completely stopped until importation without licence has been prohibited in every country of the world.

The destination of the 112 orang-utangs mentioned above was the following: United States, 66; Germany, 15; Netherlands, 10; Japan, 8; Australia, 7; Belgium, 2; Hawaii, 2; Thailand, 1; and Ceylon, 1. Most of the countries concerned are represented at this Congress, and for this reason I should like to request their representatives to submit the matter to their government. Should it be possible to extend the measures suggested also to the other animal species mentioned earlier, the smuggling trade will have sustained a heavy defeat.

If it is impossible to issue government rulings of the nature described, then we would be very grateful if the governments concerned, or else nature protection organizations in these countries would appeal to the zoological gardens to refuse to receive orang-utangs and other protected animals not accompanied by the licence required by Indonesian law. It may be taken for granted that all animals illegally exported are ultimately sold to zoological gardens.

The exportation to temperate zones of animal species not belonging to the protected fauna is restricted by a provision prohibiting their being shipped during the cold season (October to March inclusive). Considering that the shipments usually involve thousands of birds or hundreds of monkeys, the purpose of the provision was not only to restrict the numbers exported, but also to forestall criticism from the side of foreign Societies for the Prevention of Cruelty to Animals, which on humanitarian grounds object to the transportation of tropical birds and monkeys in open cages during the winter season in temperate zones.

Of course the trade is trying to evade this provision by applying for a licence to export to tropical and sub-tropical countries, whereas the ultimate destination is elsewhere, but an attempt

is being made to counter this practice by requiring the shipper to mention the city of destination and the address of the consignee in that city.

It is our conviction in Indonesia that the export of parts of the living fauna for commercial purposes constitutes a real danger to the continued existence of certain animal species, the more so as the number of individuals offered for export is in many cases only a fraction of the number of animals caught for that purpose. For this reason, I want it to be made known at this Congress what measures we are taking for the purpose of keeping the trade within justified limits and to recommend that similar measures be advocated by those animated with the same desire with respect to the fauna of their own country.

PROPOSED GAME PRESERVES AND NATIONAL PARKS IN THAILAND

BOONSONG LEKAGUL

Secretary-General, Association for the Conservation of Wildlife, Bangkok, Thailand.

Thailand is probably one of the last countries which has no game laws, game preserves, and national parks. This is not because the Thai people are too backward to know the value of their wildlife, but it is because our former governments were too occupied with the people's demands to see the vast and rapid destruction of valuable fauna, and perhaps too ignorant to realize the value of our living natural resources.

The *Niyom Phrai Smakom* or the Association for the Conservation of Wildlife of Thailand has proposed a game protection bill for many years, but this has never been put before the Parliament. It is still being considered, but never finalized. It would take quite a long time for this law to become effective, and many kinds of our wildlife, such as Eld deer, Hog deer, wild buffalo, and rhinoceros are being destroyed to extinction unless the government is quick to act.

The Association has done many things toward conservation in Thailand. It has proposed that the government establish big areas in Thailand as game preserves and national parks. These are:

1. *The Salob Range* in Kanchana Buri. This area is about 60 km. long and 40 km. wide. In the middle region, there is a big range of mountains on which there is still plenty of wildlife, and on the fringe around this area, there are stretches of rolling hills of open forests and open plains. The Association has suggested that the mountain in the middle part be kept as a game preserve in which no one is allowed to enter, and that the area around this mountain be made a national park but with no hunting allowed. This area should become one of the most popular spots because it is only 140 km. from Bangkok.

2. *Khao Yai* in Nakhon Nayok. This is a large range of mountains lying between Pak Chong and Nakhon Nayok, a short distance northeast of Bangkok. This mountain is the most important source of fresh water to the people in many provinces in the Northeast. There are still large stretches of virgin forest here. On its plateau there are wide patches of open plains and rolling hills. Game animals of very kind except the banteng are still abundant. The area is about 1,000 sq. km.

3. *Phu Phan* in Sakol Nakhon Province, north-eastern part of the country, is a lesser range of mountains of about 700 sq. km. The animals on these mountains are not very abundant because they are much hunted, but it is expected that they will increase after it has been reserved as a game preserve or national park.

4. *Thung Salang Luang* is a range of mountains in Phitsanulok Province, north-central part of the country. It is about 800-1,000 sq. km. in area and is still abundant with various kinds of our wild animals, especially the Eld deer which are very scarce in other parts of the country.

5. *Khao Kitchagood* in Chantaburi Province, southeastern part of the country. This is about 600 sq. km. in area.

6. *Khao Luang* in Nakhon Sithammarat Province in the south is about 600-800 sq. km. in area, composed of dense evergreen mountains with no open plains. There are a few nice waterfalls in these mountains.

Besides these six areas mentioned above, Phu Kadung in Loei Province in the Northeast contains many kinds of flora of the temperate zones. At the present time it is a reserved forest, but it should be turned into a national park in the future.

In the northern part of Thailand, the country is very mountainous. The forests in this area have been cut over by various tribes to make room for shifting cultivation, but there are still many places which are very scenic and have many nice waterfalls. Several good spots for game preserves and national parks can be found in the region.

STEPS TOWARD THE CONSERVATION OF WILDLIFE IN THAILAND

Thailand was once one of the richest countries in wildlife. Mr. John Bradley, a traveller and explorer, has written in his book of "Travel and Sport" of his walk from Burma to Bangkok in 1869. He noted in his diary what he saw when he camped on the bank of the Menam River (Chao Phraya River) not far from Paknam Pho (Nakhon Sawan). He said,

"During the night we were greatly disturbed by the wild animals, which came down to the river to drink and bathe. The moon was about full, and the light it gave was so brilliant that we could distinctly see elephants, rhinoceroses, buffaloes, and other animals sporting in the water. There were many hundreds of the various species, and it was rather dangerous work to approach so large a number. Each species kept to itself in the water, but they were very close together and we witnessed a fight between a bull buffalo and a rhinoceros, in which, however, neither seemed to be much hurt."

He also said that the rhinoceros at that time were as plentiful as other wild animals. He used to see them almost every day, sometimes as many as five or six of them in a day.

Elephants could be found in big herds in almost every part of the country, even a few miles to the north of Bangkok. Rhinoceros of both Javan and Sumatran varieties were at that time very plentiful in nearly every part of the country, especially in the northern, western, and southern parts. The seladang or the gaur were very plentiful in every part of the country except in the middle part. The banteng could be found down to the level of 8°N. latitude. It could not be found further south because there is no open forest from there on.

The Schomburgk deer were once very plentiful all over the middle part of the country, and could be found nowhere else in the world. They were found only in this part of the country because they were fond of feeding around the swampy ground of the low lying country. The Eld deer were found in big numbers in open forests and on plains of very part of the country. Its most southern part was Khao Yoi District between Rat Buri and Phet Buri, about the level of the latitude 12°30'N. The Hog deer were at that time also found in many parts of the country even in the brush country around Bangkok. The Malay sambar and the Barking deer were plentiful everywhere. Smaller animals like Mouse deer, hare, monkeys, langurs, gibbons, etc., could be seen almost everywhere. Winged fauna were also very numerous in the old days.

At the end of the reign of King Rama IV, Thailand had established more trade with European countries. The demand for the export of rice became greater and greater. People from other parts of the country attempted to travel to the central part of Thailand to work in the rice cultivation. A little later on, King Rama V ordered the cutting of the irrigation canals through many areas which were far away from rivers and canals and within a few years after that the whole central part of Thailand was opened for rice cultivation.

This brought rapid improvement in agriculture, but on the other hand it destroyed the habitat of many kinds of wildlife. The worst of all to suffer was one of the most beautiful kind of deer in the world; this was the Schomburgk deer. Their natural habitat was in the alluvial country of the central part of Thailand, and they were found nowhere else in the world. When their whole habitat was destroyed for cultivation, they were totally exterminated within a few years, and the last one was shot near Kanchana Buri in the year 1917.

Besides the Schomburgk deer, many other kinds of wildlife were also slaughtered and driven out of this part of the country during that period. This was really a big change in the history for our wildlife.

After that time, our game animals gradually diminished in number up to the end of the last world war, when the people of Thailand purchased war surplus vehicles which were made especially for travelling in rough country. They can be used wherever the oxcart can and thus can travel almost everywhere in the jungles. These vehicles made hunting more attractive.

Using spotlights for hunting at night in the cars became very popular. Within one night, hunters in a car can shoot quite a big number of game, which includes does and young fawns. Sometimes as many as seven or eight animals are killed while as many are wounded and left to die.

This is why the number of wildlife, both of game and non-game animals, was reduced very rapidly after the end of the last world war. This is the second era of the decline of the world of wildlife in Thailand. At present it is estimated roughly that there are only one-tenth to one-twentieth of the number of game animals as there were before the war.

Very few Eld deer and hog deer are left nowadays. Wild buffalo now are very few. These three kinds of wildlife are really in danger of being exterminated within this, or the next year at the latest. Very few rhinoceros of both Javan and Sumatran types are reported to be present on the high range of Tennasserim Mountains. A law for the protection of wild elephants exists, but as there are no special officers or game wardens, many of them have been shot for fun and for tusks in the last five to seven years, only a few are left in forests nowadays.

Because of this rapid reduction in the number of our wildlife, a group of people started a society

to control such ruthless slaughtering. This society is well known in Thai as *Niyom Phrai Smakom* and in English as the Association for the Conservation of Wildlife. It was set up in the year 1953. Its objects are not only to deal with the fauna as its name means but also with the conservation of the flora as well.

The work of the Association in its first few years has been mainly to educate the public about the value of the country's natural resources and their conservation, and to tell them about the varieties and habits of their fauna. The Association also drafted a game law but it has not been enacted.

The proposed game law follows the examples of those used in countries in Europe and America, i.e., to limit the number of game to be hunted, to limit the season of shooting, and to limit the sex and the size of the game hunted as well. Hunting of any kind of animal which become scarce will be strictly prohibited.

Besides sponsoring the game law, the Association has been active in other ways in the last year. To state briefly, these are:

1. To propose to the Ministry of Education that a course in conservation be taught.
2. To suggest to the government the reservation of six big areas for game preserves and national parks.
3. To suggest to the Ministry of Agriculture the prohibition of shooting and fishing in the big water reservoirs which are situated in more than 100 places in the Northeast.
4. To suggest the establishment of a wildlife sanctuary in Thailand as a "Deer Park."
5. To protest the destruction of a big forest on Khao Yai threatened with exploitation cultivation, and to suggest that this place be kept as a game preserve and national park and also as an important watershed area for the Northeast.
6. To start putting up a bird sanctuary at the big marsh of Lam Sai, near Pha Chi River at Rat Buri. The public has donated a big amount of money to help this program.
7. To give education in popular natural history and conservation problems to the public by giving lectures at various schools and societies, and by radio and TV programs.

8. To campaign for the game law, game preserves, and national parks. Conservation societies abroad have helped in this program by lending films on conservation.

9. To organize branches of the Association in upcountry districts so that the people in different provinces can have a good chance to see conservation in practice in their own provinces.

10. To make a collection of the fauna of Thailand and to ask the government to establish a museum of natural science in the near future. At present the Association has a very good collection of birds and mammals.

We are hoping to be very successful in the fight to have the game law, game preserves, and national parks here in the near future. Thailand seems to be the last country to give justice and mercy to the wildlife, but we will try our best to advance in the future.

DISCUSSION

Dr. H.G. Deignan of the U.S. National Museum commented on the areas in northern Thailand that are of highest national park calibre. These are of outstanding scenic beauty and represent an outline of Himalayan flora and fauna. As the most elevated topography in Thailand with rugged, inaccessible highlands, they contain many gems such as gentians and parnassias as representatives of the only temperate flora in the country, the dwarf rhododendron, serows, and a rich avifauna.

Dr. H.E. McClure pointed out the importance of education going hand in hand with conservation measures in the country.

Dr. G.C. Ruhle called attention to certain factors hitherto unmentioned that are contributing increasing measure in the destruction of game, such as the slaughter that is concomitant with wildlife photography, especially motion picture photography both professional and amateur, and the blind extermination of game accused without investigation as contributing to spread of disease or hampering development of pet projects (for example, the slaughter of Cape buffalo and other species in Africa in a campaign against sleeping sickness).

NEEDS FOR A CONSERVATION PARK IN NEW CALEDONIA

H. HÜRLIMANN

CIBA S.A., Basle, Switzerland.

A big hydroelectric power project will inundate the great majority of the flat and partly swampy areas known as "Plaine de Yate" and "Plaine des Lacs" in New Caledonia. At least ten endemic species, occurring only in this part of the island on serpentine soils, will be exterminated or endangered by the future artificial lakes, especially *Podocarpus palustris* Buchh., *Dacrydium guillauminii* Buchh., and perhaps also *Libocedrus yateensis*.

Apparently economic needs do not permit changes of the project, therefore the species in question should be preserved in other areas. In agreement with the wishes of the French forestry authorities, a conservation park should be created. The following measures should be taken into consideration in this connection:

Immediate programme:

1. A survey of the existing plants in the regions to be inundated, listing the ecological conditions and the plant communities and according special attention to plants not found elsewhere.
2. Establishment of a conservation ordinance for a park with varying ecological conditions.
3. Choice of a suitable site.

Long-term programme:

1. Better education of the population (European and native) toward protection of the nature.
2. Transfer of other New Caledonian species in danger into the conservation park.
3. Establishment of other conservation parks in other parts of New Caledonia, as proposed earlier.

The survey of the existing plants in the area of the future lakes would require the work of a botanist and his auxiliaries for about one year, during which he could also do other work of interest for the country. If approached in the

appropriate way, the industries interested immediately by the Power scheme would possibly be willing to support this survey.

The conservation project seems to have a better chance at the present time than in other occasions, as bushfires and severe droughts have influenced public opinion. However, further education of the population is needed.

The future conservation park should be out of reach of human influence as far as possible, and its site should be chosen in a way that the park would have positive effects for the ecology of the country, at least to some extent. Therefore, it could be situated for instance in the background of the valley of the "Rivière Blanche," extending from the swampy soils at the bottom of the valley up to the ridge of "Montagne des Sources," covering a wide spectre of different vegetations. This site would assure a steady water flow in the river which contributes to the future artificial lake and would be of interest even for the industry.

Cooperation and mutual understanding among the different interests will be essential in the establishment of such a conservation park in New Caledonia as it is elsewhere.

DISCUSSION

G.E.B. MURPHY: It has been repeated again and again that governments are uninterested in conservation *per se*. I urge enlisting the aid of the women, not necessarily through their acting with concerted effort as in clubs or churches, but as individuals in homes and schools.

H. GAUSSEN: There is an interesting island off New Caledonia that contains the only remnant of pure Polynesian forest. I would appreciate letters of support and detailed facts from Dr. Coolidge and Dr. Heim expressing their points of view in obtaining its protection.

H.J. COOLIDGE: A project is underway to raise funds for sending Dr. Macmillan to survey areas in New Caledonia proposed for flooding in hydroelectric projects.

The Galapagos situation in connection with the Darwin Centenary, and the plight of polar bears in Alaska were also discussed.

Symposium: *Effects of Shifting Cultivation on Natural Resources with Special Reference to Problems in Southeast Asia*

INTRODUCTION

J. E. SPENCER

Department of Geography, University of California, Los Angeles, California, U.S.A.

It would seem appropriate for this symposium to consider itself a committee nominated to plan detailed studies of the problems of shifting cultivation, rather than one meeting to propose answers, for we have too little of the factual knowledge needed to do the latter. From the experience of trying to understand the nature of shifting cultivation during a period of several years, I would suggest the following five questions as pertinent to our discussions.

1. What is shifting cultivation? We should not debate the merits of some 150 terms used for it, but should address ourselves to its content. More than anything else we need detailed factual data to establish typologies, varieties, and kinds. Only after we know the nature and diversity of this form of tropical agriculture can we name it, and can we proceed to deal effectively with its problems.

2. Where is it in Southeast Asia? Almost everywhere? Perhaps, but to date we have no good map of its broad distribution, and cannot be certain of its practice in different environments and in different regions.

3. Who practices it? Is it an attribute of simple cultures only, a cultural trait held over to the modern day from the past? Or is it a situational trait one, practiced by any and all kinds of people when particular circumstances point to its use as advantageous and profitable? Many conclusions about shifting cultivation have been written, but most of these have been recorded on the basis of too little study, and the question points to the need for more detailed examination of the actual practice in specific situations.

4. What are its results? I use the word "results" here rather than the word effects with a purpose. There seems to me two sub-questions arising here, namely:

a. Does shifting cultivation serve well or poorly those who practice it? How many people can live by it, on what areas of land, by what

level of living? This line of inquiry leads to the study of population densities, about which we need to learn a great deal more.

b. What does the practice of shifting cultivation do to the landscape and the environment? There are many expressions in the literature, and public opinions abroad, that shifting cultivation is always a destructive practice, destructive of soil and forests, but there is clearly diverse evidence on this subject.

Beyond the issues of soil erosion and of deforestation there are other categories of results which must be examined. What about fishery resources, animal populations, bird life, and water supply? Can data be marshalled to point to the results of the continuation of shifting cultivation with respect to these phases of ecologic environments? And what about the results for people themselves, people as populations? Will they thrive or be destroyed by the maintenance of shifting cultivation? Though the forester and the soils man may well wish to abolish shifting cultivation, do we really have enough evidence of the results of its practice to warrant this conclusion?

5. What should be done about it? Should we abolish it? Should we change it? Should we let it alone in remote areas? Should we "pass a law" and punish those who do not settle down on the land and cultivate it like some other people do? Experience in some areas would indicate that laws do not restrain shifting cultivators. Teaching shifting cultivators quite new traits does not quickly solve a problem. Here I would like to refer to my third question as to whether shifting cultivation is a cultural or a situational trait. If we knew that the practice is bad, and if the facts point to it as a cultural trait, then whole cultures must be transformed. If on the other hand, accumulated evidence suggests that it is a situational trait, then economic conditions for groups of people must be altered. These are two quite different patterns of action.

It seems to me that we do not now know enough to decide the effects of shifting cultivation on natural resources in any one direction. Perhaps this symposium can stimulate further

study to the end that a later Congress may again take up the question with the hope of applying developed knowledge to the general issue.

THE "BUSH FALLOWING" SYSTEM OF CULTIVATION IN THE CONTINENTAL ISLANDS OF MELANESIA

JACQUES BARRAU

South Pacific Commission, Noumea, New Caledonia.

The continental islands of the South West Pacific which form Melanesia can be schematically divided into two climatic areas: a dry one receiving less than 100 inches of annual rainfall (the main part of New Caledonia, Southern New Guinea, for instance), and a wet one receiving more than 100 inches of annual rainfall.

This wet area includes the main part of the Melanesian territories. There the humid tropical forest is the predominant vegetation and *Colocasia* taro the invariable staple sustenance crop.

The traditional system of cultivation in the Melanesian forests has been frequently called "shifting cultivation," but this could lead to some misunderstanding, for what exactly is "shifting cultivation?" I understand it as a method of land utilization where a piece of land is used for growing one or several crops and then is abandoned, the next crops being raised in the same way on virgin soil. However, if one considers the strict meaning of the word "shifting," a modern European system of farming with crop rotation could be called "shifting cultivation" as it implies also a move from one place to another during the rotation. As a matter of fact, there is no true free shifting cultivation or pioneer gardening in the Melanesian forest, but a regular rotation within a clearly defined area. I have never found in Melanesia an instance of a native garden opened on land never before used for cultivation.

The pattern of subsistence horticulture is always as follows: clearing of the forest to lay out the garden, use of the garden for about a year, and then leaving it to lie fallow for at least ten years. During the first and second year of this fallow period certain foodstuffs, mainly bananas, sometimes continue to be harvested by semi-foraging. This is a "bush-fallowing" system of cultivation.

If the climate is favourable—that is to say, with sufficient rainfall and humidity—regeneration of the arborescent vegetation is sufficient to produce a forest covering during the fallow. Horticulture is the true basis of the subsistence economy in the Melanesian forests. The natives who live there generally cultivate from 0.2 to 0.3 acres of garden per head, mainly planted with

Colocasia taro. The techniques of this gardening vary little. The land is cleared and taro cuttings planted in holes rapidly made by digging up the earth with a stick. If the clan owns a continuous stretch of land, cultivation takes place progressively throughout the entire area by immediate replanting of cuttings alongside each harvested section as it falls vacant, the land being cleared as required. Otherwise, the gardens of the clan are moved about in the forest from plot to plot, sometimes far removed from one another.

General burning seldom serves to clear land—the environment is hardly suitable. Most often the undergrowth is cut down or pulled up and piled at the foot of the tallest trees; it is then set alight, causing the tree to die slowly. The *Colocasia* taro cuttings are thus afforded shade which gradually diminishes. After harvesting, reforestation quickly takes place, especially in areas where humidity varies little throughout the year. This type of agriculture with "bush fallowing rotation" is a perfectly adapted system for the conditions prevailing in the rain forest. However, if, for some reason, the rhythm of soil utilization is suddenly quickened, reforestation is no longer possible. This can happen when, for instance, a clan has not sufficient land available to allow for the 10 to 20 years fallow necessary for natural regrowth. In this case other plant formation takes the place of the forest, the final stage of this deterioration being the formation of patches of grass. These provide native farmers with an easy solution. They are easily cleared by burning and the fire gradually causes the forest boundaries to recede. Incidentally, this was probably how the vast savannas in Melanesian territories with a definite dry season were originally formed on lands formerly occupied by a "dry forest," such as the *Acacia-Casuarina* forest which was probably prevailing on the western side of New Caledonia in ancient times.

In Melanesia, true shifting cultivation was perhaps the original form of agriculture. Today, however, the garden shifts over a definite and limited area, to which is applied the above described long fallow system of cultivation.

As indicated, the average area of garden is about $\frac{1}{4}$ acre per head and is sufficient to satisfy subsistence requirements. The duration of the bush fallow ranges from 10 to 20 years and, therefore, $2\frac{1}{2}$ to 5 acres per head are sufficient to practise this agricultural system.

These estimates can be confirmed by consulting the few detailed studies on native subsistence agriculture in Melanesia.

Thus from the agricultural inventory of Kandavu Island¹ in the Fijian group it was calculated that the average area planted with annual subsistence crops was 26.36 acres per village. The area under cultivation per head is thus approximately 1,500 sq. yds.

Again, Wilde de Ligny², in a study of native agriculture in Netherlands New Guinea, estimates at $\frac{1}{4}$ acre per head per year the area under cultivation there by communities using this particular type of cultivation.

It must be pointed out in passing that the area used for cultivation by bush fallowing rotation in Melanesia has often been overestimated. Some reports on this question have indeed assumed it to be $2\frac{1}{2}$ acres of garden per head per year. This has often led to inaccurate conclusions concerning the economic demography of territories where land is cultivated in this way.

In fact, the areas of land required for cultivation with bush fallowing are relatively limited, despite the fact that the land is left idle for long periods at a time. In the study by Wilde de Ligny, quoted above, he thus pointed out that in New Guinea the area required for this type of agriculture, supposing a theoretical population of around 1,000,000 practising this method, would represent only 5 per cent of the total area of the territory.

Each group of natives utilizing the soil in this way cultivates a certain defined area on the lands belonging to it. Since the whole of the land is not always suitable for gardening, certain plots are selected as the sites for gardens. The rhythm of land utilization varies according to the amount of arable land available. This explains the variation—10 to 20 years—in the duration of the bush fallow.

In the climatic conditions of areas where this agricultural system is the rule, regrowth of the forest cover is generally sufficient to protect the soil and restore its fertility. Moreover, since working of the soil is limited to a mere scraping up of earth with the digging stick at the site of each cutting to be planted, the risks of erosion are reduced. Furthermore, in gardens lying on the hill slopes, the natives possess the art of constructing rough terraces by stretching tree trunks along the contour lines or by other similar devices aimed at preventing degradation.

The bush fallow thus makes it possible to preserve soil fertility. Nitrogen is perhaps the only element which may sometimes be affected by this system. Cassidy and Pahalad³ have shown that in the wet part of the Fijian group, cultivation by bush fallowing rotation helps maintain the phosphate and potash content, but that, on the other hand, the nitrogen content seems to decrease. However, as a general rule, the bush fallow constitutes an economic and effective means of utilizing the soil while at the same time conserving its fertility. It can therefore be claimed, in the words of P. Samuel,⁴ that agriculture systems with bush fallowing rotation "are perfectly adapted to their essential purpose—to provide the grower and his family with food, on condition that he belongs to a sufficiently scattered population, possessing vast stretches of arable land."

Melanesian agricultural systems based on bush fallowing have provoked to date two completely opposite reactions on the part of Europeans.

One, with little justification, calls such a method of soil utilization "shifting cultivation" and therefore thinks it a waste of land and energy.

The other, approving the balance of this type of agriculture which is well adapted both to environment and social conditions of native life, prefers to change nothing in this primitive economic system.

My opinion on the subject is that sterile conservatism is as much to be avoided as a revolutionary misunderstanding of the situation which

¹ c.f. Fiji Department of Agriculture: *Annual Report for the Year 1953*; *Legislative Council Paper* No. 37, Suva, 1954.

² c.f. Ir. H.J. de Wilde de Ligny, "*Bevoekinglandbouw*", *Nieuw Guinea*, 3. The Hague, 1954.

³ N.G. Cassidy and S.D. Pahalad, The Maintenance of Soil Fertility in Fiji, *Agricultural Journal, Colony of Fiji*, 24 (3, 4), Dec. 1953.

⁴ P. Samuel, Agriculture Equatoriale Bantou et Agriculture Européenne, *Bulletin Agricole du Congo Belge*, 41 (3), September, 1950.

would seek to effect a radical change in the principles of native agriculture. Recognizing the fundamental good in traditional techniques does not prevent one from realizing that they are hardly in keeping with economic and social progress, which is inseparable from sedentary agriculture. Methods of cultivation with bush fallowing rotation are only suitable for subsistence production. It seems, therefore, that the guiding principle of all campaigns aimed at modernizing such agricultural systems should be to encourage the gradual movement towards sedentarisation of native agriculture of this type. However, along with this there will have to be some practical method of restoring soil fertility to make up for the effects of shortening the fallow and at the same time intensifying land utilization.

In traditional conditions of native life, cultivation with bush fallowing is certainly the best method of using the land if the environment favours this agricultural system. It creates a judicious balance between the native and the soil. In the numerous Melanesian territories where it is still practised, this balance has been maintained. Is it likely to continue? Doubts may be expressed on this score. The presence of Europeans in Melanesia is leading to an evolution which is inevitable and furthermore, desirable: an attempt is being made everywhere to develop cash crops on native land; at the same time the natives themselves are sought for work on plantations or European undertakings. These and other factors are tending to disturb the original balance. It must be maintained, but on a new basis, by reconciling the requirements of necessary economic development and the lessons taught by traditional agricultural techniques. To leave the customary agricultural system unchanged would mean ignoring deliberately the present evolution of Melanesian society.

The former balance of the traditional subsistence system must by some means be replaced by a new agricultural system based both on subsistence and cash crops. The manpower and area land required for the latter involves complete reorganization of the subsistence garden. In return for less labour it must be made to produce a greater variety of foodstuffs, in greater amount and for a longer period. The produce should be better distributed throughout the year and a simple means should be found to preserve some of it. How can these various aims be achieved?

By making subsistence agriculture more sedentary. The introduction of perennial cash crops, such as coffee and cacao, constitute an excellent means of inducing this effect. In the case of agriculture by bush fallowing rotation, plantations might be established for commercial purposes on the cleared land which has already served for subsistence crops. Apart from providing excellent soil cover and financial benefit for the natives, these perennial shrub crops will have the effect of restricting movement of the garden which will generally tend to be established near the village and be used more intensively.

By introducing new food plants for three purposes:

- a) to add variety to, and improve the diet;
- b) to facilitate production and preservation of foodstuffs;
- c) to increase production.

By improvement of agricultural techniques. Since evolution of subsistence agriculture means, in effect, a shortening of the fallow and more rapid exhaustion of the soil, the following should be introduced:

- a) rotation of subsistence plants grown;
- b) manuring the land, composting, for instance;
- c) planting the fallow with legumes to preserve soil fertility.

During the past few years, shifting cultivation has been strongly condemned as "the greatest obstacle in humid tropical countries, not only to the immediate increase of agricultural production, but also to the conservation of the production potential for the future, in the form of soils and forests."⁵

This is certainly valid in the case of true shifting cultivation, i.e., cultivation on one plot until exhaustion and then shifting to virgin land. Nevertheless, I feel that different systems of primitive land utilization have been too hastily grouped under the general label of shifting cultivation. This was the case for Melanesia. Indeed, true shifting cultivation in the humid tropics of the Pacific basin is perhaps today a rather rare occurrence, and better definitions are needed for a new approach to the problems involved.

⁵ Shifting Cultivation, *Unasylva*, 11 (1), 1957.

THE "SLASH-AND-BURN" (*RAY*) AGRICULTURAL SYSTEM OF THE MOUNTAIN POPULATIONS OF CENTRAL VIETNAM

PIERRE-BERNARD LAFONT

École Française d'Extrême-Orient, Vientiane, Laos.

This paper concerns a particular case of shifting cultivation. Shifting cultivation, if done correctly, is no problem for pedology. If not, it can have disastrous results.

This particular example of "slash-and-burn" cultivation shows a case of soil-destruction. It is a result of a survey in the territories occupied by the Djarais. Their neighbors, the Proto-Indochinese, do shifting with a method, therefore this example is not applicable to them.

The mountainous region of Central Vietnam, known under the name of the "Pays Montagnards du Sud" (P.M.S.), is geologically a rigid crystalline massif in part unchangeable by the overflow of basalt during the quaternary era.

Situated between the 12th and the 17th parallel (North), the Mountainous Lands of the South undergo the summer monsoon and are affected by two seasons: a rainy season from July to September and a dry season from October to June, breached in January to March by showers.

In the beginning, this region was covered by forests as confirmed by the legends of the mountain peoples and by the first European travellers.

The region is inhabited by Proto-Indochinese (approximately 1,200,000), divided into tribes, of which the most important are the *Djarai*, the *Rhades*, the *Bahnar*, the *Muong*, and the *Sedang*.

These people have, for the most part, an agricultural economy based on rice cultivation with corn and vegetables as complementary crops. This agriculture is technically the most rudimentary, and the mountain people practice the slash and burn method.

THE SLASH-AND-BURN METHOD

Technique. When a portion of a forest has been chosen as a potential field, the trees are cut down: and the brush is cleared away (February-March). Once the stumps are quite dry, they are burned. Next, the land is weeded and then sown.

In general, fields are cultivated for three years. They are then abandoned for a period of between five to seven years and are recultivated for a period of two years, after which they are completely abandoned.

Production. The average production of a dry rice field made in the forest by the *ray* system is the following:

First clearing:—

- 1st year's culture: 2.3 tons of rice per hectare;
- 2nd year's culture: 1.5 tons of rice per hectare;
- 3rd year's culture: 500 kilos of rice per hectare.

Second clearing:—

- 1st year's culture: 1.5 tons of rice per hectare;
- 2nd year's culture: 750 kilos of rice per hectare.

Brush fires. During the period between the first and second clearings, that is to say between five and seven years, the undergrowth is not permitted to come up. Each year during May, the jungle is burned so that the first rains cause the growth of grass which is used for the consumption of the buffalos and horses. Because of this, the second clearing is made on land that has already won over the jungle, the thorny brush having been destroyed by the first clearing and successive fires.

After the field is abandoned for rice production after the second year of cultivation following the second clearing, it is still burned annually in May.

RESULTS OF SLASH-AND-BURN ON PEDOLOGY

The soils of the P.M.S. are in a state of unstable balance. The large forests which covered the soil, and still exist in certain areas, were rooted in a very shallow layer of soil.

Ray cultivation could offer a lasting system of soil utilization if it were practiced wisely, i.e., with some concern to assure a reconstitution of

the exhausted eroded soil. However, instead of practicing a system with a long-term forest fallow, the mountain peoples of the P.M.S. are preventing any possible forest preservation by yearly brush fires resulting in a savanna of *Imperata* grass.

Let me add that (a) the absence of trees thereafter prohibits any renewal of the humus (once furnished by the fallen leaves); and (b) that annual burning results in the topsoil being washed away by the rains. The fact that no trees are kept in the *ray* that could serve to protect the soil, together with the lack of superficial permanent roots (fixative rhizomes) to protect the surface soil between the burned-off grass clumps, helps the rains to carry on their job of erosion. Finally, this process of erosion favors a laterization of gigantic proportions.

Soil destruction and laterization have reduced considerably the amount of arable land. Land designated as arable some 70 years ago by the Reverend Guerlach and by Captain Cupet some 60 years ago is now merely desert land. One-fifth of the land in the Pleiku district, one-fourth of the land of Haut Dak Pa, and one-third of the land in the east of the province of Kontum have become unfit for cultivation and as a result have been abandoned.

IMPACT OF SLASH-AND-BURN CULTIVATION ON MAN

Slash-and-burn cultivation is not conducive to a high density of population. The system as practiced on the P.M.S. is tantamount to a low level of consumption and is tied in with a pure subsistence economy, for a hectare effectively cultivated can supply only the minimum needs of five people.

In order to have a permanent home site, it would be necessary that the slash-and-burn techniques be practiced judiciously with an eye towards replenishing the exhausted and eroded land by putting in crops. The mountain peoples are thus forced to cultivate their *ray* fields further and further from their villages. When the fields are too far away, the inhabitants move their village to another area where it will again be in the midst of the new fields. In 1954, in the regions of Bahnar-Alakong and Die, it was noted that the villages had been relocated more than 10 kilometers away from their 1943 locations. This semi-nomadism is a direct result of the unbalanced system of soil utilization.

When moving, the villagers abandon eroded lands which quickly laterize and head for a forested region which they begin to destroy little by little.

There has been a general migration of the various tribes: the Djarai villagers in the Chu Hodrung region migrate regularly towards the Cu Ty region as well as to Cambodia; the Djarai-Sesan have occupied the Yalli region and are heading gradually towards the Kontum; and the Sedang are migrating towards the alluvial region of Bla in Kontum.

This semi-nomadism necessitated by the need for arable land explains the migration of the mountain population which can be verified by comparing village settlement at the end of the 19th and the middle of the 20th century. This village migration has a tendency to concentrate the population. If the Djarai are thus grouped in the regions of Cheo Reo, Pleiku, Plei Ky, Cu Ty and Yalli, it is only because these regions offer arable soil. If they have abandoned the regions located between Pleiku and Cheo Reo, Pleiku and Plei Ky, Pleiku and Cu Ty, it is only because they have exhausted the soil.

While the general population density of the P.M.S. is light (3 persons per square kilometer), the population density in certain regions is increased to 25 persons per square kilometer, due to migration. Whereas a hectare of *ray* field can nourish approximately five people, this figure represents the lowest level of consumption needs of the numerous villages in the provinces of Pleiku, Darlak and Haut Donnaï.

As a result of this population concentration on arable land, the density of population must be estimated at seven persons per hectare in actual cultivation, which can only be interpreted to mean inferior production in terms of consumption needs.

About one-half of the mountain people of the P.M.S. are affected by food shortages during two months of the year (the two months that precede the harvest, August and September) and cannot subsist without outside assistance.

This aid is obtained by employment on plantations. To give an idea of the significance of work on the plantations, let us use as an example the district of Pleiku. With 1,400 hectares planted, the annual need is 470,000 coolie man-hours; the lands of the P.M.S. have 10,000 planted hectares.

How long will this supplementary means of subsistence last? That is the question asked by

the Meteorological Bureau and the Economic Council of the P.M.S. The *ray* clearings and the bush fires, contributing to a decrease in the dry season rains, the most valuable for perennial crops, are endangering the existence of the plantations in the P.M.S. The example of Cada, 25 km. east of Banmethuot may be cited. The drop of rainfall has made the region impracticable for perennial crops, has forced the planters to abandon the important tea plantations, and has also restrained the extension of plantations of *robusta* coffee. It has created for the mountain people of this region the problem of survival. For the Economic Council of the P.M.S., it has demonstrated the urgency of taking steps to stop the destruction caused by the *ray* and by bush fires, destruction which has burned up the regions which formerly were areas of forest favorable to torrential rains.

PROBLEMS CREATED FOR P.M.S.

The slash-and-burn culture has resulted in the following: destruction of the soil; a decrease in arable land; a dangerous decrease of rainfall endangering the existence of plantations; causing the people to practice semi-nomadism; and a concentration of people in certain regions thereby accelerating the process of destruction of soil beneficial to production.

The French and Vietnamese official services concerned with these depredations have attempted to help improve this state of affairs. Unfortunately, the measures decided upon, even though good in themselves, have had few practical results due to difficulties in application.

Official services decided to initiate a plan for the protection of the forests (a plan which required control of tree-cutting and forest conservation), but this could not prevent the mountain people removed from administrative centers from destroying the forests with their *ray* cultivation, from "inadvertently" burning up the pasturage for their cattle and from "accidentally" burning the land they desired for cultivation. As a result, the plan for forest conservation was doomed to failure. It was technically sound, but administratively unworkable.

As to the plan for reforestation, undertaken in limited regions under the supervision of the Ministry of Water and Forests, there would have been results if the events of these last years (from 1945 to 1954) had not suppressed all control, allowing the mountain people to cut

down the trees and burn the centers of reforestation created by the Department of Waters and Forests.

This problem of the protection of forests is predominantly tied in with the introduction of a new agricultural system. As long as the slash-and-burn system is practiced, the mountain people will be forced, in order to provide for their subsistence, to destroy the forests. It is necessary, therefore, for the official services to induce the mountain people to adopt a new agricultural technique and to practice wet rice cultivation.

It seems that this new agricultural method would be well received by the mountain people, for the rice fields yield (good years and bad years) an average annual production of 1.7 tons of rice per hectare and require much less work than the *ray*. The Churu tribe, which had been practicing wet rice cultivation for a long time, could foresee no major problems in introducing the plan to the other tribes. However, a triple problem arose: (1) the mountain people refused to use their buffalos to plow the rice fields, for the buffalos are raised for sacrificial purposes and should not be used for such work; (2) the *Potao Pui* and the *Potao Ya* (the King of Fire and King of Water) prohibited the mountain people from using the plow and fertilizer, threatening death to those who transgressed; (3) lastly, they ran up against traditionalism.

The reform of agricultural techniques could not succeed without educating the mountain people and without setting an example. Education of the young mountain people gave more or less good results, each school owning a garden where the students were taught how to cultivate the ground by methods other than those practiced by their ancestors. Alas, for the past two years, the schools of the mountain people have been disappearing, and those that the Government of Vietnam has not closed no longer offer practical lessons in agriculture.

An example might have been furnished the mountain peoples by the Vietnamese living in the P.M.S., but these were merchants for the most part or were employed on the plantations. It was rare to find a Vietnamese farmer. Since 1956, the Commissary of Refugees has settled in the P.M.S. a certain number of Vietnamese refugees from North Vietnam. But this settlement was made in still fertile areas and has resulted in leaving the mountain people with only the poorest hilly lands, most unsuitable for wet rice cultivation.

As to the aid furnished by the Government of Vietnam to the inhabitants of the P.M.S., aid aimed at the creation of perennial rice agriculture, it has up until now been furnished only to those of the "Vietnamese race." The mountain peoples have been forced to continue with their traditional agricultural methods. Thus, not one of the problems resulting from slash-and-burn cultivation has been resolved on the P.M.S.

BIBLIOGRAPHY

- Guerlach, R.P., *La Mission des Sauvages Ba-hnars*.
 Cupet, Capitaine. *Mission Pavie: Géographie et Voyages*. 3.
 Bitard, P., *Carte Ethnologique de la Région de Voaine-Say*. BSEI, 1954.
Bulletin de l'Office Météorologique de l'Indochine.
Bulletin de l'Office Météorologique du Viêt-Nam.
Comptes-Rendus du Conseil Economique des Pays Montagnards du Sud (P.M.S.).

DISCUSSIONS

Dr. Blumenstock called attention to the substantial body of literature in which there is no support for the notion that shifting cultivation's removal of forests leads to climatic change. Micro-climatic changes do occur, but not of the type indicated by Dr. Lafont. Fluctuations in rainfall cannot be described as effects of shifting cultivation.

Professor Stamp strongly supported Dr. Blumenstock's position.

Dr. Spencer, the Chairman, called for further examples of shifting cultivation which could bring out the fact that there is great diversity in the practice. He described briefly the marginal situation in which Philippine landowners use tenants to help clear and plant with coconut trees land owned in large holdings in such a way that shifting cultivation actually is the result of short-term tenant occupation of any one plot of ground.

Others present pointed out that such perennial crops as rubber, coffee, and cacao have entered the economy of many shifting cultivators in many parts of the tropics in such a way that shifting cultivation sometimes does transform itself into permanent cultivation.

Dr. Goodenough called attention to New Britain where a declining population finds it difficult to rotate its field rapidly enough to prevent the development of second-growth forest trees of considerable diameter. The growth of such forests presents greater difficulty to later cultivators than is the case when rotation can bring fields into use while still covered with lesser growth.

Dr. Brown commented on conditions in North Borneo where an increase in the population has led to a shortening of the rotation, which in turn prevents the regeneration of the forest and prevents adequate recovery of the land by means of a sufficiently long fallow period.

Dr. Halpern pointed out that in Laos permanent field cultivation and slash-and-burn cultivation supplement each other. The same cultivators may have wet rice land in valleys and temporary forest clearings on the hillsides.

Dr. McClure raised a question regarding the speed of regeneration of forests once work over by shifting cultivators.

Dr. Freeman pointed out that shrubby growth maturing into forests is widespread unless repeated burnings have killed stumps and seeds. In the latter case light-loving species rapidly replace clearings and form a first stand in developing the growth on old clearings which may be very slow in becoming forests.

Dr. Pelzer remarked that natural regeneration of forest depends in part on the length of the dry season. In wet regions, forests grow more rapidly than in those with prolonged dry seasons.

Professor Stamp pointed out that changes in vegetation do not lead to changes in climate, and that forest regeneration often is closely related to the porosity or water-retentiveness of soils, with heavy forest returning quickly to areas which retain soil moisture in the face of even moderate rainfall, and forest replacement being slow on non-retentive soils in even quite humid areas.

Drs. Brown and Nicholson commented on the effect of shifting cultivation on dipterocarp forests.

Dr. Spencer pointed out that dipterocarps are often not found in the first growth on old clearings in the Philippines, where various short-lived soft woods first return, but that the dipterocarps gradually move into such clearings at later dates.

SHIFTING CULTIVATION AND SUCCESSION TO GRASSLAND CLIMAX

HAROLD C. CONKLIN

Department of Anthropology, Columbia University, New York, N. Y., U.S.A.

Under conditions of shifting cultivation it appears that succession to grassland, rather than to replacement forest, is determined partly by climate, vegetation, and topography, and partly by the use of fire and cattle. I would like to discuss the relative significance and interrelationship of these different variables in terms of the relevant farming and hunting practices observed among a contemporary group of integral shifting cultivators in the Philippines.¹

In the grassland associations of their upland territory in southern Mindoro. Hanunóo swidden farmers recognize more than 60 gramineous and other herbaceous weed types. One of three types of spear grass, known locally as kūgun (*Imperata* spp.), is usually dominant. Along rivers, and under particularly moist conditions, the most prominent grass may be tigbaw (*Saccharum spontaneum*). In addition, these associations include a dozen common but rarely dominant grasses and sedges of the genera *Andropogon*, *Bothriochloa*, *Digitaria*, *Echinochloa*, *Polytrias*, *Cyperus*, *Kyllinga*, and *Mariscus* and a number of wild legumes, composites, spurge, and rubiaceous herbs. In this discussion, however, we need focus our attention only on the predominant local forms of *Imperata* and *Saccharum spontaneum*. For the Hanunóo, these species are also unique in that they are both agricultural pests and economic necessities. In a newly planted field they are exterminated as undesirable weeds, while in other contexts they are protected and used as essential economic resources (e.g., for thatching and grazing).

In dealing with these grasses, the Hanunóo sharply distinguish three general growth stages: short (up to 30 cm. for *Imperata*, 90 cm. for *Saccharum*); tall (up to 1.5 m. for *Imperata*, 3 m. for *Saccharum*); and old or tangled. Because tall grasses can not be used for grazing, they must be removed periodically to allow for new growth where pasturage is required. The Hanunóo accomplish this task either by cutting (gārab) with a small knife, in which case the harvested grass is bundled and dried for thatch, or by burning (tūtud). In the latter case, fire paths are

cut along the inflammable second growth forest borders of the patch to be burned. Because of their dense tangled habit, and the presence of competing herbaceous weeds, old grasses can neither be cut for thatching nor used for grazing. Hence they are often burned to allow for new growth. Trails passing through a noncattle tall *Imperata* area become almost impassable grassland thickets unless such areas are cut or burned annually.

In sparsely settled regions, extensive tracts of preferably tall or old grassland are burned annually in hunting game. By one method ('irub), deer are lured out of hiding by the edible ashes which remain after firing a patch of grass. In the fire surround method (sūnug), as many as 100 men armed with javelins and harpoon-spears, bows and arrows, and bush knives cooperate in killing deer, wild pigs, and buffalo, and other game caught within a large double ring of fire set by four runners with torches. Neither of these techniques can be used where grassland is at a premium. For example, in Yāgaw, a six square-kilometer area inhabited by a community of 150-odd Hanunóo, and for which I have records of shifting cultivation activities since 1953, there are less than 25 hectares of grassland. Even roofing thatch must be cut frequently in other areas because of the local grazing requirements of more than 50 head of zebu cattle. In the late dry season (April, May), however, some Yāgaw men travel to more open regions where such hunting practices occur annually.

The Hanunóo distinguish two other related kinds of man-made grass fires: lamay (escape swidden or trail fires), and tagurarab (backfiring to fight unwanted grass fires). In the last few years there have been no accidental grass fires in Yāgaw. In fact, a large portion of the available grassland has not been burned intentionally for some time because grazing cattle and goats have kept the young grass shoots trimmed almost like a lawn. According to many independent accounts, some Yāgaw grassland appears to be decreasing in size; i.e., the forest margins are "creeping in," due to maximal grazing and con-

¹ For a more detailed ethnographic account of this particular type of economy, see Harold C. Conklin, *Hanunóo Agriculture, A Report on an Integral System of Shifting Cultivation in the Philippines*, FAO, Rome, 1957.

comitant lack of necessary firing. Other sections have not been burned because of constant cutting for thatch.

The Yāgaw area, located on the eastern side of southern Mindoro, averages more than 2,600 mm. (100+ inches) of rainfall a year. The relatively less wet "dry" season is short, rain falling on at least six days of every month. In most of the area, the terrain is steep and broken, elevations ranging from 300 to 800 meters; drainage is excellent. For ritual and geographical reasons the ridges which bound the area on three sides are covered with climax forest. Most of the remaining landscape is covered by second growth jungle in which scattered patches of grain, root, and tree crop plantings—in various stages of maturity—are located. Hanunóo mixed swidden farming is an established integral system of shifting cultivation in which extensive intercropping, dispersal of fields, and the raising of cattle, goats, and pigs for feast food and trade all share a long history. Pioneer settlement of the area has been traced back to the beginning of the 19th century. No permanent field agriculture has ever been practiced in the area, though some privately owned fruit trees originally planted in swiddens over a century ago are still protected in productive grove associations. In separate spots distributed throughout the Yāgaw area there are over 60 separate coconut plantings ranging from several to more than 50 mature trees each.

In a forest region such as Yāgaw, wind-blown seeds of grasses and various weeds take root easily in the exposed soil of a new clearing. Only by repeated knife weeding are such plant pests controlled during the growing period of the major annual crops. By the end of the main rice harvest, however, perennial bush and tree crops have begun to mature, and natural reforestation by air- and animal-borne seed from the adjacent uncut jungle, and by the resprouting of stumps and limbs of felled or pollarded trees, usually follows. As tree growth increases, grasses as well as other light-seeking herbaceous weeds are gradually shaded out.

The speed with which these grasses disappear is partly determined by the location of the swidden with respect to certain features of the immediate physical and natural environment. Hilltop and ridge sites remain maximally exposed to light, wind-borne, hairy-glumed grass seed while reseeding from forest stands, the nearest of which are at lower elevations, is minimal. Similar deterrents to rapid reforestation obtain where a site is bordered only by other new swiddens or

grassland instead of by secondary or climax forest vegetation. As a general rule, a swidden located on a slope facing into the prevailing winds during the drier post-grain-harvest months is favored over one located on a leeward slope where dry season rainfall is much reduced and where the consequently longer periods of soil exposure encourage the spread of *Imperata* and wild *Saccharum*. The Yāgaw area as a whole tilts toward the east, the direction from which the rain-bearing hot season winds blow.

Where climatic and terrain conditions are ideal for swidden agriculture, a single firing of cut jungle does not — by itself — start a succession to grassland. However, repeated firing of the same site during the following and successive years, for recultivation or by accident, may kill many of the coppicing stumps and young tree seedlings, and discourage the growth of broad-leaved shade-providing shrubs, while favoring the spread of erect grasses (especially *Imperata*) whose extensive stoloniferous rhizomes and deep roots are left uninjured. If allowed to continue, these underground parts form a dense sod matting 10 to 15 cm. thick, the deeper rhizomes of which may extend down to 30 cm. below the ground level. This results in an extremely persistent weed source which cannot be controlled effectively except by the use of permanent-field agricultural soil-turning techniques. Even if the weed situation could be kept under control, grassland associations lack sufficient ligneous growth to provide the ash cover desired for swidden cropping. The Hanunóo never attempt to clear a new swidden at a site largely covered by grasses.

The Hanunóo recognize that some trees like salibangbang (*Bauhinia malabarica*), barunāsi' (*Antidesma ghaesembilla*), and tūlung (*Ficus nota*) have root systems well enough developed to withstand repeated grass fires. But the main process known to the Hanunóo by which woody species can replace grassland is intensive grazing and browsing. Cattle give the forest a fresh start by keeping down the choking grass and by scattering the undigested seeds of pioneer trees they have eaten. These trees include not only the fire resistant species just mentioned, but also such types as 'ambabālud (*Neonauclea formicaria*), 'anudla' (*Pipturus* sp.), kūpang (*Parkia javanica*), and maslākut (*Acalypha amentacea*). In a number of neighboring areas swiddens are being cleared today for the first time in this century in forests which, as a result of continued and intensive cattle raising, now cover what was extensive grassland 25 to 30 years ago. As one Hanunóo stated

succinctly, "bāka lang ti magda'ug sa kūgun" (only cattle can conquer cogon).

The numerous specific activities noted in the foregoing description of shifting cultivators' direct influence on grassland associations can be summarized briefly in terms of the four basic processes involved:

- (1) weeding,
- (2) grazing,
- (3) cutting (for thatch and fodder), and
- (4) firing (for attracting and scaring game, improving grass for grazing and cutting, trail clearing, fire fighting; and by accident).

We have noted particularly how these and other activities may interact differentially in accelerating or checking the succession to grassland climax. In Yāgaw, partly because of favorable climatic and topographic conditions, the established patterns of mixed swidden farming are apparently sufficient to maintain a continuing balance between forest and grassland.

Large sections of the western side of Mindoro, however, are covered by cogon grass. As on many of the other islands of western and central Malaysia, one cannot help being struck by this contrast between old areas of shifting cultivation which are densely forested and those which are surrounded by, or adjacent to, large tracts of *Imperata*-dominant grassland. In view of this contrast and the Yāgaw evidence, it is obvious that the simple equation of grassland climax with shifting cultivation is inadequate to explain the processes by which the present uneven distribution of this climax was achieved.

If we assume that agricultural clearance of forested islands originally proceeded from coastal regions to interior regions, from lower to higher elevations, it is quite probable that cleared ridges were the first sites of grassland development because they lacked adjacent, higher forest margins from which reseeded could take place. This occurred more rapidly in areas (such as western Mindoro) where there was a prolonged dry season during which the winds, having lost most of their moisture on the eastern, windward slopes of the island, helped to carry seed from the

exposed ridges to lower land that had recently been cleared. Thus, the chances for expansion of grassland seawards were great. On the other side, where hot-season rain-bearing winds blew in from the sea, most of the air-borne grass seed originating on the lower, exposed ridges ended up in uncleared primary forest where it could not survive.

This process probably continued slowly until it was halted at higher elevations by the increase in quantity and distribution of rainfall and the concomitant loss of any differential effect of a "dry" season. Only the deep or sheltered valleys and unusual terrain features broke the pattern which eventually left long dry season leeward slopes and ridges of most islands *Imperata* covered, and allowed short dry season windward slopes to remain relatively well forested.

Within this broad pattern of floral succession associated with primitive techniques of pioneer forest clearance, further local changes in landscape have resulted from different types of shifting cultivation. As we have noted above, features of these systems which favor the expansion of grassland areas are:

- (1) Use of ridges and hilltops as swidden sites,
- (2) Simultaneous clearance of many adjacent sites,
- (3) Escape fires,
- (4) Repeated grass burning for hunting purposes,
- (5) Successive plantings of grain crops—for more than two years in the same swidden,
- (6) Lack of intercropping;

while features which help to decrease or reverse the succession to grassland include:

- (1) Associated cattle grazing,
- (2) Dispersal of swiddens,
- (3) Extensive intercropping,
- (4) Avoidance of exposed ridges as swidden sites,
- (5) Use of fire breaks in swidden burning,
- (6) Annual grass burning for grazing and cutting purposes,
- (7) Only one or two plantings of major grain crops per swidden cycle.

POPULATION-LAND BALANCE UNDER SYSTEMS OF TROPICAL FOREST AGRICULTURE

HAROLD C. CONKLIN

Department of Anthropology, Columbia University, New York, N.Y., U.S.A.

The estimation of population limits beyond which certain forms of land utilization may not be continued without noticeable deterioration of natural resources is particularly complex in areas where systems of tropical forest agriculture occur. Upon the accuracy of such estimates, however, rests the potency of many comparative and theoretical arguments concerning the viability and evolutionary position of such systems. In this symposium, therefore, it would seem appropriate to outline briefly the essential measurements upon which reliable estimates must be based by noting how we can determine most efficiently and express most simply the critical carrying capacity of a tropical forest agricultural area in terms of population size and density.

In the humid tropics, forest agriculture means shifting cultivation, which may be defined minimally as any continuing agricultural system in which fields (known as swiddens, or locally as *ladang*, *kaingin*, *rai*, *djum*, etc.) are cleared by fire and are cropped for shorter periods than they are fallowed. In such systems, critical population limits can be expressed meaningfully only in terms of cultivable area, not in terms of total area. And, in any given region, there can be no absolute carrying capacity, but only one which is relative to a particular system of land utilization.

Thus, for each type of shifting cultivation and for each set of external (environmental) conditions, it is necessary to reduce the relevant cultural and agronomic data to three quantifiable variables: L maximum cultivable land available (conveniently expressed in hectares); A minimum average area required for clearing, per year, per individual (in hectares); and T minimum average duration of a full agricultural cycle (in years). These in turn, by the use of very simple formulae, can be used to obtain C_s the critical population

size and C_d critical population density (in people per square kilometer of L)—the two ways of expressing critical carrying capacities:

$$\frac{L}{AT} = C_s \qquad \frac{C_s}{T} \times 100 = C_d$$

The arithmetic is simple, but the estimation of L , A , and T is not. Nor are these three variables equally transparent or equally significant for the analysis of swidden farming systems through time. I have listed them there in the order of decreasing ease in their determination, and, simultaneously, in the order of increasing importance for the study of change and the long term effects of such systems.

L is correlated, at least in part, with non-renewable natural resources, determined mostly by basic limiting factors such as climate (rainfall and temperature) and soils (terrain and relief); A is correlated with human resources, with units of the population and their requirements in new land per annum as determined by varying rates of clearing; and T is correlated with the most elusive units of all, those changes in the sequence and duration of swidden activities which are largely determined by specific techniques and methods of crop and soil treatment. The highest adaptive potential is concentrated in the cultural factors which determine most of T and part of A . Because the estimation of these two variables cannot be provided by short-term or partial analyses, it should be stressed that in the investigation of population-land problems of tropical forest agriculture—whether for functional, historical, comparative, or applied purposes—the first step should be the thorough analysis of the structure and content of the particular systems involved.

SOME ECONOMIC ADVANTAGES OF SHIFTING CULTIVATION

E. R. LEACH

University of Cambridge, Cambridge, England.

I should start by explaining that I have had the opportunity to observe, at first hand, shifting cultivation procedures in three different parts of the world: North Burma, Sarawak, and Dry Zone Ceylon. The ecological, technical, and economic factors involved differ in each case. The particular factor to which I wish to draw attention in this paper is the economic one. One of the most general features of shifting cultivation everywhere is the persistence with which native peoples adhere to shifting cultivation techniques in the face of administrative disincentives put forward by the local government.

In most parts of Southeast Asia, European colonial governments have been fairly consistently hostile to all forms of shifting cultivation over the best part of a century, but in most areas the practice of shifting cultivation continues unabated. Indeed in my North Burma work I came to the conclusion, after a very careful study, that shifting cultivation was more extensively practised in 1940 than it had been in 1860. In Ceylon too, shifting cultivation practices become rampant whenever strict government control is withdrawn.

This persistence is quite commonly attributed to some combination of conservatism, stupidity, and laziness on the part of the farmers concerned. It has often been supposed that education in more scientific agricultural methods must alone, in the long run, bring about reform and the end of shifting cultivation. I have often heard such views expressed even among experienced agricultural officers and other high administrative officials with long experience of the countries concerned. This utopian belief, that all will be well if only the government is patient, ignores the fact that shifting cultivation often offers greater economic rewards than any alternative form of agricultural practice. The nature of these incentives towards shifting cultivation deserves closer study than it has usually received.

Administrative opposition to shifting cultivation is usually focussed on two particular features:

- (1) the destruction of valuable forest timbers;
- (2) the dangers of deforestation and erosion.

Those who emphasize the former factor often forget that, from the point of view of the villager, the destruction of valuable timber is irrelevant; he himself will never get any benefit from the forest timber anyway. As regards the deforestation factor, this clearly is a matter of great importance to the shifting cultivator, but it only becomes significant when migratory movements of the population are artificially restricted by government action. Dr. Freeman, writing of the Iban in Sarawak, has recently described in detail a strikingly destructive system of shifting cultivation. The Iban however are not lunatics; they practise this kind of cultivation in an area where they are thin on the ground and where experience over the last fifty years has proved to them that the government, when put to the test, will always release further virgin jungle for destruction. In other parts of Sarawak where there is no more virgin jungle to destroy, the Iban have modified their system.

I suggest then that instead of always looking upon shifting cultivators as economic lunatics we should make the contrary assumption that they are intelligent people who, given their special circumstances, are acting in an economic way.

Let me mention briefly the three areas of which I have had experience. In North Burma shifting cultivation is used to grow hill rice. The country is steeply mountainous, and the only alternative way of cultivating the land is to construct expensive terraces and practice irrigated agriculture in the manner followed by the Ifugao of the Philippines. In most parts of the area there is no scarcity of water, but the area is remote, and certainly up to 1940 there had been very little cultivation of cash crops. The density of population varied from about five to the square mile to fifty to the square mile. It was noticeable that in the areas of very low population density where the land was plentiful, shifting cultivation was always the preferred technique; efforts by the government to persuade the population to adopt fixed agriculture were almost completely futile. On the other hand wherever the local population density was high so that land was scarce, terraced agriculture is the standard, traditionally established, preferred technique. There is no cultural

difference between the shifting agriculturalists and the terraced field agriculturalists. Precisely the same tribal peoples practice both forms of cultivation. They recognize the two techniques as alternatives and are prepared to discuss the relative merits of both. Terraced agriculture represents much harder work but can be relied upon to produce a moderately good yield. Shifting agriculture on the other hand will produce a very high yield in areas where the forest cover has been thick but a very poor yield in areas of deforestation. There is therefore a perfectly definite economic point at which, from the villager's point of view it becomes advantageous to change over from shifting agriculture to terraced agriculture.

In the Sarawak case, shifting cultivation is again used for hill rice. Here in most cases wet rice cultivation hardly provides a satisfactory alternative; the quality of the subsoil in Sarawak is such that in most localities terraced agriculture is not practicable. Swamp land wet rice agriculture is practised but it is of low grade efficiency. For peoples such as the Iban, the real economic alternative to shifting cultivation is the practice of cash-crop farming in the form of rubber growing in small plantations. It is noticeable that the rate at which cash crop plantation economy has been adopted varies with the density of local population. In areas of relatively dense population shifting agriculture in its traditional form quickly becomes uneconomic so that there is a powerful incentive to look for alternative forms of income. Now it is true that the population of these cash crop zones is more sophisticated than the population of the hinterland areas where shifting cultivation is still the normal pattern. But the sophistication is due to the cash economy and not to any special advantages of education.

In the North Burma case, the risk of deforestation will, in certain circumstances, force the population to adopt fixed agriculture; but since the fixed agriculture is designed to grow the same crop as the original shifting agriculture, there is no automatic improvement in the standard of living. General economic progress has therefore been very slow and depends solely upon the rather arbitrary circumstances of demography. In the Sarawak case, on the other hand, while the risk of deforestation again provides an incentive to give up shifting agriculture, the alternative, rubber growing, puts the population into a cash economy which raises their standard of living and increases the incentive towards a modernized

outlook.

My third example, that of Dry Zone Ceylon, is the reverse of the Sarawak case. In Dry Zone Ceylon the scarce commodity is not land but water. Almost all utilizable water has already been brought under control for the purposes of irrigated rice cultivation. Further expansion of the irrigated rice land can be achieved only at the cost of very heavy capital expenditure. This is sometimes possible for government agencies but is quite beyond the powers of the ordinary villager.

In former times shifting cultivation was a kind of safety expedient against the risk of breakdowns to the irrigation system. Throughout the 19th century, for example, the condition of most of the irrigation works was extremely bad, and the ordinary villager could not possibly maintain himself on what he could cultivate from his irrigated field. He employed shifting cultivation to raise an auxiliary food crop. Since 1900 the condition of the irrigation works has been steadily improved; most villagers can maintain themselves quite easily from their irrigated fields, and with artificially inflated guaranteed prices, can even make a cash profit off rice cultivation. Nevertheless, from the villager's point of view, the irrigated rice field is simply a source of subsistence, it does not ordinarily bring in cash. But Ceylon villagers have been moving fairly rapidly into the sphere of western economy, there are many expensive items of equipment such as bicycles and pressure lamps which the average villager is now coming to look upon as necessities rather than as luxuries. To raise the cash for such forms of investment the villager turns to shifting cultivation. He has learnt that there are a variety of oil seed crops which can be grown successfully in the dry forest lands surrounding his village. In consequence the government carries on a continuous guerilla warfare with the village. The villagers try to exploit shifting cultivation to the maximum while the government endeavours in a rather futile manner to prohibit it altogether. There is little doubt that were it not for the severe government regulations on the subject many villagers would abandon irrigated rice cultivation altogether in preference for shifting cultivation and cash crops. From the government's point of view this is an appalling prospect, but from the villagers' point of view it makes very good sense. The villagers' preference for shifting cultivation is not due to conservatism or stupidity but to a perfectly correct assessment of his own economic condition.

The facts to which I have drawn attention are in no way profound. Everyone is fully aware that shifting cultivators cultivate in this way because they find it advantageous to do so, but although this is an obvious fact, it is a fact which is somehow very often ignored. The moral of my comparison is simply that if the government in any particular region seriously wishes to do away with shifting cultivation it is quite futile to rely

upon better education as the ultimate panacea. What is necessary in each case is a careful, objective study designed to determine just what are the economic incentives which induce people to continue shifting agricultural practices. Only when these economic factors are fully understood will it be possible for the government to formulate a rational system of disincentives.

DISCUSSION

Dr. Leach was questioned on his observations that, in most parts of Southeast Asia, European colonial governments have been hostile to all forms of shifting cultivation.

Dr. Freeman supported Dr. Leach and called attention to the practice of fining shifting cultivators.

Mr. Brown pointed to the practice of employing shifting cultivators by forestry departments.

K.J. PELZER: I recalled that Sir Dietrich Brandis was the first to support the incorporation of shifting cultivators

into the forestry service. Just as a former poacher might make a good game warden, so the shifting cultivator can be most useful in reforestation projects as long as he is permitted to practice his traditional pattern of planting food crops between newly planted trees.

A. MAJID: In Malaya the aborigines practice shifting cultivation, and plant hill rice, corn, cassava, and sometimes even rubber. During the recent emergency, the Government tried to resettle aborigines and attempted to get them to change their land use system. However, many aborigines move back into the jungle and revert to their traditional way of living, not liking the newer patterns.

SHIFTING CULTIVATION AMONG THE IBAN OF BORNEO†

J. D. FREEMAN

Australian National University, Canberra, A.C.T.

(Abstract)

A description of shifting cultivation among the Iban of Borneo based on the author's field

work in Sarawak during 1949-1951. Particular attention is paid to the problem of land usage.

† The Manuscript was not received at time of going to press. — *Editor.*

SYSTEMS OF LAND TENURE AMONG SHIFTING CULTIVATORS†

PIERRE DE SCHLIPPE

*Food and Agriculture Organization, Rome, Italy.**(Abstract)*

Whether we wish it or not, within the few coming decades, the whole population of the world will be taken into the current of one single civilization, and one single economic system, which is characterized by exchange of goods and ideas, by highly developed technical means and scientific attitudes.

It is therefore vain to discuss whether shifting cultivation in its natural balance with the local environment is in certain cases better than an alternative which can be introduced as a result of acculturation.

The problem is in every case how to respect local cultures and local natural environments, despite the necessity of this acculturation, or in other words, how to plan the synthesis between local and universal values.

All professions and all nations should put themselves together for the purpose of solving this problem, and academic centers should be created in which people of the various professions, with their varied regional experiences, could meet to learn from each other.

† Paper incompleted due to illness of the author; abstract was presented by J.E. Spencer.

SHIFTING CULTIVATION AND INLAND FISHERIES

J. A. TUBB

Regional Fisheries Officer, For Asia and the Far East, FAO Regional Office, Bangkok, Thailand.

Any human activity which results in the use or misuse of natural surface waters must inevitably have an impact of greater or less effect on the fish population of these waters. This impact is transferred to the human community when the fish stocks inhabiting the waters are of significance to the community. Modern planning on national or regional bases which aims toward the development and increased standard of living of the people necessarily entails the application of measures of control over the natural waters of a country or region, and there is developing a valuable and close liaison between the authorities concerned with agriculture and water control and the fisheries authorities concerned with the care and management of the fish stocks. In many instances, however, the implementation of developmental plans involves also the correction of long standing abuses resulting from destructive agricultural or forestry practices.

In the areas comprising Southeast Asia, the fishes inhabiting the streams, lakes, and swamps form an important contribution to the diet of the local people, and the general overall inadequacy of marketing and distribution facilities for marine fish, even where production or potential production might be considered adequate to supply the requirements of the people of the hinterland, precludes the ready supply of marine fish to those people.

In most countries of the region, the great bulk of the population are of the peasant class, small farmers with relatively small holdings. Fairly intensive cultivation of those holdings is essential to provide a livelihood for the farmers. Under these conditions, the amount of land available for the development of a pastoral industry and the consequent provision of meat protein is usually limited, and the protein intake of the people is largely dependent on the small flocks of poultry which the individual farmers may raise, upon the development of fish cultivation practices in impounded waters and to a great extent upon the stocks of fish in the natural waters.

The method of cultivation known by many names in many lands but usually called "shifting cultivation" since it involves only temporary

occupancy of a given area of land, does not appear to be gravely deleterious where the native population is comparatively small, and the normal cycle of cultivation is of the order of 10 years or more. However, in the vast majority of areas in the Far East the continuing increase in population is resulting in a progressive shortening of the "shifting cultivation" cycle to the point where natural re-generation of secondary vegetative cover does not proceed far enough to ensure the deposition of adequate plant material as natural compost, nor does it allow for the maturation and seeding of many of the species within the second growth complex. Hence, there is a marked tendency for the land to become devoid of the larger vegetation, and there is no replacement of nutrients during the now very brief "resting" period.

It is evident of course that the baneful effects of shifting cultivation are more marked on hill slopes and mountain sides than on the relatively flat country. Nevertheless, there are instances, particularly in some of the smaller islands in the Java Sea and Banda Sea where cultivation which originated as a form of shifting cultivation by a small population rapidly developed to the point of over-cultivation, the invasion of much of the land by *Imperata* grass, the complete removal of all major vegetation, the loss of the water-holding capacity of the soils and eventually the desertion of the island by the inhabitants. Although the most striking evidence is found on restricted areas such as small islands, nevertheless parallel instances of destruction of the productive capacity and deterioration of part at least of the water resources, can be found on the larger islands and in parts of the Asian continent.

The lack of adequate vegetative cover and the constant burning, cultivating and cropping of the soil reduce the water-holding capacity and destroy the natural structure of the soil to the point where serious erosion during flooding or by heavy rain can take place.

The process of erosion removes the surface layers of the soil exposing the sub-strata which in some cases will not adequately support plant life. The area is deserted by the cultivator, and there is little or no chance for the development

of new vegetative cover. The effect on the river systems and natural waters is twofold. First, rain erosion carries away the fine soil particles and results in the heavy deposition of silt in the lower reaches of the streams often many miles from the site where the erosion takes place. Secondly, the lack of adequate vegetative cover permits extremely rapid runoff resulting in flash floods which in turn disrupt the normal river system. The water-retaining quality of the area is completely lost, and the flood-cycle in the river is greatly changed, giving periods of destructively high flood levels over the affected stretches of the river system during the rainy season and the complete or nearly complete drying out of a large proportion of tributary streams and sometimes of major sections of the main river itself during the dry period.

Where river or stream water debouches into swamplands, either regularly or periodically during floods, the silt laden runoff water from eroded lands contributes very swiftly to the reclamation of such swamps. Although this reclamation may result in the provision of further agricultural lands, nevertheless the elimination of swamp conditions inevitably destroys the swamp fish fauna. This has been demonstrated in several areas in Southeast Asia where swamps have been filled by natural silt deposition¹ or through their use as safety values to diminish flood effects in the main river system during the wet season. The change in ecological conditions must have very serious consequences to the original fish population of the river system.

During the flood period in degraded areas, the rate of runoff and stream flow are frequently in excess of that which the natural fish population can withstand and a large proportion of the fish are driven down-stream.

It must be appreciated of course that there are a number of stream and riverine fish which can and do successfully contend with rapid water flow, but the majority of these species are specially adapted in this regard. With one or two outstanding exceptions such as the Mahseer of India and Burma, the great majority of the fish appear to be able to contend with rapid stream flow only for short periods and travel upstream in an intermittent fashion resting for considerable

periods in the river pools and in places where the rate of flow is reduced. There are of course also a large number of less active species whose movement upstream may be completely prohibited by stream flow in excess of about 1.0 to 1.5 metres per second.

The heavy silt content of the water during the wet season also tends to drive out those species with preference for clear water. The floods themselves destroy the gravel beds over which many species of fish would spawn, either by scouring or, in the less turbulent stretches of the river, by silt deposition which renders conditions untenable in the first case for the fish themselves and in the second case creates conditions under which the egg and early fry of bottom spawning species tend to be suffocated by the fine silt.

The scouring effect of rapid floods together with the deposition of silt has a destructive effect on the fringing vegetation of streams and rivers as well as swamps. The diminution or destruction of fringing vegetation or of submerged or emergent aquatic plants will further reduce the normal spawning areas and tend also to diminish the food supply for the fish population.

The drying out of the streams during the season of no or minimum rainfall reduces the water areas and inevitably the fish population. The final result being that the total available natural protein for the people is reduced in some cases to the point of extinction in certain areas, or to less than subsistence level in others.

The problem of shifting cultivation and its effect on the water resources of the country and hence upon the inland fisheries, form but one part of a major complex controlling the behaviour of these fisheries. On the basis of present knowledge, it is impossible to define accurately the precise effects directly attributable to shifting cultivation. Much research is still required to determine the relative importance of such deleterious practices as shifting cultivation, improper forest exploitation and the use of fires for developing agistment² areas or for game-driving in relation to the progressive deterioration of a watershed and consequently of the inland fisheries. Changing climatic conditions whether related to local modifications of vegetative cover or of wider scope also require attention,

¹ In the Nuyyal Valley (Coimbatore District) in Madras State, over a period of about 50 years a series of nearly fifty tanks have been affected to the point where some are now completely dry and are used for dry cropping of cucurbits and sorghum, the silt being derived from erosion of the upper and middle watershed area of the Nuyyal River. A similar development may be observed in the Cumbum Valley, Andhra State.

² Agistment — involving the seasonal transfer of herds from lowland (winter) pasture to upland (summer) pasture.

DISCUSSION

and it is probable that the relative significance of the several factors will be determined only on a basis of comprehensive limnological and hydrological investigations designed to cover entire watersheds and perhaps even nation-wide in character.

The Food and Agriculture Organization of the United Nations has recently commenced an intensive study of "shifting cultivation" practice and effects.³ The study was initiated in the first instance by the Divisions of Agriculture and Forestry. It soon became evident that the information collected during this survey would be of value to and could in some cases be supplemented by the Fisheries Division. Every effort is being made to collect information so that a comprehensive report may be prepared and a realistic programme drafted to eliminate such destructive practices, to restore vegetative cover, soil fertility, and the water-retaining capacity of the area, and to develop the essential social agricultural and topographic stability of the affected areas.

The subject is of significance to fisheries departments and fishing industries of the Region, and should be given close attention by all governments.

Dr. Freeman remarked that in those parts of Borneo where he had first-hand experience the depletion of fishery resources seems unimportant.

Dr. McClure asked whether one does not find changes in fishery resources whenever man works upon the land.

Professor Stamp wanted to know more about changes resulting from shifting cultivation. He pointed out that soil erosion may be a good thing in many areas. Professor Stamp called attention to the term "land rotation" used in the World Land-Use Survey, preferring the term to shifting cultivation. He also noted that there is yet no good legume for use in the tropics to assist the recovery of land strength during the fallow period in which forests now are serving as the only recovery agency.

F. LOETSCH: In Thailand the run-off of rainfall has changed its patterns during the last fifty years as a result of forest destruction in northern Thailand, to the end that higher floods have become an increasing problem.

J.E. SPENCER: Heightening flood levels in alluvial lowlands is a normal long term phenomenon, owing to the sedimentation of river beds, and that higher floods cannot be laid, alone, to the door of the shifting cultivator.

³ *Unasylva*, 11 (1): 9-11, 1957.

SHIFTING CULTIVATION—FAO'S POSITION AND COURSE OF ACTION†

FOOD AND AGRICULTURAL ORGANIZATION OF THE UNITED NATIONS

Rome, Italy.

Shifting cultivation practiced by the hill peoples in remote areas is being loudly condemned as one of the major causes of a large-scale forest destruction in the upstreams. However, it is also an undeniable fact that shifting cultivation constitutes, under the present circumstances, the sole means for those hill peoples' subsistence. Again, some experts, after a careful study of the situation, have even come to a conclusion that it is the only type of farming that conserves the soil, at least so far as present knowledge goes.

It is therefore clear that shifting cultivation cannot be treated as an evil that should be "eliminated" at once, despite the fact that it is reducing an enormous amount of valuable forest resources to ashes every year.

This problem has naturally been of a grave concern to FAO, and over the past few years, it has undertaken a limited number of case studies, stressing the forestry aspects of the problem. An article "Shifting Cultivation in the Belgian Congo" was printed in *Unasylva*, Vol. 9, No. 2, followed by an FAO publication on a case study taken from Africa. The second volume "Hanunóo Agriculture in the Philippines", by Dr. Conklin of Columbia University, has just been published. This is a very valuable work of which FAO is very proud.

The intention is to follow up the publication of these studies with analyses of the effect of shifting cultivation on soils and forests, as well

as with proposals for improving the situation. FAO has, therefore, the intention of mobilizing the contributions of as many scientists as possible to help solve this problem in all interested countries. An appeal to this effect by FAO to governments, research centers, universities, associations and private persons who are in a position to help has been published in *Unasylva*, Vol. 11, No. 1. It is important to centralize all the documentation available on the problem at an international level and to coordinate the theoretical work on means of overcoming shifting cultivation. That is what FAO proposes to do. It appeals to all those who have acquired experience in the various branches connected with the problem to help by sending in suggestions and criticism and by indicating bibliographical sources at their disposal. The next step will be to issue systematic questionnaires, each adapted to the disciplines involved. The work is to be carried out by the joint participation of the Agriculture and Forestry Divisions of FAO, since a reasonable solution of this problem lies beyond the sphere of the foresters alone.

At the last session of the Asia-Pacific Forestry Commission of FAO, this course of action was much welcomed since it had repeatedly been stressed at the past sessions of the APFC that, since one of the most pressing problems in watershed management is that of shifting cultivation, some adequate steps should be taken by FAO to help improve the situation.

† Presented by J. A. Tubb, FAO Regional Office, Bangkok.

THE INFLUENCE OF THE SHIFTING CULTIVATION CYCLE ON SOIL PROPERTIES IN CENTRAL AMERICA†

HUGH POPENOE‡

University of Florida, Gainesville, Florida, U.S.A.

Vast land areas of the humid tropics are subjected to shifting cultivation. Crops are planted and harvested in clearings cut and burned from the forest. After productivity declines, the land is abandoned to second growth and another forested site is cleared. Throughout the world there is increasing interest in replacing shifting cultivation with a more permanent type of agriculture. A growing world population which is gradually outstripping its food supply has emphasized the need for increasing agricultural production on lands now utilized for very short periods of time. The importance of large-scale research concerning this type of land use cannot be overemphasized. Kellogg (6) says; "No research is more badly needed than that to establish the precise actions of the bush fallow . . . I should rather know the answer to this question than that of any other unanswered question in soil science. The results affect millions of acres and millions of people." Meggers (7) stresses the important influence of food resources on human culture by stating that, "The level to which a culture can develop is dependent upon the agricultural potentiality of the environment it occupies." The Food and Agriculture Organization of the United Nations (5) estimates that the problem affects some 200 million people occupying 14 million square miles (34 million sq. km.), and Dobby (4) says that approximately one-third of the total land area used for agricultural purposes in Southeast Asia today is under shifting cultivation. Detailed descriptions of this wide-spread practice are provided by Cook (2), De Schlippe (3), FAO (5), and Steggerda (9).

A knowledge of the alterations which occur in a soil, when the native forest vegetation is removed and later allowed to regenerate, should help to provide the necessary information for improving the efficiency and productivity of agriculture on lands now used for shifting cultivation. With this in mind, a study to determine the changes in various soil properties during the

cycle—forest, crop, second growth—was undertaken on mountain slopes bordering the Polochic Valley in Central America.

DESCRIPTION OF THE AREA

The valley of the Polochic River in northern Guatemala has a humidtropical climate. The area lies well within tropical latitudes (16°N.) and is near sea level. Annual precipitation averages 135 inches (3,429 mm.), the greatest portion occurring during the summer months.

The Polochic River originates in the highlands of the Meseta de Coban and flows eastward into Lake Izabal, which eventually feeds into the Atlantic Ocean. The valley at its western end separates two parallel limestone mountain ranges: the Sierra de Zucaneb on the north, and the Sierra de Pansal on the south. These ranges were probably deposited during the upper Permian period, and subsequently folded and faulted along an east-west axis during the Pliocene orogeny.

The soils in this area are latosols in various stages of development and are derived from limestone and metamorphosed material. Volcanoes, further to the south, have enriched the region with occasional light deposits of ash. The surface soils are characterized by a good crumb structure, excellent permeability, and good drainage.

The virgin forest vegetation although now limited in extent, is typical of a climax rain forest. In a few places where the soils are sandy, pine forests dominate. Since vegetative growth is extremely rapid through out the valley, five-year second growth will contain trees up to 10 inches in diameter.

The mountains on both sides of the valley are characterized by a patchwork pattern of vegetation in all stages of the shifting cultivation cycle. Here the cycle is relatively short and is typified

† The research conducted in connection with this paper was supported in part by funds from the Rockefeller Foundation.

‡ Research Associate in Soils, University of Florida, Gainesville, Florida, U.S.A. The author wishes to acknowledge the guidance and council of Dr. I. C. Hammond, Associate Professor of Soils. The use of facilities provided by the Hemsteads in Guatemala for field work is gratefully appreciated.

by the use of a single cultigen—corn. The land is cropped for as little as one year, following clearing and burning of the forest, before abandonment to second growth. First year corn yields are reported to be about 10-20 bushel/acre, while yields for a second crop, if planted, are often reduced by one-half. A minimum of four years of second growth is allowed to develop before the cycle is repeated. Since the fields are usually less than ten acres in size, several stages of the cycle may join in a small area of relatively uniform soil—a convenient situation for a study of the effects of shifting cultivation on soil properties.

Some of the well-drained alluvial soils in the valley bottom are capable of producing crops continuously without fertilization, but grasses, diseases, and pests become serious problems when the land is cleared for long periods of time. In many cases crop rotation or a brush fallow is used to help alleviate the rapid build-up of an injurious biotic population. On areas in the hills under shifting cultivation, grasses apparently have little chance to affect agriculture since the land is generally unshaded for only one out of five years.

METHODS

Samples of soil were collected from thirty fields in eight locations within an area of approximately one hundred square miles, where two or more stages of shifting cultivation adjoined. In the flood plain of the Polochic River one field with an apparent high yield potential was sampled as a reference.

Each field was sampled at ten random points. Pits were dug and samples were collected from depths of 0-2", 2-8", and 8-16" by cutting into the soil profile with a large knife. The ten samples from each field were composited into single samples by depths. Two of the ten pits in each field were sampled in the 2- to 4-inch zone with a 5×3.5 cm. cylinder for bulk density. The airdried soil samples were subsequently analyzed in the United States at the University of Florida.

Soil was analyzed for total nitrogen by the Kjeldahl method and carbon by the wet combustion method of Walkley-Black as modified by Walkley (10). The exchange capacity was determined with neutral normal ammonium acetate extraction. Calcium, magnesium, potassium, and sodium were determined in the extract—calcium and magnesium by the versenate method (1), potassium and sodium with a Beckman B

flame photometer. Percentage base saturation was calculated by summing the exchangeable bases. Soil pH was measured on a 1:2 (vol. basis) soil suspension using a thin glass electrode.

RESULTS AND DISCUSSION

Analyses of soil properties at different stages in the shifting cultivation cycle are shown in Tables 1 and 2. The data in Table 1 are average values from four locations where there were three adjoining stages of the shifting cultivation cycle: forest, cleared land, and two-year second growth. Table 2 is a more complex compilation of data which duplicates some comparisons of Table 1, but also adds a comparison of older second growth. Unlike the data in Table 1, the data in Table 2 are averages of from five to six locations where two fields of different stages in the shifting cultivation cycle joined. Locations used for the three groups of comparisons A, B, and C are not identical though they contain some duplication. Location numbers are found in the footnotes to each table to indicate the sources of single values used in the averages. The data for cleared land in Tables 1 and 2 were obtained during the middle of the cropping season. Young second growth in Table 2 includes fields that have been out of cultivation for one or two years; old second growth refers to fields that have not been cleared for three to five years. This method of grouping second growth fields was necessary since the number of such fields was inadequate to make a yearly breakdown.

Physical and chemical properties of the alluvial soil in the reference field are shown in Table 3. This soil had been in cultivation for a number of years and had never been fertilized. Corn in the tasseling stage at the time of sampling appeared to have a yield potential of approximately sixty bushels per acre.

The data of Tables 1, 2, and 3 are used as a basis for the following discussion on soil physical and chemical changes in relation to the practice of shifting cultivation.

BULK DENSITY

The values for bulk density (apparent density) of the soils under shifting cultivation were very low (averages ranged from .56 to .78 gm/cc), but similar figures have been reported from elsewhere in the tropics (8). Since these values were still much lower than the bulk density of the reference field (1.25 gm/cc) where crop production

was good, it can be assumed that the small increase in density, brought about by clearing the land, in no way limited crop production. The bulk densities of soils under second growth indicate a gradual trend towards restoration of the high porosity of soil under virgin forest.

bon to nitrogen ratio. Establishment of second growth on cleared land once more increased the amount of organic materials deposited on the soil surface. These additions had a high carbon to nitrogen ratio and consequently immobilized much of the nitrogen. The small amount of

Table 1.
Physical and chemical properties of soils under three stages of shifting cultivation.*

Stage	Depth	Bulk density	pH	Nitrogen	Carbon-Nitrogen ratio	Potassium	Calcium	Magnesium	Exchange capacity	Base saturation
	Inches	g/cc		%		ppm.	ppm.	ppm.	m.e/100g.	%
Forest	0 - 2	0.56	5.75	1.027	15.9	280	6343	964	94.3	53.7
	2 - 8		5.74	.486	14.4	97	3264	516	45.2	51.7
	8 - 16		5.93	.232	10.9	51	2143	435	33.7	45.8
Cleared land	0 - 2	0.71	6.37	.741	12.0	406	5615	868	68.4	58.4
	2 - 8		5.69	.353	13.2	154	2757	539	41.9	43.3
	8 - 16		6.14	.189	10.5	84	2782	584	39.3	44.4
2 year 2nd growth	0 - 2	0.70	5.85	.759	15.2	306	5048	667	75.0	53.3
	2 - 8		5.79	.320	11.7	92	3022	347	43.4	45.6
	8 - 16		6.07	.194	9.4	64	3491	324	35.3	50.0

* Average four locations - II, III, V, VI.

Since bulk density is inversely proportional to the per cent pore space, the low values provide an explanation for the fact that even heavy rains are readily absorbed by the soil. Thus, little surface erosion is found on the cultivated slopes. Instead, most of the erosion is by landslides during heavy rainfall.

CARBON AND NITROGEN

The carbon and nitrogen contents were much larger than for most mineral soils in temperate climates. The reference field had lower carbon and nitrogen values and a narrower carbon to nitrogen ratio than the average of the fields under shifting cultivation. However, in all fields the carbon to nitrogen ratio was probably never too wide to hinder adequate nitrification.

Removal of virgin forest resulted in a decrease in the amount of soil organic matter in the three depths sampled. Burning was probably the main cause, especially in the surface two inches where there was a marked narrowing of the car-

bon to nitrogen ratio. Establishment of second growth on cleared land once more increased the amount of organic materials deposited on the soil surface. These additions had a high carbon to nitrogen ratio and consequently immobilized much of the nitrogen. The small amount of

EXCHANGEABLE BASES AND SOIL ACIDITY

The ash left from the burned forest cover contains various amounts of the oxides of calcium, magnesium, potassium, and sodium. The reaction of these bases with the exchange complex increases the percentage base saturation and reduces the acidity (increases the soil pH). These changes and the subsequent gradual loss of bases by leaching and crop removal are clearly reflected in the data of Tables 1 and 2. Apparently calcium and magnesium moved more readily than potassium to lower depths in the soil profile.

During the period of young second growth, the bases were gradually depleted as a result of plant utilization and deep leaching. Acidity

Table 2.

Physical and chemical properties of soils under four stages of shifting cultivation.

DEPTH (Inches)	FIELD GROUP A*		FIELD GROUP B**		FIELD GROUP C***	
	Forest	Cleared Land	Cleared Land	Young 2nd Growth	Cleared Land	Old 2nd Growth
<i>Bulk Density (g/cc)</i>						
2- 4	.56	.66	.78	.78	.74	.70
<i>pH</i>						
0- 2	5.41	5.94	6.43	5.87	6.01	5.89
2- 8	5.44	5.47	5.66	5.72	5.38	5.65
8-16	5.67	5.80	5.99	6.04	5.55	5.57
<i>Nitrogen (%)</i>						
0- 2	1.075	.779	.658	.692	.786	.961
2- 8	.505	.391	.333	.294	.428	.401
8-16	.296	.219	.179	.183	.213	.229
<i>Carbon-Nitrogen Ratio</i>						
0- 2	18.3	12.3	12.1	14.3	13.2	17.0
2- 8	17.6	18.9	12.5	11.6	16.6	12.2
8-16	11.5	11.0	9.9	8.9	10.7	10.6
<i>Potassium (ppm.)</i>						
0- 2	268	334	387	274	360	319
2- 8	86	122	136	83	108	65
8-16	47	73	74	61	56	43
<i>Calcium (ppm.)</i>						
0- 2	4717	4153	5081	4505	4224	4545
2- 8	2339	1975	2453	2742	1658	1735
8-16	1502	1913	2410	3225	1213	1227
<i>Magnesium (ppm.)</i>						
0- 2	746	660	788	600	657	911
2- 8	378	381	463	337	303	366
8-16	301	405	485	336	250	264
<i>Exchange Capacity (m.e/100g.)</i>						
0- 2	88.8	62.4	59.6	67.9	61.6	72.0
2- 8	44.5	39.3	37.6	42.2	37.5	35.3
8-16	34.6	35.4	35.2	34.4	33.9	26.9
<i>Base Saturation (%)</i>						
0- 2	42.0	46.7	63.3	50.4	54.9	52.0
2- 8	37.5	32.3	42.4	42.4	30.5	39.4
8-16	32.2	31.6	41.5	49.3	23.9	40.6

* Average of fields at locations II, III, V, VI, VII, VIII

** Average of fields of locations I, II, III, V, VI

*** Average of fields at locations I, II, VI, VII, X

Table 3.

Chemical and physical properties of soil in reference field.*

Stage	Depth	Bulk density 2-4"	pH	Nitro- gen	carbon- Nitrogen ratio	Potas- sium	Cal- cium	Magne- sium	Exchange capacity	Base saturation
	Inches	g/cc.		%		ppm.	ppm.	ppm.	m.e./100g.	%
Cleared	0 - 2		6.06	.229	11.96	224	2152	340	22.5	66.1
Land	2 - 8	1.25	5.89	.194	11.49	124	1901	146	20.6	56.8
	8 - 10		5.79	.076	10.39	76	897	33	14.8	36.6

* Location IV

increased in the topsoil. In old second growth, the status of the bases in the soil was more nearly that of virgin forest, since potassium, calcium, and magnesium were further depleted in the lower horizons but augmented in the top two inches as plant residues accumulated.

EXCHANGE CAPACITY

On land cleared of forest, the exchange capacity decreased in the top eight inches of soil and increased between eight and sixteen inches. Second growth reversed the trend. The large decrease in exchange capacity in the surface after burning was probably caused by the loss of organic matter.

FUTURE OUTLOOK

The present study has revealed certain anomalies in our concepts of shifting cultivation in relation to soil properties. For example, the low bulk densities, high organic matter contents, high exchange capacities, and a not too acid pH have not generally been associated with areas of shifting cultivation. Thus, one must exercise care in extrapolating data from one tropical area to another.

Shifting cultivation appears to be a very conservative agricultural practice in the Polochic Valley. Second growth, after one year of corn brought about a rapid restoration of the physical and chemical conditions that existed in the soil prior to clearing of the land. Where fertilizers are unavailable or relatively expensive, a practice which requires no outlay of capital has many advantages. However, the need for a more intensive utilization of these soils is indicated by the growing emphasis on raising the level of agricultural production and standards of living in tropical regions.

Although the nutrient status of soils included in this study appears to be at high levels, a broader investigation might reveal deficiencies of some elements and possibly toxicities of others. Grass, cited many times as an important contributor to declining production, appeared to be a secondary factor in the Polochic Valley. Although total nitrogen contents were exceptionally high, the rate of release through mineralization of the nitrogen by the soil organisms should be studied.

Specialists with adequate laboratory facilities and financing are needed to study the problem of shifting cultivation. Emphasis on soil research in the tropics thus far has been on the major economic crops. Some effort should be channeled into the much more acute world-wide problem of subsistence farming which at present supports millions of people.

SUMMARY AND CONCLUSIONS

A knowledge of the influence of shifting cultivation on soil properties is necessary before any drastic steps can be taken to alter the pattern as now practiced by the indigenous peoples of many tropical areas. A detailed investigation of changes in the soil during the sequence of forest, clearing, second growth was undertaken in a limestone area of northern Guatemala. Soils from thirty fields under various stages of management were sampled. In general, the soil data indicated comparatively high levels of fertility. Differences in soil properties were related to the various stages in the shifting cultivation cycle.

When forest was removed by felling and burning the following changes took place in the top sixteen inches of soil:

1. Bulk density increased.

2. Acidity decreased and percent base saturation increased in the top two inches.
3. Nitrogen and carbon decreased throughout the soil profile.
4. Potassium increased throughout the profile but in greater amounts in the top two inches.
5. Calcium and magnesium decreased in the top two inches but increased between two and sixteen inches.

Subsequent second growth after one year of corn reversed the above trends in the following ways:

1. Bulk density decreased but the low value for virgin forest was not restored within a

period of five years.

2. Acidity increased and percent base saturation decreased in the top two inches.
3. Nitrogen and carbon increased in the top two inches but carbon decreased in the two- to eight-inch zone.
4. Potassium decreased throughout the profile.
5. Calcium continued to be translocated from the topsoil to lower horizons during young second growth but the trend was reversed after at least two years.
6. Magnesium decreased throughout the profile during young second growth but began to increase in the topsoil after at least two years.

REFERENCES

- (1) Cheng, K.J. and Bray, R.H., 1951, Determination of Calcium and Magnesium in Soil and Plant Material, *Soil Sci.*, **72**: 449-458.
- (2) Cook, O.F., 1921, Milpa Agriculture, a Primitive Tropical System, *Ann. Report, Smithsonian Institution, for 1919*, 307-326.
- (3) De Schlippe, P., 1956, *Shifting Cultivation in Africa—The Zande System of Agriculture*. London: Routledge and Kegan Paul.
- (4) Dobby, E.H.G., 1950, *Southeast Asia*. New York: John Wiley & Sons, Inc.
- (5) F.A.O. Staff., 1957, Shifting Cultivation, *Unasylva*, **11**: 9-11.
- (6) Kellogg, C.E., 1956, World Food and Agricultural Potentialities, *Soil Survey Field Letter*, April 1956.
- (7) Meggers, B.J., 1954, Environmental Limitation on the Development of Culture, *Amer. Anthropologist*, **56**: 801-824.
- (8) Shaw, H.R. and Swezey, J. A., 1937, Scientific Irrigation Management, *Hawaiian Planters' Record*, **41**: 199-279.
- (9) Steggerda, M., 1941, Maya Indians of Yucatan, *Carnegie Institution of Wash. Publ.* **531**, Washington, D.C.
- (10) Walkley, A., 1947, A Critical Examination of a Rapid Method for Determining Organic Carbon in Soils, *Soil Sci.*, **63**: 251-264.

A BIBLIOGRAPHIC REVIEW OF THE LITERATURE ON SHIFTING AGRICULTURE AND FIRE AS ECOLOGICAL AGENCIES IN THE TROPICS

HARLEY HARRIS BARTLETT

University of Michigan, Ann Arbor, Michigan, U.S.A.

The literature which is indicated by title as strictly or largely on shifting agriculture and fire in the tropics is limited in extent and might be reviewed in a single volume. If, however, one attempts to review all of the books and articles in which there is some significant reference to the subject, the task appears to be endless. Approaching the subject from their various points of view, botanists, anthropologists, foresters, agriculturists, geographers, explorers, administrators, and travellers have all contributed valuable observations, often quite incidentally, in publications of the most diverse content. It is a hopeless task for one reviewer to attempt to find them all, but even though a general review may seem shockingly incomplete from the standpoint of a fully informed regional bibliographer, it will nevertheless present a great deal of comparative material which a local specialist would fail to find, for there are few libraries (if any) which contain all of the pertinent literature. Furthermore, the tropical countries where the problems presented by fire and shifting agriculture are most acute are those in which libraries are most deficient.

The writer undertook to write a brief general chapter on "Fire and Primitive Agriculture in the Tropics" for presentation in 1955 at the symposium of the Wenner-Gren Foundation on "Man's Role in Changing the Face of the Earth" and for subsequent publication in a volume with the same title.¹ The chapter was supplemented by a volume of detailed reviews,² distributed at the meeting to the more botanically or agriculturally interested participants, and was sent later to about 300 scientific institutions and libraries throughout the world, using the exchange list of the Library of the United States Department of Agriculture as a basis for the mailing list. A second volume was in preparation when the writer learned that a special session would be devoted to Shifting Agriculture at the Bangkok meeting

of the Pacific Science Congress. The master sheets for offset printing had already covered authors from A through F, without geographic limitation. Beginning with G and extending through J, general coverage was discontinued and only those reviews were included which dealt with tropical eastern Asia (India to Indochina), the East Indies and the Pacific Islands. Thus restricted, Vol. II will be available for distribution to those who contribute on shifting agriculture, ethnobotany, botanical bibliography and related subjects at Bangkok. It will be followed by Vol. III, including only the remaining material from K through Z, with the same geographic limitation. Vol. III is also to be available on request to those individuals who will have received Vol. II, or to their institutions. It will also cover references omitted from A through G, in so far as they shall have been secured for review.

The several volumes of the series will not overlap, and each will be indexed for geographical, botanical and ethnic names, and otherwise, but there will be no index entries for very general subjects (such as "fire," "shifting agriculture," "forest," etc.) which would require useless references to nearly every page.

There are some aspects of shifting agriculture which are common to countries around the world, and therefore, inevitably, there will seem to be much repetitiousness in the reviews. This is quite unavoidable, for the great majority of those who will consult the volumes will wish to read only what pertains to one region or country.

Such persons may find reviews of only a part of the literature they are already acquainted with. Thus, a valued correspondent, Professor Tamayo of Venezuela, sent the writer a special bibliography for that country which consisted largely of titles that would probably be of more than local interest, locally published in newspapers or other periodicals which do not appear

¹ Bartlett, Harley H., *Fire, Primitive Agriculture, and Grazing in the Tropics*, in Thomas, William L., Jr., (ed.) *Man's Role in changing the Face of the Earth*. pp. 692-720. Chicago: University of Chicago Press. 1956.

² Bartlett, Harley H., *Fire in Relation to Primitive Agriculture and Grazing in the Tropics*. Annotated Bibliography I, 568 pp. Ann Arbor: University of Michigan, Botanical Gardens. (lithoprinted).

to be available in the United States, or perhaps even in Venezuela, where valuable material from ephemeral periodicals may be preserved only in a few collections of clippings arranged by subject or author.

There is, however, a very different aspect of the bibliography of the subject. The writer was informed by responsible agricultural officials and librarians in several countries that nothing has been published on the subject of shifting agriculture or the burning-over of land that had any specific reference to their countries; yet several or many titles came to light. It has seemed, therefore, that a copiously annotated bibliography such as the writer's (actually a collection of reviews and abstracts) might be serviceable to almost any one as a point of departure for locating the scattered and difficultly found literature on primitive agriculture and related topics.

Those individuals who are to receive Volumes II, and III, which will not overlap Vol. I, will doubtless find the latter in their institutional libraries. Vol. IV is expected to deal only with Africa, and Vol. V with the Americas.

It is hoped that conspicuous omissions (A to J) for Asia and the Pacific will be reported to the writer so they may be inserted in Vol. III. Many have already been noted. The writer has only made rare exceptions to the rule of including only books and articles that he has seen. Hundreds of references have accumulated that have not been verified, many so obscure that one may be sure that they could not possibly be found in most libraries and therefore, the title without review or abstract would seldom help anyone.

Any attempt to review the whole literature of such a subject as primitive agriculture is frustrated by language limitations. There are doubtless many historically significant references to aspects of vegetation and agriculture in the ancient and modern literatures of several oriental countries that have not been translated and that have completely eluded the present reviewer. It is only necessary to point out the dearth of accessible information on tropical southern China. The numerous ancient gazetteers of Chinese provinces might yield much to a reader of Chinese. If so, it would be a substantial contribution to historical ecology and plant geography to dig out from the old literary sources all that pertains to forest distribution in South China, where the replacement of forest by grassland must have had some historical record, for official reports date back to ancient times.

Even in European literature, there are many general works of travel, etc., whose titles give no indication of what is to be found in them, and many of them do not have any indexes at all, or only very imperfect ones. To a specialist it helps very little or not at all to find the title of such a work unless it is at hand for analysis of content. Periodicals are often highly miscellaneous in content and also very scarce outside of the country of origin. In a specialized library one often finds few general works or periodicals of diversified content, and in a recently established library one may find little except what is currently in print. It takes much time and effort to assemble photographic copies such as photostats or microfilms of unavailable literature from distant libraries.

For these reasons, among others, it was considered that most workers in tropical countries would find use for a copiously annotated bibliography on the effect of fire and shifting agriculture on the degradation of tropical vegetation from forest to thorn-bush, savanna or grassland, and finally, in some instances from thorn-bush to desert. The subject of man's effect on vegetational change has far-reaching theoretical importance to botanists, geographers, general ecologists, and anthropologists. It is so far to the front in the minds of participants in the Bangkok Science Congress that the revised outline program included (1) a special symposium on "Climate, Vegetation, and Rational Land Utilization in the Humid Tropics," sponsored by UNESCO, which cannot possibly fail to involve discussion of shifting agriculture and fire; (2) a symposium on "Vegetation Types of the Pacific Basin," in which the speakers will be confronted by the problem of man-made vegetation types; (3) a symposium on the "Effects of Shifting Cultivation on Natural Resources," held jointly by the Divisions of Botany, Forestry, Soil and Land Classification, and Anthropology; (4) symposia on national parks, reserves and conservation in general; (5) a symposium by the Division of Forest Resources on "Natural Reforestation," which is profoundly modified by shifting agriculture and fire; (6) a symposium on the tremendously important topic of "Reforestation of *Imperata* Waste Lands", the characteristic end product of fire and shifting cultivation over vast areas of the Southeast-Asiatic area; and (7) a symposium of the anthropologists on "Problems of Land Use and Land Tenure," many of which problems have grown directly out of past and still continuing misuse of land.

Therefore, the writer hopes to have contributed to the background of a dominating subject before the Congress by presenting to its members a review of much background material in the

second volume of the Annotated Bibliography and by promising a continuation in the third volume of the literature pertaining to tropical Asia and the Pacific.

Miscellaneous Contributions on Conservation

THE GUANO INDUSTRY OF PERU AS A PRACTICAL CONSERVATION PROJECT†

R. C. MURPHY‡

Research Associate, American Museum of Natural History, New York 24, New York, U.S.A.

(Abstract)

History of the Peruvian guano industry was reviewed stressing the destructive exploitation in the latter half of the 19th Century. Guano production was down to only 23,000 tons in 1903 but annual production is now up to 300,000 tons and still increasing. The principal bird

species were listed and their natural history was reviewed providing a basis for understanding the conservation measures which have been so successful. Possibility of further increasing the production was considered.

† A report well illustrated with colored slides.

‡ Professor Stamp, the Chairman, on behalf of the meeting expressed thanks to Dr. Murphy for the excellence of his presentation and the magnificent quality of the colored slides. He congratulated Mrs. Murphy on the important part she had played in the field investigation.

OTHER CONTRIBUTIONS

Dr. Akira Watanabe of Japan described briefly and exhibited examples of the program of mapping Japan at a scale of 1:50,000. A land use map is being made using a carefully prepared system of classification, nine 260 sheets being published to date.

Other maps, which will contribute greatly toward understanding of the land use map, are of land forms, surface geology, soils, and hydrology, of which experiment sheets have now been published.

Mr. Thanom Premrasmi of the Royal Forest Department of Thailand presented a 35 minute color film of several national parks and botani-

cal gardens which have been established by Thailand as preserves and recreational areas.

Publications
of the
NINTH PACIFIC SCIENCE CONGRESS

Abstracts of Papers, 1957.	\$ 2.00
General Programme.	0.50
Proceedings*	
Volume 1 — Introductory and International Cooperation in Science.	
Volume 2 — Animal Improvement.	
Volume 3 — Anthropology and Social Sciences.	
Volume 4 — Botany.	
Volume 5 — Chemistry in the Development of Natural Resources.	
Volume 6 — Coconut Problems.	0.50
Volume 7 — Conservation.	1.00
Volume 8 — Crop Improvement.	
Volume 9 — Entomology.	
Volume 10 — Fisheries.	
Volume 11 — Forest Resources.	1.00
Volume 12 — Geology and Geophysics.	
Volume 13 — Meteorology.	
Volume 14 — Museums.	0.60
Volume 15 — Nutrition.	
Volume 16 — Oceanography.	2.50
Volume 17 — Public Health and Medical Sciences.	
Volume 18 — Soil and Land Classification.	
Volume 19 — Zoology.	
Volume 20 — Climate, Vegetation, and Rational Land Utilization in the Humid Tropics.	2.00
Map of Thailand, SCALE 1:2,000,000.	0.50

Thailand, Past and Present. Out of print

* The Proceedings of the Congress will not be published in consecutive order. The price of each volume will be fixed after its publication, and will include surface mail postage to all countries.