

PROCEEDING OF THE SYMPOSIUM
ON BIOLOGICAL RESOURCES AND
NATIONAL DEVELOPMENT

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CONTENTS

	<i>Page</i>
Preface - - - - -	iii
Introduction - - - - -	v
Acknowledgements - - - - -	vi
Opening Speech by <i>J.A. Bullock</i> , President of the Malayan Nature Society -	1
Opening Address by the <i>Honourable Dato Haji Taib Mahmud</i> , Minister of Primary Industries - - - - -	3
Agricultural Aspects	
The Role of Agriculture in National Development by <i>Tan Sri Haji Mohd. Jamil</i> - - - - -	5
The Importance of Pest Management to Agricultural Efficiency in Malaysia by <i>B.J. Wood</i> - - - - -	17
Crop Protection and Environmental Pollution by <i>Mohd. Sharom b. Mohd. Said, J.A. Manring, and Ting Wen Poh</i> - - - - -	27
Soil Conservation by <i>R.F. Allbrook</i> - - - - -	35
Agriculture and Forestry in the Development of Sabah by <i>P.F. Cockburn and A.J. Hepburn</i> - - - - -	39
Land Planning and Conservation in Sabah by <i>Liew That Chim and Shim Phyau Soon</i> - - - - -	45
Induced Breeding and Early Development of the Rabbitfish, <i>Siganus oramin</i> (Schneider) by <i>C.L. Soh and T.J. Lam</i> - - - - -	49
Hydrology and Pollution	
An Appraisal of the Flood Situation in West Malaysia by <i>C.H. Leigh and K.S. Low</i> - - - - -	57
Some Effects of <i>Hevea</i> Plantations on Rainfall Redistribution by <i>Teoh Teck Seng</i>	73
A Preliminary Study of the Ecology of a Polluted Stream, The Sungai Renggam by <i>Ho Sinn Chye</i> - - - - -	85
Forestry Aspects	
Multi-use Management of West Malaysia's Forest Resources by <i>Lee Peng Choong</i> - - - - -	93
Some Aspects of the Utilization and Conservation of the Forest Resources of West Malaysia by <i>Salleh Mohd. Nor and H.T. Tang</i> - - - - -	103
Malaysian Tropical Forests: An Underexploited Genetic Reservoir of Edible-fruit Tree Species by <i>Kwiton Jong, B.C. Stone and E. Soepadmo</i> - - -	113
Lesser Known Timber Trees of Malaysia by <i>K.M. Kochummen</i> - - - - -	123
The Impact of Commercial Forestry on the Hill Forests of the Malay Peninsula by <i>P.F. Burgess</i> - - - - -	131
Conservation and Development	
Waste Recovery as an Aid to Conservation of Natural Resources by <i>W.R. Stanton</i> - - - - -	137

The Values of Fauna Conservation by <i>Mohd. Khan bin Momin Khan</i>	-	-	141
The Importance of Marine Reserves to Tourism by <i>Richard B. Lulofs</i>	-	-	147
Protected Habitats for Protected Animals by <i>Francis C. Cadigan, Jr. and Lim Boo Liat</i>	-	-	153
Mt. Kinabalu and Development in Peripheral Districts in Sabah: A Review of Progress of the Sabah National Parks by <i>David W. McCredie</i>	-	-	159
Human Aspects			
Land Settlement and National Development in Malaysia by <i>Tunku Shamsul Bahrin</i>	-	-	163
Population and Family Planning by <i>S. Zechariah</i>	-	-	169
Closing Speech by <i>J.A. Bullock</i>	-	-	173
Closing Address by <i>The Honourable Dato Ong Kee Hui, Minister of Technology, Research and Local Government</i>	-	-	175

Preface

The Biological Resources of a country, its forests and grasslands, lakes and rivers, undergo diminution and change as a nation develops. This is inevitable. But it is not inevitable that such transformation should be absolute, nor is it axiomatic that all development is good. Rather there is a need to maintain a balanced approach, to decide what is good for the nation in the long term, that valuable resources, both known and unknown, shall not be eliminated in the name of development and that the quality of the environment shall not be debased.

In Malaysia, there is a clear need to develop to provide employment for the rapidly increasing human population. But such development must be conducted in such a way that biological resources are maintained in a healthy state for the resources are the vital reserves of the country. It is necessary that some of the lowland forest should be cleared for agriculture and industry, it is also necessary that some forest be retained as a source of timber, of 'jungle produce' and of later exploitation for tourism, for agents of biological control, for wild relatives of cultivated crops for crop improvement, for as yet unknown vegetable products, for a source of proteins, and as a public amenity. From the aspect of good land management, the maintenance and research of the processes operating in the natural vegetation is vital for a *proper* understanding of the management of cultivated land.

The purpose of this symposium is to establish, once and for all, the need for enlightened maintenance of segments of the natural environment as an essential resource. There is no conflict between development and such conservation. Rather conservation is an integral component of development, forming an insurance for the future and a protection for the present.

We had hoped to attract rather more participants who were actively concerned with development, to submit papers to the symposium, but despite the refusals of several organisations, we can claim a fair success.

On behalf of the Society and the Organising Committee, I have to place on record our indebtedness to the following:—

The Vice-Chancellor, University of Malaya for permission to hold the symposium on the campus of the University, and for the provision of facilities including the use of the foyer of the Dewan Tengku Chanselor for an exhibition.

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Mr. S.K. Yap

Mr. N. Lew

Mr. P.T. Arumugam

J.A. Bullock

President 1971/72.

Introduction

The Symposium on **Biological Resources and National Development** held on the 5th. - 7th. of May 1972 was a great success. Not less than 22 working papers covering Agriculture, Hydrology & Pollution, Forestry, Conservation and Human Aspects, were presented and discussed. In addition a *Forum* on "**Blue Print for Survival**" was also conducted, in which we were fortunate to have *Tuan Ismail bin Haji Ali*, Deputy Director General of Forestry, *Professor Thong Saw Pak*, formerly Head of Physics Department, University of Malaya, and *Professor A.J. Berry*, School of Biological Sciences, University of Malaya, as our panels. *Professor N.S. Haile*, Head of the Geology Department, University of Malaya was chairing this Forum.

During this three days discussion it was obvious that Development and Conservation if administered correctly, can go hand in hand, and in combination, they could give a more optimum benefit to our country. It was also stressed that the general policy in our development should not be based on *using up* but rather on *using rationally* our resources. The reasons behind this way of thinking, as pointed out by several speakers, are that careless development and exploitation of our biological and other resources, though profitable in short term economics, may in the long run, give rise to various undesirable effects in the form of pollution of our environment, disappearance or extinction of our valuable genetic resources, obliteration of our natural drainage systems causing erosion and flooding of our agricultural lands, villages and cities, etc. It was also felt that any future developments, especially in the fields of forestry, agriculture and urbanisation, should be based on optimising the existing resources rather than opening up a huge tracts of natural forests without due consideration to pollution, degradation and erosion of our lands and genetic resources, and other undesirable hydrological and ecological effects on our own environment.

Under the agricultural aspects, it was emphasised that more basic and systematic research should be carried out to find out the undesirable effects of indiscriminate usage of pesticides, insecticides, and other chemicals, and that a strict legislation should be introduced in this country to control such usage.

In the hydrological aspects of the Symposium three well written papers demonstrated clearly that careless planning and indiscriminate exploitation of our land and forest resources may create many unwanted effects on our environment. In one of these papers (Leigh & Low) various measures are suggested to control and minimise flood problems affecting the country in the past few years. It is also pointed out that damming of rivers alone is not the most effective measure; rather it should be combined with other measures relating to reduction and control of the increase of rain water hitting soil surface, thus minimising surface run off, erosion, and other related aspects.

Papers concern with forestry aspects stress that by careful management and optimising the utilisation of our forest resources through proper research and planning, more beneficial and long lasting forest products could be exploited. In their papers, both the professional and amateur conservationists believe that conservation of our biological resources has an important role in our National Development, in the form of preserving our environment, providing recreational facilities for all concerned, as well as providing the country with invaluable genetic resources for future development and source of income in the form tourism.

Finally our speakers on the humanitarian aspects of the biological resources point out that family planning, thus prevention of population explosion, is an integral part of National Development.

Acknowledgements

We are very grateful to *Drs. J.A. Bullock, G. Smith, and Yong Hoi Sen*, for their help in going through and editing some of the papers and to my wife, *Patricia*, and to *Miss Foong Foo Lian* for typing and arranging the MS and the discussions into an orderly format.

E. Soepadmo, May 1973.

Opening Speech

by J.A. BULLOCK

President of the Malayan Nature Society

Hon. Minister, Your Excellencies, Distinguished Guests, Members of the Malayan Nature Society, Ladies and Gentlemen. In the absence through ill-health of His Excellency the Governor of Malacca, the duty of giving an address has devolved upon me.

What I shall attempt to do is to explain why we have organised this symposium, what we hope to achieve by it and how this function has been adopted by the Malayan Nature Society.

You are all by now probably tired of hearing about the dual problems of population and pollution, but this is no reason why the problems should be ignored. Chiefly, the fault lies in over statement of cases by alarmists and apologists alike. But no one can surely deny that if the world's population continues to increase, if exploitation of resources continues unabated and if pollution remains unchecked, then surely, sooner or later, with or without 'green revolutions', the human population must undergo a cataclysmic disaster.

For the time-being, however, these problems seem remote from Malaysia. The somewhat sensational approach of the 'Blueprint for Survival' seems remote and the fulminations of the prophets of doom appear gross hyperbole.

And yet we are not without problems. Severe pollution of rivers and streams, incipient and sometimes evident air pollution in urban areas and the waste lands of tin-tailings are all the results of human activities. Also we are aware of changes on the face of the land, the outward spread of urban areas, and the rolling bash of the jungle to make way for agricultural development.

Such changes are in part necessary in order that we may accommodate an expanding population and increase their standard of living. At the same time it is vital to know what are the effects of these activities. To what extent is land clearance associated with severity of flooding? How much pollution of air, water and land by industrial and domestic waste, and by agricultural chemicals is it necessary to permit or to tolerate? What may be lost in land development which we or our children may bitterly regret in years to come? What is the effect of cultivation on forest soils?

These are the types of questions which we should ask, and this what this symposium attempting to discover. That we shall find more blanks than we shall find answers is certain but to know that one does not know is the beginning of knowledge.

We had hoped to have a somewhat broader spectrum of speakers than you will find in the programme, although this is not to decry any of the participants. It is unfortunate that commercial concerns are grossly under-represented; some were approached twice, and vouchsafed no reply, although others were admittedly approached rather late. Perhaps next year, we can organise another symposium or a conference, in which they will be prepared to take part.

This in truth is what we wish to develop, a dialogue between those who wish to exploit and those who wish to conserve. The conservationist must accept development; the developer must accept the need for care and discrimination. By joint action we may hope to ensure a reasonable standard of living for all, and assure a heritage for future generations.

The Malayan Nature Society has been a bastion of conservationism in Malaysia. Throughout its history it has striven to prevent what has appeared to it to be needless damage to biological resources. Usually it has received a sympathetic hearing from those concerned, and its advice taken at least in part. But in this present era of rapid development, there is a need for constant assessment and it is by such means as this symposium that we can secure an exchange of ideas and information.

As I mentioned earlier, there is a shortage of information. The papers to be presented during the next three days in many cases are research papers, and it is to be hoped that this knowledge will expand. There is an outstanding need to study our biological resources, not only from the point of short term exploitation but from the long term aspect of understanding how they function and maintain themselves. Such basic research is sadly lacking throughout the world, but principally in the tropical regions. In Malaysia, we have as yet no authority charged with such a role, but for long term benefits, such an agency is highly desirable.

In conclusion, I should like to express my sincere thanks to all those who have contributed to this symposium, by donations of funds, or of materials, by preparing papers or exhibits, by lending films or by generally helping. Particularly I must thank the symposium sub-committee and above all, Dr. Soepadmo, for carrying the trust of organising and coordinating this symposium.

Finally, I must express our deep gratitude to Y.B. Tuan Haji Taib bin Mahmud, the Minister for Primary Industries, for kindly consenting to attend this opening ceremony. Thank you for your attention.

Opening Address

by DATO HAJI TAIB MAHMUD
The Honourable Minister of Primary Industries

Mr. Chairman, ladies and gentlemen, I am very pleased to be invited to open the Malayan Nature Society Symposium on Biological Resources and National Development. The first item concerns me in particular as Minister of Primary Industries, and the second concerns all of us as Malaysians determined to ensure the success of the Second Malaysia Plan.

The subjects on which you will be hearing papers range widely from the problems of timber resources, to those of human resources and demography. Your list of speakers and participants indicates an equally wide range: representatives from the government sector, the University, the industrial and private sectors, and, even from individuals speaking in their private capacities on subjects of considerable importance in which they have become experts as a result of their efforts "after hours".

I commend this broad approach. I am confident it will result in an increasing awareness throughout the country of the challenges and problems which we face.

For Malaysia now, economic growth means the development of our country's resources, but we must not forget at the same time that we must conserve these resources in so far as possible to ensure that our future generation will not suffer from lack of these resources which can with some foresight be made renewable. You may think this is a contradiction in terms, but let me explain.

Very broadly this country's primary resources may be divided between those of an agricultural nature and those of a mineral nature.

Agricultural advances have indicated that with proper care and attention to the maintenance and improvement of soil conditions there is no reason why the same land should not continue to yield economic returns indefinitely. I refer not only to such established agriculture as padi-planting, vegetable growing, rubber or palm oil plantation, but also to forest exploitation. This country, as you well know, is rich in natural forests. Much has already been felled and planted with other crops which yield quicker returns, but much still remains to be logged, or left untouched. If our children are also to enjoy the revenues which we in this country have enjoyed over the last decade from timber, we must ensure that adequate regeneration of the natural forest takes place now. Areas leased for logging and not earmarked for other purposes thereafter must be worked systematically and under sufficient controls to ensure regeneration of commercially valuable timbers which may be relogged within a proper cycle.

Our memories of last year's floods are too recent to allow us to forget the price which we may have to pay if we persist in the indiscriminate destruction of those areas in our natural watershed so essential in preventing floods.

In our cities, trees (in particular) are not only of aesthetic value. They are also necessary. The large volume of water which evaporates from the foliage produces cooling effect and in itself helps maintain an equable climate. The respiration of the tree removes many pollutants. Few people realize the value of trees in noise reduction, but one needs only step behind a thick bush or row of trees at the road-side to realize how effectively they can reduce the problems of traffic noise.

I would like to turn now to mineral resources. Tin has always provided the backbone of our mineral exports. Much of the alluvial land on the West Coast has been, or is being dredged for tin. While mineral resources of this nature are not renewable, we trust that refinements in dredging techniques in the future will make commercially viable deposits that have previously been regarded as marginal or totally uneconomic. At the same time, however, we must realize that larger areas than the present will be made unfit for subsequent use unless we press actively for research into methods of reclaiming such land for agriculture, after it has been dredged.

The acreages at stake are vast: I feel that an important area in which your Society may be able to assist is in finding how to speed up the return of areas stripped for tin mining to agricultural productivity. Certainly the process of eutrophication which is turning the lakes of some of the developed countries into swamps can be usefully applied here to accelerate the enrichment of old mining pools and thus hasten the process of "pool to swamp to marsh to meadow". Perhaps controlled addition of processed sewage and industrial waste combined with deliberate introduction of plants, fish and animals may cut down the time during which these areas are non-productive and reduce the number of these aesthetically unsightly areas.

Land of this type would when reclaimed in all probability show a profit of \$100-200 per acre per annum. You will thus appreciate how much this country stands to gain if reclamation work could be started on the hundreds of thousands of acres of derelict tin tailings in the country now.

More recently, the possibility of large oil deposits in Malaysia's coastal waters has been investigated. The potential wealth is considerable. But here again, such deposits cannot be renewed.

Thoughtless exploitation, while profitable in the short run, may eventually destroy the marine and coral life. The latter, of course, has value as a potential source of revenue from tourists wishing to see the coral reefs. The need for care in offshore drilling cannot be too strongly emphasized.

I am pleased to note that a paper is to be presented dealing with certain aspects of this problem.

Finally I note that you will be holding a forum to discuss the article "Blueprint for Survival" which has received much publicity in the Western press recently.

The arguments have been dominated by extremists. On the one hand there are the conservationists who are against killing or cutting down trees, shrubs or anything. (They probably object to cutting the lawn in front of your house). On the other hand are the extremists who in the name of development (but really in single-minded pursuit of their own personal wealth) would cut down or dig up everything and leave a barren desert of asphalt roads and cement flats for our children. There is a need for the moderates, the reasoning men who see the necessity for both conservation and development to gather together to work out a system by which both ends can be achieved.

I look forward to receiving the full transcript of your symposium in due course, and meantime I have pleasure in declaring open your Symposium on Biological Resources and National Development.

The Role of Agriculture in National Development

TAN SRI HAJI MOHD. BIN JAMIL¹

The importance of agriculture in the national economy of Malaysia can never be over emphasised. Malaysia is basically an agricultural country. Approximately 6,768,653 acres which is 20.7 per cent of the total physical area of West Malaysia, is utilised for agriculture. On the basis of the agriculturally used land, the population density is 784.6 person per sq. mile or 1.2 per acre (7). The acreage under different crops, which has been growing steadily, emphasises our dependence upon agriculture (Table 1).

If the growth and development of towns in Malaysia is studied, it would appear that the greatest development has taken place in areas where rubber has been planted or where tin deposits have been found in sizeable amounts. The early history on the finding of this natural mineral lead to the development of towns, chiefly, in the States of Perak and Selangor. During the beginning of this century, it is needless to say, that if the rubber seeds had not been introduced by Wickham, a large portion of Malaysia would perhaps have been a natural equatorial rain forest representing, much to the delight of naturalists, a climax community of tropical vegetation.

Oil palm presently occupies only about 3 per cent of the total world production of oils and fats. Malaysia exports about 90 per cent of its crude palm oil production and 25 per cent of palm kernels. At present consumer countries process crude palm oil and palm kernel to manufacture a wide range of products. However, if most of the processing were done in Malaysia itself, there is no reason why valuable foreign exchange could not be earned and additional jobs created.

In the recent census (2) of 1970, it has been shown that about five out of every seven people in the country live in rural areas. Therefore, apart from the other natural resources, the rural farming community forms a biological asset which if harnessed properly could lead to the advancement and progress of the nation.

There is no denying the fact that, in a society where a large sector of the population is not cared for by any improvements to its welfare, no harmonious social order can be established. Discontentment caused by poverty creates discord and is conducive to insurgency and disorder. Any progressive government, to remain stable, therefore, cannot ignore the rural sector which is the backbone of the country.

While a large portion of Malaysia, especially the West Coast, has been mainly opened for tin-mining and plantation crops like rubber and oil palm, there has been an equally important portion which has been used for cultivation of other crops. As plantation crops (rubber and oil palm) have more or less allowed labour to follow them it is mainly the traditionally cultivated areas which have not experienced any large scale shifting or migration of population. Consequently, these areas which are mostly populated by the bumiputras have not changed significantly in their mode of living. It is in these areas that an accelerated rate of development is required.

BIOLOGICAL RESOURCES AND AGRICULTURAL DIVERSIFICATION

Malaysia has tremendous biological potential. The equable climate, the abundance of water, the sound management techniques gained from estate crops, coupled with the

¹ Director-General of Agriculture, West Malaysia.

TABLE I. Increase in Acreages of Crops from 1965-1969

Year	Padi	Oil Palm	Coconut	Rubber	Pineapple	Groundnut	Tapioca	Maize	Cocoa	Coffee	Sugarcane
1965	1,039,980	239,800	506,700	4,328,000	51,015	5,617	40,356	9,474	1,881	11,364	2,726
1966	1,053,380	303,700	505,800	4,342,300	54,640	5,265	36,202	7,809	2,031	12,778	2,307
1967	1,087,350	402,000	504,400	4,298,400	57,530	5,636	44,784	10,401	2,137	12,504	2,326
1968	1,182,500	497,500	516,800	4,257,800	56,206	5,413	42,063	8,707	2,777	13,157	4,762
1969	1,241,280	598,153	531,700	4,457,300	52,464	5,888	43,289	7,605	4,699	13,309	7,046

ease with which the private sector is able to adapt itself to technological innovations are some of the factors conducive to high production in agriculture. The lush vegetation itself indicates that with some effort much can be done to obtain different crops from the soil. The different soil types are suited for particular crops only.

As the price of rubber has been fluctuating at low levels, it is clear that it was unwise solely to rely on one main crop. Hence, the government has taken the initiative for switching from a system of monoculture to multiculture. As the largest segment of population in the rural areas depended upon padi cultivation mainly, the emphasis of the government on attempting to diversify agriculture is therefore, well justified.

DOUBLE CROPPING OF PADI

Over the years, there has been an increase in the rural population. In view of the population pressure on the land, the only way to meet the challenge was to make intensive use of land to multiply the croppings. This has consequently led to the multiple cropping concept and to the development of double cropping of padi. While in localities where water is available, more than two crops of padi are grown, it is the areas where water resources are scarce that the population is unemployed for the major portion of the year.

Labour intensive cropping is one of the most useful methods of relieving population pressure and seasonal labour surpluses. Favourable social and economic conditions are required to facilitate adoption of this cropping system. First of all, it should provide the increase in the farmers' income without which the farmer will be reluctant to accept such a system (3).

Usually most farmers know through experience the most profitable crop to grow. If a crop is to be encouraged, it is necessary that markets are first found. If market demand is low, an increase in production will tend to lower the prices of these crops and the profits from them would also drop. It is therefore logical that farmers should be more inclined toward accepting labour-intensive cropping when these crops yield a high profit. But apart from the improvement to cultural practises and cultivated land, it is necessary that labour-intensive cropping systems should be further supported by the development of agricultural processing industries.

During the last few years several innovations have been introduced by the Department of Agriculture. The introduction of short-term varieties like Malinja, Mahsuri, Ria, Bahagia, Murni, and Mas-Ria which have been evolved locally and are adapted to Malaysian conditions, the increased adoption of mechanised cultivation and application of fertiliser, use of improved seed and pest control measures, have been factors which have contributed to increased yields. In order to keep the rural population gainfully employed not only has the acreage under padi increased but wherever possible, irrigation facilities have been improved so that double cropping can be made practical and the padi farmer who was kept unoccupied after the harvesting of the first crop could have a higher rate of employment. Irrigation projects which were designed to meet the needs were planned and implemented. The Muda and Kemubu Projects, the Trans-Perak and the Krian Irrigation Schemes, are some of the notable projects which are changing the pattern of agriculture and the social structure of the society in the rural areas.

The Muda project, largest of the irrigation schemes of Malaysia, is planned to irrigate 260,000 acres of land. Approximately 130,000 acres have already been irrigated and it

is hoped to achieve the full target by 1973. Problems generated during the implementation of the projects need the services not only of the agronomist or irrigation engineer, but also that of the sociologist. While the technical problems, such as the low capacity of the padi-dryers owing to the increased out-put brought about by double cropping, can perhaps be solved by the use of additional machinery, there are others which impinge on the social structure of the community. If agricultural innovations and recommendations are to be followed by the farming community, there is no doubt that the various problems and solutions in a given environment should be studied as a whole. There is an inter-relationship amongst the various factors making a cohesive community in a kampong and as such, for smooth implementation, it is essential that this fact is taken into account. Too often, it is believed that as long as irrigation facilities are provided, the agricultural sector would take care of itself and high yields and income would automatically accrue.

While, with plantation crops it is easy to create or establish new communities and bring about innovation owing to better commercial and social facilities being available, the already established order or pattern in traditional communities is least amenable to change unless the underlying social factors have been studied thoroughly.

The development of the MUDA Scheme has not only brought about increased prosperity to the farmers, but has also created problems which might be of concern to conservationists.

Double cropping has led to the gradual disappearance of the traditional buffaloes as more and more farmers turn to mechanisation, and grazing grounds are reduced.

The increased mechanisation has led to the breakdown of the plough-sole in certain soils with the result that normally used machinery for cultivation cannot be employed unless modifications are made. In other cases, the use of pesticides has polluted the irrigation water which in the rural areas is used for drinking as well. Fish toxicity, caused by the application of chemicals to the padi crops, has been observed in certain fields and fish forms an important source of proteins for the farmers. In the near future, if experience in other countries is a pointer, chemicals, although assisting the farmer in the protection of his crops, are likely to cause harm to man by accumulation in the food chain. However, their role in agriculture is bound to remain significant, if the increasing population is to be fed.

The government, in its attempt to stabilise the price of padi and to allow farmers to earn a steady income, has fixed the gross minimum price (GMP) of padi at \$16/pikul. So as not to compete in the export market with countries whose cost of rice production is low, it has been the policy to attain the target goal of 90 per cent self sufficiency only.

INTERCROPPING

Apart from mono or multiculture cropping patterns, intercropping is also being practised. Several farmers are able to grow successfully different crops, (e.g. green chillies, groundnuts, bananas, vegetables, etc.) in between recently planted rubber.

Although rubber and oil palm are already occupying sizeable tracts of land, in recent years it has been the policy of the Department of Agriculture to encourage replanting of coconuts. Coconut is the third major crop in West Malaysia with a total of 530,000 acres. Of this 460,000 acres are small holdings and 70,000 acres under estates. As the return from a coconut holding is less than that of such crops as rubber or oil palm, to increase the income from the small holding, intercropping with crops like pineapples, banana, coffee and cocoa is being promoted.

Cocoa has been introduced as an intercrop mainly on the more fertile coastal alluvial clay soils of the west coast and it is hoped to intercrop 20,000 acres under the Second Malaysia Plan (6). Cocoa under coconuts thrives well and owing to the good demand for this commodity even several large estate organisations are expanding the acreage under this crop with improved planting material. The production of cocoa in the densely populated rural areas would bring in additional sources of income to the farmer.

While cocoa might be suitable under coconuts, there are large tracts of coastal briz soils extending from Pahang to Trengganu, which are generally more suited to cashew-nuts. Thus, depending upon the soil and the climate a wide range of crops can be grown. Much has been said of the backwardness of the east coast and it is here that more research efforts are needed so that the rural folk who depend mainly upon the fishing can have a useful vocation during the South China monsoon when it is highly hazardous to go out fishing.

DEVELOPMENT EXPENDITURE

The increased expansion of the acreage under different crops has mainly been the result of the progressive policy of the government under the different Five Year Plans. Within a decade the amount spent for the development of agriculture increased many fold (Table 2). For the Second Malaysia Plan the Government has earmarked more than seventy-three million dollars for the development of the agriculture sector.

TABLE 2. Development Expenditure from 1956-1970

	Total amount spent	
	\$	c
First Malaya Plan (1956-1960)	917,879.63	
Second Malaya Plan (1961-1965)	14,646,009.00	
First Malaysia Plan (1966-1970)	34,123,067.00	
Second Malaysia Plan (1971-1975)*	73,509,394.00	

*Estimate for the whole period.

The figures indicate clearly that the government has poured in considerable sums of money for raising the standard of living of the farmers of this country. The testimony of this lies in the fact that there have been an increasing number of motor vehicles and other items of luxury found in the rural areas, in recent years, indicating a rise in the living standards.

THE CONCEPT OF AREA DEVELOPMENT IN THE SECOND MALAYSIA PLAN

For a long time the average farmer in Malaysia has not been able to enjoy the standard of living of urbanised areas. This was mainly due to the fact that credit facilities for the purchase of fertilisers and other chemicals or hiring of machinery were not readily available. The farmer in some instances was a tool in the vicious circle of getting loans only from sources which were willing to purchase and market his products on unfavourable terms.

Agricultural development has been defined as "a process over time through which farmers become more productive by increasing farm production, by producing a given value of farm output at decreasing cost, or by a combination of the two" (5).

To stimulate development in the rural areas, the concept of area development has been formulated (4). This concept has been designed mainly in keeping to the fore, the objectives of the new economic policy, viz. the eradication of poverty and creation of employment, restructuring of society by removing economic imbalance and the promotion of overall economic growth. The force for socio-economic development of the rural area is urbanisation which, in the absence of any vast industrialisation programme, is dependent upon agricultural development. Thus, if a thrust is to be made in the rural sector, then agricultural development should be concentrated on an area basis. The

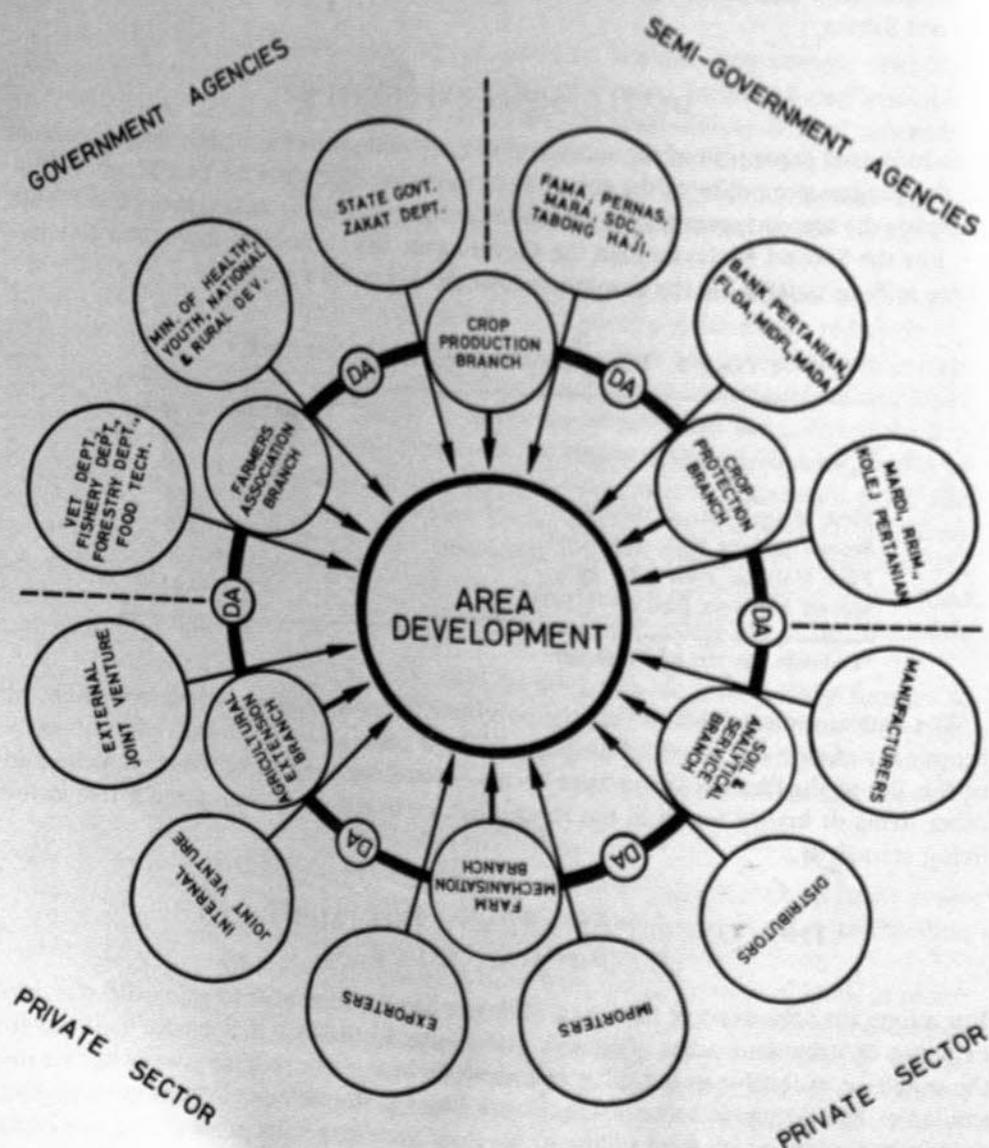


FIGURE 1.

twin slogans of 'Jaya Diri' and 'Area Development' to some extent are complementary and synonymous. However, there is one basic difference between the two. In Area Development the different agencies, both government and quasi-government, have a dynamic inter-relationship which is shown diagrammatically in Fig. 1.

The aims of the area development programme would be, broadly speaking, to increase productivity and income and welfare of the farmers through greater effort and participation in agricultural development, and to generate dynamic leadership amongst the farming community, which can be motivated to participate in different economic activities, so as to contribute to the overall growth and economy of the country and thus to bring about socio-economic changes within the community.

To implement effectively the programme of area development it is my firm belief that the Farmers' Association is the most appropriate vehicle suited for the task.

Apart from implementing the concept of area development, the Farmers' Association shall serve as the agency through which the various government agencies and the private sector operate.

FARMER'S ASSOCIATION

In 1967 the Farmers' Association was established. The Farmers' Association as an instrument forms a link between the government and the farmer. Several activities which at present hamper economic growth in the rural areas, can be carried out. These may be listed as follows:

- i. to organise and harness the resources of the rural community for more effective and integrated agricultural and rural development.
- ii. to increase farm productivity and incomes through improvement in the farming skills, know-how and managerial ability of the farming community.
- iii. to provide and organise essential farm services such as farm supplies, credit, marketing, warehousing, mechanization, transportation and processing and to render the services in a more integrated manner and make them more readily available to the farming community.
- iv. to harness and accumulate rural capital through the encouragement of sowing and investment and to encourage capital formation through a properly programmed investment in agricultural and economic activities related to farm production in the farm locality.
- v. to generate new economic activities, ancillary services, and agro-business in the rural community through the farm and business activities of the Farmers' Association.
- vi. to increase the capacity for employment of excess rural labour through a planned programme of agricultural business and economic operation within the Farmers' Association.
- vii. to develop rural leadership, social services and the spirit of participation, self-help, self reliance, sustenance and community welfare through the various extension programmes in the Farmers' Association.

It is the intention of the Department of Agriculture, with its various technical branches, to provide the necessary services for economic 'take off' of rural areas which are ready for development. The role, however, of other agencies both government and private can

TABLE 3. Report of Farmers Association of Selangor

Farmers' Association	Membership	Total Shares	Total Assets	Liabilities	Net Worth	Profit
1. Tanjung Dua Belas	620	5,850.00	124,308.70	82,296.02	13,426.87	25,782.78
2. Mukim Tanjung Karang	1,959	11,880.00	181,459.36	83,862.30	47,746.36	47,746.36
3. Sura Maju, Panchang Bedena	1,699	19,585.00	454,714.24	301,948.45	64,355.57	82,805.89
4. Gerac Maju, Mukim Beratang	296	1,575.00	22,823.55	1,165.65	16,478.00	4,851.30
5. Kawasan Kelang	750	6,710.00	56,038.46	11,708.00	6,710.00	36,906.56
6. Mukim Sepang	471	3,445.00	126,705.80	44,198.90	3,445.00	78,158.10
Sub-total	5,795	49,045.00	966,050.11	525,179.32	151,750.34	276,250.99

never be minimised as development is the result of efforts by many and each according to his means and capabilities should contribute something.

Hence, it is apparent that the Farmers' Association has an important role to fulfil in the context of national development. Some Farmers' Associations are already marketing their own products and are performing well by working in conjunction with the other agencies of the government such as the Bank Pertanian, Co-operatives, etc. The assets of the Farmers' Association of Selangor indicate clearly (Table 3) that if Farmers' Associations are properly run and managed, they could be an economic force in the rural areas.

GENERAL DISCUSSION

In economies which are solely based upon agriculture, the biological sciences have an important role to play. Better and improved varieties adapted to local conditions can raise yields tremendously. The final production of seed is the results of efforts by many related biological disciplines. The multidisciplinary approach to agriculture is essential and is increasingly being followed by several nations. In this respect, in developing countries where scientific manpower is limited, it is desirable that research efforts are directed towards national problems of an applied nature. Experience in neighbouring countries has clearly shown that the concept of 'publish or perish' needs to be constantly reviewed. Otherwise, developmental problems would never be tackled by the scientist who is perhaps more interested in obtaining data for an obscure paper.

If rural areas are to be urbanised, the various agencies that can contribute to the economic growth of a community in an area should establish suitable rapport and move in together, keeping the objectives and interests of the rural community at heart.

If the present trend of rural-to-urban migration is to be discouraged, then it is essential that activities which can utilise local products and which are available abundantly are established in the rural areas. Agro-based industries utilising local produce, such as the processing and canning of fruits, fish products, etc. are some which come to mind easily. The projects should be labour intensive, as the surplus labour available would need to be fully employed. One clear example is the production and processing of tobacco in the State of Kelantan which employs surplus labour during the off-season for the growth and manufacture of this crop.

Opening of new land schemes for the landless and the youth, by cutting down the jungle, is not at variance with the conservation and protection efforts which are being encouraged by the Nature Society. While intensification of agriculture does bring about problems of soil erosion, flooding and pollution it is nevertheless important to emphasise that a properly planned development policy will not only create more jobs but also bring about stability, harmony and unity which is so vital for the fabric of our nation. So as not to spoil our natural national heritage, I am of the opinion that wherever possible, small parks of natural forests should be left untouched so that they could act as 'breathing lungs' for new townships or villages and for the upcoming generations to enjoy. Otherwise, with the rapidly dwindling natural forests, some day it might become impossible to know even our common trees!

The stark economic realities of several South East Asian countries bring to the mind the time worn adage that an 'idle mind is a devil's workshop'. It is towards the creation of more jobs and full employment that the various development projects are being undertaken so that the rural community can enjoy the benefits of urbanisation. The de-

mands being made upon agriculture are bound to increase, unless the question of population growth is tackled energetically by one and all. At a 3 per cent rate of development, Malaysia would have doubled its population in 25 years time.

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DISCUSSION

Salleh Mohd. Nor.—In your paper, you suggested the retention of parts of natural forests within development areas. To what extent has this been planned for or put into practice?

Tan Sri Haji Mohamad b. Jamil.—In general you can say that there exists the natural conflict between agriculture and forestry especially at the present stage of national development. There seems to be a tendency for agriculture to encroach into forest interests. However, a balance seems to be successfully arrived at especially in respect of the Jengka and the Johore Central and Johore South Regional Development Areas.

Ng Siew Kee.—In terms of your concept of an integrated biotechnical/socio-economic system for the development of smallholder agriculture and the need to attain sound conservation of forest reserves, what are your views on the approach towards land development in the future in Malaysia, with particular reference to block planting and fringe alienation schemes?

Tan Sri Haji Mohamad b. Jamil. As you have observed block planting and fringe alienation schemes have been developed in 'isolation'. That is, where factors such as social and economic growth have not been incorporated. In short these two projects are concerned only with physical, biological and to a lesser degree, chemical factors. Invariably the consequence of this, as we have often encountered, is expressed in terms of 'the human problems'. In the case of FLDA the same experience seems to be true, although settlers' involvement is more than in the two earlier projects. FLDA was quick to recognise this and has provided the settlers development programmes (social) and also economic supports of the nature of cooperative shops and marketing services.

I would say that to ensure effective development in block planting and fringe alienation types the FLDA experience should be most valuable.

E. Soepadmo.—In view of: (i) the government policy to encourage Malaysians to eat more local fruits, (ii) the fluctuating price due to the varying availability and quality of fruit at a given time; (iii) and the need of this country to improve the quality of local fruits by collection, selection and hybridisation of all available gene pools in our forest—What steps or plans have been and are going to be taken by the Department of Agriculture or MARDI?

Tan Sri Haji Mohamad b. Jamil.—Speaking for the Department of Agriculture, I can say that in all these years it has strived to maintain the collection of the best fruit materials in the country and has also introduced material from overseas. It is still pursuing this activity.

P.K. HERNON.—What steps does the Department of Agriculture take to investigate the effect of the use of weed killers and insecticides (on the local farms), and what powers can your Department use to control the use of toxic substances in agriculture?

Tan Sri Haji Mohamad b. Jamil.—I must say that no effective work in this has been undertaken. To the best of our ability the Department informs the farmers through various media about recommended pesticides, bringing to their knowledge too the toxicity or otherwise of these materials. They are also informed of the precautionary measures to be taken in handling the toxic materials. The Department has as yet no powers to control the use of toxic substance in agriculture. An appropriate legislation is in the course of preparation.

M.M. SINGH.—What steps are available or should be initiated, in your opinion, to ensure that there is no wastage of our agricultural resources? Do you think there is a need for an Agricultural Advisory Council comprising of representatives from different agencies and Ministries dealing with agricultural development to advice on effective use of agricultural resources?

Tan Sri Haji Mohamad b. Jamil.—One of our most vital agricultural resources is land and to ensure that there is no wastage, planning in agricultural development has been one of the most significant factors during the last few years. The success of this planning is reflected in the achievement of the FLDA schemes. Of course such planning and subsequent implementation must be entrusted to a competent organisation.

As regards the establishment of an agricultural advisory council, I am not in a position to say in definite terms one way or the other. From personal experience, a body with advisory functions may not be effective since it can only advise.

The Importance of Pest Management to Agricultural Efficiency in Malaysia

B.J. WOOD¹

ECOLOGICAL STABILITY IN CROPS

The complicated interactions between the various forms of life within an area of natural vegetation tend to confer a dynamic stability. Actions lead to reactions that buffer the original action, so that extreme developments are uncommon. This is especially so in the tropics, where no marked climatic fluctuations occur that would lead to major cyclic changes. When a crop plant is grown over a large area the diversity is reduced and an element of instability is introduced. Certain animals may increase tremendously to damage the crop and thus become pests, but the natural forces still tend to operate, so that the establishment of a monoculture does not by any means inevitably lead to regular devastation by animal pests. Although somewhat simplified from the situation in diverse natural vegetation, interactions between all the life forms in an area of crop (referred to as an agroecosystem) are still complicated and tend to be self-buffering much of the time. In the last few hundred years, man has become more aware of the possibilities of controlling pests. This has happened in association with a great intensification of agriculture and the movement of himself, his crops and their pests around the world. All of this has tended to highlight and intensify the problems.

EARLY PEST CONTROL AND MODERN PEST MANAGEMENT

Into the first part of this century, pest control attempts primarily comprised studies of the pests' biology and their ecology, which especially concerned the reaction to environmental effects, particularly relating to their numbers. Where possible, steps were taken to make the environment less favourable to pests by cultural or biological means, the latter including the importation of parasites. Such lethal chemicals as were available to kill pests were simple, not highly effective and luckily, as we shall see, not with a long residual contact potency. In 1940, DDT became available, capable of killing insects in tiny doses, on contact and with long-lasting residual activity. A revolution in control was promised, and a whole range of synthetic organic compounds were rapidly invented. It is now widely appreciated that all this happened, but that there was no panacea. Pest problems continued, or even worsened, and often there were unfortunate side effects from the chemicals. The tendency now is to swing back to the old approaches, biological and ecological understanding assuming predominance. The judicious use of these new chemicals adds an important weapon to pest control practice, but does not comprise the whole armoury. This kind of approach may be called integrated control, a term originally coined to imply the combining of biological control with compatible chemical application (Stern *et al*, 1959). It has now come to assume the wider meaning of considering the agroecosystem and the requirements of the crop as a whole, utilising all possible control measures in a compatible manner (Smith, 1968). Pest management is an alternative term (Geier, 1966) and is perhaps preferable, not least because the term management implies the need to reach decisions on the information available, whilst

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building up knowledge, rather than awaiting full understanding before attempting to implement the technique

INSECT PESTS

Insects, of course, are predominant among the principal animal groups that contain crop pests. Malaysia's tropical climate would appear ideal for the multiplication of many species in particular crops. Neither weather, food availability nor reproductive potential are restricting to their increase, except at extreme numbers, and yet many potentially devastating pests remain at very low numbers, or are even virtually absent. The reason for this is the continuous background of control by natural enemy insects, the predators and parasites which kill the pests and which exist in balance with them. Once the balance is tipped beyond a certain point, extreme reactions may occur. Various stories illustrate this, and two especially interesting ones come from Fiji, where there is a fairly equable tropical climate.

Coconut moth in Fiji

On one of the main islands, Viti Levu, prior to the 1920's, coconut plantations were declining, and production was virtually nil due to the leaf-feeding of the caterpillar of the moth, *Levuana iridescens* (family Zygaenidae). It is quite closely related to *Brachartona catoxantha* (*Artone catoxantha**) that attacks coconuts in Malaysia. How it came to Fiji is still unknown—probably by chance on a boat from a place where it is extremely scarce, due to the activities of natural enemies. Freed from the enemies, its increase was unrestricted. The time when it came is also not certain—it was present before 1877, but probably not much before. Total defoliation was regular and the only factor that brought outbreaks to an end was starvation of all caterpillars, after which there was a brief respite before the next attack. When the moth began to spread to other islands, three entomologists were appointed to study the situation and seek a control (Tothill *et al.*, 1930).

A fly parasite was brought from Malaya and was reared and released. This fly *Ptychomyia remota* (*Bessa remota*) of the parasitic family Tachinidae, looks rather like a house fly and attacks *Brachartona catoxantha* here. Only a few thousand were eventually released, but the parasite was established throughout the range of the pest within six months, and within a year had reduced it to insignificance! Since then, only limited increases occur here and there and then clear up due to build-up of the parasite. This is a dramatic example of the power of parasites and of the continuous devastating outbreaks that can occur in their absence.

The coconut leaf-miner in Fiji

Another pest became important in coconuts in certain climatic zones. This is the beetle *Promecotheca reichei* (*P. coeruleipennis*) (family Hispididae) whose larvae mine the leaves and whose adults scrape them. Originally, it was well controlled by parasites, but in the 1920's its equilibrium was upset, surprisingly, by the accidental introduction of a parasite highly lethal to the pest! The story of this and the measures taken to deal with it is recounted by Taylor (1937) in a saga at least as gripping as a good detective story (the lay-reader will easily skip the intimate biological details).

*For various reasons, the names of many of the insects in these descriptions of events in Fiji have changed. I have used the original to avoid confusing the reader who refers to source material, giving the new names in brackets at the first mention.

The adult pest has a short egg-laying period, whilst the introduced parasite—*Pedicularoides ventricosus* (*Pyemotes ventricosus*), a mite in the family Tarsonemidae—is strongly effective in dry weather, but is virtually eliminated when it is wet. In places where it remained dry for a spell, if the pest was by chance at a peak in the normal cyclic fluctuations between it and its other natural enemies, the mite could build up and eliminate most stages of the pest, leaving only the adults. The adults laid their eggs and a generation in a one-stage condition developed, all the pests being of about the same age. This is not the normal situation, in that there is an overlap of generations, so the indigenous parasite population had evolved without there being any pressure towards synchronization of life cycles. The parasites had shorter life cycles, and thus in the unusual one-stage condition, the native parasites largely died before their host stage (eggs or larvae, depending on the parasites) came round again. Although wet weather occurred and reduced the disruptive parasite, this now only made the continued increase of the pest inevitable, and maximum defoliation occurred before the limited spread of the egg-laying period allowed enough overlap of generations for the parasites to regain control. In the meantime, the pests spread into surrounding areas and a similar cycle occurred. Taylor postulated certain characteristics a parasite should have to assist in restoring control, and one was found in Java attacking a related leaf-mining hispid, *Promecotheca nuciferae* (*P. cumingi*), which appeared to have them. The parasite, *Pleurotropis parvulus* (*Pediobius parvulus*) (a small wasp of the family Eulophidae) is internal, developing inside the body of the leaf-mining grub, and is thus protected from the attentions of the mite parasite, which would feed on it as well as the host leaf-miner. The new parasite can survive as an adult for a long period, but it can complete more than one generation within the host's generation time, and, perhaps its most important feature, it can attack a wide range in the pest's life cycle, from early larva to pupa. These characteristics meant that it could survive and build up on a host in the one-stage condition. Interestingly, although quite common on its original host in Java, it was not the predominant parasite, but these characteristics ideally suited it to the new situation. It rapidly spread and predictably ended the problem caused by this pest.

This story shows the way in which external factors, by influencing the balance between pests and their enemies, may lead to a temporary escape from natural control, and well illustrates the fact that killing a pest is by no means certainly controlling it. I quote these two stories from outside Malaya, that occurred before modern insecticide became available, not only for their intrinsic interest, but because the events and explanations have much in common with some more recent stories in Malaysia.

Induced outbreaks in Malaysia

In West Malaysia oil palms were grown from about 1917 to the late 1950's, with only sporadic and circumscribed trouble from leaf-eating caterpillars. Then there were several major outbreaks of bagworms (Psychidae) and other families. Investigation showed that the only feature in common that these outbreaks had was the previous application of broad spectrum contact insecticides, originally against relatively small outbreaks or against other minor pests. Leaf-eating caterpillars were temporarily freed from control by natural enemies and in many areas reached the next stage of natural control, that is complete elimination of their food source, meaning defoliation of palms, with heavy crop loss. Recurrent sprays were being carried out in some areas, each round having the effect of reducing the infestation, but also setting stage for the next outbreak. When the connection was realised, spraying was stopped and some pests disappeared, asso-

ciated more or less obviously with a build-up of parasites, but others continued, often rising to high numbers. The reasons postulated for this (Wood, 1971a) were that in the normal situation, a pest under good natural control is rare and hence its enemy is rare, so that if the pest gains an initial advantage it may continue to increase for some generations before the natural enemy catches up with it. In addition, the pest enters a single phase condition due to the spray differentially sparing certain stages. Thus, bagworms often came under control simply by stopping spraying, but not always, and they often broke out some generations later, with spread and build-up in surrounding areas, before the natural enemies again took control. Here too, the complete overlap of generations is normal and the natural enemies are evolved for this. A wasp parasite (*Apanteles metesae*, family Braconidae) is apparently the most important factor in regulating the bagworm, but it has a shorter life cycle, so it was at a disadvantage. The situation was dealt with by the use of selective insecticides which, when applied at the right time in the generation of the pest, largely eliminated it, but, by sparing the natural enemies, allowed them to deal with the limited number of survivors. Most of these outbreak situations were cleared up eventually by one such spray.

In cocoa too in Sabah there was a similar series of event. These are described and critically interpreted by Gordon Conway (1971). Early plantings in jungle clearings became attacked by a ring bark-boring caterpillar. This led quite naturally to the planters applying insecticides in attempts to deal with the pest. Some effect was obtained, but other pests of various kinds began to occur, mostly leaf-eating caterpillars, including bagworms. Spraying was stopped, many of the pests declined through the clear intervention of natural enemies, but the bagworms continued on this crop also. Selective insecticides helped to bring these infestations to an end. At this time it was found that the borers—the original cause of the trouble—could be, in fact, controlled by application of insecticides to the bore-holes only, whilst the infestation was reduced by removing one of the forest trees, which had been left behind as a shade tree for the young cocoa, and which was found to act as an alternative host.

A pest complex on tea in Ceylon

Another demonstration of the power of natural enemies occurred in tea in Ceylon. The crop was first planted in 1867 and the acreage rapidly expanded. Early on, one of the main pests was the tea tortrix, *Homona coffearia* (family Tortricidae) a leaf-eating and web-spinning caterpillar. This persisted until 1935 when a parasite (*Macrocentrus homonae*) was imported from Java. It gave such good control that the pest was then reduced to minor status. Another pest was the shot-hole borer (*Xyleborus fornicatus*—Coleoptera, Scolytidae) which has always been a problem on tea in Ceylon. Control research has mainly comprised studying the biology and attempting to devise cultural methods. Eventually, a broad spectrum contact insecticide, dieldrin, was found to be effective as a spray. Unfortunately, although sprays were effective against the borer, the tortrix resurged and in many areas this was sprayed in turn, using DDT (Baptist, 1956). Eventually severe trouble with the tortrix became common, and two other caterpillar pests broke out in major infestations (Danthanarayana and Kathiravetpillai, 1969). Previously, one had been noted only as a minor pest and one was completely unrecorded. Both led to consequences far worse than either of the previous pests, but disappeared rapidly when spraying was discontinued. A search for integrated control measures for the shot-hole borer continues.

THE INTENSIVE BACKGROUND OF NATURAL ENEMY ACTIVITY—
IMPORTANCE AND UTILIZATION

All these examples illustrate the very strong background of biological balance in tropical crops. As time goes on, more and more detail of the ecological factors is built up to make our pest management programme, which depends so heavily on this biological balance, more effective. There is a need for continuing and necessarily somewhat opportunistic studies of pest ecology, if rational and effective action is to be possible at crisis. Opportunistic because numbers sufficient for study may occur only sporadically. It is not always insecticides that trigger off outbreaks; chance factors may disturb natural balance to the point where increases occur. Weather may be responsible, and the state of the crop may be critical. Usually a selective insecticide can restore the balance and allow the natural enemies to build up. It is likely that had the second Fiji story, concerning the leaf-miner which broke out sporadically, occurred today, insecticidal control would have been attempted. Apart from the continuing expense, a broad spectrum contact insecticide would almost certainly have set off other problems. A selective insecticide might well have been effective, although of course not permanently, as was the parasite importation.

The characteristics of selective insecticides are various. They were discussed in a previous edition of MNJ by Gordon Conway and myself, at an earlier stage in considering these problems (Conway and Wood, 1964). Briefly, they may affect pests more than parasites by being stomach poisons, by having fast-fading residues or simply by being specifically more poisonous to the pest than to the natural enemies.

Most of the stories quoted concern perennial crops, where the lack of regular cycling lends an even greater degree of stability than occurs in short-lived crops. Nonetheless, in these crops there is a continuing force of natural control and any rational pest control programme is going to take this into account. The situation with rice is perhaps most disturbing. The crop is becoming increasingly sprayed, and of course small farmers cannot be expected to understand the ecological subtleties. Regular intensive spray programmes are one thing, but the occasional "dabble" here and there is most likely to do harm. Indeed, there seems to be some correlation between the intensity of outbreaks and the amount of spraying that is done (Lim, *in press*). Whilst it is difficult to discern cause and effect, there is reason to suspect that the worsening of the pest situation follows from rather than leads to spraying. Clearly, insecticides can be of help in rice, but proper integrated control programmes, which take account of the background of natural enemy pressure, are essential. Staggered cropping, where practicable, could give a continuity which would enhance stability. In vegetables too, problems are occurring from the use of insecticides. The diamond back moth, *Plutella maculipennis*, is a continuing problem and is sprayed as often even as daily, right up to harvest in some places. The dangers are obvious and the alternatives certainly merit serious investigation (Ho and Ng, 1970).

Natural enemies will not control every pest, and several are regularly a problem in certain situations, despite any enemies that may attack them. It is important, however, in considering the control of these to bear in mind that wrong chemical attempts could unleash some of the numerous other potential pests. Ecological investigations are likely to show the way to integrated control. For example, the rhinoceros beetle is potentially very severe in oil palms, but it has been shown (Wood, 1969a) that a dense cover of ground vegetation protects the palms at a critical young stage. This is not agronomically

undesirable and is simple and effective. Rao (1969) has found that light traps can be used to control cockchafers, which are a pest in rubber at jungle borders. Cultural measures such as the removal of the alternative host plant of the borer pest in cocoa, or modified pruning systems in tea to reduce the effect of shot-hole borer, are other possible approaches. Importation of parasites can help, as it did in Fiji and for any chronic pest it is certainly worth investigating. Apart from cheap control of pests, and the reduction in the risk of setting off devastating outbreaks through disrupting natural balance, effective management systems, by not relying on regular intensive insecticide applications, also greatly reduce the problems of pollution, toxicity and pest resistance, which increasingly bedevil the totally insecticidal approach.

RATS

Mammals too include serious crop pests, none more damaging than rats, which in our climate can continuously abound in the open wherever food is plentiful. Oil palms and rice have long been known to be chronically afflicted by rats, represented in the former mainly by the Malaysian wood rat, *Rattus tiomanicus*, and in the latter by the ricefield rat, *Rattus argentiventer*. The classification of these mammals was early established (e.g. Harrison, 1966) and it was apparent that they could reach high numbers and do considerable damage. Early work was valuable in defining the problem and various possible control measures were devised. This work was reviewed by Gillbanks *et al.*, 1967. There was a notable absence of objective standards to assess population size. This made it difficult to determine comparison of the number of rats in different circumstances, or assess either the real effectiveness of various possible control measures, the resilience of the rats after control, or the value of the damage being done. Recent opportunities for study have allowed some of these gaps to be filled, by carrying out investigations employing well-known ecological techniques.

Rats in oil palms

Catch mark release and recapture (CMR) methods can be powerful weapons in studying animal populations and determining their size within reasonable and definable limits. Such methods have produced useful results in Malaysia. The Lincoln index has been employed successfully. This technique is analogous to sample counting of, say, beans in a jar. A handful is removed, counted, marked and remixed thoroughly. A second handful is then removed and the proportion of marked beans contained represents (within sampling error limits) the proportion of the handful to the total number, which can thus be calculated. Rats are live-trapped, marked (by serial to eclipsing) and released for a period ("1st handful") and then more rats are captured in the area by hunting ("2nd handful").* The technique is very useful where a reasonable proportion of the population is captured, where there is not too much influence from migration during the period of the study and where there is an equal probability of capture for all individuals (or if this is not the case, as with most rats, because some individuals are more susceptible to trapping than others, the second index catch is by a different method, which is not biased in the same way). All these conditions appeared to be met in oil palms, and extensive studies reveal an average population of more than 100 rats per acre. Another technique involves continuous assessment by recurrent periods of trapping in the same

* Population estimate = $\frac{\text{number marked} \times \text{total number in subsequent capture}}{\text{number in the subsequent capture previously marked}}$

plot. Serial toe clipping allows individual recognition, so the history of individual rats and the development of populations can be followed. Damage is inferred from the population size and the amount of fruit eaten in captivity. This estimates direct loss only, so is a minimum; even so it is equal to about 150 lb oil per acre per year, a substantial loss.

The population study techniques allowed an objective comparison of the effectiveness of various control methods, and in conjunction with bait acceptance trials showed that baits could be more attractively formulated than before, and if applied in the proper way could eliminate the rats virtually completely at a cost far below the value of the damage (Wood, 1969b). The rate of increase of the rats is surprisingly slow after control. Natural checks seem to operate even at low densities, and the theoretical potential increase (litter size \times number of litters possible per year) is not reached. No reason for this is yet known with certainty, but it means that control remains effective for a long period, up to one year or more. A major gap in our knowledge still concerns those biological factors that regulate population size to a particular level. Natural enemies do not appear to be responsible, nor does complete exhaustion of food supply. The answer probably lies in competition within the species, effective reproduction being slowed down through stresses arising from excessive social contacts at higher numbers. The word "effective" implies that there is not necessarily any reduction in conception; it covers such possibilities as spontaneous abortion or failure to rear litters. No doubt answers to this important question will become apparent as time goes on.

Rats in paddy

Similar studies were then carried out in rice. Population studies have been rather less successful because the rat is variable in its trappability, and is usually difficult to capture in any numbers. It begins to attack the rice soon after planting, chopping down the growing stalks to feed on the succulent shoots. It occurs throughout the year in rice-fields, and it is still not clear if there is any massive invasion at planting, or whether reproduction only occurs from those already there, to lead to larger populations as the rice develops. Nevertheless, there are quite definite indications about populations and although these are less precise than in oil palms, it is clear the rat can be controlled. The yield increases from this are quite amazing. In several areas where rats are a known, but not an especial problem (areas where they are not a problem are the exception rather than the rule), plots of from 25 to 100 acres have been subject to rat control using a baiting method similar to that employed in oil palms (Wood, 1971b). Comparisons have been established outside the baited area and confirm that rat activity is greatly reduced. The non-baited areas continue to produce yields usual for the areas, ranging from 1,200 to 4,300 lb per acre. The improvements in these areas, where rat control is practised, have ranged up to 220% extra yield, the bigger improvements being where the signs of rat activity are greatest. The cost of rat control, although high in some cases, is insignificant compared with the benefits. An interesting feature of the work, currently being investigated, is the possible involvement of weed growth in yield differentials. Tillers damaged early are known to have good recovery powers (Swink, pers., comm.), but this may be affected by weed competition. The newly planted rice rapidly growing away might be expected to suppress weed growth to some extent, but if the start is held up, weeds too could become established. There is some observational evidence that weed growth is indeed considerably heavier in rat infested plots.

Control of rats does not seem to have led to any undesirable side effects, except occasional loss of domestic animals that feed on the baits. The poison used is an anti-coagulant which breaks down after the animals have died so it does not accumulate in the food chain. There are no signs of resistance by Malaysian rats. Their elimination has not led to any ecological side effects such as the increase of a snail or insect (which are preyed upon by rats as a source of protein), nor the increase of a competitor not susceptible to baits, like squirrels.

RELEVANCE OF EFFICIENT AGRICULTURE AND THE PART OF PEST MANAGEMENT

Efficient agriculture is vital to Malaysia. Export of produce is a corner-stone of her economy and provides direct livelihood for many of the people. Animals that become pests pose a threat that must be dealt with, but this must be through understanding, and depends on harnessing and assisting the natural forces at work, not opposing them. As all these events show, control is not simply a killing process, but a regulatory one and in this sense is closely akin to conservation. The mite parasite that killed the leaf-mining beetle in Fiji, and the insecticides that killed bagworms both had the ultimate effect of causing massive increases in the populations of the animals they killed. Destruction of rats by various means, such as inefficient baitings, trapping and hunting did not worsen the problem, but made little material difference to the total population. Only killing methods devised in conjunction with careful ecological studies make this regulation at low levels reliably attainable. For the ordinary farmer to take dead pests as the criterion of control success is excusable, until he is educated. To find this view occasionally in trained agriculturalists and those professionally engaged in pest control is less acceptable.

The tropical climate provides a good background for sound pest management by conferring continuity. At the same time, it can favour continuous and rapid pest increase. Pest management is proving effective in oil palms and cocoa, and undoubtedly very considerably increases in the output of other crops can be achieved. In rice, for example, with present technological knowledge, the benefits of double cropping could be enhanced by careful integrated insect control and efficient rat control to get very considerable yield increases. Fifty per cent increase would not be an exaggeration. The problem is largely organisational, for individual farmers taking wrong or no action, contrary to the general need, can upset rational programmes.

The reliance on agriculture will increase as demands for improved feeding increase in a growing population. As the non-renewable resources (mineral wealth) continue their rapid running out, the renewable ones, rationally employed, will be more needed if our civilisation is to have any hope of survival. This leads on to a second major reason for maintaining an efficient agriculture, that each acre must produce the optimum, to restrain the need for the continual expansion of agricultural land, a process which is destroying the wilderness in which the resilience for the future resides (Wycherley, 1971). If a reasonable area of natural vegetation cannot be retained, the overall loss of fertility, the changes in water balance conditions and climate and the loss of genetic potential might well prove disastrous. The lesson of the biological balance situations goes beyond its immediate practical importance, and illustrates the dire consequences that can arise once a naturally self-buffering system is pushed beyond a certain limit.

The pest control situations described are not the unproven theoretical fabrications of "nature cranks" or "environmental scaremongers". They include practical experiences by numerous people primarily doing their job of protecting crops. Malaysia has been fortunate that the ecological approach to pest problems has long been emphasised, and the successes are an encouragement to similar investigations in other crops and places, as well as for their continuation here.

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DISCUSSION

- J. A. Bullock.*—I was interested by your proposal that continuous planting could be used to stabilise pest population. The humid tropics is possibly the only area where such could be considered; it is more usual to think in term of restricted planting seasons. Have you any evidence that this stabilisation can be achieved?
As I recall, Conway reported that the parasites and predators of endemic pests were normally present in the forest which act as a reservoir.
- B. J. Wood.*—There is as yet little practical evidence of this being a successful method and it is suggested mainly on theoretical grounds. We have the opportunity of continuity in Malaysia and certainly it should be tried. Of course, planting just odd plots out of season will not help, since they will serve as an area of concentration. It will have to be tested in a properly patterned system in a discrete area. Little is known about the origin of parasites and predators, but certainly they are just as effective in areas well away from the jungle as they are in the jungle itself in most cases.
- D.W. McCredie.*—I am interested in your statement that ground cover cuts down rhinoceros beetle infestation in old stumps. Is it a microbiological or microclimatical effect?
- B.J. Wood.*—It appears to be neither. Simply a physical effect through interference with flight.
- R.E. Sharma.*—In regard to the total elimination of local pest species, has not the technique employed in the central or southern States of the U.S. resulted in a virtually complete wiping out of the screw-fly?
- B.J. Wood.*—Occasionally in limited areas elimination is achievable, but it is not generally applicable method of pest control.
- R.B. Lulofs.*—Can the introduction of natural control become so widespread as to wipe out a particular species?
- B.J. Wood.*—No, because any effect in natural control is density dependent, i.e. intensity of control slackens as the numbers of pests decline.
- Salleh Mohd. Nor.*—In your experience, has the occurrence of natural forest area adjacent to agricultural land been of benefit to pest control or has the reverse been the case?
- B.J. Wood.*—Largely neutral, except in specific instances, for example, cockchafer whose adults can only feed in jungles, so infestations are restricted to jungle margins. Undoubtedly, there are some subtle effects, but these have not been closely studied.

Crop Protection and Environmental Pollution

MOHD. SHAROM B. MOHD. SAID, J.A. MANRING AND TING WEN POH¹

The success of modern agriculture depends heavily on efficient and reliable pest control measures. In the recent past this has too often implied the almost exclusive use of pesticides as if they were the only means of controlling pests. During the 50 years preceding World War II significant progress was made in developing pest control measures based on ecological principles. Some very important developments in biological control took place during this period, particularly in utilizing the introduction of biotic agents against pests. The potential for reducing pest problems through cultural methods was also demonstrated. It was found that a relatively small change in planting date or timing or disposal of crop residues significantly affects certain pest populations as do crop rotations, moisture control, and fertilization practices. Another important contribution to pest control during the pre war period was the development of pest-resistant varieties of crops. Today many agroecologists feel that plant breeding for pest resistance has been neglected and that its potential has hardly been tapped. However, with the advent of synthetic insecticides in the mid 1940's, the public turned away from ecological approaches to pest problems (Rabb, 1970).

PESTICIDE POLLUTION

The use of pesticides has resulted in a dramatic increase in food production in modern times. These compounds have been the principal means of protecting crops from damage by insects and diseases for over twenty years. Moreover, many human and veterinary diseases, which are transmitted by insect and rodent vectors have been effectively controlled and even largely eliminated by the use of chemical pesticides. However, within the last ten years the use of these compounds has generated great public alarm as a result of the increasing awareness and concern over environmental pollution.

DDT, a chlorinated hydrocarbon, is the most familiar pesticide and has been in heavy usage since 1942. As a result of this chemical's persistence and mobility, it has worldwide distribution appearing in the lipids of most organisms (Risebrough, 1969; Wurster & Wingate, 1968), in air (Tabor, 1966; Antommaria, Corn & Demaio 1966; Risebrough Haggatt, Griffin & Goldberg, 1966), and in the antarctic snows (Perle, 1969). Concentrations of DDT in some forms of life have reached toxic levels causing spectacular declines in their numbers and threatening significant contamination of human food chains (Moore, 1966; Woodwell, 1967).

Many pesticides, particularly the chlorinated hydrocarbons, have an activating effect on the hepatic microsomal enzymes which normally function to metabolize foreign compounds. Contamination of the food and the environment by these chemicals can thus produce prolonged induction of these enzyme systems. The implication of this altered metabolic state in man is a topic of current, concentrated research.

Some pesticides are prepared with the addition of a second synergist compound such as piperonyl butoxide or piperonyl sulfoxide. These substances enhance the primary toxicant by inhibiting the detoxification mechanisms of cells. In experiments conducted by Falk *et al.* (1965) rats which normally detoxify the carcinogen benz(a) pyrene were

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prevented from doing so by the administration of these synergist compounds and neoplasia was induced in these animals. Recently it became evident that non-pesticide chemicals in the environment can also act synergistically with respect to pesticides. Polychlorinated biphenyls, which are widely used in many industrial applications, extensively contaminate the biosphere. These compounds interact with DDT and other chlorinated pesticides. Non-toxic amounts of polychlorinated biphenyls increase the toxicity of DDT and some organophosphate pesticides by as much as 100% (Hammond, 1972).

So many pesticides are proving to be of mutagenic, teratogenic, or carcinogenic potential (Fishbein *et al.*, 1970) that public skepticism towards the widespread unregulated usage of pesticide is not unfounded.

The undesirable side-effects which pesticides have been shown to cause, or are feared to cause, in non-target animals are not the only drawback to the heavy reliance placed on these chemicals. Concentrated pesticide usage has been responsible for inducing the development of pesticide-resistant strains of pests. Outbreaks of secondary pests have been caused by the pesticide-destruction of predators. In addition, chemical treatment of a pest has sometimes had only temporary effect on pest population necessitating repeated treatments; this condition brings us back to our initial pollution concerns.

Although pesticide will continue to be the major weapon in pest control, notable advances in non-pesticidal controls, indicate that with continued research in these areas the campaign to save the environment from hazards inherent in the use of pesticides will be successful. Techniques involving the sexual sterilization of insects, genetic manipulations, repellents, pheromones, hormones, and antimetabolites point to the day when integrated control programmes will be broad and far-reaching enough to deal with any pest problem. Let us take a brief look at some of these techniques.

BIOLOGICAL CONTROL MEASURES

Biological control of pests is essentially the use of one life form to control another. To establish satisfactory biological control demands a thorough ecological knowledge of the pest. Animal pests can be controlled by using parasites, predators, fungus and bacteria, viruses and sterile matings. Biological control of plant diseases involves the use of parasitic fungi, bacteria and phage as well as competition by saprophytic organisms. Weed pests can be successfully controlled by parasites or predators as well as by fungi, bacteria and viruses. These biological agents are investigated in detail and when found suitable may be introduced in large numbers at critical periods in the pest's life cycle. However, the potentialities of biological control have not been fully exploited as this method requires extensive research.

PHYSICAL CONTROL MEASURES

The use of electro-magnetic energy for pest control has not been fully explored for it has seemed promising to a rather narrow range of pests. Wave-length energy has been used to control stored product pests and insects in wood. Ionising radiations such as X-rays and gamma-rays has been used to sterilize insects when used at low dosages. With high dosage grains can be disinfested at the rate of several tons per hour. In general, the cost of this method is considerably greater than control by chemicals, and in the case of grain disinfestation, there appears to be no obvious advantages other than rapid disinfestation.

Dehydration is another method used to control insect pests. The physical agents used destroy the water-proofing properties of the insect cuticle making it vulnerable to desiccation. Dehydrating dust has been used against grain pests and ectoparasites. However, this method is limited by the very nature of the dust which inadequately replaces residual contact insecticides. Nevertheless, the method deserves further investigations for it is less harmful to man.

CHEMICAL CONTROL (OTHER THAN POISONS)— ATTRACTANTS AND REPELLENTS

The use of attractants and repellents are alternate methods of pest control which, if successful, would undoubtedly eliminate the growing problems of insect resistance and insecticide residue problems. Investigations on thousand of compounds have resulted in the production of repellents and attractants of both synthetic and natural origin. These substances, when properly used, can greatly increase the efficiency of the control measures.

Potent attractants may be effective for long distances and are usually specific, attracting only one or a few closely related male species. This specificity has made the attractant useful for the detection and estimation of the pest populations before control measures are taken. The combination of an insecticide and attractant for pest control will ensure the elimination of the pest without affecting the natural enemies or wild-life. Use of attractants and chemosterilants (possibly together with a food lure to encourage feeding) could be another promising method of pest control.

CHEMOSTERILANTS

There are now three major ways of sterilizing insects: by genetic manipulations, by radiation, and by treatment with chemosterilants. While the first two methods involve mass production of insects and their release, the ultimate hope with chemosterilants is that it would be possible to sterilize the natural insect population and thus eliminating itself. Moreover, the exterminating effect should be more rapid than the first two methods, since both sexes of the wild population are sterilized. Chemosterilants are dangerous chemicals and should be handled properly; effective dosing of sufficient insects by these chemicals should not harm man and other organisms.

ANTIMETABOLITES

Antimetabolites are compounds that block metabolic processes resulting in the eventual death of the organism. Most of the studies on these compounds have been carried out in the laboratory; very few full-scale field experiments have been carried out. These compounds can be classified tentatively as follows: triazenes, organotins, organometallics, and many others. The development of antimetabolites is relatively recent and it is still difficult to predict their future potentialities.

PHEROMONES

Pheromones are sex attractants that were originally extracted from the female insects and are now available in synthetic form. Pheromones for cabbage loopers, fall armyworms, etc. are now commercially available. Some of these potent chemicals can lure

large numbers of males from distances measurable in miles. Using pheromones along with chemosterilants would be a promising possibility. They could also be useful for early detection or/and estimation of pest population.

HORMONES

Hormones have been utilized to disrupt moulting, metamorphosis, reproduction and diapause in insect pest. The juvenile hormones control larval growth and prevent pupation and adulthood. These chemicals have the advantage of high biological activity towards insects and low toxicity to man and other animals. However, there are some problems associated with the use of hormones for pest control. The period in the life history when it is most vulnerable has to be determined for each species. This would not be a great problem in cases where all the individuals of the pest species are at approximately the same stage of development, but this seldom occurs in the tropics. Another problem is that of getting the hormones into the insect body. The possibility of using insect hormones in baits is not very promising. In the case of spraying a suitable solvent must be used. Under field condition there is the possibility that these compounds would be inactivated by climatic factors. Their adverse effect on non-pest organisms, persistence, and development of resistance by the pest insects must all be studied before they can be used as to control pest. It is hoped that scientists will continue their research efforts in this field to resolve some of the problems associated with this method of control.

INTEGRATED CONTROL

Integrated control may be defined as the reduction of pest problems by actions selected after the life systems of the pests are understood and the ecologic as well as the economic consequences of these action have been predicted, as accurately as possible, to be in the best interest of mankind. The basic biological discipline involved here is ecology although other disciplines have provided and will continue to provide valuable information relative to specific control methods and agents; however, final decisions regarding the use of any method or combination of methods must be made by persons firmly grounded in ecological principles and thoroughly familiar with the population dynamics of the pest to be controlled (Rabb, 1970).

In Malaysia, the Crop Protection Research Division of MARDI is developing an integrated pest control programme. Many factors have to be considered in the creation of such a programme. One of the problems to be faced is a scarcity of trained personnel at the research as well as the surveillance, extension, and administration levels. To be successful, an integrated control programme needs trained scientists to provide background information. The success of the programme also depends on efficient and able organization which is prepared to maintain surveillance of pests, to supervise the control procedures, to educate the growers, to provide appropriate legislation, to regulate pesticide usage, and to overcome difficulties involved in the smooth operation of this system of pest control.

CONCLUSION AND RECOMMENDATION

We are aware that pesticides are extensively used in Malaysia, but we have not fully realised the implication of the increasing use of these compounds to our environment. Besides the occasional reports of cattle death and fish poisoning due to agricultural che-

micals, little work has been done on the effects of pesticides to our ecosystem. There is obviously a conflict between the need to control pests to prevent a diminishing food supply and the equal need to reduce environmental pollution by pesticides. This is not to say that the two frequently opposing views cannot be reconciled. It is a question of getting our priorities right; that is to ensure on the one hand that the quality and quantity of food production will sustain an ever increasing population, and on the other hand, that any long or short risk is recognised and controlled. We in Malaysia can learn from the experience of other countries and use the knowledge available in literature and reports to avoid repeating the same mistakes.

Volumes have been written on pesticide pollution. In the past few years there has been considerable public pressure (especially in Western Nations) to eliminate or control the use of dangerous and persistent pesticides. But before any drastic action is taken along this line in Malaysia we must not forget that in following suit we are denying ourselves a valuable tool for pest control and that there are problems associated with many of the alternatives. To legislate against the use of pesticides is to ensure the safety and purity of our environment; but to do so without supplying alternatives could be disastrous. Growers must be provided with new methods to control pests in place of the banned chemicals.

The quantity of pesticides used in Malaysia has been increasing over the last few years and will continue to do so for a long time. The opening of new lands for agricultural development programme and the interest shown by commercial sectors to formulate and manufacture these chemicals will add to the increased use of pesticides. We need to adopt a set of measures for controlling pests without endangering our farmers, consumers, and our environment. The use of modern pesticides is a relatively new method of pest control to most of the small holders in this country and thus pesticide problems will remain until the farmers have a sound understanding of what pesticides are capable of in both a positive and a negative sense. Pesticides belonging to the high mammalian toxicity group are unsuitable for use by certain operations and in countries (such as ours) where climatic conditions render the wearing of protective clothings impracticable these chemicals should be prohibited or restricted to trained groups. It is easy to make the farmer understand the immediate toxic effect of chemicals, but to persuade him that a chemical possesses long-term hazards through skin absorption and inhalation is the most difficult problem confronting an agricultural advisor. Most of the small-holders use knapsack sprayers and the chances of the chemical coming in contact with the operator is enhanced.

The desire for a clean environment is shared by every citizen. At the present rate of development, both in industry and agriculture, we can rightly say that Malaysia is heading towards environmental pollution unless control measures are taken along with this progress. Prevention is preferable to cure and the cost of cleaning a polluted environment is great. The price that we will have to pay in controlling pollution will also be high at the present time, but delay will result in a much higher cost later. The following suggestions should be considered with regards to reducing pesticide pollution of the environment.

- 1) Pest control research should be increased to assure that the safest and most effective pesticides are used in the future. Wherever possible, selective and non-chemical controls measures should be developed.

- 2) An educational programme should be initiated to inform the farmers on pest problems and the benefit and danger of pesticide use in order to ensure that these pesticides are properly used with due consideration to the non-target organisms and the environment.
- 3) No action should be taken against pesticides that would place food production in jeopardy unless an alternate, reliable method of controlling the pest is available.
- 4) To determine how and to what extent our environment has been polluted by agricultural chemicals, it is necessary to make a survey on pesticide usage throughout the country. Information on the levels of pesticides in our soils, water, and animal life should also be obtained. Continuous studies should be made not only of the presence but also of the origin of the pesticides entering our environment and the extent and pattern of their movement.
- 5) An orderly, methodical analysis of the documented, scientific findings of research workers should be compiled to guide us in solving the present pesticide problems, and in preventing similar and new occurrences in the future.
- 6) We should be in touch with the development of new technologies involving crop protection and problems of pesticide pollution occurring elsewhere.
- 7) A co-ordinated publicity and information programme should be developed so that the public is correctly advised about the importance of crop protection and environmental pollution.
- 8) Since the indiscriminate usage of pesticides constitutes a potential hazard to man and the environment, society must regulate the sale and the implementation of these chemicals. Legislation should be enacted requiring the registering of all pesticides sold. Legislation should also be enacted requiring *complete* and *accurate* labelling of pesticides.

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DISCUSSION

K.G. Singh.—Has any survey been done on the use of pesticides in this country? I think there is danger in buying a lot of expensive equipment when no simple basic information has been obtained.

Mohd. Sharom B. Mohd. Said.—We have just ordered equipment which will take some time to arrive. Meanwhile we are making a survey on pesticide usage throughout the country. The equipment ordered is essential for obtaining basic information on the levels of pesticide residues in our food and environment.

J. A. Bullock.—On the question of biological control, what possibilities do you see for the use of this or of integrated control in small holdings on annual crops such as rice?

Do you believe you can more readily coordinate positive action as in integrated control rather than negative action by preventing spraying?

Mohd. Sharom b. Mohd. Said.—The success of a biological control programme involves considerable expenditure of research effort to understand the nature of the controlling agents and the behaviour of the pest in relation to these agents and the environment so that it may be used to best advantage. At present much of the relevant information is not available and it would be unwise to proceed with this method of control. But, this does not mean that we should not exploit the potentialities of this method of control where possible.

Integrated control can be defined as the manipulation of several pest control techniques, which may include the use of chemicals, biological control, resistant plant varieties etc., in reducing the pest population below the economic level. Thus, it is clear that integrated control should be practised. It has been difficult to persuade the Malaysian farmer to use this approach. To answer your second question I should say that at present it would be difficult to prevent farmers from indiscriminately spraying their crops. It is hoped that when the Pesticides Legislation is ready the government would take action against indiscriminate spraying.

B.J. Wood.—Is it understood that biological control that is going on all the time is basic to any pest control programme? The need to study a situation is agreed, but this applies equally to all forms of pest control, otherwise there is a high chance of doing more harm than good.

Mohd. Sharom b. Mohd. Said.—The answer is no. I would certainly agree that naturally occurring biological control plays an important role in pest control, but there are situations in which it is necessary to spray chemicals without consideration of the pest's natural enemies.

B. J. Wood.—Is the present method of rice growing, with each small holder having his own little plot, a good system *vis a vis* the organization of national pest control or any other activity for that matter?

Mohd. Sharom b. Mohd. Said.—The organization of national pest control is certainly a more systematic, efficient, and effective method of pest control to that practiced by the small holders.

J.A. Bullock.—Referring to plant pathogens, what actions are currently taken to control pathogens and how much use is made of phenyl-mercurials?

Mohd. Sharom b. Mohd. Said.—These compounds have not been widely used in this control methods which include the use of resistant varieties, crop rotation and the use of chemicals. Most fungicides are not very toxic or persistent and they contribute very little to the problems of pesticide pollution.

K.G. Singh.—Phenyl mercury acetate compounds have not been used on any large scale in this country and the figures reported in press statements are grossly inaccurate.

The subject is very controversial and it is only recently that the Government has become aware of the problems of pollution. Because of the lack of legislation all sorts of pesticides are being imported and sold, sales depending mainly on the aggressiveness of the vendor.

P.K. Hernon.—After any form of chemical control has been used is any investigation made to find out what proportion of the residue is carried over into the food chain?

Too great an emphasis is placed on the amount of money that goes into man's pocket, too little on what gets into his stomach.

Mohd. Sharom b. Mohd. Said.—We have looked into this matter; in fact we had a meeting with other interested organizations to discuss the feasibility of joint efforts in pesticide research. One of the project proposal includes studies on pesticide residues in food chains.

Soil Conservation

R.F. ALLBROOK¹

Recently, the idea that we have to consider our environment if we as a species are going to survive in our present, or better conditions, has been brought to the fore in newspapers, television and films.

The proper use of natural resources is being discussed particularly with reference to pollution.

The basic natural resources of the world is its soil which provides a medium for plant growth. Whether that plant is a tree for timber, rubber or vegetable oil, or a cereal for animal or human consumption, or a bush whose fruit we eat or process into a drink or oil, it can only achieve its potential if a fertile soil is available for it.

The conserving of the soil is therefore a vital need if a country is to retain the productivity of forest and agricultural areas.

Another important reason for soil conservation is that it is closely connected with hydrology, that is the prevention of the floods which too frequently affect large areas of this country. A catch phrase that has been used emphasises this connection, "Save the water and you save the Soil".

The title of this symposium is "Biological Resources and National Development". I have already shown that the soil is a major resource. The importance of soil conservation really becomes paramount with the second half of the title, "National Development".

The land form as it occurs over a most of the Malay Peninsula has not changed appreciably during the past thousand or so years. As long as the vegetation cover, tropical rain forest, remains, then the subject of soil conservation can remain, perhaps, as a topic in the Agricultural undergraduates curriculum but need not unduly worry the planner.

Once National Development gets under way however it is inevitable that a change from tropical rain forest to some other form of vegetation will be made. Soil conservation becomes of vital importance during this transitional period between the removal of the forest and the establishment of a new vegetation cover. Since the major crops in this country are tree crops, once the new vegetation gives 100% cover conditions will then be similar to the original state.

If one takes a medical analogy, the disease we are concerned with is soil erosion which as it gets progressively more serious blocks the arteries or veins of the country, that is its rivers, so that flooding occurs. The cure of this disease or better the prevention of it is soil conservation.

Is this disease important? I don't feel the answer to this question can be doubted by anyone. The floods which occur in most years in the lower reaches of the Kelantan and Pahang rivers are the largest examples of the acute state and of seriousness of the disease. Here on the campus the lake is gradually silting up.

That is one aspect of the disease but there is another, more important. All this soil that has been and is being eroded, into the rivers and seas has once been part of the land surface and most of it was the top soil. The top soil is the biologically active part of the soil in which the roots of plants live and hence it is the most important part from an agricultural and biological view.

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This then is the soil conservation problem, to conserve the soil in place so that plants can grow on it and so that it will not be carried away to block up the rivers and cause floods.

Strangely enough the problems at the root cause of soil erosion are very simple to solve. It is only as one gets progressively further from the basic cause that the dimensions of the problem begin to appall one.

Therefore if we start at the site where soil erosion begins we may be treated as those who do not suggest a big enough solution to a big problem.

Soil erosion only occurs on a large scale when three factors work together; these are (1) a heavy rainfall (2) a steep slope and (3) no vegetation.

Taking the heavy rainfall, this is the intensity of individual storms which we have and cannot escape in our tropical climate. The steep slopes too are common in Malaysia therefore the only factor which we can readily control is the vegetation cover.

As already pointed out, National Development and deforestation are linked. It is therefore important to establish cover on the soil as soon as is humanly possible after the forest has been cut down.

The problems here is that, in order to establish new crops, not only must the forest be felled but the trees must be removed. Burning is only a beginning but as soon as this has been done a cover crop of legumes like *Calypogonium* or *Pueria* should be established.

The establishment of cover is to literally cushion the effect of rain on the soil. The beginning of most soil erosion is a type of erosion known as splash erosion.

This erosion is caused by the kinetic energy in the rain drop. The kinetic energy detaches very small particles of soil and so gets the soil into a slurry, which then if a slope is present, can be carried away either in gulleys (gully erosion) or over a wide area (sheet erosion).

A cover crop or mulch of plant residues will absorb this kinetic energy and thus the soil will not be detached and no slurry is formed.

The principle to be followed is not to cut down a large area of trees than can be dealt with in a short time so that the soil surface is not left exposed for longer than is absolutely necessary.

The steepness of the slope is a factor, as we have seen, and this has been acknowledged in this country so that slopes greater than 20° are not recommended for agricultural development. Not only is this because of the direct danger of soil erosion but also because areas having such a slope will have to be terraced which therefore increases the overhead costs in bringing an area into a state of greater productivity.

When a hilly area is being cleared an idea that can be followed is to do the clearing in two stages.

Suppose we have a conical hill of unit radius. The area will be approximately π . If the top $\frac{1}{3}$ is left under forest this will amount to only $\frac{1}{9}\pi$ leaving $\frac{8}{9}\pi$ for development. However the length of slope is reduced by $\frac{1}{3}$ and since the amount of soil eroded is proportional to the length of slope then the amount of soil eroded is reduced by $\frac{1}{3}$.

Also since in this country hills tend to increase in steepness with altitude the amount of reduction of erosion is likely to be greater than $\frac{1}{3}$ as the amount of erosion is also proportional to the angle of slope.

Agricultural Development is by far the largest National Development in Malaya but I feel I should mention development for industry or housing. When this is carried out it is quite clear, if one looks, for instance at the site of Shah Alam, that no thought

regarding soil conservation has been or is being considered. The land is cleared of vegetation and then all slopes are reduced to a minimum by extensive earth moving operations. Thus the top soil is removed possibly to a valley either far away or near at hand.

They are not concerned about plant growth, so there is no need to conserve this fertile soil, one may think, but the point now is that the subsoil is much easier to erode than the surface soil. The structure is very weak and hence splash erosion has no difficulty in forming the slurry which quickly finds its way into the drainage systems of the new factory or housing complex, and from there to blocking of the river or, in our case here, the campus lake.

I have just mentioned the removal of earth to valleys to form flat areas. This too is a bad practice as the blocking up of a valley which is the natural water pathways of an area may lead to another form of soil erosion which is more dramatic, the mass movement or land slide.

Whenever buildings are put up on an artificially created foundation the dangers of slips is very great. Here at the campus we have seen this occur following development.

Therefore to potential buyers of buildings I would say be careful and be sure that the solid ground of your house or factory has been there for a long time and not a recent man-made creation. If it is recent not only will setting occur causing cracks to the fabric of the building but one day the solid ground may not be there at all!!

DISCUSSION

J.A. Bullock.—Would you comment on the loss of nutrients under different types of cover or lack of cover?

R.F. Allbrook.—In a soil, the content of nutrients and particularly that of available nutrients falls with depth. This fall is most marked in the top few inches. If, therefore, the top few inches are eroded, the loss of nutrients is very high and may be as much as 2/3 of the total. The soil is therefore impoverished and a much poorer crop will result. The loss of fertility is not only confined to nutrients, but perhaps more important, includes loss of structure since, over most of Malaysia, it is only the surface horizons that are well structured. This loss means that, a much poorer root system will develop which cannot then support a good plant.

If a cover crop is planted which prevents erosion then these faults will not occur. The planting of legumes as a pioneer crop does, of course, in addition, increase the level of soil nutrients with respect to nitrogen.

Tunku Shamsul Bahrin.—The pattern of opening land at the rate of 5,000 acres may be "technically" undesirable but there is need to open up land quickly for economic and social reasons. These may be contradictory to one another. How do we overcome this problem to the satisfaction of both?

R.F. Allbrook.—It is important when one is talking of economics to follow the study to the end. It is true that a contractor might tender a lower cost per acre for clearing 5,000 rather than 1,000 acres. However, that is not the end, when one comes to the production stage a partially eroded area will produce far less and any savings on clearing will be cancelled out by loss of production.

Similarly, the social aspect follows from the economic. A settler on partly eroded land will be discontented and impoverished because of the lack of productivity of his land.

The answer is the development of small units of about 1,000 acres. The number of such units is not limited and therefore the speed of National Development is not slowed.

Wong Yew Kwan.—It can be taken that under tropical conditions the natural forest is the most effective cover *vis-a-vis* soil erosion. This is because of the complex number of species occupying any particular site; their roots and their litter physically minimise erosion.

R. F. Allbrook.—The efficiency of the natural forest is due to the mixture of species giving several stories so that maximum interception of rain occurs, reducing the kinetic energy of the rain drops to a minimum.

The litter is of minor importance, mainly because in tropical conditions there is very little. Similarly the importance of organic matter in the soil and structure of the soil are small because of their weak development.

Francis C. Cadigan Jr.—The principal vector of malaria in W. Malaysia is *Anopheles maculatus* which requires moving water exposed to the sun for successful breeding. It can do with very little water, but it requires sun. Therefore clearing the forest from large areas can greatly increase the breeding sites (and thus the risk of malaria). The immediate planting of dense ground cover to prevent erosion will also prevent the breeding of that mosquito, thus one not only preserves the soil for the farmer, but preserves his health as well.

Agriculture and Forestry in the Development of Sabah¹

P.F. COCKBURN AND A.J. HEPBURN²

Sabah has an area of 29,388 sq. miles much of which is covered in Dipterocarp forest. Forests reserved for timber production, protection and recreation cover 11,229 sq. miles or 38.2%. Other State forests, many of which have been logged out under special licence cover 12,060 sq. miles (41.03%) while the remainder is under shifting cultivation, or alienated by land title. This latter 5.56% or 1,634 sq. miles is the area from which comes nearly all the exportable agricultural products; rice being the exception. 2,500 sq. miles are under secondary forest following shifting cultivation and may be regarded at present as total waste.

Of the alienated land 62.36% is planted with crops (Table 1).

TABLE 1. Major Crops Planted by Area 1970

Total	Sq. Miles 1,019.43	% 100
Rubber	409.5	40.13
Coconut	212.7	20.80
Rice	162.0	15.89
Oil Palm	148.0	14.52
Cocoa	15.5	1.52
Others	71.73	7.14

Source: Department of Agriculture.

The population of Sabah is small, 1970 provisional figures indicate a total number of 655,295, of which it is estimated 245,000 are economically active (i.e. employable for production). Agriculture is very labour intensive especially in respect of the crops which seem here to be the most successful. In fact, as can be seen from Table 2, 67.47% of the available work force are employed by agriculture.

TABLE 2. Persons Employed by Agriculture and Forestry 1960

Total available	176,626	%
Rice	77,681	43.98
Rubber	24,878	14.08
Coconuts	7,499	4.24
Oil Palm	243	0.13
Other Crops	8,904	5.04
Forestry	10,573	5.98

Source: Department of Statistics.

The figures are unfortunately out of date and very many more are now employed by oil palm estates. However many of these have come from Hemp production which is

¹ The views expressed in this paper are the personnel views of the authors and do not necessarily reflect the policy of the Sabah Government.

² Forest Department, Sandakan, Sabah.

now defunct. More recent figures are available for employees employed by employers with more than 20 workers (Table 3).

TABLE 3. Persons Employed by Employers with more than 20 Workers by Industry (30.6.1970)
Total 38,994 = 15.9% of estimated work force

Estates 11,305		% of Total — 28.99	
Rubber	4,944		12.67
Oil Palm	5,384		13.80
Cocoa	853		2.18
Other	124		0.31
<i>Commerce and Industry</i>			
Logging	9,473		24.29
Wholesaling etc.	1,572		4.03
Building	1,061		2.72
Fishing	182		0.46
Others	3,166		8.12
Government	12,235		31.37
		<hr/>	
		99.95%	

Source: Department of Statistics.

From the figures it can be seen that most Forestry workers are employed by companies with more than 20 workers. By the nature of the operation this is to be expected. In Agriculture however a far lower percentage of all crop workers are employed by companies. A large number therefore must be working on small holdings producing rice, rubber, vegetables etc. and on oil palm and other settlement schemes and land development cooperatives.

The value of exports is probably the most important single factor in the availability of funds for development. It is well known that at present timber is producing far more revenue, foreign exchange, and individual wealth in Sabah than any other trade or crop. It is suggested from the evidence presented that it could go on doing this in perpetuity while the future for agriculture as a profitable, revenue earning, export industry seems less certain (Table 4).

TABLE 4. The change in crops since 1961 and their respective values (in \$ million)

	Rubber		Palm Oil		Copra		Cocoa		Hemp	
	Tons	Value	Tons	Value	Tons	Value	Tons	Value	Tons	Value
1961	23,612	41.2	NIL	NIL	67,862	27.08	101	0.18	4,115	4.8
1970	31,307	36.4	28,197	18.09	14,792	6.8	1,948	4.4	367	0.34

Three major crops have therefore decreased in value since 1961. Only two, Palm Oil, and Cocoa have increased, and there is a definite limit on the volume of the latter as soils suitable for cocoa growing are rare. Much of the accessible cocoa soil has already been exploited or earmarked for exploitation, and it is unlikely that total annual production could exceed 20,000 tons, which might be expected from 45,000 acres.

Many crops which were once common in Sabah have disappeared. Tobacco, Cinnamon, Coffee, etc. have all declined because of a variety of difficulties. Among these must surely be, cost of production, labour problems, and markets for the quality of goods produced.

Oil palm is therefore the real competitor with timber for land, labour and export value. In view of this a brief analysis of production costs and profits for these two industries is necessary.*

One may in Sabah expect to produce 40** tons of oil from one acre of oil palm over the maturity period of 25 years. This is based on 10 tons of bunches per acre year for 22 years with a conversion rate of 18%. This is admittedly a low rate, but higher rates than this are so far rare in Sabah. Taking an average F.O.B. value of \$500.00 per ton this gives a gross value of \$20,000 over the maturity period. Approximate average costs of establishment including a factory are estimated at \$2,400 per acre, (of this figure some \$900 is attributed to the factory). The estate to ship production cost is approximately \$380 per ton on average and at current rates the export duty per ton of oil with an F.O.B. value of \$500 is \$45.00. Thus total production costs are in the region of \$425 per ton, and over the 25 year maturity period approximately \$19,400 per acre. This leaves an estimated gross profit of only \$600 per acre in 25 years. The profit over the second maturity period should be slightly better assuming that the factory will last for two periods, but it is likely that increased fertilizer requirements will increase production costs. Taking a profit of \$600 per acre for the first period and \$2,000 for the second the gross profit over a 50 year period is only \$2,600.

Profits from timber operations are very difficult to assess on a state wide basis; however, from a variety of available figures the following might be considered reasonable. Average quantity of timber saleable per acre excluding sinkers 1,200 cubic feet, average F.O.B. value per cubic foot \$2.00 thus average value per acre \$2,400. Average cost is estimated at \$1.30 per cubic foot + royalty, which at the above F.O.B. value is .35 cents, i.e. a total estimated cost per cubic foot of \$1.65. This does not include any premium or other payment which may in some cases be paid for the right to fell and extract timber. Thus for a total capital outlay of \$1,560 per acre excluding royalty a clear profit of some \$420 may be expected, i.e. about 27% return on capital within a very short period of time (royalty is not included as a capital cost since when logs are exported payment is often received before royalty falls due). This compares very favourably with oil palms where the total capital investment over a 25 year cycle is approximately \$17,600 to yield an estimated profit of \$600 i.e. about 3.4% return on capital over a lengthy period. Over two cycles the return is expected to be higher, perhaps about 7.3%.

Apart from the fact that the return on capital invested in oil palm is much lower than that invested in timber the difficulties of growing oil palm on a really big scale are daunting. The indications are that without a major change in attitude towards agricultural work it is unlikely that many more of the economically active population will voluntarily become plantation workers. It is only necessary to talk to managers of large estates in Sabah to quickly realise the very serious problems regarding agricultural labour. It is not unfair to say that any major increase in Estate acreage would have to be accompanied by the recruitment from elsewhere of a substantial labour force. Immigrant labour has its own problems.

Forests on the other hand are, given proper management and 15-20 years of unskilled treatment starting 1 to 2 years prior to felling, self perpetuating. On a proper sustained yield basis it should be possible to exploit some 112 square miles per year i.e.

* Oil Palm kernels make up only a fraction of the value of palm oil and in the figures quoted the profits derived from kernels have been deducted. Similarly in the calculations of timber values minor forest produce has been excluded.

** All figures quoted here are approximate averages. Actual figures vary tremendously depending upon soil conditions, estate size, efficiency of management etc.

one hundredth, of the permanent forest estate in perpetuity. This should yield an estimated 86,000,000 hoppus cubic feet of timber with a current F.O.B. value of approximately \$172,000,000 and revenue to Government in the form of royalty amounting to some \$30,000,000. (If the remainder of the State owned forest (some 12,000 square miles) were to be brought under the same form of forest management the figure could be doubled). It should be noted that these figures are based on current timber prices, which are considerably lower than previously. With a revival in timber prices and a return to previous levels, the F.O.B. value and hence the royalty would increase considerably. A small increase in labour for logging operations would be necessary together with a considerable increase in the State Forest Department responsible for management. This latter should not be surprising considering that at present the Department only has 14 professional and 26 sub-professional staff, which compares most unfavourably with the Agricultural Department having 39 and 76 officers in the respective categories. Together with staff increases would be the need for additional funds. It is estimated that the total cost of the Department should not exceed \$14,000,000 annually. With a guaranteed annual revenue of at least \$60,000,000 this should not be considered excessive.

The export of timber in log form has for many years been the most profitable method of operation. It is considered desirable to try to diversify the timber industry, and over a period of years to process locally as much as possible, thus increasing F.O.B. value and Government Revenue and providing more skilled jobs. Such diversification however is extremely expensive and companies cannot be expected to advance the capital involved without long term security of tenure and timber supplies.

With the experience gained over the past few years in forest plantation work, it should be possible to enlarge the forest estate with plantations once the necessary experimentation is complete. However like oil palm, timber plantations also are labour intensive and until the labour becomes available plantations on a big scale are likely to be limited.

From the evidence here presented it would seem wise not to allow an agricultural project to interfere with the permanent forest estate, at least at present. It is essential that the forest estate should be kept on a sustained yield basis and the necessary staff and funds to ensure proper forest management provided.

Before any major land use policy can be accepted the long term value of Forestry when conducted upon the lines laid down in the Silvicultural code, and Management framework used in Sabah, must be substantially bettered, if the forest is to be cleared once and for all. 2,500 sq. miles of land in Sabah which have been used for shifting cultivation are totally unproductive, the forest having been cleared and the land burnt, it now carries only poor secondary forest. Only 35,214 acres of the total of 72,195 acres of rubber were tapped in 1969. In the Sandakan residency hardly any rubber is now tapped because of the high cost and low numbers of labourers. The average monthly wage of a forest worker is much higher than for an estate worker, and where forest jobs are available there are always many applicants.

World demand for timber shows no downward trend and indeed is likely to increase considerably in the future. Sabah should be well placed to take advantage of this if the policy of sustained yield is vigorously adopted.

The most advantageous development in agriculture would be the production of sufficient rice to allay the money spent on rice imports which in 1970 amounted to \$15 million. Areas for rice growing must come however from areas cleared of forest where it is too late to change back to timber production.

Agricultural development is at present absorbing most of the revenue that the forests are producing. In the Second Malaysia Plan \$26.8 million is earmarked for Research and Training in Agriculture and a further \$191 million for rice, rubber and the resettlement of rural people in Settlement Schemes, which are at present tied almost completely to Palm Oil Production. The total budget for forest development for the five year period is \$8.63 million with an additional contribution from the Canadian Government of \$2.2 million. Good forest management is essential for the future development and prosperity of Sabah. To ensure this a considerable increase in the funds annually allocated for forestry is necessary; the total however is unlikely to exceed 25% of the expected revenue. Coupled with security of tenure for timber producers, to encourage them to process locally, the timber industry can and should continue to yield the wherewithall for National Development at the same time being the most profitable and economic form of land use in the State.

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Land Planning and Conservation in Sabah

LIEW THAT CHIM¹ AND SHIM PHYAU SOON²

SUMMARY

Land use has an important bearing towards the development of a country. This paper points out that land *is* available for all purposes but that these claims should be subject to a thorough economic analysis in order that uneconomical use of land can be avoided.

INTRODUCTION

Conservation is seen from different view points by the different sections or departments and this has invariably led to friction between those concerned. They all have their claims as to the uses to which rural land should be put, but these claims should be based on an evaluation of their land use objectives. Sabah is a young state and the demand for land for agricultural and urban development has not yet reached a critical stage, but the rush to use rural land is already on. However, the importance of forestry has not been taken into due consideration by most developing countries. The current emphasis is on agriculture but unless an analysis of the economics of the situation has been done, much of the land which is, or may be allotted, might in the long run revert to forestry use as experienced in Australia and New Zealand.

CRITERIA FOR LAND PLANNING

Rural land in Sabah has traditionally been thought of in terms of agriculture. In Australia the demand for such land for non-agricultural use has been strongly opposed (James, 1968). Sabah is a developing State and it is in our best interests to see that such conflicts do not arise.

Claims for land by any section should be based on the concept that no one has any first hand claim on rural land although all sections have a legitimate right to acquire such land. The land so claimed must then be thoroughly investigated as to the use to which it is best suited. Rainfall, topography, soil structure and natural vegetation have to be taken into account.

The selection of criteria on which claims for land are based is not always straight forward. Intangible benefits cannot be objectively measured, but neither can they be ignored. An *economic* criterion provides us with the best method of determining claim for a variety of possible activities on a given piece of land. This is because land is a natural factor of production. It is an economic good, in that it possesses value. Economic analyses provide us with not only a direct comparison between output of, for example, rubber and timber in a given area of land, but also an assessment of intangible benefits. This does not mean that social, political or welfare issues should not to be taken into account, but they should not rise above the economic criterion.

EVALUATION OF LAND USE

Land whether large or small in area is seldom homogenous. Soil, altitude and topographical features vary even within short distances and the break down of a given region

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into smaller units, each representing a homogenous type of activity becomes necessary. The existing principle of a broad pattern of land use should be reassessed and alternative uses, to which the area could be put, should be imposed. For example, should 10 square miles of virgin forest be converted to agricultural land or should its recreational potential be developed? The assessment made, should be to ascertain what *parts* of the forest, if any, are better suited to agriculture or recreation than to forestry and not necessarily the *whole* forest. It does not mean that because the financial rewards from forestry are poor, the area should be better developed for agriculture or recreation because these claims have not been proved. Alternatively might good agricultural land not be better forest land?

Sound methodology should be followed in the economic analysis of land use, taking into consideration the respective production cycles, land value and capital invested between the alternative land-using activities under review. A comprehensive methodology has been outlined by James (1968).

APPLICATION OF ECONOMIC ANALYSIS OF LAND USE

In the application of the economic criterion, certain areas will prove by objective economic analysis, to be economically more suitable to agriculture than to forestry. This category of land should be reserved for agriculture e.g., the volcanic soils around Tawau in Sabah may fall into this category but, on the other hand, not all claims on land suitable or profitable for agriculture should be approved because the land so claimed may be necessary for other purposes, e.g., as a water catchment area. Alternatively, sub-marginal agricultural land may prove more profitable to forestry than to agriculture.

There are in Sabah, also, large areas of hilly and mountainous country and land on ultrabasics where neither forestry nor agriculture would be profitable. Neither are these required for urban development of industrial purposes. These categories of rural land which produce little tangible end product should be reserved for water conservation, recreation, and for the preservation of wild life and the native flora, depending on their physical or natural advantages. The creation of National Parks from such areas may be of economic value. For example, the existing National Parks of New Zealand and Sabah are an attraction to overseas tourists and thus a source of income in overseas currency. In these areas shifting cultivation must be discouraged.

In the allocation of land, social benefits should also be accounted for. Where the benefits of two or more claimants are about the same, the one which employs more men should have top priority.

CONCLUSION

In recent years forestry has played a vital role in the development of Sabah's economy. More than M\$400 million worth of timber has been exported annually with royalties amounting to some M\$75 million. Sabah is also one of the largest hardwood producers in the world. It is hoped that future land problems in Sabah will take into account the importance of forestry in their economic analysis of land-use. With the completion and availability of Forest Inventory data, this should be used in conjunction with Soil Classification data to the utmost, to evaluate alternative land use. As indicated earlier, Sabah is still a young state but the land rush is on. It is therefore vital that research should be done in this field. An example has been shown in West Malaysia where pro-

ductive lowland Dipterocarp forest is disappearing with forestry being driven up into the hill country (The Ad Hoc Editorial Committee of the Malayan Forester, 1970). It is hoped that similar events will not occur in Sabah.

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DISCUSSION

- G. Smith.*—It appears that the authors advocate that any land which is of no use for urban development, industrialisation, forestry or agriculture should be given over to recreation, water conservation and the preservation of wild life. Surely we are interested in conserving wild life and the native flora in its *original* habitat and not relegating it to land which is unsuitable for all other purposes. While economic criteria may be very important in certain instances where potential landuse is being investigated, I cannot believe that such criteria can be applied when selecting areas for National Parks or Nature Reserves.
- J.A. Bullock.*—The scheduling of unuseable land as nature reserves is inadequate. Other areas must be included because of the diversity of fauna and flora.
- Liew That Chim.*—In the economic analysis it would be anticipated that various forest types would be allocated to forestry. But forests allocated to forestry may be managed from a forester's point of view (a) solely for timber production (b) for multiple purposes, e.g. recreation, wildlife preservation, timber production etc. and (c) for single purpose preservation of landscape, habitats and wildlife. Although management of the three categories must vary radically, each may contribute to a forest use pattern that is, at the same time, sound forest resource conservation (Florence, 1969). The reservation of unuseable land for recreation, water conservation or for the preservation of wildlife depending on their physical or natural advantages falls under category (c). Various potential forest types which have unique flora or fauna may be reserved for research purposes under category (b) or (c), e.g. Sepilok Forest Reserve near Sandakan.—*Reference:* FLORENCE, R.C., 1969. Conservation in eucalypt forest from a Forester's view point. *Forestry Log.* 38-39.

Induced Breeding and Early Development of the rabbit-fish *Siganus oramin* (SCHNEIDER)

C.L. SOH AND T.J. LAM¹

ABSTRACT

In captivity, sexually-mature *Siganus oramin* would not feed while at the same time its gonad showed progressive degenerative changes. Injections of human chorionic gonadotropin (Antuitrin 'S', Parke-Davis) caused the fish to ovulate or spermiate; this was followed by successful artificial fertilization. Very high percentage success of fertilization (at least 90%) and hatching (70-80%) was obtained but the hatchlings (larvae) did not survive for more than a few days. This problem of larval mortality has been discussed.

The eggs are small (0.42-0.46 mm), contain oil globules and adhesive. Six stages of maturing eggs have been described. An account of the early development of the fish has also been given.

INTRODUCTION

Siganus oramin is a species of rabbit-fish known locally as 'Dengkis' in Malay and 'Peh Thor' in Hokkien (Chinese). It is a common food fish collected from coastal waters in this region. It is especially popular with the Chinese people during the Chinese New Year season when the fish is in its breeding condition: the female is full of roe. During this season the fish fetches a high price in the market. It is therefore an economically important fish well-worth being considered for aquaculture.

Except for some information on the taxonomy, general morphology and distribution (Herre and Montalban, 1928; De Beaufort and Chapman, 1951; Scott, 1959), the biology of this fish is unknown. This is generally true for all siganids. However a few species of siganids (especially *Siganus vermiculatus*) have been successfully cultured in coastal ponds in the Philippines (Pillai, 1962) and another species, *Siganus rivulatus* has been shown to be feasible for culture in Israel (Ben-Tuvia and Kissil, 1971).

Our preliminary studies have indicated that *Siganus oramin* is also suitable for culture. The young fish feeds on *Enhalus* plant, cooked rice and any other food item which is offered, and shows a good growth rate (8-10 gm per month initially) in a pond.

Now, a successful fish culture would depend on a regular supply of fry for stocking purposes. In the Philippines and Israel, the siganid fry for culture are obtained from nature (Pillai, 1962; Ben-Tuvia and Kissil, 1971). However, this may not be reliable on a long-term basis; furthermore, the practice may cause undesirable upsets in the population dynamics of the fish. It would therefore be better to breed the fish, if possible.

We found that *Siganus oramin* could not be bred in captivity (further evidence given in this paper). An attempt has therefore been made to induce the fish to breed.

Induced fish breeding using hormones has now been increasingly practised in aquaculture (Chaudhuri, 1968; Clemens, 1968; also see FAO BULLETIN on AQUACULTURE). Human chorionic gonadotropin (HCG), a hormone secreted by the human placenta during pregnancy, has often been used with success (see above references). This is based on the fact that the action of fish gonadotropin may be mimicked by HCG (Yamazaki and Donaldson, 1968).

We have earlier successfully used HCG to induce the marble goby, *Oxyleotris marmorata* to ovulate, followed by successful artificial fertilization (Tan and Lam, 1973). HCG has therefore been used in the present study.

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This paper reports the initial success in induced breeding of *Siganus oramin* and gives an account of its early development.

MATERIAL AND METHOD

Source and maintenance of fish

Gravid females and mature males were used in the present studies. They were collected in Johore Straits, near Tuas (North West of Singapore) on 30th January 1972. The fish were transported back in plastic pails and kept in four concrete tanks of $4' \times 1\frac{1}{2}' \times 1\frac{1}{2}'$ containing sea water collected from Johore Straits (salinity: 26–28.5‰). The temperature of the sea water varied from 25 to 27°C while the pH value changed from 8.0 to 9.0 during the course of the experiments. All the sea water used was treated with streptomycin sulphate (B.P. Glaxo) at a concentration of 0.05 mg/ml.

The fish refused to feed under the above conditions (in contrast with the young fish which feed well under the same conditions). However, they survived for as long as a month which provided sufficient time for the experiments.

Experimental methods

The gravid females were divided into four groups with five fish in each group. The first group served as the control; the second group received a daily intramuscular injection of HCG (Antuitrin 'S', Parke-Davis) with a dosage of 0.25–0.30 I μ /gm body weight; the third group received a dosage of HCG of 0.5–0.6 I μ /gm body weight and the fourth group received a pituitary gland (obtained from a gravid female) plus 0.25–0.30 I μ HCG/gm body weight.

Egg samples were taken prior to the injection from each group with the use of a finely-drawn glass dropper. They were then examined under the microscope to determine the stage of maturation of the eggs. Only those fish with approximately the same stage of maturation were used.

On the second and third day, egg samples were again taken prior to the corresponding injection, and examined. If oil globules appeared in the eggs, samples were then taken hourly until ovulation occurred.

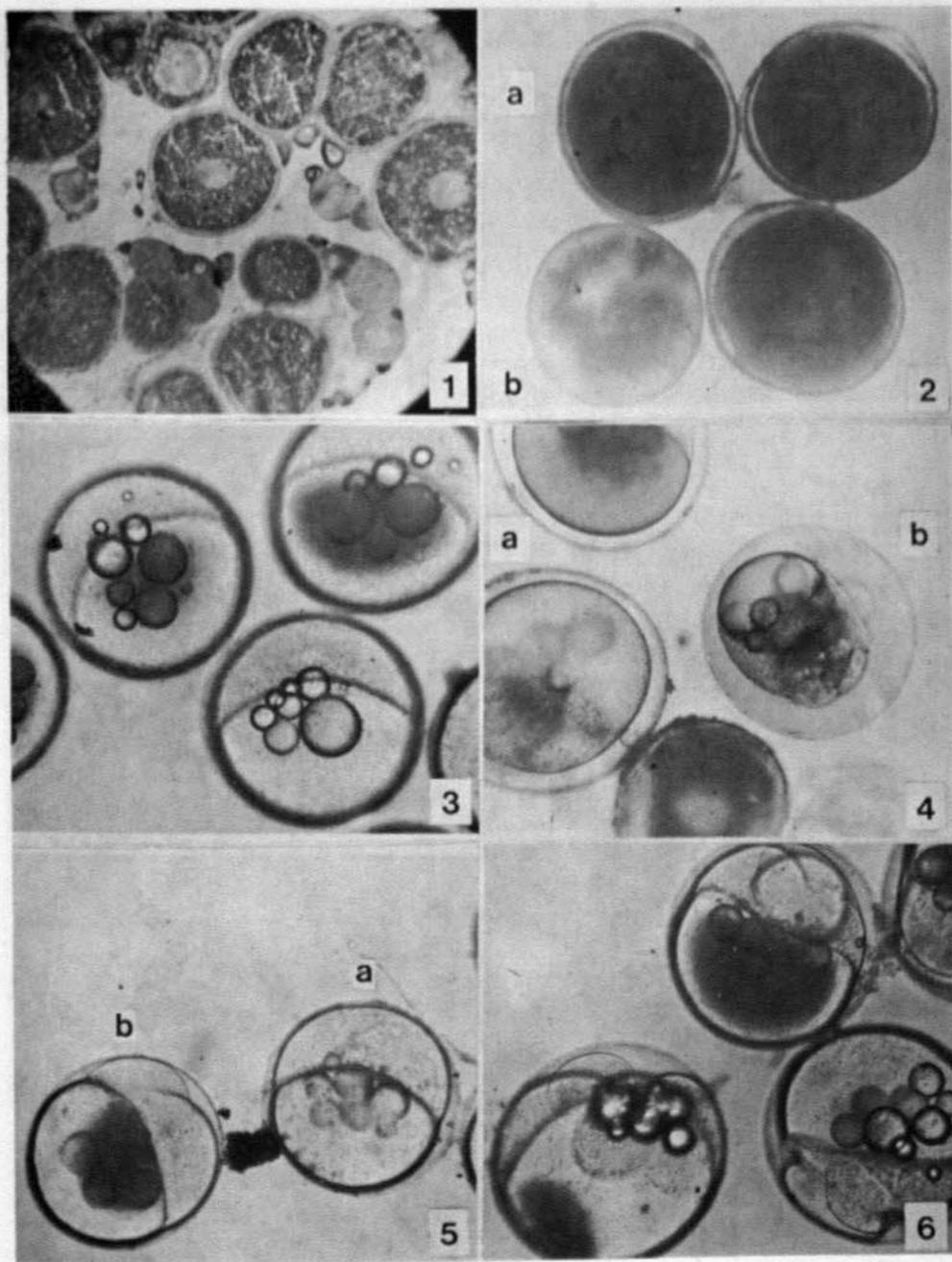
Eggs of different stages of development were thus sampled and artificial fertilization was attempted with the eggs of each stage.

Artificial fertilization was carried out by the wet method. A fully mature male previously injected with HCG (0.25–0.30 I μ /gm daily for 2–3 injections) was used. The milt was expressed out into a bowl containing about 100–200 c.c. of clean sea water and the ovulated eggs were then stripped from a female into the sea water with the sperm suspension. The eggs of other stages were similarly mixed with the milt in sea water. About 3–5 minutes later, the sea water was renewed and subsequent changes of water were done at intervals of two hours.

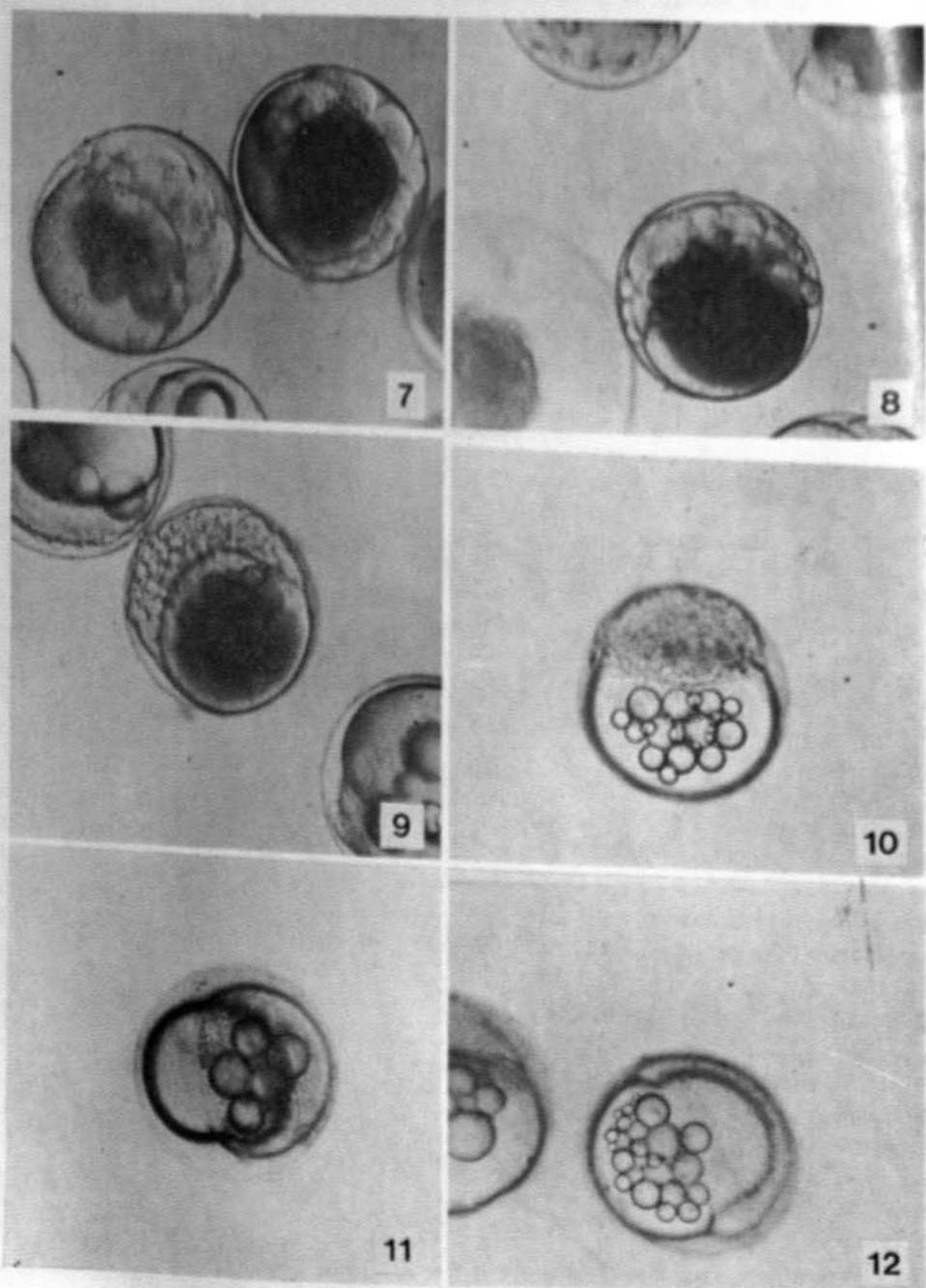
The chorionic membrane of the eggs is very sticky and will stick to any objects it comes into contact with; hence this facilitates changes of water.

As soon as the mixing of eggs and milt was done, samples were taken and examined under the microscope. The changes of the fertilized eggs were noted and photographed.

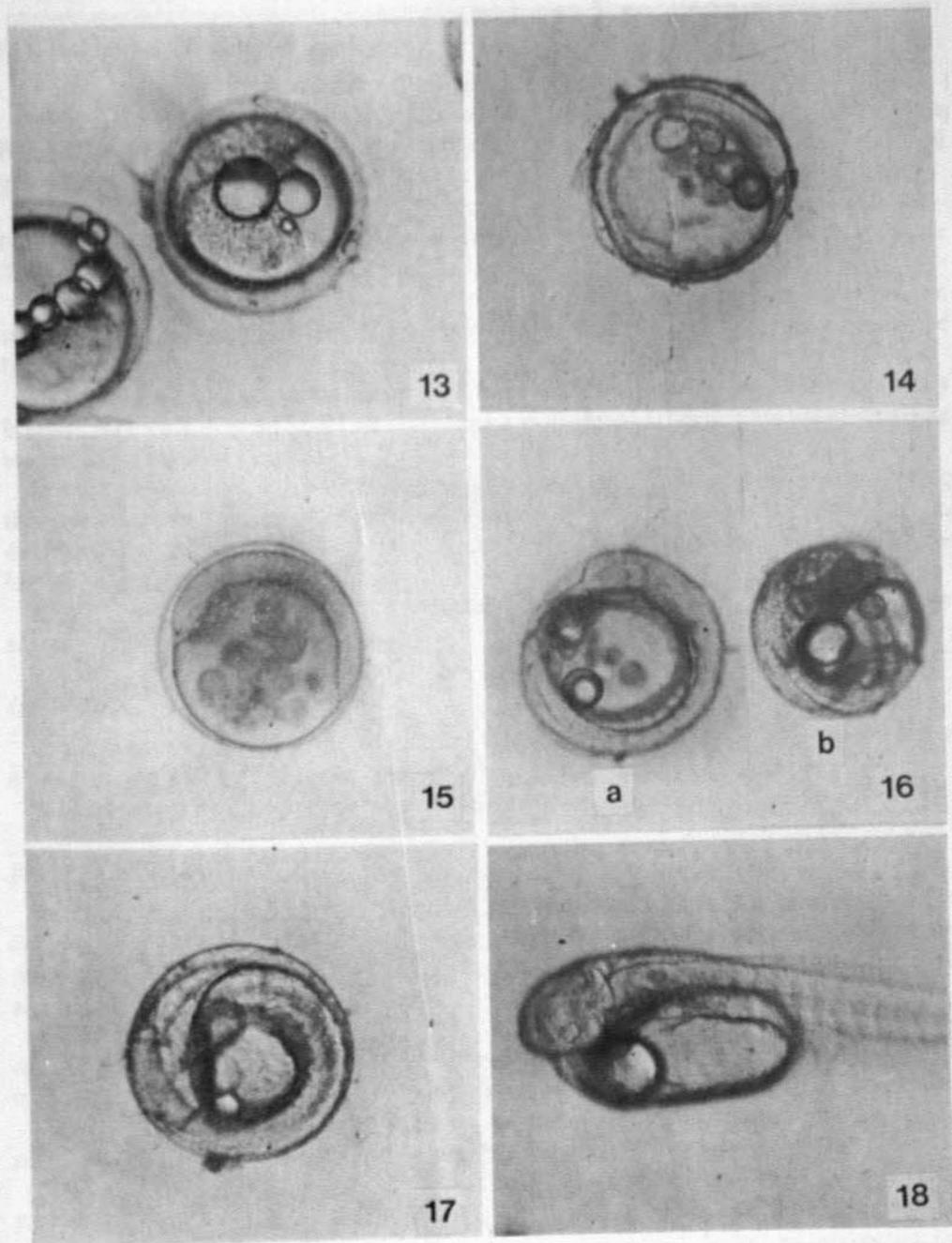
Eggs of the different stages of development were preserved in Baker formal calcium preservative. The larvae were anaesthetized with MS222 before being preserved in the same medium in order to avoid distortion of the body.



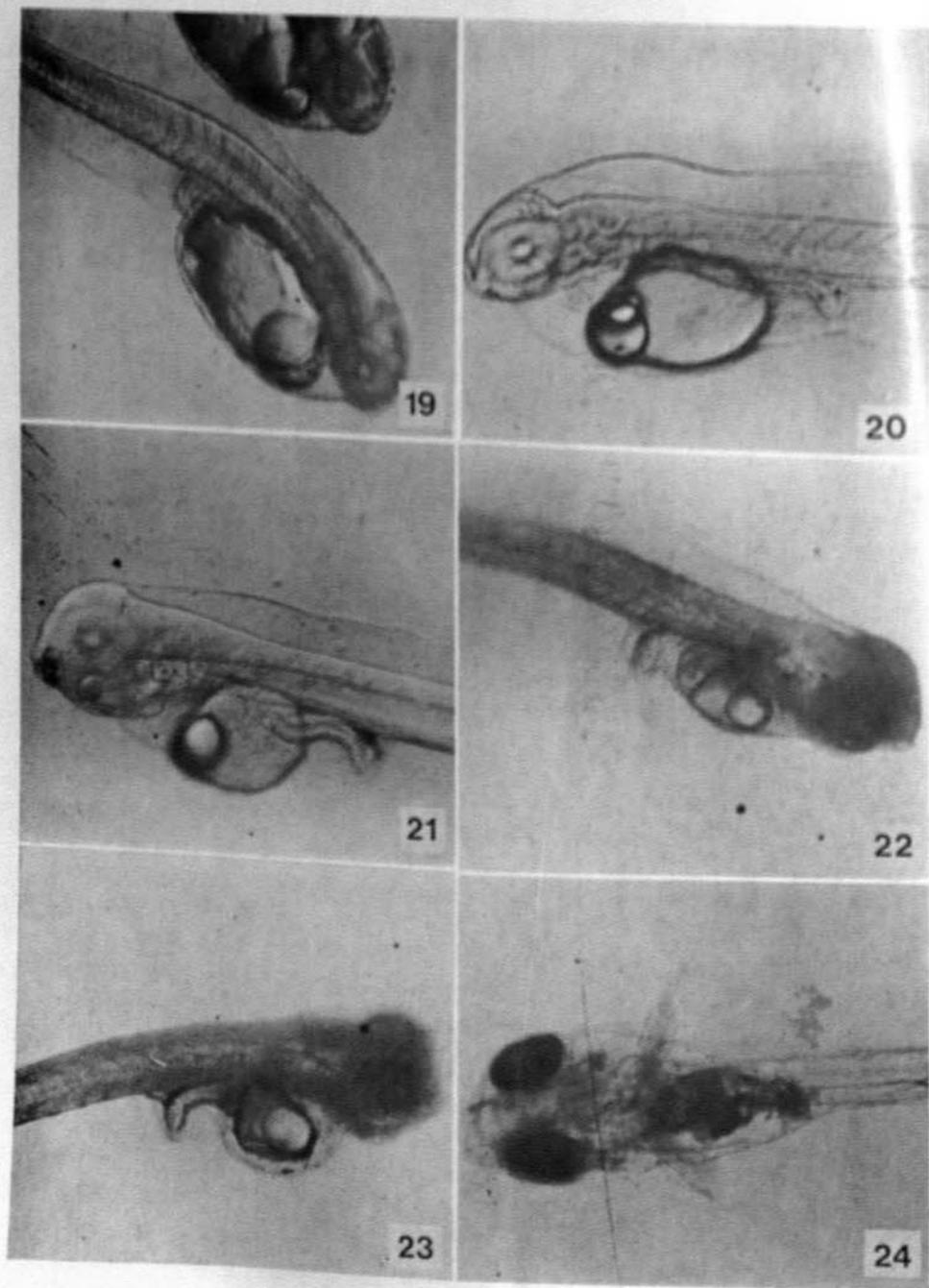
PLATES 1-6. 1: Eggs in Stage 1 (section); 2a: Eggs in Stage 2; 2b: Egg in Stage 3; 3: Eggs in Stage 4; 4a: Egg in Stage 5; 4b: Egg in Stage 6; 5a: Fertilized egg; 5b: 2-celled stage; 6: 4-celled stage.



PLATES 7-12. 7: 8-celled stage; 8: 16-celled stage; 9: 32-celled stage; 10: Many-celled stage; 11: Blastula; 12: Early gastrula.



PLATES 13-18. 13: Late gastrula; 14: Neurula; 15: 2-somite stage; 16a: 12-somite stage; 16b: Stage at which heart beat occurred; 17: Larva just before hatching; 18: Newly hatched larva.



PLATES 19-24. 19: Larva at 40 hours after fertilization; 20: Stage at which eyes were formed; 21: Larva with gills and rudimentary jaws; 22: Larva at 61 hours after fertilization; 23: Larva at 62 hours after fertilization; 24: Larva at 72 hours with yolk completely absorbed.

RESULTS

Different stages of maturing eggs

Six stages of maturing eggs were recognized.

Stage 1. Eggs in this stage are still relatively immature and have not reached the full size, measuring 0.35–0.39 mm in diameter. They look opaque and contain no oil globules. A section of the eggs is shown in Fig. 1. These eggs cannot be fertilized.

Stage 2. Eggs of this stage have developed to the full size which measured 0.42–0.46 mm in diameter. They are still opaque and contain no traces of oil globules (Figure 2a). These eggs cannot be fertilized.

Stage 3. Eggs which are a few hours prior to ovulation. They appear to contain traces of oil globules and are slightly transparent (Fig. 2b). These eggs also cannot be fertilized.

Stage 4. As the eggs mature, there is an increase in transparency and the oil globules become very well defined. Eggs in this stage are ovulated; they are viable and can be successfully fertilized (Fig. 3).

Stage 5. About six hours after stage 4, there is a gradual increase in transparency; the yolk and protoplasm undergo degenerative changes and become non-viable (Fig. 4a). Eggs of this stage may sometimes be fertilized but the fertilized eggs can only develop up to a certain stage.

Stage 6. The eggs appear glassy and the inner content has degenerated. They are non-viable and soon died (Fig. 4b).

Oviposition

In nature it is presumed that ovulation is followed by oviposition; however, some freshly caught mature fish have been observed to contain eggs in Stage 6.

In the injected fish, no oviposition has so far been observed.

Effect of HCG injections (see Table 1)

The uninjected gravid females (control) had eggs which remained in stage two for the first three days; subsequently, the eggs appeared to undergo degenerative changes resulting in shrinkage (Table 1). The eggs finally clumped together and became flattened and disfigured.

All five gravid females which received 0.25–0.30 I μ /gm body weight of HCG daily ovulated in the fifth or sixth day, while those receiving a higher dosage of HCG of 0.5–0.6 I μ /gm body weight died between six to 24 hours after the first injection.

Females receiving one pituitary gland plus 0.25–0.30 I μ /gm body weight of HCG showed similar results as those receiving HCG alone.

Fertilization

When the ovulated eggs were brought in contact with the sperm, fertilization took place within five minutes. Immediately after fertilization the eggs underwent the following changes: a condensation of protoplasmic material towards the animal pole resulting in the formation of a cytoplasmic 'cap'. A perivitelline space appeared between the chorionic membrane and the vitelline membrane surrounding the ovoplasm (Fig. 5a). Eggs prior to the first cleavage measured 0.42–0.46 mm in diameter. At least 90% of the eggs were fertilized.

TABLE 1. Effect of HCG on egg maturation in gravid females

Days and number of injections*	Stages of eggs development			
	Control	0.25-0.30 IU HCG per gm body wt.	0.5-0.6 IU HCG per gm body wt.	0.25-0.30 IU HCG per gm body wt. plus 1 pituitary
1	2	2	2	2
2	2	2	(All died)	2
3	2	2	—	2
4	1? (1 died)	2-3	—	2-3 (2 died)
5	1? (eggs clumped together)	2-3 (2 fish) 3 (3 fish)	—	2-3 (2 fish) 3 (1 fish)
5-6**	Eggs degenerating	4: ovulated (3 fish) 3 (2 fish)	—	4: ovulated (1 fish) 3 (2 fish)

Number of fish in each group = 5

*Samples taken just prior to each injection.

**Samples taken 5-10 hours after 5th injection.

Cleavages

First Division. Forty-five minutes after fertilization the eggs underwent the first cleavage; it began as an indentation on the cytoplasmic 'cap' and later became a furrow which separated the cytoplasmic 'cap' into two equal halves. The plane of division was meroblastic and meridional (Fig. 5b). The whole process took five minutes to complete.

Second Division. Five minutes after the first cleavage, the second cleavage began; a furrow appeared to intersect the two blastomeres at right angles resulting in four blastomeres of approximately equal size (Fig. 6). The division was meridional and took 10-15 minutes to complete.

Third Division. Five minutes after the second cleavage, a furrow appeared on each of the blastomeres intersecting the blastomeres to form eight blastomeres which lay in two parallel rows. The division was meridional and at right angle to the first cleavage (Fig. 7). This cleavage took about ten minutes to complete.

Fourth Division. Immediately after the formation of the eight blastomeres, the fourth division began; a furrow appeared on each of the blastomeres and soon intersected the blastomeres at right angle to the second and third cleavages. This resulted in the formation of 16 cells lying in four parallel rows of four cells each with minor irregularities of arrangements (Fig. 8). The whole process took 25 minutes to complete.

Fifth Division. The fifth division occurred immediately after the completion of the fourth cleavage. The division was meridional and at right angle to the first and fourth cleavages, resulting in the formation of 32 cells. The marginal cells showed a tendency to move downwards towards the equatorial region; hence the arrangement of blastomeres became more irregular (Fig. 9). The whole process took about 15 minutes to complete.

Sixth Division. The sixth division began as soon as the fifth division was completed. Sixty four blastomeres were formed resulting in the formation of a convex blastodisc lying on top of the yolk (Fig. 10).

Further Divisions. After the sixth cleavage, the tracing of the plane of cell divisions became difficult. However, the progressive increase in the number of cells with a con-

comitant reduction in cell size indicated that cleavages were in progress. In the first hour after the sixth division the blastomeres were still relatively large enough to be recognized under low-power magnification. In the second hour, the blastomeres became too small to be seen clearly.

Blastula

As the blastodisc spread out over the yolk (epiboly), the yolk appeared to bulge into the blastodisc (Fig. 11). An enlarging blastocoel was formed and the embryo had now entered the blastula stage.

Gastrula

Early Gastrula. About five hours after fertilization, the margin of the blastodisc (blastoderm) gradually thickened and a rim was formed at the equatorial region. This rim indicated the formation of a germ ring. This stage marked the transition from the blastula to the gastrula (Fig. 12).

Late Gastrula. As the blastodisc extended over nearly three-fourth of the yolk's surface, the embryonic shield increased in length and width and ran almost the whole length of the egg (Fig. 13).

Neurula

About seven to eight hours after fertilization, the embryonic axis became well defined. The main divisions of the brain (forebrain, midbrain and hindbrain) and the rudimentary optic vesicles were distinguishable. A faint mark of somite formation could also be noted in the mid-region of the embryo. At the anterior end, just below the brain, there was an extension of the embryonic shield into the yolk forming a large vesicle which was possibly the forerunner of the pericardial cavity (Fig. 14).

Organodifferentiation

About nine hours after fertilization, two somites arose at the mid region of the embryo. The optic vesicles and the brain became more marked (Fig. 15).

About 13 hours after fertilization, 12 somites were formed and the optic cup was now prominent. With additional growth and differentiation, the main divisions of the brain were better defined and the optic vesicles were now distinctly visible (Fig. 16a). The heart was formed.

15 hours after fertilization, the heart began to beat and an occasional movement of the embryo could be observed (Fig. 16b).

17 hours after fertilization, the embryo had grown in length and the number of somites had also increased. The air bladder had developed, situated just above the yolk sac, and the tip of the tail was free from the yolk sac.

With additional growth and differentiation, the divisions of the brain became very well defined. The formation of the olfactory lobes, lens and otoliths was completed. Pigment cells were present, scattered sparsely over the yolk sac.

About 29 hours after fertilization, the embryo had increased to its full size and there was an increase in bodily movement (Fig. 17).

Larval Stage

30-35 hours after fertilization, vigorous twisting of the embryo caused the chorionic membrane to be broken and the larva hatched out. About 70-80% of the eggs hatched out successfully. The newly hatched larva was about 1.55 mm in length. The heart was by now well developed. A rudimentary hindgut was seen just posterior to the yolk sac (Fig. 18). The larvae remained inactive at the bottom for most of the time but occasionally made jerking movements.

About 40 hours after fertilization, the short hindgut became very distinct and the caudal fin rays were visible. Pigment cells increased in number all over the yolk sac and the body (Fig. 19).

About 50 hours after fertilization, the larvae had attained 1.80 mm in length. An accumulation of gill bud cells was observed just above and anterior to the heart. Pigments were also developed in the retina which now appeared bluish in colour. The hindgut was more prominent and longer than before (Fig. 20).

About 57 hours after fertilization, the gills had been formed although they were still not fully developed. The jaws were being differentiated. The yolk sac had reduced in size and part of the midgut had been formed above the yolk sac (Fig. 21).

61 hours after fertilization, the pectoral fin buds appeared and the midgut became more prominent. The jaws became more distinct and the gill covers were visible. The retina was now very heavily pigmented and the lens had been fully formed (Fig. 22). The larvae had grown to 2.21 mm in length.

62 hours after fertilization, the pectoral fins were fully grown and functional. The yolk sac was reduced to a very small size and the midgut and its associated organs became very prominent (Fig. 23).

72 hours after fertilization, the larvae had attained 2.33 mm in length. The jaws were fully developed and functional. By this time the yolk had been completely absorbed. Rudimentary dorsal and ventral fins were being formed. The movement of the larvae became more active and was light orientated (Fig. 24). The larvae did not feed on the green algae given; however, they survived for 92-97 hours after hatching.

DISCUSSION

The present studies have shown that in captivity, sexually-mature *Siganus oramin* will not feed while at the same time its gonad undergoes progressive degenerative changes. It is therefore not possible to breed the fish naturally under captive conditions.

Injections of HCG could induce fish containing Stage 2 eggs to ovulate. However, a high dose of HCG appeared to be detrimental; this point needs confirmation and further investigations. The injection of a homoplastic pituitary together with HCG did not seem to enhance the effect on ovulation although this has been reported in studies of other fishes (Ling, 1969; Shehadeh, 1969).

Following induced ovulation, artificial fertilization was successfully attempted. At least 90% of the eggs were successfully fertilized. It was found that if the ovulated eggs were not stripped from the female and fertilized within a few hours after ovulation, they underwent degenerative changes (Stage 5 and 6) and became non-viable. This phenomenon of 'over-ripeness' has also been encountered in the induced breeding of the striped bass, *Roccus saxatilis* (Stevens, 1966).

Although a high percentage (70-80%) of the fertilized eggs hatched out successfully, the hatchlings (larvae) did not survive for more than a few days. This problems of larval

mortality has also been encountered in the induced breeding of other fishes, for example: the grey mullet, *Mugil cephalus* (Ling, 1969; Shehadeh, 1969) and *Oxyeleotris marmorata* (Tan and Lam, 1973). The cause of the mortality is not known. In the present study, the larvae could have died of starvation. Although green algae were given, no feeding was observed. Other possibilities include unfavourable environmental factors (temperature, pH, salinity, O₂ availability, concentration of nitrogenous wastes), which had not been adequately controlled in our experiments due to lack of facilities. Work is continuing to study this problem of larval mortality.

Whether or not the HCG injections caused abnormal development of the eggs and thereby contributed to the larval mortality is not known for certain. However, the early development of the fish described here appears normal; it has the normal pattern of development of pelagic eggs which normally hatch out at a relatively early stage of development (Norman, 1963; Chua, 1969).

If this problem of larval mortality could be solved, induced breeding using HCG would be an important step towards the culture of *Siganus oramin*. As stated in Introduction, we have reasons to believe that the fish is suitable for aquaculture, particularly when other species of the same genus have been successfully cultured elsewhere (Pillai, 1962; Ben-Tuvia and Kissil, 1971).

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DISCUSSION

A.J. Berry.—Might not changing temperature affect the fish by lowering oxygen concentrations? Might it not be better to attempt culture in more open, natural seawater? I suspect that rearing the larvae through the early stages and actually culturing the fish will prove more difficult than the inducement of spawning.

T.J. Lam.—We have found that *Siganus oramin* cannot tolerate a sudden temperature change of 2–3°C but whether this is due to the temperature change itself or to the change in oxygen concentrations, which would probably result from the temperature change, has not been ascertained. It is certainly a worthwhile point to investigate.

Yes, it might be better to attempt culture of the fish in more open, natural sea water than in coastal ponds but the management would probably be more difficult. I understand that the Primary Production Department in Singapore is conducting some experiments on culturing *Siganus* in cage-nets suspended in the open sea.

We agree with you on your last point. However, the inducement of spawning is a necessary step to ensure a reliable supply of fry for stocking purposes (see Introduction).

R.B. Lulofs.—Where do the larvae develop in nature? Mangrove or open water?

T.J. Lam.—Shoals of gravid females and mature males have been observed in shallow waters around the *Enhalus* sea bed and the coral reefs. After the spawning period, juvenile fish have been found and collected in these waters. On this basis, we believe that such areas are the spawning grounds of the fish and the larvae develop there.

R.B. Lulofs (Comment).—Larvae of reef fish, probably of different species are found at depths varying from 6 in. to 40 ft. through a temperature range of 10°F.

R.B. Lulofs.—Have any fish breeding experiments been carried out in Singapore in natural habitats such as estuaries?

T.J. Lam.—Not at the moment to our knowledge.

N. Langham.—Have you done any salinity tolerance tests?

T.J. Lam.—Yes. We have found that the fish can withstand a wide range of salinity changes from at least 27.5‰ to about 5‰; the upper limit has not been established.

Lim Wah Ching.—Have you done any experiments with covered ponds?

T.J. Lam.—We do not have funds to carry out such experiments although they are probably very worthwhile doing.

An Appraisal of the Flood Situation in West Malaysia

C.H. LEIGH AND K.S. LOW¹

INTRODUCTION

"...a flood is sometimes said to begin when a river overflows its banks or when rain water ponds up in poorly drained areas. By another criterion, no flood occurs until damage begins" (Burton *et al.*, 1968, p. 9). There is no standard definition of what constitutes a flood, but on the basis of either criterion mentioned above, flooding is an all too frequent occurrence in many parts of West Malaysia.

The recent, exceptional floods of January 1971 are still fresh in the minds of most Malaysians, and clearly demonstrate that large areas which are normally flood-free may be inundated by such extreme events. Floods of the magnitude of those of January 1971 are fortunately rare, although reference to the records of the 'Great Flood' of 1926 (Winstedt, 1927) indicates that they are not unique. It is possible, at least statistically, that in the future, floods of even greater magnitude could be experienced.

The problems and damage caused by flooding in West Malaysia are manifold. Physically, property and crops can be damaged or destroyed, livestock drowned and at worst human life lost. River banks and soil can be seriously eroded during times of flooding while, conversely, mud and sand might be deposited over good agricultural land. Lines of communication are frequently cut, either by the destruction of structures such as bridges, or by the flooding of roads and railway lines. Such disruption could conceivably be strategically undesirable. In West Malaysia the only road and rail links to the north-east are frequently cut during times of floods, and while the bridge to be built across the Sungai Pahang at Temerloh will do much to alleviate the problem along the Bentong-Kuantan road, the main East Coast trunk road from Kota Bharu to Johor Baharu will still be subjected to the visitations of flood waters for many years to come.

Economically, the effects of flooding can be serious. The flooding of transport links halts the movements of materials, while life in both towns and rural settlements is disrupted, thus impairing their productive capacity. Loss of production can economically affect all, from the individual to the whole Nation. Disruption to those industries engaged in production for export can be particularly damaging to the National economy. The scale of financial loss which can be caused by floods can be judged by the estimated loss incurred by the timber industry during the January 1971 floods and the floods of December 1971 - January 1972. Export revenue from sawn timber and logs for January 1971 was \$5.3 million less than in January 1970, while an estimated \$3 million was lost during the December 1971 - January 1972 floods (Straits Times, 18.1.1972).

Flooding can also result in problems of a social nature, although these are frequently linked with economic factors. Evacuation from flooded areas is clearly disruptive to family life, and children's schooling may be interrupted. In urban areas, dwellings in flood prone locations are often occupied by people of low socio-economic status, for here rents and property values tend to be lower, and it is such groups who are least able to absorb economic losses. A further social problem which can be engendered by flooding is the danger to public health, for sewage, animal carcasses and garbage are often pollutants in flood waters.

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Less rainfall is intercepted and evaporated back into the atmosphere, while the removal of the ground cover can result in the development of a denser rill network on the slopes which will tend to increase overland-flow. On bare soil of clayey texture, swelling of the particles will reduce the absorbent capacity of the soil which will also cause an increase in overland-flow (Douglas, 1968). Few detailed studies of rainfall-runoff relationships in altered catchments in Malaysia have been undertaken, but there is evidence to show that in semi-forested and partly urbanized catchments, runoff accounts for between 60-65% of rainfall, which is considerably higher than in areas of natural forest (Low and Goh, 1972).

SOME FACTORS AFFECTING THE SEDIMENT LOADS OF STREAMS

An important contributory factor to flooding, especially in the lower reaches of rivers, is the deposition of sediment which tends to raise river beds and partially block river mouths. As will be shown, man's activities have tended to increase the sediment loads in rivers in humid tropical areas, and hence this aspect of the flood problem is possibly of greater significance today than it has been in the past. However, in order to be able to quantitatively assess the increase of sediment loads in rivers resultant upon anthropogenic activities, it is essential that we have some idea of degradational rates under the naturally occurring vegetational systems.

The Humid Tropical Denudation System¹

Unfortunately much remains unknown regarding the nature and rates of degradation in humid tropical areas. This is perhaps exemplified by the conflicting statements of the rate of erosion in such areas in comparison with other climatic environments. Corbel (1964) considers erosion to be least active in the humid tropics, while Fournier (1960) considers it to be relatively rapid, and places West Malaysia in his second highest category. Strakhov (1967) concurs with Fournier but considers erosional rates in West Malaysia to be relatively less than those given by Fournier. As Stoddart (1969) indicates, these workers' conclusions are in many cases based on few results (for instance Corbel's conclusions are based on an analysis of 39 basins in cold areas but only 9 in humid tropical areas), while none make any correction for basin size.

Douglas (1969) suggests that in general the humid tropical denudational system is a relatively stable one. This is perhaps contrary to some views which assume that the high rainfall totals and accelerated rates of chemical weathering, which produce deep, loosely-consolidated weathered profiles, are reflected in high degradation rates. According to Douglas (1969), in humid tropical areas which are tectonically stable, a delicate equilibrium is attained within the system. The vegetation stabilises the deep weathered material with its roots and also shields the ground from the direct intensity of the rain, while the leaf and duff layer tends to inhibit surface runoff, and hence erosion. It is only when the rainforest is disturbed, either by natural events (landslides, base-level changes) or by man, that degradation becomes excessive.

Effects of Forest Clearance

The alteration of the natural vegetation cover in West Malaysia has been proceeding apace for centuries, but has been greatly accelerated in recent decades as a result of

¹ This term has been taken from the title of a paper by Douglas (1969), 'The Efficiency of Humid Tropical Denudation Systems'.

agricultural and mining developments. A concomitant increase in river erosion and pollution has been recorded by several workers (Ow-Yang, 1965; Johnson, 1968; Prowse, 1968; Buck, 1969; Douglas, 1968, 1970). A critical evaluation of the effects of forest clearing upon degradation and riverflow is more urgent now than ever before, for the next two decades will see the completion of massive land development schemes (the Jengka Triangle project, the Johor Tenggara and Pahang Tenggara schemes) while additional large-scale timber operations are planned in many states, particularly Pahang, Kelantan and Trengganu. Ominously many of these land development schemes and timber operations are located in drainage basins in which the lower parts are already frequently subject to flooding.

The effects of human interference upon the tropical rainforest ecosystem, in terms of sediment yields of rivers, can be seen by reference to Table 2.

The extremely high suspended sediment load carried by the Tjiloetoeng River in West Java is a direct result of the mismanagement of the soil during the first part of the pre-

TABLE 2. Suspended Sediment Loads of Some Humid Tropical Rivers

River	Drainage Area (sq. km)	Vegetation cover	Sediment load	Source
Perak River at Kenering, West Malaysia	5500	Rainforest c 86% Rubber c 10% Padi c 4%	144m ³ /km ² /yr.	Douglas, 1970 after — Shawiningan Engineering Company
Gombak River at Kuala Lumpur, West Malaysia	140	Forested headwaters, agricultural and mining land	67.3m ³ /km ² /yr.	Douglas, 1968
Kial, Cameron Highlands, West Malaysia	21*	Rainforest 70% Agriculture 30% (in 1956)	111m ³ /km ² /yr.*	Shallow, 1956
Telom, Cameron Highlands, West Malaysia	77*	Rainforest 94% Agriculture 6% (in 1956)	21.1m ³ /km ² /yr.*	Shallow, 1956
Upper Barron River, East Queensland, Australia	11.91	Essentially rainforest	5.65m ³ /km ² /yr.	Douglas, 1967
Lower Barron River, East Queensland, Australia	225.33	Open sclerophyll woodland 25% Agricultural land some rainforest 75%	13.60m ³ /km ² /yr.	Douglas, 1967
Tjiloetoeng River, West Java	620*	Deforested 'ladang' cultivation, pasturing	1352m ³ /km ² /yr.*	Van Dijk and Vogelzang, 1948
Amitioro River, Ivory Coast	170	Forest	12.6tns/km ² /yr.	Monnet, 1971
Loserique, Ivory Coast	3.6	Savanna	171.3tns/km ² /yr.	Monnet, 1971
Mbeya Range catchments, East Africa				
Valley A	0.06 sq.mls.	Forest	155 lbs/acre/yr.	Pereira and Hosegood, 1962
Valley C	0.06 sq.mls.	Cultivated	642 lbs/acre/yr.	

*From Douglas, 1968 and 1970.

sent century (Van Dijk and Vogelzang, 1948). In West Malaysia the sediment loads carried by the Perak and Gombak Rivers, although nowhere near as high as the value for the Tjiloetoeng, are also a reflection of human activity and there is certainly no room for complacency. A striking example of the effect of forest clearing upon sediment load can be seen by reference to the Telom and Kial Rivers in the Cameron Highlands (Shallow, 1956), the former draining a predominantly rainforest catchment and the latter a catchment which has been developed for agriculture (30% of the forest has been cleared). Comparable results are given by Pereira and Hosegood (1962) for an agriculturally developed and an unaltered forest catchment in East Africa. These examples, together with those from Queensland and the Ivory Coast (Table 2) illustrate the relatively low sediment loads of streams and rivers draining natural forest catchments in humid tropical areas. In the Ivory Coast the low sediment yield of a catchment draining forest as compared with one draining savanna, can be clearly seen.

The relationship between forest clearing and sediment loads is not, however, a simple one. Other factors such as lithology require consideration. The importance of the lithological factor is illustrated by the work of Van Dijk and Ehrencron (1949) in their study of two adjacent catchments in Java, the Tjabalan, which is underlain by marly rocks, and the Rambut, which is underlain by volcanic rocks. Land use in the two basins at the time of study was approximately similar, with narrow strips of irrigated rice along the rivers, small acreages of unirrigated arable land and forested slopes. The difference between the suspended loads of the two rivers is marked, the Tjabalan carrying more than ten times the amount of the Rambut (66.01 tns./ha./yr. and 5.29 tns./ha./yr. respectively), even though precipitation in the latter catchment was heavier. The Tjabalan has a higher suspended load than any of the rivers listed in Table 1, although it was less developed than some of those rivers when the records were taken. This clearly indicates that the lithology, as well as the amount of human interference in a basin must be taken into account when assessing sediment loads of rivers.

In relation to flooding the average annual suspended loads listed in Table 1 can be misleading, for during flood-flows significantly higher loads will be transported, and presumably subsequently deposited. This is shown in Douglas's (1968) study of the Gombak River, and one of its tributaries, the Sungei Pasir. During a thunderstorm on the 11th June 1966, Douglas records that within a forty minute interval, suspended sediment load in the Sungei Gombak at the 12th milestone on the Kuala Lumpur-Bentong road increased from 6.2 m³/km²/yr. to 164.5 m³/km²/yr. On the Sungei Pasir suspended sediment loads ranged from 2.1 mg./lt. at low flows to 5,788.9 mg./lt. at high flows, with a maximum suspended sediment recording of 6197.6 m³/km²/yr.

Clearly, large amounts of sediment are transported at flood-flow, and as discussed in the previous section as natural vegetation is altered, there will be a greater tendency for floods to occur. Hence a chain effect is established; floods become more frequent and at the same time more sediment is readily available to enter the fluvial systems. Greater volumes of sediment are transported and later deposited with the result that flooding will occur at much smaller discharges than before.

Although the general pattern is known, few detailed studies of the effects of deforestation and land management practices upon degradation have been undertaken in South East Asia. Three studies which do exist, that by Shallow (1956) in the Cameron Highlands of West Malaysia, that by Van Dijk and Vogelzang (1948) in the Cheribon area of West Java and the study quoted by Shallow in the area to the south of Bandoeng,

Java, clearly illustrate the effects of forest clearance upon degradational rates and the need for careful land management practices.

Shallow's (1956) study in the Cameron Highlands was undertaken to establish the river regimes and sediment loads within three small catchments supplying a H.E.P. scheme in the area, the Kial, Bertam and Telom. The size, land use and sediment yields of these three catchments is shown in Table 3, and as can be seen, the Sungei Telom Catchment, with a 94% forest cover, is the most stable degradational system of the three.

TABLE 3. (from Shallow, 1956)

	Sungei Bertam	Sungei Kial	Sungei Telom
Catchment area sq. miles	22	8.25	30
Landuse %, 1956			
Jungle	64	70	94
Tea	21	11	5
Vegetables	7	19	1
Open	8	—	—
Soil erosion lbs/acre/year	2,300	2,450	470

Rates of erosion under different crop types and management practices are likely to vary. In the Cameron Highlands Shallow estimates that soil erosion under natural forest cover is in the order of 300 lbs/acre/year, while under tea it increases to 6,000 lbs/acre/year and under vegetables to *circa* 9,000 lbs/acre/year. Fortunately the steeper cultivated slopes in the Cameron Highlands, particularly those under vegetables, are terraced, otherwise erosion rates would probably be far higher. The value of terracing for soil erosion control is shown by an experiment carried out at Tjiwidei, to the south of Bandoeng in Java (quoted in Shallow, 1956). During the first year after the clearing of an area of virgin forest, sediment yields of 1,500 lbs/acre/year were recorded for terraced areas and 4,700 lbs/acre/year for non-terraced areas, while during the second year after clearing, sediment yields rose phenomenally to 22,000 lbs/acre/year for the terraced areas and 45,000 lbs/acre/year for the non-terraced areas.

The need for careful land management is further exemplified by the findings of Van Dijk and Vogelzang (1948) in the Tjiloetoeng basin in West Java. A comparison of records of the water years October 1911–September 1912 and October 1934–September 1935 indicated a marked deterioration in terms of suspended sediment loads carried, from 821 thousand tons in 1911–12 to 1,790 thousand tons in 1934–5. The cause of the increase can be directly attributed to the misuse of the land as Van Dijk and Vogelzang indicate—'In the Tjiloetoeng basin the gradually increasing deforestation, reckless cultural methods and pasturing after 1917 caused a doubled soil erosion' (p. 9).

The Effects of Mining Upon Sediment Loads of Streams

Surface mining for tin is extensive in several areas in West Malaysia, and it is apparent even to the casual observer that sediment loads and turbidity increase significantly downstream from mining areas. Buck (1969) notes the marked increase of suspended sediment load at the Johor River pipeline intake above Kota Tinggi between the years

1962 and 1968, from an annual average concentration of 125 mg./lt. to 635 mg./lt. This increase he ascribes to three factors, increasing land development in the catchment, the reversal of river flow at high tides and the mining activities upstream, particularly along the Sungei Pelepah.

In the lower reaches of the Kinta River the excessive deposition of silt derived from mining operations upstream causes flooding in the Telok Anson and Ipoh areas, while silt from mines in the Tapah area caused the Sungei Batang Padang to change its course and create areas of swampy land, although these have now been reclaimed through the Manik River irrigation scheme (Wycherley, 1969).

Legislation exists to prevent the excessive pollution of rivers in Malaysia by mining activities, but how effective in the legislation?

THE EFFECTS OF URBANIZATION UPON FLOODING

In urban areas, where the ground is covered with impervious surfaces, runoff can be as high as 100%. If artificial drainage is inadequate then flooding will ensue, as can be frequently witnessed along the Bangsar Road in Kuala Lumpur. The high percentage runoff possible in urban areas was clearly demonstrated during the exceptionally high rainfall over Singapore Island on the 9th and 10th December, 1969. During this period the estimated runoff from three small urbanized catchments was 64%, 67% and 74% respectively (Chia and Chang, 1971), the variations probably being related to the degree of urban development. Such figures contrast with the much lower values of storm rainfall runoff for forested catchments in West Malaysia (Table 1). The type of hydrological changes which might be expected subsequent to urban development are shown in Table 4, where urbanization is considered in three general phases. As Table 4 indicates the flood hazard will probably increase as the result of increased surface runoff and through aggradation of channel beds.

Anderson's (1970) study of the effects of urbanization upon flooding in Fairfax County and the city of Alexandria, in North Virginia, clearly demonstrates that flood magnitudes increase as urban development proceeds. In small, steep basins Anderson found that drainage improvement could result in floods of three times the previous average magnitude, and in areas where stream channels had been made one hundred per cent impervious the magnitude could increase by eightfold. Another factor that Anderson found significantly affected by urban development is the lag time interval of floods following heavy rains. Within completely storm-sewered systems the lag time is reduced to approximately one eighth of that for comparable natural systems, while if only the tributaries are sewered the reduction is to a fifth. Such increases in flood magnitudes, and the reduction in lag time intervals, are clearly significant to flood warning systems and to urban planning schemes. In Malaysia where rainfall totals are considerably higher than in the area studied by Anderson the effects of urban development upon the flood hazard could be even more acute. As existing urban areas expand and new towns are created (for instance thirty eight new towns are planned for the Pahang Tenggara scheme by 1990—*Straits Times*, 3.4.1972) the flood situation can be expected to deteriorate unless extensive flood preventive measures are taken.

As Table 4 indicates, building construction results in increased amounts of sediment entering the stream courses. During the constructional phase relatively large areas of land are frequently completely cleared of vegetation. A measure of the effect of building construction upon the sediment loads of streams is given by the variation in suspended

TABLE 4. Hydrologic Effects Associated with Urbanization

Change in Land or Water Use	Possible Hydrologic Effect
I. <i>Transition from pre-urban to early-urban stage</i> Removal of trees or vegetation. Construction of scattered city-type houses and limited water and sewage facilities.	Decrease in transpiration and increase in storm flow. Increased sedimentation of streams.
II. <i>Transition from early-urban to middle-urban stage</i> Bulldozing of land for mass housing, some topsoil removed. Mass construction of houses, paving of streets, building of culverts.	Accelerated land erosion and stream sedimentation and aggradation. Increased flood flows. Elimination of smallest streams. Decreased infiltration, resulting in increased flood flows and lowered groundwater levels. Occasional flooding at channel constrictions (culverts) or remaining small streams. Occasional overtopping or undermining of banks of artificial channels on small streams.
III. <i>Transition from middle-urban to late-urban stage</i> Urbanization of area completed by addition of more houses and streets and of public, commercial, and industrial buildings. Channels of streams restricted at least in part to artificial channels and tunnels.	Reduced infiltration and lowered water-table. Streets and gutters act as storm drains, creating higher flood peaks and lower base flow of local streams. Increased flood damage (higher stage for a given flow). Changes in channel geometry and sediment load. Aggradation.

From Jens & McPherson (1964).

sediment load between a sample taken from the Marong Kanan Catchment in Negri Sembilan (64 mg./lt.) and one from the Anak Ayer Batu Catchment in the Damansara area of Selangor (496 mg./lt.). The former catchment is larger and more dissected than the latter, but whereas the Marong Kanan Catchment is under natural forest, the Anak Ayer Batu Catchment is a developed one, in which a considerable amount of building construction is taking place. Fortunately, once construction is completed the sediment load will decrease, although it is unlikely that it will revert to pre-construction levels. Where there is delay in construction, and land is left devoid of vegetation for considerable lengths of time, not only is sediment removed at a high rate but gullyng often develops. In the Petaling Jaya - Kuala Lumpur area, for example at Damansara, Pantai Hills and Petaling Jaya Hill, this is only too clearly illustrated. There is a need for further legislation concerning the development of land for both housing and industrial purposes.

THE NEED FOR A FLOOD STRATEGY IN WEST MALAYSIA

From the review of the hydrological and degradational factors affecting flooding in West Malaysia, it is apparent that the flood problem is likely to deteriorate in the coming years unless preventive measures are taken. Further investigations are required, and there is a need for a comprehensive co-ordinated flood strategy in the country.

In Malaysia to date, remedial measures have perhaps been somewhat *ad hoc* in nature, and have tended to be either isolated flood protection schemes or relief activity during

and after floods. The range of adjustments to floods within four major river basins in West Malaysia is shown in Table 5. Although the data included are of a generalised nature they do serve to show the limited range of adjustments undertaken and the paucity of such measures as catchment treatment, crop re-scheduling, construction of upstream reservoirs and flood-plain zoning. A further point illustrated by Table 5 is the variation between the four basins in terms of flood alleviation/prevention activities, the Sungai Kelantan having received relatively little attention compared with the other three.

TABLE 5. Floodplain Use and Readjustments Observed in Some Major Basins

	Sungai Selangor	Sungai Pahang	Sungai Kelantan	Sungai Perak
<i>Landuse on Floodplain</i>				
Commercial	++	+	+	++
Manufacturing	++	□	+	++
Residential	++	++	++	++
Transport	++	++	++	++
Recreational	++	+	+	++
Mining	++	□	□	++
<i>Emergency measures in practice</i>				
Removal	+	+	+	+
Treatment (catchment)	+	□	□	□
Re-scheduling (crops)	□	+	+	□
<i>Structural measures in effect</i>				
Land elevation	+	□	□	+
<i>Protection</i>				
Channel improvement	++	+	□	++
Upstream reservoirs	□	□	□	+
Levees (small and channel levees)	+	+	□	+
Zoning	□	□	□	□

++ Common
 + A few cases
 □ None observed

It would seem that in the light of the increasing awareness of the flood problem, other alternative adjustments, on a long term basis, should be considered. A range of possible choices of adjustments is listed in Table 6. These adjustments are divided into four groups, those which seek to affect the causes of flooding, those that accept that floods will occur but which seek to modify the hazard, those which seek to minimize the loss potential, and perhaps least satisfactory of all those which adjust to the losses incurred. In West Malaysia three types of flood can perhaps be tentatively recognised, minor floods of relatively frequent occurrence, medium-sized floods which might be experienced once every few years and major floods of relatively infrequent occurrence. As stated previously it is not possible to be precise about the magnitude and frequency of floods in the major drainage basins, for to date no such analyses have been undertaken. The adjustments to be made in an area must take cognizance of the nature of the floods which may be expected, and an appropriate strategy planned which will facilitate the maximum cost—benefit ratio possible. In certain areas however, social factors could override purely economic considerations.

TABLE 6. Possible Choices of Adjustments to Floods

Class of Adjustment	Nature of Adjustment
I. Affect the cause	Reduce flood flows by (i) abatement by landuse treatment
II. Modify the hazard	Control flood flows by (i) reservoir storage (ii) levees (iii) channel improvement (iv) flood zoning
III. Modify loss potential	(i) warning systems (ii) emergency evacuation and preparation (iii) building design (iv) landuse change (v) permanent evacuation
IV. Adjust to losses	(i) individual loss bearing (ii) public relief (iii) insurance (possibly subsidized)

After Burton, Kates and White (1968).

It should be possible to reduce flood-flows, or to insure that they do not increase in either frequency or magnitude, by appropriate landuse treatment. Correct management of the watershed areas and careful implementation of land development schemes could ensure that surface runoff and sediment loads from such areas will not markedly increase. Any activities in the watershed areas which are likely to result in increased flood flows should be undertaken only if deemed to be essential.

In many areas, particularly around the Federal capital, the need for industrial development and the spatial expansion of urbanization has obliterated much of the forest vegetation, such that lack of interception results in high sediment loads and increased flood-flow. However, it is both possible and practicable to reduce the frequency and magnitude of the smaller and more frequent floods in such areas by improved land management practices. If the land cleared needs to be 'settled' before housing can be built, it is perhaps not too much to ask for the area to be covered with grasses. In this connection lallang (*Imperata cylindrica*) with its tight root fabric could bind the soil together and break the impact of raindrops while allowing infiltration of water to sub-surface flow.

The second class of adjustment calls for the modification of the hazard. As can be seen from Table 5 some modifications, such as river training and levee construction have been carried out in some of the major river basins in the country. This type of adjustment has to date been one of the most widely practised in West Malaysia, and is likely to continue to be in the coming years. However, such measures are usually only considered in relation to an individual location and are not part of an overall flood mitigation scheme for the whole basin. There are also certain dangers inherent in the construction of levees and in the improvements of river channels, particularly if dredging and straightening are undertaken. Where levees are built the river may be encouraged to aggrade, and should the levees be breached or overtopped during exceptionally high flood-flows, then water cannot freely drain back into the river once the flood has subsided, and the problem could be aggravated rather than improved. Where river courses

are dredged and straightened a delicately balanced system may be disturbed and erosion may be induced in that stretch or downstream.

The majority of reservoirs constructed in West Malaysia have been for purposes other than flood mitigation. The building of dams for flood control, although in many areas desirable, has to date been generally prohibitively costly. However, plans to dam some of the headwater tributaries of the Sungei Pahang system (J.K.R. and J.P.T., 1972) indicate a change in policy.

Flood-zoning within the major floodable areas in West Malaysia has yet to be implemented on a systematic basis, and is a field into which research is required.

For medium and major floods, a modification of the loss potential is probably the only feasible solution. Property and people may be removed from the reach of floods. Possibly production in factories, agricultural activities and rearing of livestock could be rescheduled so as to avoid or minimise losses due to interruption. This requires a relatively accurate system of flood forecasting and flood warning. Since the major floods in 1967 and 1972, an effective system of flood warning has been recommended (Water Resources Committee, 1971). To date, the flood warning system comprises three storm warning radar sets on the East Coast which provide an adequate 24-48 hour forecast of heavy rainfall, and a number of telemetric water-level and rainfall recording stations with associated equipment in the States of Perak, Trengganu and Kelantan. Not all of these are yet fully operative. Besides the above, the installation of automatic picture transmission equipment for the reception of weather satellite data at the Meteorological Office Headquarters in Kuala Lumpur provides almost instantaneous data on generalised synoptic weather patterns.

Permanent evacuation from flood areas is not practical for the majority of the population, although it would be by far the best solution in many lowlying areas, such as Pekan. In Pahang, the seriousness of flooding along the Sungei Pahang has in fact resulted in proposed legislation for the voluntary resettlement of villages away from flood prone areas. The idea behind such a scheme is twofold. Besides resettling the people from flood prone areas, these new villages would, it is hoped, include people from other isolated settlements in the area and would form the nuclei for a rural development plan based on a regional development concept. Such new resettlement villages would then enjoy amenities such as piped water and electricity, which if in a dispersed state they would be unlikely to obtain.

Landuse change as a method of modifying flood loss potential has been little practised in West Malaysia. While changes might be implemented relatively easily in urban and semi-urban areas, in rural areas it would not be easy, for the way of life is geared to a pattern which accepts flooding as being normal, and in some parts of eastern West Malaysia the onset of the annual floods are celebrated by a water festival. Such cultural habits are hard to change or discard for rural people tend to be conservative in nature, and it is for these reasons that agricultural change and resettlement may not be popular. At present many people, whether by choice or compulsion, have to adjust to the losses incurred, either through individual loss bearing or through public relief, for insurance against flooding in rural areas is not thought to be common practice. Studies of people's attitudes to the problem and their perception of the flood hazard are required.

It is probable that the most effective solution to the flood problem does not lie in any single type of adjustment, but rather in a combination of several. In this connection the whole river basin should be considered and not just the section where the flooding

occurs, for a levee constructed in one part of the basin may only be helpful if appropriate landuse treatment to regulate flood-flows is undertaken in the upland regions.

Much basic research remains to be done, while co-ordinated policies pertaining to land development and urban planning in potentially floodable areas are required. Far too little is known about the physical causes of flooding in Malaysia. Further details regarding rainfall-runoff relationships in upland catchments are required, and in connection with this, there is a need for additional rainfall gauging stations at high altitudes. Even less is understood of the effects of land development, both for agricultural and urban purposes, upon flood-flow and sedimentation in Malaysia, although studies from other regions indicate the magnitude of the changes which might be expected.

In terms of flood-plain management it would seem that there has been little co-ordinated research planning as for example along the lines undertaken in the U.S.A. (Dalrymple, 1960; Scheaffer, 1960; White, 1964). In addition, there would seem to be a necessity to study the social aspects of the flood problem, particularly the attitudes of the people to possible resettlement. It would seem that in the coming years the flood situation in West Malaysia can be expected to deteriorate. Hence, it is imperative that further research into the problem should be implemented, that co-ordinated planning policies should be established and that where appropriate new legislation, with adequate provision for enforcement, be provided.

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DISCUSSION

N.S. Haile.—I would like to congratulate the authors on their excellent paper. Experience in U.S.A. and elsewhere shows that the so-called flood-control methods often have undesirable long-term effects. Thus a dam may enable intensive settlements

in formerly flood affected areas downstream, but dam reservoirs inevitably silt up, which may necessitate another, higher dam, taking an enormous amount of capital. Raising levees likewise usually causes the river bed to be raised, and floods which occur when the levees are breached are even more destructive. Thus long term planning and careful thought are needed before methods of flood-control are attempted, bearing in mind that one is interfering with inexorable geomorphological processes.

Ho Sinn Chye.—To substantiate what Prof. Haile has said about the effects of damming rivers to reduce flooding, I want to point out that damming causes nutrient enrichment of the dammed water which in the long term entails the phenomenon of eutrophication.

P.F. Burgess.—Is there any evidence that the increase of logging activity from 1959 has resulted in increased flooding?

Salleh Mohd. Nor.—Logging in West Malaysia is very selective and removes a minimum percentage of the canopy. However in Sabah the extent of logging is not much dissimilar from land clearances, and therefore the effect on water run-off and erosion would definitely be the same as any agricultural development areas.

Wong Yew Kwan.—I would be inclined to agree with Mr. P. Burgess that logging would substantially alter the hydrological pattern of a forested area because the operation would remove a large area of the canopy and therefore reduce the interception of the rain.

Since this subject is of importance in changing stream flow it is suggested that Dr. Leigh and his colleagues should include the logging factor in relation to stream flow in their research programme. One interesting study would be to vary the logging intensity and then observe the run-off and the sediment loads.

Hew Choy Kean.—Extraction of timber necessitates road construction and log transport by heavy vehicles. As these operations are continuous, serious disturbance of soil has been observed.

C. Leigh.—As far as we know there is no quantitative evidence to indicate whether or not logging activities since 1959 have aggravated the flood situation in any of the river basins in West Malaysia. If logging operations result in sediment reaching the river channels, as evidence from overseas indicates, then siltation could result in more frequent flooding. The comments made by Salleh Mohd. Nor and Hew Choy Kean suggest that in some areas logging has resulted in quite serious erosion. It would seem to be essential that studies are undertaken to assess the effects of logging upon erosion.

R.F. Allbrook.—Separation of water flow from sediment load is necessary. Although increased flow may increase sediment this is not necessarily so. In Table 3, does an increase in erosion imply an increase in stream flow?

C. Leigh.—In general it would seem that suspended sediment loads of streams generally increase with discharge, although the reverse is often the case with dissolved load. In Table 3 Shallow gives estimated rates of soil erosion for three small catchments with varying land-use. These estimates are based on the sediment loads of the three rivers. Removal of the natural vegetation would presumably increase surface run-off, which accelerates soil erosion.

- R.E. Sharma.*—One factor which has not been considered here but which certainly plays an important part in the creation of flash flooding in Singapore is the state of the tide particularly in areas such as Bukit Timah where heavy rainfall coupled with a rising tide (especially during Springs of course) rapidly overloads the canal which overflows and flooding is all too frequent in the area.
- C. Leigh.*—We have no information concerning the effect of the state of the tides upon flooding in West Malaysia, but it could well be an important factor in some areas. It is possible that along the East coast of West Malaysia during the period of the north-east monsoon, onshore winds might 'pile up' water along the coast making it difficult for flood-waters to drain into the sea.
- E. Soepadmo.*—Could you suggest any possible best way of preventing flood?
- C. Leigh.*—It is unlikely that floods in Malaysia can ever be entirely prevented. However, the problem can be alleviated by careful flood-control planning, preferably on a basin to basin basis. Also further research into the causes of flooding is necessary.
- Lim Wah Ching.*—Are the biologists and geographers represented on the Authority in charge of flood control in Malaysia?
- C. Leigh.*—As far as we are aware there is no one Authority in charge of flood control in Malaysia at present. One body which is concerned with flood control, among other things, is the Water Resource Committee which was constituted in 1961 as a Sub-committee of the Technical Committee for Land Capability Classification. Members of the Water Resources Committee include a representative from the Dept. of Geography, University of Malaya and a representative from the Forestry Department. (In June 1972, the Government announced the establishment of a Permanent Royal Commission on Floods. Members of the Commission include Dr. Low Kwai Sim and representatives from the Ministry of Agriculture).

Some Effects of *Hevea* Plantations on Rainfall Redistribution

TEOH TECK SENG¹

ABSTRACT

This paper reports some data on stemflow, throughfall and interception in a *Hevea* planting at the R.R.I.M. Experiment Station, Sungai Buloh.

Six clones of twenty-three-year-old *Hevea brasiliensis* (planting density 536 trees per ha, and planting distance 3.05 m × 6.09 m) in a field were compared. Significant differences in percentage stemflow, throughfall and interception were observed between the clones. Clone RRIM 609 has the highest percentage stemflow (0.27%) whereas clones Tjir 1 and RRIM 605 have the lowest value (0.10%). Clonal differences in percentage stemflow were also significant on the basis of monthly rainfall.

Results of the present study are compared with those obtained for eight-year-old *Hevea* trees (Rubber Research Institute of Malaya, 1971). The practical implications of these hydrological observations in relation to problems of biological resource exploitation such as wash-out, late tapping and late drip in the conventional method of latex collection are discussed. Attention is drawn to the importance of vegetation conservation in urban areas.

INTRODUCTION

In recent years there has been a growing interest in the study of forestry aspects of precipitation, runoff, infiltration and other components of the hydrological balance sheet (Lawson, 1967; Aldridge, 1968; White and Carlisle, 1968; Czarnowski and Olszewski, 1968; Teller, 1968; Rogerson, 1968; Ray, 1970; Klincov, 1970; Rubber Research Institute of Malaya, 1971; Low, 1971, 1972).

Rain falling on a plantation crop such as the extensively-cultivated *Hevea brasiliensis* in Malaysia, is intercepted by the tree canopy and some of this intercepted water evaporates before reaching the ground. The question arises: is it desirable to increase ground-level precipitation? Increasing throughfall by thinning, a lower planting density or pruning may lead to increased runoff, soil erosion and even flooding, particularly if a gradient exists in the plantation floor. On the other hand, increasing throughfall in plantations on level sites would reduce interception losses and improve crop yields and timber values.

This paper presents data on stemflow, throughfall and interception obtained from a rubber planting at the R.R.I.M. Experiment Station (mean annual rainfall was 20.3 cm for 1969 to 1971). The implications of this basic study on *Hevea* plantations hydrology are discussed in relation to certain problems of the exploitation of biological resources.

MATERIALS AND METHODS

Material. Six *Hevea* clones were selected from an experimental field (36 ha) for this study: RRIM 501, 600, 605, 609, Tjir 1 and G1 1. These twenty-three-year-old trees have a mean height of 21 m, a mean girth (1.5 m-height) of 84 cm and a mean "area under the canopy" of 73 m². The planting distance is 3.05 m × 6.09 m, and the planting density is 536 trees/ha. Ten sample trees per clone were randomly selected, but each sample tree has no vacant point adjacent to it.

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Stemflow Measurements. Expanded polystyrene strips were attached to the tree trunk at a height of 1.8 m above the stock-scion union, using latex concentrate as adhesive. Trunk flow was collected in a calibrated plastic vessel via a rubber tube (Rubber Research Institute of Malaya, 1971). After each storm, the water collected in the 41-litre-capacity vessel was measured. The polystyrene rainguards were inspected periodically for any obstruction to water flow due to fallen leaves or twigs.

Throughfall Measurements. Throughfall was measured by placing 4 troughs (each 65 cm \times 25 cm) under each sample tree. Two troughs were placed close to the trunk union and the other two near the crown edge. These troughs were re-located periodically to ensure unbiased catches (Helvey and Patric, 1965). The catches of the 4 troughs were bulked and measured after each storm, and converted to a volume of water equivalent to the sampling area under each tree canopy. The area under each canopy was previously determined.

To be directly comparable with throughfall data, the gross rainfall was measured using gauges located in adjacent clearings at a distance of $1\frac{1}{2}$ times the height of the surrounding trees in the experimental plot.

RESULTS

The hydrological terms used in this paper have the following connotations: throughfall is that portion of the gross rainfall which reaches the forest floor through spaces in the tree canopy and as drips from leaves and branches; gross rainfall is the total rainfall in the open, measured close to the experimental area; total throughfall includes stemflow and interception is the difference between gross rainfall and total throughfall. Both stemflow and throughfall are influenced by factors such as plant species, tree age, planting density, rainfall characteristics, and seasonal effects such as defoliation.

Table 1 gives the monthly values of stemflow, throughfall and interception percentages obtained between June and December 1971, for clones RRIM 501, 600, 605, 609, Tjir 1 and GI 1. The analyses of variance of these data are given in Table 2, and the means of clones in Table 3. There are significant differences in stemflow, throughfall and interception between clones. RRIM 605 and Tjir 1 have the lowest mean percentage stemflow (0.10%) whereas RRIM 609 has the highest (0.27%).

The monthly variation in percentage stemflow for the six clones is shown in Table 1. Total rainfall per month during the period of investigation varies from 6.07 cm in June to 34.57 cm in August. On a monthly basis (averaging about 8 storms/month during the seven-month period), no correlation was apparent between total rainfall and percentage stemflow. Stemflow, but not necessarily percentage stemflow, generally increases with increasing storm-size. The following observations are typical of the relation between storm-size and the volume of water collected as stemflow:

Date of collection	9th Oct.	27th Oct.	23rd Aug.	16th July
Storm-size (cm)	3.15	4.32	5.46	6.91
Stemflow/tree (lt)	2.12	5.48	9.93	15.08

TABLE 1. Percentage of Stem-flow, Throughfall and Interception for six Clones

Measurement in 1971	RRIM 501			RRIM 600			RRIM 605			RRIM 609			Tjir 1			Gl 1		
	SF	TF	I	SF	TF	I	SF	TF	I									
June	0.27	84.02	15.71	0.24	86.65	13.11	0.10	62.11	37.79	0.28	82.42	17.30	0.15	84.02	15.83	0.21	82.04	17.75
July	0.23	86.40	13.37	0.51	88.07	11.42	0.18	51.43	48.39	0.53	83.58	15.89	0.12	76.20	23.68	0.23	77.15	22.62
August	0.23	77.47	22.30	0.16	88.23	11.61	0.12	77.41	22.47	0.35	70.03	29.62	0.11	67.78	32.11	0.18	73.13	26.69
September	0.11	79.43	20.46	0.09	76.01	23.90	0.05	62.21	37.74	0.16	67.97	31.87	0.07	73.74	26.19	0.12	67.00	32.88
October	0.10	71.43	28.47	0.13	76.53	23.34	0.08	70.66	29.26	0.18	64.59	35.23	0.08	87.04	12.88	0.12	67.11	32.77
November	0.13	84.13	15.74	0.15	77.84	22.01	0.08	73.64	26.28	0.19	71.65	28.16	0.10	69.19	30.71	0.14	79.61	20.25
December	0.13	75.56	24.31	0.16	77.06	22.78	0.11	57.90	41.99	0.22	67.40	32.38	0.09	84.93	14.98	0.14	72.15	27.71

SF = Stem-flow; TF = Throughfall; I = Interception

TABLE 2. Analyses of Variance

Source of Variation	Degrees of freedom	Mean Squares		
		SF	TF	I
Months	6	0.029035***	59.370NS	61.812NS
Clones	5	0.029293***	248.427**	224.317**
Error	30	0.003473	48.121	46.783
Total	41	—	—	—
	s.d.	0.0589	6.937	6.840
	Mean	0.1698	75.070	25.023
	CV%	34.71	9.24	27.33

SF = Stem-flow; TF = Throughfall; I = Interception; ***Significant at P = 0.001;
 **Significant at P = 0.01; NS = Not significant.

TABLE 3. Mean Percentage Stem-flow, Throughfall and Interception for six clones over a period of seven months

Clones	SF	TF	I
RRIM 600	0.21	81.48	18.31
RRIM 501	0.17	79.78	20.05
Tjir 1	0.10	77.56	22.34
Gl 1	0.16	74.03	25.81
RRIM 609	0.27	72.52	27.21
RRIM 605	0.10	65.05	34.85
s.e. of a mean	±0.022	±2.622	±2.585
Min. sig. diff. (P = 0.05)	0.06	7.57	7.47

SF = Stem-flow; TF = Throughfall; I = Interception

Amongst the six clones mean monthly percentage interception increased in the order: RRIM 600, RRIM 501, Tjir 1, Gl 1, RRIM 609 and RRIM 605, with a corresponding decrease in monthly percentage throughfall in the same order of clones (Table 3). RRIM 600 has the highest percentage throughfall and lowest percentage interception, whereas RRIM 605 shows the lowest percentage throughfall and highest percentage interception.

GENERAL DISCUSSION

The present data for twenty-three-year-old *Hevea* trees showed a lower percentage stem-flow than that of eight-year-old trees obtained in an earlier study (Rubber Research Institute of Malaya, 1971). The greater stemflow in the younger trees is probably due to their comparatively more compact crown structure which steers more water towards the trunk. After a shower of rain, it has been observed that the tapping panel of older *Hevea* trees dries faster than that of younger trees. Thus on late tapping days in areas with both young and older trees, it is sufficient just to inspect the younger trees for tappable, and if satisfactory, to assume that the older trees are also tappable. The tapping panel of an older tree dries faster than that of a younger tree due partly to the

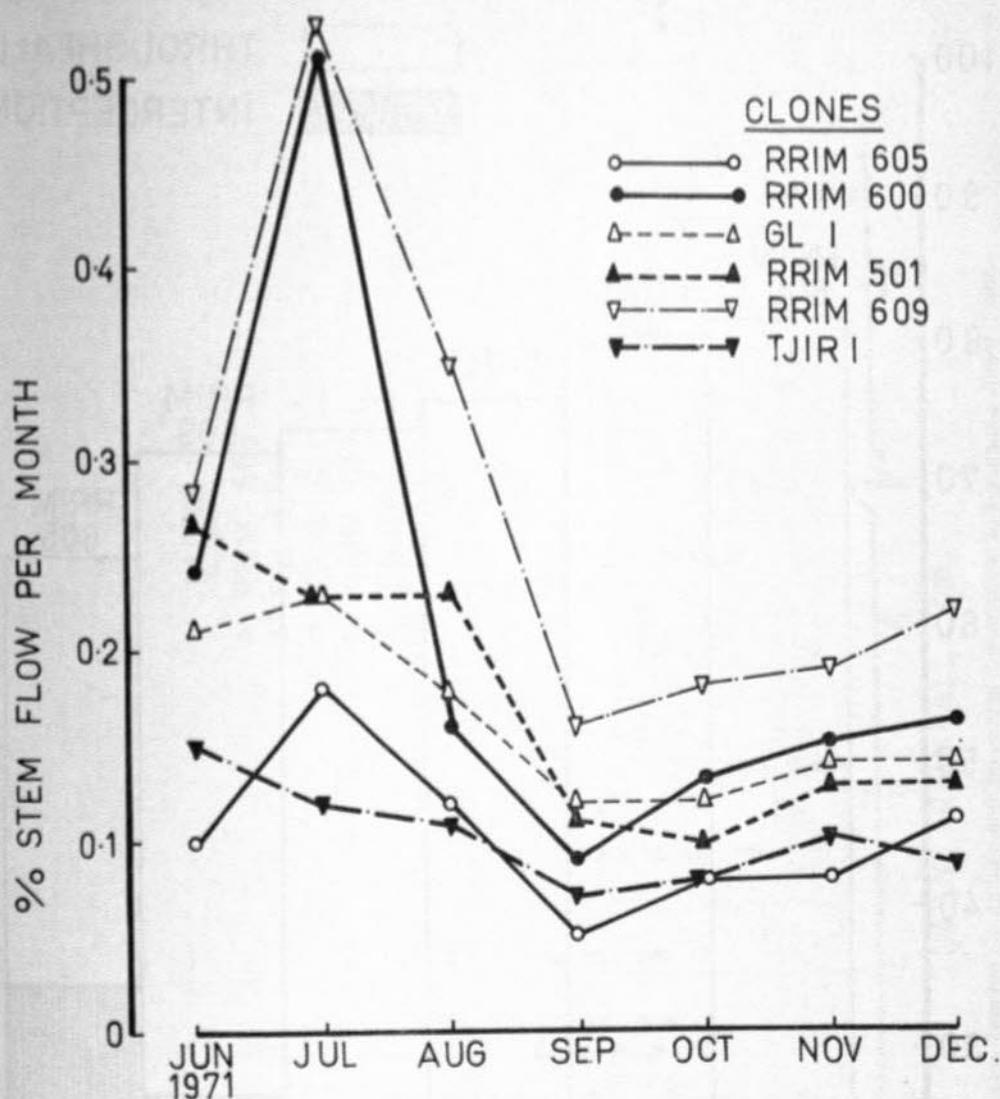


FIGURE 1. Percentage stem flow for 6 clones.

greater sunlight penetration through the canopy of the former and also to the greater air circulation under the canopy of the taller trees (Low, 1972).

Throughfall under forest and plantation trees is generally 60–80% of gross rainfall (Zinke, 1967). In a twenty-five-year-old loblolly pine plantation, Rogerson (1968) recorded throughfall values averaging 85.9% of gross rainfall in an area where annual rainfall averages 132.08 cm. These data are comparable to the *Hevea* throughfall values obtained here (Table 3) and earlier (Rubber Research Institute of Malaya, 1971).

Hevea interception values obtained in the previous study on eight-year-old trees (Rubber Research Institute of Malaya, 1971) are comparable to those for a Spruce/Fur stand aged 150–200 years reported by Klincov (1970) who observed that with light showers of 1–5 mm and no fog, interception was 40–50%; whereas with storm rainfalls of 40–50

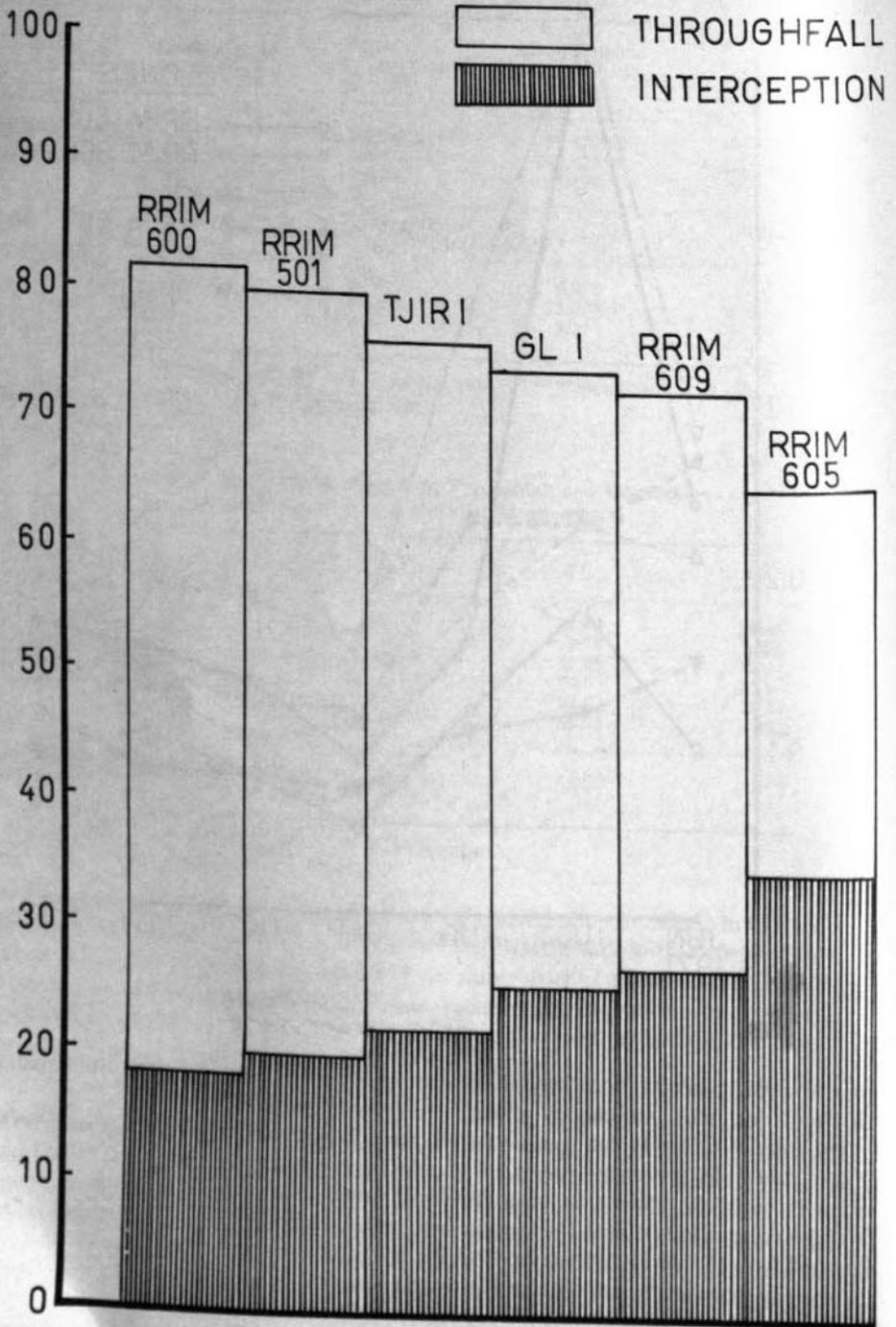
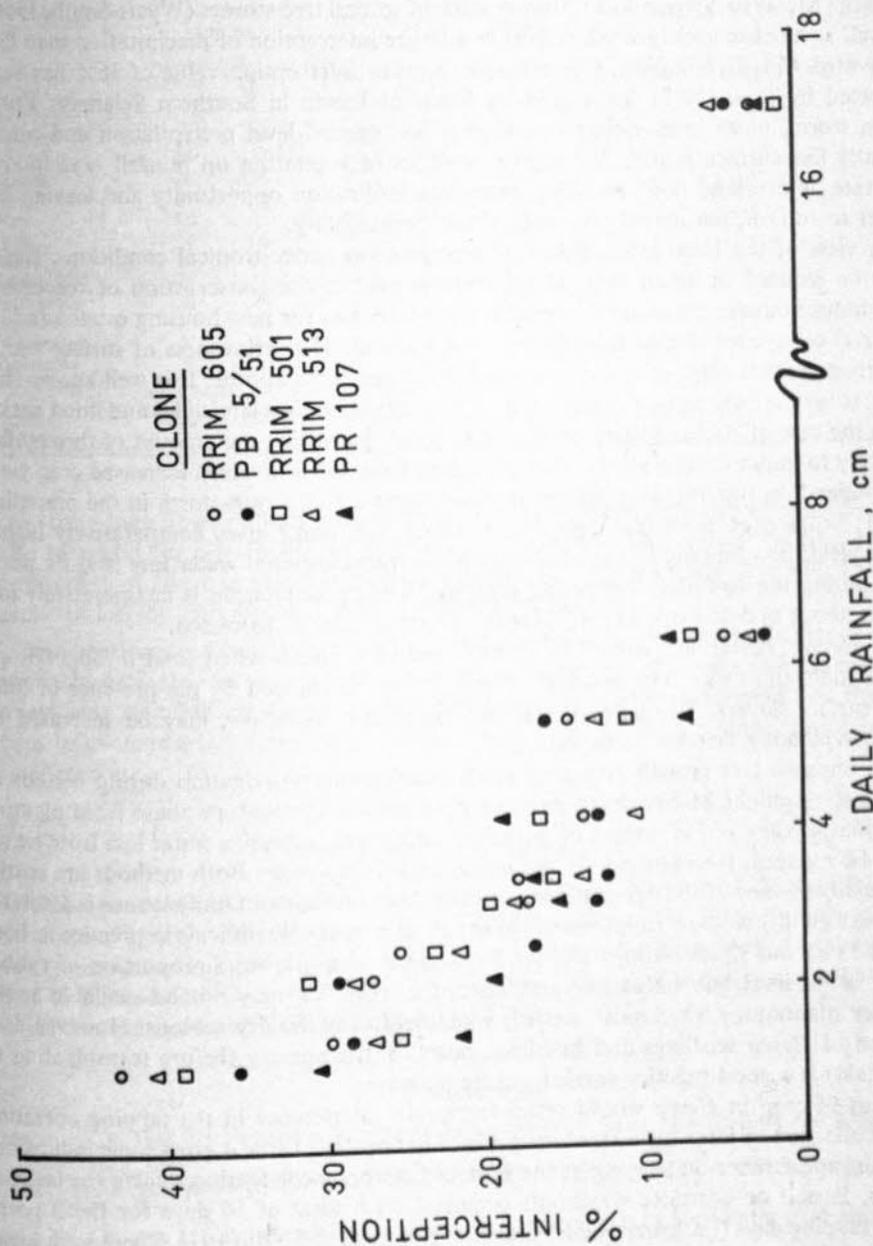


FIGURE 2. Mean monthly values (7 months) for % Throughfall and % Interception.

FIGURE 3. Relation between Storm size and Percentage Interception in 8-years-old *Hevea* Trees.

mm, interception was only 10%. He obtained a mean interception value of 26.1% over the summer, which is comparable to the mean value of 25.0% for twenty-three-year-old *Hevea* trees (Table 2).

In the Malaysian virgin forest the presence of several tree storeys (Wyatt-Smith, 1964), as well as a dense undergrowth results in a larger interception of precipitation than in a cultivated *Hevea* plantation. For example, a mean interception value of 36% has been reported by Low (1972) for a primary forest at Lawin in Southern Selangor. For a given storm, more interception loss implies less ground-level precipitation and consequently less surface runoff. An important effect of vegetation on rainfall is restricting the rate of overland flow, resulting in greater infiltration opportunity and leaving less water to run off, particularly on soils of low permeability.

In view of the large interception of precipitation under tropical conditions, runoff may be reduced in urban areas if attention is paid to the conservation of vegetation. The indiscriminate removal of vegetation to make way for new housing estates and industrial complexes should therefore be discouraged. The seriousness of surface runoff in urban areas is often only realised when flood problems appear. It is well known that vegetation not only reduces surface runoff, but also minimises landslides and flood peaks.

In the case of rubber estates on the other hand, increasing the amount of throughfall is likely to improve crop yields. This is evident from the following: increased crop yield is obtained on tapping days following the occurrence of a rain-storm in the preceding night; tapping at dawn (commencing at about 6.30 a.m.) gives comparatively higher latex yield than tapping in the afternoon when transpirational water loss is at its peak, and during the so-called "wintering months" when precipitation is comparatively low (from about mid-January to mid-March) the crop yield is depressed.

In *Hevea* plantations, runoff on a sloping terrain occurs when total throughfall exceeds infiltration rate. The amount of runoff may be reduced by the presence of litter and surface covers. Throughfall, but not necessarily stemflow, may be increased by a lower planting density, or by pruning.

To improve tree growth and crop yield, supplementary irrigation during periods of water stress might be beneficial, particularly during the immature phase from planting to about 4 years' old in respect of growth. Alternatively excessive water loss from leaves may be reduced, for example, by the use of anti-transpirants. Both methods are costly, especially in view of the current low price of rubber. Although family labour is available in most small-holdings, supplementary irrigation is generally difficult in practice in both the estates and smallholdings for the following reasons: a large proportion of rubber land is not level but undulating and water for irrigation may not be available at the rubber plantations when most needed, which is during the dry seasons. However, irrigation of *Hevea* seedlings and buddings raised in the nursery (before transplanting to the field) is a good practice carried out by planters.

Loss of crop in *Hevea* would result from rain interference in the tapping operation and collection of latex by current methods of harvesting. Table 4 gives some indications of rain-interference on tapping at the R.R.I.M. Experiment Station during the last two years. Partial or complete wash-outs occurred on a total of 16 days for the 2 years. Late tapping days (i.e. lower yields) totalled 58 in 1970 and 34 in 1971. There were losses of 18 and 29 working days in 1970 and 1971 respectively due to rain.

In order to minimise the loss of crop caused by rain interference, various methods of protecting the tapping cut and collecting vessels from rain would be desirable, thus effective rainguards are necessary for polybag collection of latex or to harvest the maximum

TABLE 4. Rain Interference of Tapping Days at R.R.I.M. Experiment Station

Month	No. of tapping days						No. of days no tapping			
	Normal tapping		Rain interfered tapping		Late tapping		Rain		Holiday	
	1970	1971	1970	1971	1970	1971	1970	1971	1970	1971
January	22	25	-	-	6	1	2	5	1	-
February	28	26	-	-	-	1	-	-	-	1
March	26	26	-	-	3	2	1	2	1	1
April	19	25	-	-	8	2	-	2	3	1
May	20	23	2	1	7	3	1	1	1	3
June	24	26	-	-	3	-	2	3	1	1
July	27	25	1	3	3	2	-	1	-	-
August	28	19	-	2	2	4	-	5	1	1
September	22	23	-	1	6	5	2	1	-	-
October	14	24	2	-	10	3	3	2	2	2
November	21	22	-	-	5	6	4	2	-	-
December	21	19	2	2	5	5	3	5	-	-
Total	272	283	7	9	58	34	18	29	10	10

crop from long flows of latex such as from stimulated trees. Effective rainguards would also be useful for certain situations where particular combinations of tapping systems and variety of *Hevea* used could produce a large proportion of late drip which is more prone to loss by rain under current methods of collection.

In rubber production it is an economic problem balancing returns and costs. It would probably be a step in the right direction to research into the economic feasibility of minimising stemflow on *Hevea* tapping panel and eliminating throughfall on the latex cups to overcome the problems of wash-outs and loss of tapping days caused by rain interference.

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DISCUSSION

- P.F. Burgess.—Is there any relation between crown shape and stemflow? Do trees with flat cauliflower shaped crowns have a low stemflow?
- T.S. Teoh.—Yes, particularly between plant species, for example the oak, the pine and the elm. Trees with flat cauliflower shaped crowns such as the oak would give more throughfall and less stemflow. In the case of *Hevea* trees in which crown shape is not very conspicuous or definite, differences between clones may be large.
- E. Soepadmo.—Is there any direct correlations between the amount of stemflow and interception and the different stages of development of the rubber plant, i.e. the canopy area, the shape of the canopy, and the actual number of leaves the trees bear.
- T.S. Teoh.—Since the canopy shape of *Hevea* is not very well defined and changes somewhat with different stages of development, there is a tendency for wider gaps to occur in the canopy as the tree grows older resulting in more sunlight penetration and more throughfall. Also, the amount of stemflow and interception would be less during the 'Wintering' period when defoliation takes place over several weeks.
- Wong Yew Kwan.—Surely this also depends on the weather conditions preceding a storm. For example if it has been very dry for some days, the bark of a tree may be dehydrated and some water would first be absorbed before stemflow begins.
- Lim Wah Ching.—How much rain must fall before there is stemflow?
- T.S. Teoh.—As a plant pathologist Dr. Lim is probably interested in the implications of *Hevea* stemflow in relation to panel disease such as black stripe (*Phytophthora*) which is a wet-weather fungus. This would certainly be a worthwhile study.
- In an average rubber tree in tapping, stemflow should begin after about 1 cm of rain has fallen, depending on factors such as rainfall intensity, age of tree, and as pointed out by Mr. Wong, whether the bark condition preceding a storm is wet or dry. In addition to reducing latex washouts an effective rainguard could also serve to reduce black stripe incidence since the latter requires the presence of free water to initiate an infection.

Hew Choy Kean.—Are there any correlation studies on the stemflow or throughfall with soil moisture?

T.S. Teoh.—Soil moisture in relation to *Hevea* stemflow and throughfall has not been investigated. Ground-level precipitation should increase with decreasing interception (i.e. increasing total throughfall). If more total throughfall is desirable, pruning or a lower planting density may be the solution, provided crop yield is not adversely affected. Pruning in the case of *Hevea* has been reported to reduce crop yield by as much as 25%.

Wong Yew Kwan.—I think Dr. Teoh's hydrological study is one of the very first carried out on a plantation crop in this country. I should very much like to see the hydrological study extended to cover some lysimeter studies in relation to weight of manuring of our crops so that the correct weight can be applied with minimum amount escaping root activities through leaching. This may also eventually lead to a reduction in stream pollution by chemical fertilisers.

Hew Choy Kean.—Could Dr. Teoh suggest some methods of minimising stemflow and eliminating throughfall on latex cups?

T.S. Teoh.—Various methods of protecting the tapping cut and latex cup from rain have been attempted in the past, but the cost factor has been the bugbear. In Ceylon for example, where rain-interference on tapping is a more serious problem than in Malaysia, about 80–90 tapping days per year are lost as a result of rain. A skirt-like type of rainguard has been tested by planters in that country but it appears to be unsuitable, mainly due to problems such as high cost, increased panel disease, interference with the tapping operation and collection, and insects sheltering beneath the skirt.

In rubber production it is essentially an economic problem balancing costs and returns. Factors such as theft, current low price of rubber, shortage of tappers (as in Sabah at present) have to be considered. It would be worthwhile to examine the economic feasibility of using new types of rainguard in conjunction with a cup-lid, with the view that on rain-interference tapping days it may be profitable to (1) reduce wash-outs, (2) delay collection, (3) save late-drip crop, (4) tap earlier on late-tapping days, (5) carry out late tapping on otherwise lost working days, and (6) reduce panel diseases.

A Preliminary Study of the Ecology of a Polluted Stream: The Sungai Renggam

HO SINN CHYE¹

INTRODUCTION

To-day, there is much professional and lay interest in our environment, particularly with respect to pollution problems. Man's increasing use of water for domestic, agricultural, industrial and recreational purposes poses problems which are already familiar to everyone. The concern over deterioration of water courses as a result of poor land utilization and their use as carriers of exogenous pollutants has stimulated research into the basic dynamics of the river ecosystem. In its overall effect, pollution tends to shift an ecosystem from a complex stable state to one which is less stable and in which diversity is decreased and the auto-regulating buffering capacity against change is diminished. Klein (1957), defines pollution as 'anything causing or inducing objectionable conditions in any water course and affecting adversely any use, or uses to which the water thereof may be put'. For the purpose of this paper this definition is accepted as a reasonable statement of fact since nothing can be gained by an analytical comment on it.

This paper presents the results of and inferences based upon a preliminary study on the ecology of a polluted stream namely the Sungai Renggam. The work to date has been limited mainly to the monitoring of the physical and chemical conditions of the water. Further investigations are still being conducted. These include the study of the physico-chemical properties of the bottom deposits, the bacteriological conditions of the water and the floral and faunal compositions existing in the stream.

THE STUDY AREA

The Sungai Renggam drains a watershed that runs from north to south in the eastern sector of the District of Klang (Fig. 1). The catchment area occupies 20,000 sq m and lies at altitudes between 6 and 50 m above chart datum. The axial length of the drainage basin is about 9 km and the average width of the stream itself is about 1 m just below the source and about 5 m just above its confluence with the Sungai Klang. The water level in the stream as well as the velocity of water current vary greatly depending on the wet and dry seasons. For the former, values ranging from 20 cm/sec to 60 cm/sec have been recorded at the sampling stations. On the whole, the stream flow is slow and gradual. This is especially so downstream where the gradient of the stream bed is gentle (Fig. 2).

The watershed can be divided arbitrarily into two zones: the demarcation line being the Federal Highway which bisects the drainage basin into the Upper and Lower Zones (Fig. 1). Almost all of the catchment area lies within the Upper Zone. This zone takes in the apparently undisturbed forest reserve, rubber and oil-palm estates. At the moment a major part of this area is undergoing severe land development and urbanization. The rubber trees and oil-palms are being replaced by new roads and concrete structures. In short, the landscape is becoming drastically altered. At certain places the land has become so stripped of vegetation that it appears barren but for the presence of a few

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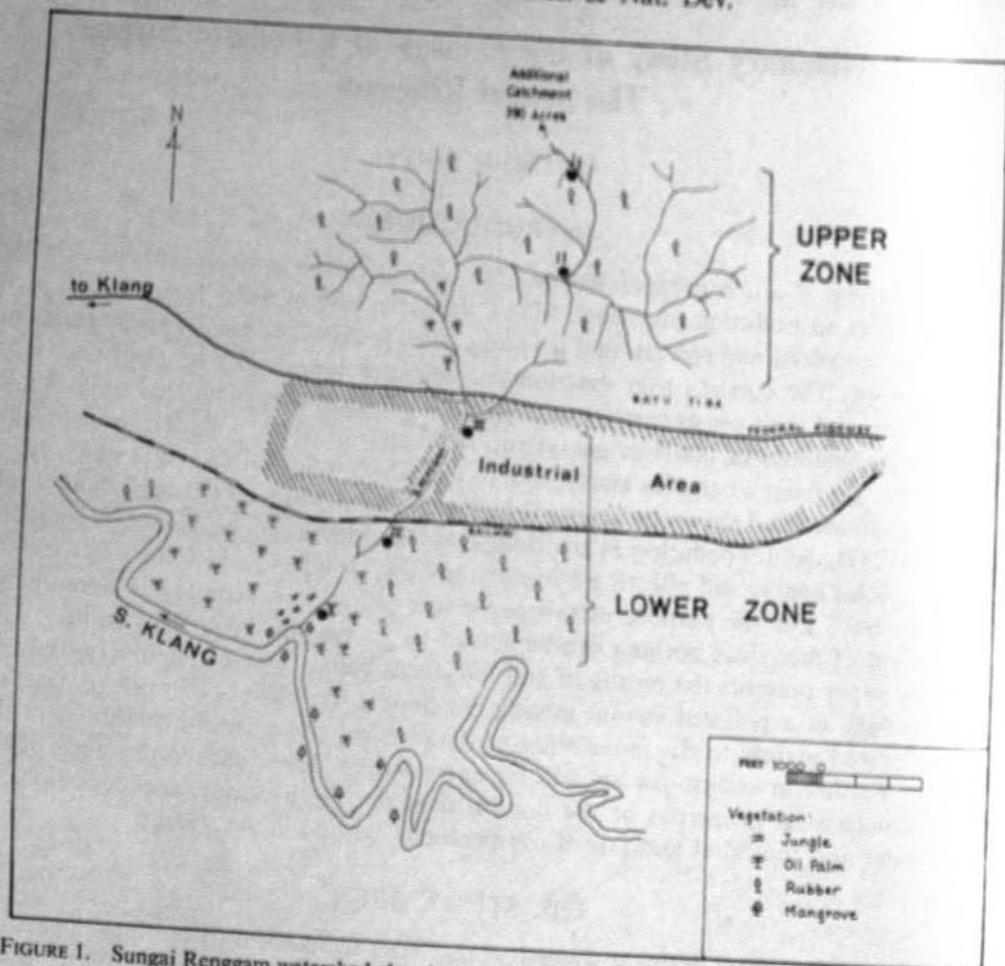


FIGURE 1. Sungai Renggam watershed showing drainage system and distribution of sampling stations.

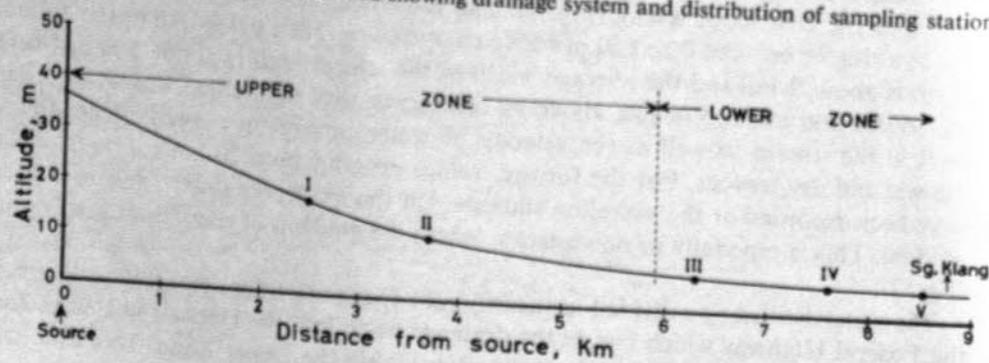


FIGURE 2. Profile of Sungai Renggam.

species of primary colonizer plants. Braiding of the stream channel is seen and excessive erosion of the channel during flood peaks has left large areas of constantly shifting sand and gravel bars through which the stream now finds its course. The water appears turbid owing to high erosional load content. Consequently there is a marked shortage of autochthonous phytoplankton in the water. In the lower zone, the stream meanders through a relatively stable but heavily industrialised area. It is here that Sungai Renggam becomes

a depository for almost all the industrial effluents originating from the factories nearby. These factories include several big automobile assembly plants, a cigarette factory, food and confectionery factories, a glue factory, electronic components manufacturing plants and others. The wastes from these factories are channelled by a network of culverts to be eventually discharged into the stream. Traces of oil have been found occasionally on the surface of the flowing water. Except for the presence of small amounts of sludge deposits at the outfall of these culverts, the bottom substratum of the stream is relatively stable with little change in bed-configuration even after a rain storm. The marginal vegetation too is more firmly established consisting mainly of the profusely growing *Commelina nudiflora*. However, there is considerable undercutting of the banks in the lower reaches, particularly near the mouth of the stream. The mouth of Sungai Renggam lies just within the tidal zone, hence at periods of extreme high tide there is a small influx of dilute sea water. The effect of this incursive estuarine water on the ecology of the stream will be discussed later.

The sampling stations have been selected to represent the most obvious areas of the stream. Stations 1 and 2 are located in the Upper Zone; the former being sited at a relatively undisturbed area while the latter is located in the midst the development area. The remaining three stations are located in the Lower Zone. The stations are distributed in such a way that comparison of the water quality of the stream before and after industrial pollution is rendered possible.

RESULTS AND DISCUSSION

The results of water analysis are presented in Table 1. Each test should be considered not in isolation but in relation to the analysis as a whole. In order to generalize the finding of the study and bring out differences more clearly, the nine analyses determined for each station over the study period have been pooled and a mean calculated for each station (Fig. 3). Granted that this treatment tends to smooth out the data, nevertheless, it will bring out any consistent long-term differences between stations.

The stream in the upper zone is characterized as having relatively low specific conductivity, pH weakly acidic, low buffering capacity and alkalinity, low B.O.D. and low concentration of nutrient salts but with high silica content. The high erosional load measured in terms of the total suspended solids can only be attributed to the effects of prevailing land-clearing and earth-excavating activities. On the whole, the water is chemically uncontaminated.

In the lower zone, the chemical content of the water increases. The water becomes harder thus possessing better buffering capacity. Total alkalinity and conductivity also increase, the latter indicating an increase in ionic concentration. Rises in albuminoid nitrogen, nitrate and phosphate concentration have been noted. In fact, phenomenal increases in phosphate concentration has been obtained at Station A on some occasions. The fact that no apparent increase in phosphate has been found at Station 5 on the same occasions rules out the possibility of mineral enrichment from tidal influx. Thus allowing for the fact that a fraction of the nitrate and phosphate content have been derived from the natural input of allochthonous plant materials from the riparian vegetation, an exogenous input is suspected. The general decrease in concentration of dissolved nutrients at Station 5 can probably be attributed to rapid assimilation by the pelic community. Results also indicate that there is a progressive increase in organic matter down the stream, paralleled by increase in B.O.D. value in the same direction.

TABLE 1. Analysis of water from the sampling stations

Range of analysis values (in p.p.m. unless otherwise stated) for period July '71 to March '72	Station				
	Upper Sg. Renggam 1	2	3	Lower Sg. Renggam 4	5
pH	5.50-6.90	6.00-6.50	6.00-7.48	6.00-7.10	6.50-6.71
Suspended solids	1500-3000	2000-4500	1600-3000	400-600	300-600
Dissolved solids	450-600	600-1000	350-800	200-400	200-500
Dissolved oxygen	5.40-6.25	4.80-6.87	4.10-6.85	3.85-5.90	4.50-6.10
O ₂ saturation, %	65.3-75.1	60.2-91.0	51.4-84.9	48.4-86.1	51.5-85.0
B.O.D.	1-3	2-3	8-14	10-15	10-16
C.O.D.	1.74-3.92	4.00-6.00	5.42-6.62	5.78-6.01	5.50-7.12
Hardness (as CaCO ₃)	3.50-9.00	3.80-15.0	9.00-40.0	11.0-85.0	10.5-95.0
Alkalinity (, ,)	3.00-10.0	5.00-11.0	9.30-33.0	10.0-85.0	25.0-64.0
Conductivity, umho	10.5-14.5	9.20-27.0	35.0-90.0	51.0-260	60.0-420
Chloride	1.60-2.13	1.39-1.42	2.90-65.3	3.19-19.2	4.20-95.0
Free & saline NH	0.08-7.60	0.08-9.10	0.34-10.1	0.87-9.73	0.98-6.93
Nitrate nitrogen	0.02-0.11	0.03-0.05	0.07-0.18	0.02-0.24	0.04-0.22
Nitrite nitrogen	nil-0.03	nil-0.04	nil-0.05	nil-0.12	nil-0.04
Orthophosphate	0.01-0.31	0.01-0.10	0.55-5.13	0.01-7.93	0.10-0.43
Silicate	1.70-4.70	1.68-5.10	1.60-8.18	1.50-5.64	1.50-5.20
Organic matter	5.38-9.91	3.19-5.04	3.68-12.5	3.86-16.8	4.10-20.5
Anionic detergents	nil	nil	2.10-4.50	2.30-3.10	1.80-2.80
Cations:					
Aluminium	nil	nil-0.01	nil-0.04	nil-0.02	nil-0.02
Calcium	0.25-0.60	0.21-1.40	1.05-3.80	1.18-7.45	2.90-18.6
Chromium	nil	nil	nil	nil	nil
Copper	nil	nil	trace	trace	trace
Iron	0.84-1.80	0.64-1.00	0.30-1.48	0.40-6.60	0.40-0.55
Magnesium	0.15-0.35	0.20-0.50	0.45-1.10	0.40-1.81	0.68-2.09
Potassium	0.04-0.55	0.04-0.70	0.15-3.49	0.22-5.35	0.90-8.90
Sodium	0.08-2.20	0.50-2.10	0.29-5.85	0.26-62.4	0.60-21.6
Zinc	nil-0.33	nil-0.38	nil-0.85	nil-0.77	nil-0.69

From the amount obtained at Stations 4 and 5, a strong case of organic pollution is apparent.

Cations such as copper and zinc which are not detected at the stations upstream are found in some significant quantities at Stations 4 and 5. It is doubtful whether their presence in the water is due to industrial pollution or not, as cation exchange between the water and the bottom mud could have taken place (Lenhard, Ross and Du Plooy, 1962). Further investigation into this problem is necessary.

On the whole, it appears that the major sources of pollution present are of geologic and organic origin. The former, in the form of inorganic sediments, is without doubt the chief pollutant in our water courses, originating as a result of a wide spectrum of human activities. From an ecological view point, the insidious effects of transported inorganics are more important than the normal conspicuous phenomena. Direct effects on fish are manifested by reduction in visual feeding capacity owing to turbidity. Deposited silt affects spawning gravels by blocking interstitial flow and oxygen exchange may lead to high egg and larval mortality. Loss of invertebrate niche diversity due to the smothering effects of the silt is another possible consequence. All these account partly for the poor invertebrate fauna and algal flora existing in Station 2. Examination of plankton hauls reveals only algae of the green filamentous form (mainly *Spirogyra* sp.). In the case of invertebrates, one species of a free-living nematode (probably of soil origin) has been frequently recorded in the water samples. The situation improves at the lower stations where stream conditions are more stable and there is less physical

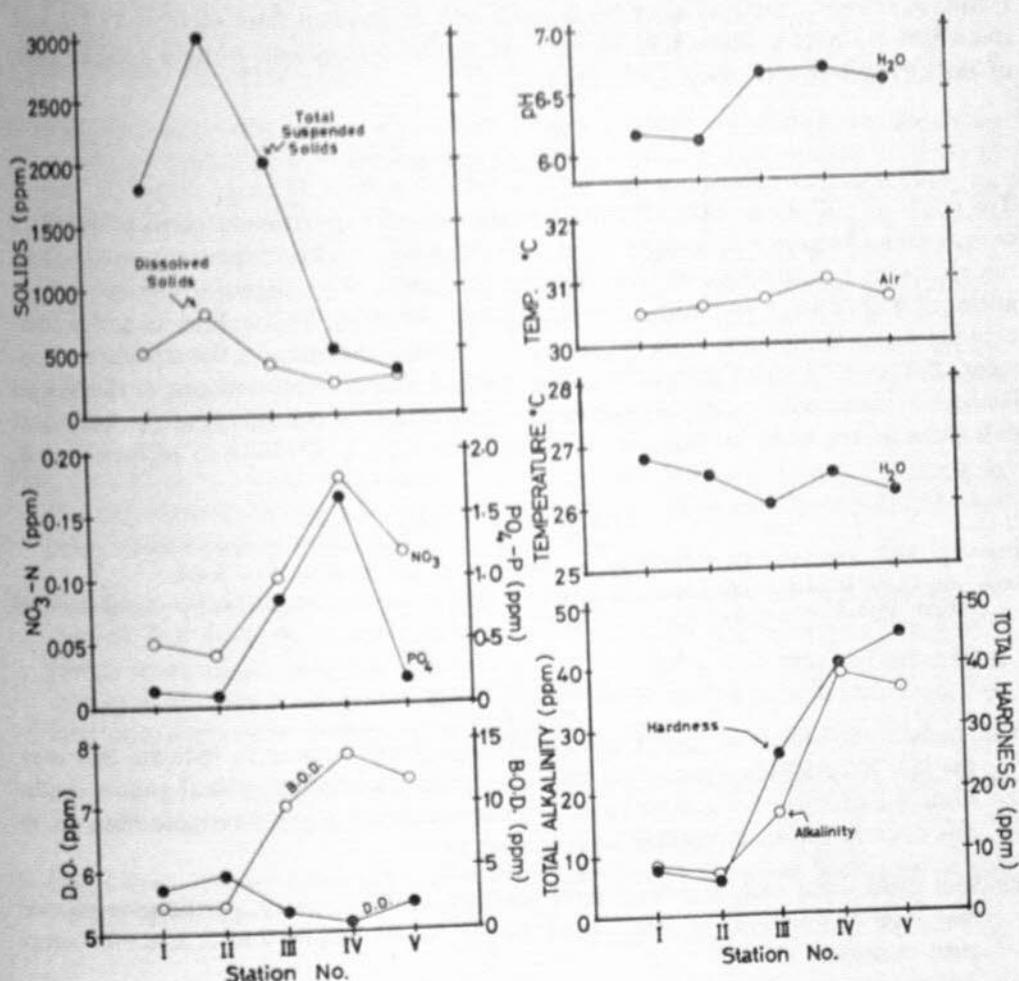


FIGURE 3. Physical and chemical conditions in the Sungai Renggam.

interference from the suspended inorganics. Some members of the blue-green algae (e.g. *Oscillatoria* sp.) appear in the water. There is also a general increase in phytoplankton and invertebrate populations, presumably attributable directly to the general enrichment of the environment and its effects on them. Under such condition one would expect an increase in population diversity as well. This is, however, not so as the occurrence of organic overloads has encouraged the proliferation of pollution-tolerant species only. Thus the macroinvertebrate population at Station 4 and 5 consists predominantly of the bloodworm *Chironomus* sp. and the sludgeworm *Tubifex* sp. Attempts are now being made to study their distribution and to evaluate their abundance. No mayfly or caddisfly larvae have been encountered so far from soil cores taken from these stations. This condition appears to persist throughout the remaining stretch of the stream. The fact that there is hardly any sign of recovery of the clean-water species downstream suggests that the natural process of self-purification is probably slow and incomplete, in spite of the periodic flushing action of tidal water coming from Sungai Klang. As it is, the immediate effect of this influx of Klang water appears to be one of ionic enrichment.

Cations such as sodium, potassium, calcium and magnesium have increased in quantities which can only be accounted for in terms of tidal enrichment. A more detailed study of the affected area is therefore necessary.

CONCLUSION

The entry of pollutants into a flowing stream sets off a progressive series of physical, chemical and biological events in the downstream waters. Their nature is governed by the character and quantity of the polluting substance. With regard to the above categories of pollutants, the combined effects of low discharge, heavy effluents and accompanying high temperature must indeed be potentially damaging to the stream environment. Fortunately, these threats have not reached alarming proportions in the Sungai Renggam. Nonetheless, with future expansion of activities, the effects of the individual pollutants on the biota, in the context of local conditions, will have to be investigated.

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DISCUSSIONS

R.B. Lulofs.—Information gained from kampong people appear to indicate that over the last 20 or 30 years there has been a considerable change in local stream conditions indicating a far greater pollution than realised. Have standards been set in this country for an acceptable level of pollutants?

Ho Sinn Chye.—No such standards have been set in this country. At the moment, we make use of standards of other countries (e.g. Great Britain and U.S.A.) for reference purposes.

Hew Choy Kean.—What is the sampling method and sampling frequency?

Ho Sinn Chye.—Briefly, the water for chemical analysis is obtained from the stream using a water-sampler. Snap samples are taken at every station. Sampling is carried out every fortnightly.

N.P.E. Langham.—Are you sampling at various depths at each station? Because salt water and freshwater have different densities and your results will be affected if you sample at different depths at different states of tides.

Ho Sinn Chye.—So far, water sampling has been confined to the surface water only. This is quite permissible as the stream is relatively shallow and the water well mixed.

A.J. Berry.—There are mangrove trees at the confluence with the Sungai Klang. Do you know what affects tidal salt water has on this part of the stream? Are brackish-water organisms present there? Are there tidal cycles of nutrient abundance?

Ho Sinn Chye.—As no investigation has been carried out at the confluence itself, I am afraid I cannot answer your questions.

- A.J. Berry.*—Generally, the data presented are strikingly different from those of more 'normal' streams. Would the speaker care to comment on the differences caused by the development of the Shah 'Alam area as compared with a more 'normal' stream?
- Ho Sinn Chye.*—To begin with, I would like to point out that very little is known of the general hydrochemistry of our streams. For the purpose of comparison, I can single out an interesting paper by D.S. Johnson which appeared in the journal *Archiv fur Hydrobiologie* (Vol. 63: pp. 477-96, 1967). This paper gives an account of some chemical characteristics of freshwater in Southern Malaya and Singapore. The data that Johnson obtained for his open-country and tree-country streams are generally lower than what I obtained for Lower Sungai Renggam. This is due partly to the unpolluted conditions of the country streams of which Johnson made his study. Thus with regards to Sungai Renggam, we can reasonably attribute the present findings to development activities going on in Shah 'Alam.
- Wong Yew Kwan.*—I think I am correct in saying that Malaysia is very fortunate in that the streams feeding our impounding reservoirs are relatively unpolluted. Are there some instances where pollution does occur?
- Ho Sinn Chye.*—There are scattered cases where mild pollution has occurred in such streams. For example, a stream feeding the Subang Lake has been known to discharge water which has high ammoniacal nitrogen content—a result of using large quantities of ammonium hydroxide in the process of rubber coagulation. I am sure that such a situation prevails in other places as well.
- Teoh Teck Seng.*—With reference to streams in rubber estates, has any work been done on pollution, if any, due to pesticides?
- Ho Sinn Chye.*—To my knowledge, very little quantitative work has been done in this field in Malaysia.

Multi-use Management of West Malaysia's Forest Resources

LEE PENG CHOONG¹

INTRODUCTION

That forests are more than just a source of timber but have also important functions in soil and water conservation, protection of wildlife and recreation have long been recognised. Further claims that forests are necessary to maintain regional climatic conditions have however not been proven, although micro-climatic changes will undoubtedly occur in an area cleared of forest, or in a forest being harvested for timber, or for the matter in a gap created naturally within a forest. More recently the importance of forests in preserving regional biological resources for the maintenance of genetic reservoirs is also being recognised, particularly in relation to the study and maintenance of equilibrium within the biosphere, a field of investigation which becomes more and more pressing in the wake of modern Man's increasing erosion of genetic resources through the expansion of single species crops, and especially through selective breeding. In view of these multiple functions that forests perform, the concept of multiple-use management has long been established in forestry.

The relative importance of the different roles of forests are dependent first on the physical conditions prevailing in a region, namely climate, topography and soils, and second on the state of economic and social development. Accordingly, in formulating management policies for a country's forest resource, these policies should be related to the physical nature of the country and to prevailing economic conditions. In this regard, historical developments in forest utilisation and management in the more developed countries provide useful lessons on the role of forests, their importance in conservation as well as in economic development; but while these comparisons are useful as guide lines to the possible directions in which forestry will develop in a given country, the fallacies of adopting policies appropriate to one region at a given stage in its development to another region in a different state of development should be recognised and avoided. The values derived from forests change according to the stage of development in a country, and these changes are related to changes in the relative scarcity of forests as a resource. In the less developed countries, forests may even be regarded as being a hindrance to development, when market or transportation problems preclude the exploitation of the timber resource, and when forests have to be cleared for agricultural development. In other regions, the timber resource itself may assume paramount importance, while in other countries still the value of forests in watershed protection and for recreation often outweighs their value for timber production.

Together with the concept of multiple use of forests, the concept of the management of forests to provide the greatest benefits to the largest number of people both now and in the future has been prominent in forest management policies. These two concepts are inter-related and together take into consideration the indirect benefits accruing not only from exploitation of timber, but also benefits from soil, water, environmental and biological conservation. That there seems to be emphasis in forest management for timber production both here and in other countries do not necessarily mean that other values of the forest are being neglected; this is because the production of timber is often

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compatible with most of these other uses, particularly with objectives of soil and water conservation, which objectives are basic to continued forest production.

Without an adequate understanding of the complexity of factors which maintain the delicate equilibrium between the forest and the physical environment, in managing forests for optimal timber production it is inevitable that unexpected and undesirable changes in soil productivity has occurred, but in a managed forest, this becomes apparent sooner or later and remedial action can be taken. Minor setbacks of this nature should be contrasted with disastrous changes in unmanaged forest lands where over exploitation of the forest resource has resulted in widespread and run-away undesirable consequences. This has been particularly acute in arid regions where over-exploitation of the natural forests for firewood or through grazing, has resulted in advancing deserts. In more humid regions, floods and soil erosion problems are important, but here again disastrous consequences have been more the result of deforestation for other land use, or through over-exploitation, rather than through forest operations in a managed forest.

It is important that in the management of forests to perform all these functions a balanced outlook is maintained. In managing forests for the production of timber there should be an awareness of other functions which each particular area of forest has to perform in order that other functions are adequately protected. On the other hand the exploitation of timber resources should also not be sacrificed through over-zealous efforts on conservation. Thus the management decision will depend on an assessment of all the values required of the forest to realise the maximum net value given all these uses, a task which is undoubtedly difficult since not all these values can be easily quantified.

WEST MALAYSIA'S FOREST RESOURCE

Before discussing how West Malaysia's permanent forest resource should be managed in order that they may most efficiently meet with the multiple uses required of them, it is necessary to examine the nature of the forest resource and the conditions which are necessary to promote each specific use of the forest.

The last overall survey of West Malaysia's land resources carried out through interpretation of aerial photographs taken in 1966, showed that at that time about 22.4 million acres from a total of the 32.5 million acres of the country were under primary forest cover, although part of this consisted of logged forest. In a land capability classification study to determine the potential land use, it was found that about 14.3 million acres (43%) are unlikely to be developed for agricultural use, comprising peat swamps and forest above the stepland line. The latter is defined as the level above which slopes are generally in excess of 20°, but also including all flat areas within valley re-entrants. About 8.1 million acres of forested land are therefore regarded as being suitable for agricultural development, although it is not assured that all these areas will be cleared for agriculture. The rate of land development in West Malaysia during the Second Malaysia Plan is projected to total about 1 million acres so that at this rate it will be eight five-year plans or 40 years before this conversion is completed. Hopefully the need to convert all suitable land to agricultural use may not arise.

Even assuming that these projections of agricultural expansion are correct and these 8.1 million acres will be necessary for agriculture, there is evidence that the climate of public and political sentiment is such that certain areas, for example, the National Park as well as the other proposed national park areas have a good chance of being preserved.

Assuming that this is the case, and that some of the more remote agricultural opportunity areas will be unlikely to be developed due to access problems, the likelihood is that the total area of permanent forest land will exceed 45% of the total land area.

It is this 45% of the country which will remain permanently forested that will meet the needs of the West Malaysian population for forest based utilities. These forests consist of mangrove swamps, peat swamps, lowland and hill forests on steep land forming two thirds of the permanent forests and having the most important productive forest potential, and montane forests with negligible productive potential. How these forests should be managed in relation to their multiple uses will depend on the relative importance assigned to each form of use and to what extent these uses are compatible. Accordingly it is necessary to examine in some detail these different demands made on the forest, in relation to their importance as reflected by ambient social needs and the extent to which these needs are compatible.

TIMBER PRODUCTION

Although the timber industry in West Malaysia has expanded tremendously over the last decade, to the extent that it now ranks third behind rubber and tin in value terms in the primary producing sector, the bulk of production has been from the lowland forest areas which are currently being converted into agricultural use, so that there has been little change in the hill forests. These lowland forests are rapidly disappearing and it is estimated that the remaining unlogged areas would be entirely logged over at least once within another ten years, and increasing attention will be given to the exploitation of the permanent hill forests, and to a lesser extent, the swamp forests.

As a management objective timber exploitation results in the most drastic change in the forest environment and most severely diminishes the ability of the forests to fulfill its other functions. This is particularly true with the application of clear-felling systems using fast growing species on short rotations, in which case forest management may be compared with tree crop agriculture as practised in this country, and can lead to even more severe conservation problems than with crops like rubber or oil palm. For economic reasons however such a system of management is frequently applied, although as yet not in West Malaysia, other than in experimental forest plantations on a very limited scale. The application of clear-felling systems has been favoured in the developed countries in temperate regions, where through a combination of factors of high labour costs, and the suitability of relatively uniform and pure forests of soft wood species to mechanised logging systems, development of timber harvesting machinery has enabled significant savings in exploitation costs. This may not necessarily be true elsewhere where both physical and economic factors may be different, factors such as lower labour costs, necessary precautions against soil erosion in mountainous terrain, silvicultural characteristics of species, and trade-offs between the cost of adopting more labour intensive methods against higher returns through possible increase in timber yields. In the Alpine region of Europe for example, a selection system of management is favoured partly for soil conservation reasons but also because it is claimed that the annual growth is higher under such a system. Here the higher value of trees for quality timber in a timber deficient region is undoubtedly a factor favouring such a system against clear-felling systems producing low valued pulp-wood.

In West Malaysia, as in other tropical rain forests no information is available on the relative merits of clear-felling or selection working since neither system have been prac-

tised. At this stage, for a complexity of reasons, the exploitation of timber in tropical forests is far from efficient, since no more than 20-30% of the available volume is utilised. In effect forest logging practice in its effects on the forest environment is similar to selection working. The result is that except for the first year subsequent to logging while regeneration and secondary species become established to close the canopy again, the conservation functions of the forest are hardly impaired. This situation is however likely to change and as technology and demand in timber utilisation progresses, the intensity of exploitation is likely to increase and it is probable that within a decade or two harvesting of timber will become so intensive that due to significant effects on secondary forest functions it may be necessary to adopt selection systems of management on some lands. Whatever system of management is applied, it is likely that so long as forests are managed rationally in relation to land capability, the protective functions of the forests in soil and water conservation will not be impaired, since the continued production of timber will depend on this.

In spite of the very many difficulties attendant to the exploitation of hill forests, because of a demand for timber, and unless there remains substantial areas of lowland forests, the hill forests will have to meet with the nation's requirement of timber. What this demand is likely to be can be estimated, taking into consideration factors such as population size, standards of living, scarcity of timber resource and drawing from the experience of more developed countries. Assuming that by the time that most of the available suitable land has been converted to agricultural use and a more or less stable pattern of land use has evolved, West Malaysia's population will be at about 20 million, that the per capita consumption of wood will reach the level of the timber deficient developed countries of Western Europe or of Japan, which is currently about 25-30 cu ft. per annum, and assuming that half of the requirement will be met from indigenous forests producing about 100 cu ft/acre/annum and half from plantations of fast growing species producing 300 cu ft/acre/annum, then it can be estimated that West Malaysia's demands can be met with a total area of intensively managed forest of about 4 million acres. This does not mean to suggest that this should be the target to be aimed for, but the figure is provided merely to show roughly what is required in order to meet with minimal demands for wood products. How we will use our forests will depend on the value that we put on timber as against other products, or on wood as against other forest values.

SOIL AND WATER CONSERVATION

Soil and water conservation depends on the maintenance of vegetative cover over the bare ground. As discussed above, so long as rational systems of forest management are applied in productive forestry, this function of the forest is unlikely to be significantly impaired. That any disturbance of the forest canopy or disturbance of the soil through logging will reduce to some degree the efficiency of the undisturbed forest cover in water and soil retention is a fact which cannot be denied, and consequently there will be accelerated movement of soil and water into streams and rivers, but there is as yet no conclusive evidence that siltation due to logging as distinct from other development activities such as mining or urban development will be significant to the extent that expenditure on remedial measures will be required. This does not mean to imply that current systems of logging are ideal and that precautions against soil damage need not be undertaken, and with more intensive logging as may be expected in the future, more attention should be given to soil conservation in order to keep soil erosion to insignificant

levels. In relation to this it may be noted that in spite of popular belief there is no evidence that the floods in 1971 were the consequence of, or even significantly intensified by accelerated run-offs or siltation of rivers due to logging or even land development. These floods can be more directly attributed to extreme meteorological conditions.

WILDLIFE CONSERVATION

Although there have been very few studies made on the ecology and behaviour of the several species of wildlife in West Malaysia it is probable that in the long run wildlife management can be integrated with productive forest management. Considering the larger mammals which require larger ranges such as the elephant, seladang, tapir, the Sumatran rhinoceros and the larger deer, which feed preferably on secondary growth species, virgin forest conditions do not appear to be necessary, and the forest is required only for cover, a function which is just as well fulfilled by logged forest. The larger predators such as the tiger and leopard may be expected to be similarly affected by logging. Nevertheless, there is a need to study the behaviour of these species in relation to their reaction to frequent contacts with man. It is also necessary to study the needs of the specific demands of the smaller more specialised species, for example mammals of the upper canopy as well as birds which require specialised nesting sites located only in primary forests, before it can be ascertained whether at least all the more prominent species of wildlife which are of general interest can be integrated into productive forest management.

BIOLOGICAL CONSERVATION

The multitude of plant and animal species in the forest is the result of millions of years of evolution. While changes in the natural forest through logging can in many cases accommodate other uses of forest, and can in time even be reversible the extinction of a single species is an event which cannot be reversed. Hence the conservation of an entire genetic population is a function which cannot co-exist with productive forestry, since in order to do so whole biological communities need to be preserved, a requirement which is in contrast to species selection in productive forest management.

RECREATION

There is very little use of forest areas for recreation in West Malaysia. Recreational use of forest covers a wide range of activities but these activities can be related to a few characteristics of the forest environment—the landscape itself, forest flora and fauna and good water for water related activities. Provided that some attention is paid to the maintenance of the attractive qualities of the forest landscape, general recreational use of forest does not require virgin forest conditions. In fact judging by current usage, logged forests because of their ready access are used more for recreation than inaccessible virgin forests. However, deeper aesthetic appreciation of forests depend on the preservation of certain values which are related to undisturbed nature, to an awareness of the timeless origin of the forests, to the awe that groves of giant trees inspire and to the variety of life that exists. In this regard, certain management goals of forests for recreation will conflict with aims for timber production.

MULTI-USE MANAGEMENT OF THE FOREST RESOURCE

The multiplicity of functions and the uses which are made of the forest which require different management techniques raise the problem of the selection of a management policy for West Malaysia's forest resource in order that the optimal balance between these different functions can be met. The problem is also complicated by the fact that this optimal balance is not static, but changes over-time depending on changing social, economic and cultural demands of the country's population which determine at any given point in time the hierarchial order along which the different values of the forest may be ranked according to their scarcity. Consideration of this provides the first principle on which multi-use forest management must be based, that there should be a way out for changes in management policies to be adopted and any changes induced can be reversible. In this regard, in practice it is probably true that any set of conditions within a forest area maintained for any specific purpose can be converted to another set, with the exception of the conditions required for biological conservation. For example, provided that some action is taken to maintain a complete range of species for re-afforestation, then it is possible to convert single species forest grown on short even-aged rotations to multi-species uneven-aged forests, or even to allow the forests to approach a pristine untouched state.

A second principle is that in order to secure the multiple uses required of the country's forest resource it is not necessary that the same uniform system should be applied to each and every forest area; on the other hand the same objectives can be better achieved by a spatial distribution of different systems so that each forest area could be managed in a way that would best meet the demands made on it, in a given set of circumstances which take into consideration the ecological system, and its geographic location in relation to population centres. A part of the country's forest resource managed intensively for timber production in the most efficient manner will reduce pressures for exploitation in other forests which can then be made to fulfill more multiple functions.

In an earlier paragraph in this paper an estimate of 4 million acres of intensively managed forests has been given as being necessary to meet with West Malaysia's demand for timber. Assuming that even with these forests, water and soil management are implicit in any forest management system applied, these 4 million acres which will probably be located in the most accessible areas close to population centres will also be suitable for intensive recreational use. With the exception of plantations of exotic fast growing species, they will also support at least the more common species of wildlife. For biological conservation, it is also probable that the Forest Department can be persuaded to maintain a small proportion, perhaps one percent, as virgin jungle reserve, comprising units of up to 1,000 acres judiciously distributed according to regional and ecological criteria. These may be ideally located within critical water catchment areas. This will leave about 10 million acres for multiple-use management where it can be expected that intensity of timber exploitation will be less and larger areas can be set aside for biological conservation, wildlife sanctuaries as well as for the preservation of recreational and aesthetic values. Of these about 4 million acres are unlikely to be productive comprising the unproductive montane forests, peat swamp forests, or forests growing on ecologically unstable sites due to edaphically deficient soils, leaving about 6 million acres for multiple use management. This is about 6 times the size of Taman Negara.

These 6 million acres forming a central core in the northern half of the country with smaller outliers in South Pahang and North Johore will provide opportunities for the

application of multi-use management principles. Exploitation of timber can and should be carried out in conjunction with wildlife management, maintenance of aesthetic values and biological conservation. To attain these objectives surveys need to be carried out; these surveys will identify the areas for which different techniques and intensities of management should be applied to promote or preserve one use or another. Areas of cultural, aesthetic or recreational interest should be logged in a manner that these values are not diminished. Other areas should be selected for management to increase their capacity for sustaining particular species of wildlife, if necessary through the introduction and maintenance of forage species. Concentration of wildlife populations in this manner will also facilitate observation. Biological conservation sites should also be identified and measures taken to ensure their preservation.

SOME CONCLUSIONS

That forests perform a multiplicity of functions cannot be doubted. Whereas the most direct benefit in kind which is derived from the forest is timber, given that the production of timber is dependent on soil and water conservation within forested lands, these functions of the forests are implicit in any form of forest management. Forests managed intensively for timber production can also provide general recreational facilities.

However management of forests for wildlife conservation and to cater for deeper aesthetic values such as can only be derived from relatively wild lands may require the sacrifice of a degree of timber productivity. This requires more comprehensive knowledge of the forest domain, particularly of the ecology and ethology of wildlife species and the character and variety of landscape which lend to it specific aesthetic values. At the furthest extreme, forests managed for biological conservation require total protection, but this is of the utmost importance in the preservation of genetic resources.

In order that optimal benefits may be derived from management of the forest resource, no single system of management can be applied to the total forest resource. Each area of forest should be managed using the most efficient system to realise the specific objectives of management.

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DISCUSSION

J.A. Bullock.—Although I accept the fact that such animals as seladang and rhino may be able to utilise secondary growth, I doubt whether this is true for other animals such as deer, pelanduk, etc. And also I am concerned with the fact that there may be a drastic change in predator/prey relations and the general ecology of the ecosystem. Furthermore, I must take issue with the equating of natural mosaics which are rarely exceeding 20–30 acres and are usually not more than 1 acre, with areas of managed forest which in most cases may cover an area of more than 1000 acres. The ecology will be entirely different, and to prove otherwise requires facts and figures. This is, in fact, an outstanding problem! There are no facts; there is too

little research, and even less coordinated research. Nor shall we change this until we have an effective research agency.

Lee Peng Choong.—I agree that we need much more research to determine the ecological relationships between wildlife species and their adaptability to an altered ecosystem, not only of the species mentioned by Dr. Bullock but also of the canopy species of which we know so little. On the other hand, there is already a fair amount of evidence that deer and pelanduk do make use of secondary growth, since there is much hunting of these species and their tracks are frequently encountered in logged forests, even in old secondary forests. I am confident that with adequate protection these animals can survive in logged forests.

I have raised the issue of natural mosaics of secondary growth in primary forest not to suggest that their ecology can be equated to logged forests, but to point out that the primary forests far from being in a static state for millions of years as has been suggested in some writings is subject to cyclical changes. I do not argue that the ecology of logged forests is different from that of primary forests. It will be necessary to preserve some areas of primary forests for the study of cyclical as well as evolutionary changes but not all of it.

Wong Yew Kwan.—The speaker this afternoon has spoken on multiple use of managed forests. Being an officer with the EPU we would very much like him to comment on the present land-use policy. For example it has been stated that the lowland forests would eventually be converted into agricultural land. That being the case it is conceivable that the lowland ecosystem would be completely destroyed. What then would happen to the flora and fauna including the fish-life associated with this ecosystem?

If my statistics are correct there are supposed to be some six million acres of lowland forests left. Can't we plan our development in such a way so that some of the 6,000,000 acres could be left aside for nature conservation?

Lee Peng Choong.—Even if all the lowland areas were to be converted to agricultural use, an event which even now is not certain, it is not true that the lowland ecosystem would be completely destroyed, since this system extends above the stepland boundary to an elevation of about 1,000 feet. However, we do allow for flexibility in our planning and besides accepting the status quo for the meantime in relation to the National Park, steps are also being taken to preserve other areas of lowland forests as national parks, in addition to programming development in such a way that areas of lowland forests will be left intact until as when they are actually required for logging or land development. Hopefully within one or two decades we may find that our dependence on land for agriculture will not be as great, and we can devote more areas of nature conservation.

R.B. Lulofs.—Most of the conservational emphasis so far discussed concerns mainly with ground level mammals; what consideration has been given to the high level animals/mammals which live in the treetop levels and have a fairly confined zone of habitation?

In the present cycle of forest management, has a sufficient time been given to allow the regrowth to reach a level suitable for the high level mammal species?

Lee Peng Choong.—In the present cycle of forest management no consideration has been given to the survival of high level canopy fauna since the upper canopy is completely destroyed. This will be one of the factors to be considered when adopting systems of forest management for multi-purpose objectives.

K.G. Singh.—What sort of genetic reservoir does the Malaysian forest possess in relation to the crops being grown in this country?

Lee Peng Choong.—Apart from indigenous fruit trees, genetic reservoirs are also important for improvement of timber producing tree species.

Some Aspects of the Utilization and Conservation of the Forest Resources of West Malaysia

SALLEH MOHD. NOR¹ AND H.T. TANG²

INTRODUCTION

Malaysia has been endowed with one of the richest forests in the world and the utilization of this "biological" resource has been of direct benefit to the country and its population. However in West Malaysia, the demand for timber together with the urgent demand for land for agriculture, has resulted in a depletion of this valuable resource to a stage where its continued contribution to the future development of the country is uncertain. In the pursuit of immediate benefit from this resource, it is imperative that we heed the effects of its rapid liquidation on the long term economy of the country. The overall consequences of the disruption of the delicate natural ecological balance that we are effecting and the need for the application of multiple use management should also be recognized.

FORESTRY IN NATIONAL DEVELOPMENT

The contribution of the forest sector to the national economy is very significant, accounting for about 4% of the G.N.P. in 1970. Direct foreign exchange earnings have grown to over \$290 million in 1970, making it the third largest earner of foreign exchange. In the field of employment, forestry in West Malaysia offers over 30,000 jobs as direct employment while over 120,000 are employed in the wood-based industries (Forest Department Files).

Tables I to IV illustrate the growth and development of the forest sector and its associated industries. In nearly all the fields, increase in monetary returns is the general feature. Although the value of veneer and plywood exports increased from \$43 million in 1970 to \$64.9 million (about 51%) in 1971, the value of log exports increased only by \$1.5 (about 1.5%) million from \$99.2 million to \$100.7 million for the same period whilst sawn timber exports decreased by \$6.3 million (about 4%) from \$155.6 million to \$149.3 million. The aftermath of the 1970/71 floods coupled with the general recession in the world log and sawn timber trade, were probably largely responsible for these trends. In spite of this, that plywood and veneer exports increased considerably, reflects the advantage in shifting the pattern in the wood-based industries towards finished end products. Departmental revenue for State Governments increased by \$3.1 million from \$55.5 million (1970) to \$58.6 million, and for many states in West Malaysia forest revenue has been and still is the main source of finance for state expenditure.

The development of the two main wood-based industries, viz. sawmills and plywood/veneer mills, over the past decade is given in Table VII. The figure show a sharp increase in the 1969/71 period in the number of plywood/veneer mills (80%) and a smaller increase in the number of sawmills (8%). The increase in timber supplies required by these mills would have necessitated an increase in the volume of timber removed from the forest. This is borne out by Table VI.

The impressive development and growth of the wood-based industries is a reflection of the dynamic and favourable economics of the industry, which has and will continue

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TABLE I. Veneer and Plywood Products

Year	Quantity (Square feet) (5 mm thickness)	Value \$
1960		
1961	339,759	83,157
1962	916,669	203,133
1963	2,744,604	592,578
1964	4,871,546	1,138,016
1965	13,937,805	2,193,498
1966	29,919,194	3,919,635
1967	51,890,340	7,345,712
1968	74,733,822	12,110,025
1969	151,390,285	22,455,795
1970	225,494,452	33,958,107
1971	329,694,886	43,001,864
	536,955,491	64,889,693

Note: Source of all appendices: Forest Department.

TABLE II. Log Export

Year	Singapore		Other Overseas Markets		Total	
	Quantity (ton)	Value \$	Quantity (ton)	Value \$	Quantity (ton)	Value \$
1960	268,382	14,939,052	7,098	574,496	275,480	15,513,548
1961	282,335	15,448,766	73	4,769	282,408	15,453,535
1962	304,943	16,950,947	197	12,467	305,140	16,963,414
1963	407,774	23,255,489	9,346	999,277	417,120	24,254,766
1964	485,746	26,501,809	7,088	342,005	492,834	26,843,814
1965	573,689	30,382,432	713	37,706	574,402	30,870,138
1966	742,011	39,972,278	35,423	3,211,970	777,434	43,184,248
1967	730,004	52,857,268	85,655	6,134,657	815,659	58,991,925
1968	856,062	68,332,627	103,076	6,626,887	959,138	75,959,514
1969	945,066	76,995,066	85,146	7,778,802	1,030,212	84,773,868
1970	1,036,163	87,527,547	114,397	11,702,239	1,150,560	99,229,786
1971	1,006,100	88,080,587	121,258	12,606,104	1,127,359	100,686,691

TABLE III. Sawn Timber Export

Year	Singapore		Other Overseas Markets		Total	
	Quantity (ton)	Value \$	Quantity (ton)	Value \$	Quantity (ton)	Value \$
1960	48,607	6,589,937	168,843	33,174,625	217,450	39,764,562
1961	38,412	5,079,482	133,075	20,909,530	177,487	25,989,012
1962	46,973	6,134,831	154,906	25,427,594	201,879	31,562,425
1963	61,841	8,266,893	189,419	32,960,127	251,260	41,227,020
1964	77,240	10,064,544	246,441	49,500,032	323,681	59,564,576
1965	76,445	10,645,015	258,849	50,645,015	335,294	61,290,030
1966	85,652	11,139,911	259,606	44,864,446	345,258	56,044,357
1967	91,308	11,960,928	320,373	59,371,998	411,681	71,332,926
1968	124,302	15,613,752	471,326	95,137,647	595,628	110,751,399
1969	132,528	17,716,861	534,898	113,337,415	667,426	131,054,276
1970	162,010	19,295,188	598,179	136,272,372	760,189	155,567,560
1971	163,916	20,569,068	579,582	128,770,077	743,498	149,339,145

to play a significant role in the country's economic growth. However, it would be relevant to point out that even our forest resources have a physical limit and the accelerating rate of exploitation will hasten the approach towards that limit.

Tables II and V show that log export and the consumption by sawmills and veneer and plywood mills in 1971 totalled about 4.3 million tons. This corresponds to a conservative estimate of 300,000* acres of forests exploited. Based on Table VI, and allowing for the major portion of this acreage to have been from State Land, the toll on Forest Reserves would still have been heavy.

The 2 major factors influencing the extent of annual exploitation are:—

1. The demand for land for agricultural development schemes. During the Second Malaysia Plan, it is planned to develop one million acres in Malaysia, at the rate of about 150,000 acres per annum in West Malaysia. These development schemes may result in large tracts of virgin jungle being hurriedly exploited to give way to land development.
- and 2. The recent increase in wood-based industries involving considerable monetary investment which will require a sustained supply of sufficient raw materials. Based on the present consumption, this amounts to a minimum of 3.5 million tons annually.

In addition to the above factors, another important consideration is the proposal to establish large integrated timber complexes in various parts of the country. These would exert further strain on the already limited forest resources.

Over the short term period, factor 1 above may be able to meet with the requirements of factor 2. However, over the long term, an adequate sustained out-run can be obtained only if there is a more effective degree of administrative control over the exploitation of all forested land (including State Land) and if the total available wood resource is utilized more efficiently i.e. utilization of a wider range of species and of lower dimensions and log quality.

After conversion of forested land to agriculture, the long term future of the timber economy must rely on second rotation forests. As the future of wood-based industries depends entirely upon the availability of adequate raw material at a price which will permit it to operate effectively, it is important that the nature and quality of this second rotation crop be ensured by proper effective management.

Results from experimental plots indicate that the productivity of second rotation forests can be many times the mean figure of 10–15 tons/acre for natural forests, even in hill areas. The economic feasibility of achieving this, however, has to be examined.

The 1 million acres of land to be developed for agriculture under the 2nd Malaysia Plan will serve to bridge the economic gap between the rural and urban populations of the country as well as play its role in the programmed diversification of industries of the government.

However, there is a need for close control over and co-ordination between the timing of the alienation of forested lands and the subsequent land development. The alienation of forest land should not become a device for short-term financial gains from timber exploitation unaccompanied by actual development for agriculture. Such practices result in a waste of forest resources and possible upset of the timber market.

* Based on the fact that in 1969 the average production of forest reserve areas was about 12 tons per acre (Forest Department 1969 Annual Report in draft).

TABLE IV. Forest Revenue

Year	Revenue (\$)
1960	18,322,992
1961	19,094,231
1962	20,022,905
1963	22,294,092
1964	25,166,401
1965	26,568,271
1966	31,311,022
1967	35,915,447
1968	43,027,680
1969	47,679,027
1970	55,464,556
1971	58,603,746

TABLE V. Log Consumption for Sawmills and Veneer/Plywood Mills
(50 cu. ft. tons)

Year	Sawmills	Veneer/mills
1960	1,219,628	2,628
1961	1,181,142	3,842
1962	1,236,142	7,898
1963	1,379,522	11,918
1964	1,505,896	22,866
1965	1,520,089	47,352
1966	1,630,904	79,692
1967	1,829,421	102,050
1968	2,271,968	190,554
1969	2,292,672	244,375
1970	2,616,892	321,650
1971	2,723,222	441,504

TABLE VI. Production of Logs in West Malaysia
(in ton of 50 cu. ft.)

Year	Forest Reserves	Other Forest	Total
1960	600,176	988,858	1,589,034
1961	675,452	888,008	1,563,460
1962	719,788	912,704	1,632,492
1963	781,948	1,123,352	1,905,300
1964	856,760	1,248,408	2,105,168
1965	954,537	1,323,163	2,277,700
1966	920,896	1,770,528	2,691,424
1967	1,157,286	1,808,230	2,965,516
1968	1,294,942	2,291,886	3,586,828
1969	1,215,560	2,555,045	3,773,404
1970	—	—	4,619,292
1971	—	—	5,047,350

TABLE VII. Number of Sawmills and Veneer/Plywood Mills in West Malaysia

Year	Sawmills	Veneer and Plywood Mills
1961	404	4
1962	411	6
1963	411	6
1964	417	9
1965	421	11
1966	432	13
1967	434	15
1968	443	15
1969	444	18
1970	454	25
1971	477	33

Source: Forest Department.

TABLE VIII. Breakdown of Wood-based industries West Malaysia, March 1972

State	Sawmills	Plywood Mills	Pencil Factory	Match Factory
Johor	45	7	1	-
Kedah	32	2	-	1
Kelantan	32	1	-	-
Malacca	12	1	-	-
N. Sembilan	38	2	-	-
Pahang	89	7	-	2
Perak	90	7	-	1
Perlis	4	-	-	-
Selangor	79	5	-	-
Trengganu	24	1	-	-
Total	477	33	1	4

Source: Forest Department.

Forest land comprises 20 million acres (62%) of the total land area of West Malaysia. After the exclusion of all areas suitable for agriculture, we will be left with about 10 million acres (31%) of potentially productive forests and about 6 million acres of protective forests (18%) (Lee & Panton, 1971).

The management of our forest estate will inevitably have to get more intensive in order to give us high yielding forests over a smaller total forest estate. This will be particularly relevant as the mainstay of our forests estate will be in the hills where silvicultural management techniques are relatively undeveloped.

THE ROLE OF FORESTRY IN SOIL AND WATER CONSERVATION

Under the Technical Land Capability Classification, priority was given to agriculture over forestry because of the higher value added from agricultural use of land as compared to forestry (Lee & Panton, 1971).

Of the 10 million acres of productive inland forests on classes 4 and 5 soils just over 50% are above the 1000 ft contour line, and about 80% above the 500 ft contour line (approx. the mean of steep land boundary). (Lee & Panton, 1971).

It is clear then, that the bulk of our forest estate and its exploitation will be carried out in hilly and mountainous areas. Under the heavy rainfall conditions in West Malaysia, particularly in these areas, including most of the land above the 500 ft elevation,

geologic erosion takes place at a relatively high rate even under a thick forest cover (Wyatt-Smith, 1963). Therefore, it is incumbent upon us to recognise and actively consider the conservation aspects of all our forestry activities.

Systematic investigations on the interference of forests and forestry activities have been undertaken in many humid temperate countries, but little has been done in tropical countries.

As mentioned above, even under a forest cover, in a wet, tropical climate, erosion as well as weathering goes on at a rapid rate. This is evidenced by muddiness of tropical rivers and the large amounts of suspended matter they deposit in a flood (Richards, 1952). Nevertheless, the ready percolation of water into the soil and the resistance of the soil to movement restricts the transport of weathered material to soil creep (Nye and Greenland, 1962).

When the forest cover is removed and not replaced by an equally effective cover the erosive action of rains are accentuated considerably and sheet flow tends to be encouraged. Heavy rain will strike the ground surface with increased energy and reach the water courses quicker and in greater quantities. Flash floods with intervening periods of abnormally low water levels will be more common.

Even if the cleared forests are quickly replaced by crops, the above effects will still occur, although to a lesser degree.

The importance of a cover crop in reducing erosion was illustrated by Hudson and Jackson (1959). Losses under 5 years continuous maize, averaged 41 tons/acre/annum with a medium level of fertility and 10,000 plants/acre and 1.2 tons/acre/annum with a high level of fertility and 15,000 plants/acre. In the first instance, 40% of the ground was exposed to rain and in the second, only 10%. Also, in all cases examined, the eroded earth was richer in plant nutrients than the parent soil.

Gonggrijp (1941) (quoted by Nye and Greenland, 1965), gives an account of an erosion experiment on volcanic soil at Tjiwidi in the per-humid mountains south of Bandoeng, Java. During the first year after clearing virgin forest and planting to rice, there was little soil lost from either an unterraced or terraced catchment of 4.85 and 8.65 hectares respectively. In the 2nd year, however, the unterraced or terraced catchment lost about 20 tons per acre and the terraced catchment half as much (these losses correspond to about 0.2 inches of the surface horizon, the most fertile layer).

The product of erosion in the upper reaches of a river is two fold, viz., it forms a bouyant load of fine clay in suspension, which once emulsified nearly never settles out again, and the heavier load of gritty sand and finely broken rock. As this load moves down stream, by an action of attrition on the river bed and banks it increases in volume. Once the stream achieves the consistency of a sloppy concrete mix it can bouy up pieces of solid rock which would not be moved by the same force of clear water (Gorrie, 1953).

As the river flow slows down in the plains, these sediments are deposited on the river bed, resulting in a reduction in the channel capacity, which in turn increases the severity of subsequent floods even with the same amount of flood water.

In West Malaysia recent floods have served to indicate that large scale land development is beginning to take its toll. It may be relevant to note that the increased severity and frequency of the recent floods follow closely on the large scale land development for agriculture, housing and industries.

Poore (1961) reports that stretches of the tributaries of Perak River north of Grik are now buried in sediment, and shifting tobacco cultivation near Langgong, Perak, was causing serious sheet and gully erosion and was pouring tons of silt into the Perak River.

The silt load in the Sg. Semarak in Kelantan, coming down a mountain tributary whose catchment has been cleared, has been serious enough to warrant dredging operations to prevent the blocking up of the main river and flooding of an important rice area (Douglas, 1970).

SOIL CONSERVATION METHODS

It is imperative that any measures devised for soil and water conservation consider carefully and seriously the vast experience of other countries in this field.

For example, the life of the Tungabhadra dam, the second largest in India is estimated to have been reduced to less than 100 years although it was originally calculated to be many times longer (Pratap Singh, 1970). This is due to the accelerating erosion in catchments resulting from forest destruction. In the Bhakra dam, the rate of siltation was about 3 times that originally assumed before the dam was even commissioned.

In one of the Damodor valley dams, Gorrie (1953) reported that the silt to water ratio had risen from 1 in 688 in 1949 to 1 in 1135 in 1951.

It is abundantly clear that for any conservation measures to be effective and long term, genuine forest conservation must be an integral part of it.

Perhaps it would be wise for us to remember the following short poem.

*"Hoards of gullies all remind us
We should build our lands to stay
And departing leave behind us
Soils that have not washed away.

So when our boys assume the mortgage
And begin their earthly toil
They'll not have to ask the question
Here's the land but where's the soil?"*

(from: 1st. Watershed Management Conference, Pakistan)

CONCLUSIONS

- (1) Forestry and Forest Industries have played a significant role in the economic development of the country and this contribution can be expected to continue and even increase in the future.
- (2) The realisation of these objectives however, is dependent upon the maintenance of a productive, accessible and sustained resource base.
- (3) The management of this base should be orientated towards increasing its productivity and quality through proper and effective cultural techniques, particularly in view of the fact that the bulk of this base will comprise Hill Forests.
- (4) In the overall management of land for both forestry and agriculture, it is imperative that more emphasis be given to soil and water conservation than has been in the past. The price of this omission has been amply illustrated by experiences in other countries.

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DISCUSSION

J.A. Bullock.—In the course of land clearance, much of the production is felled, and then burned. This is a terrific waste. Can nothing be done to utilise such production? I have the impression that much treated forest has now been cleared before any really useful timber was available. Could you give some comment on this?

Salleh Mohd. Nor.—Greatest utilisation of the forest resources before clearing for agriculture can only take place if sufficient time is given to Forestry Department to log the area. This involves proper planning of land development and prior notification of areas to the Forest Department a few years before. However at present, insufficient period is given to the Department to enable complete harvesting of the timber before clearing for agriculture.

Abd. Manap Ahmad.—With reference to Tables II, V, and VI, the total production (Tables VI) is 5,047,350 tons but the utilised only 4,292,085 tons (Tables II & V). May I know what had happened to the 755,165 tons of logs not accounted for? In view of this wastage, which may be done on purpose by the sawmillers/loggers, could it not be possible for the Forestry Dept. to organise stricter control to enforce the use of all extracted logs, especially so with the possible reduced production of timber in the future?

Salleh Mohd. Nor.—There are 3 possible causes, a combination of which can result in the situation mentioned.

1. That the volume of 755,165 tons of logs are utilised by other wood-base industries, such as match factories, coffin makers and other smaller wood base industries.
2. Some of the timber could be stored as stock.
3. The practice of tree marking in forest reserves and penalising the logger for not taking any marked tree out can result in some loggers removing logs which are ultimately not utilised.

The wastage is more apparent than real as logs removed this year are not necessarily utilised in that year. Being a business venture, the sawmillers/loggers will utilise as much of the timber produced as possible.

Wong Yew Kwan.—Encik Salleh mentioned the backlog of untreated forests. This seems to have been the complaint ever since before the War. That being the case one can take it that some of these untreated forests must now be quite old. I wonder if

there has been some survey to assess the quality of such forests. By a stroke of luck we might get good quality forests without treatment! After all the Malayan uniform system evolved out of neglect!

Salleh Mohd. Nor.—There shall be a survey of all logged over forests next year to follow the Forest Industries Development Project Inventory just completed.

E. Soepadmo.—In view of the important role the wood-based industries have in the country's economy, now and in the future, and of the fact that the rate of exploitation of our primary forests is increasing every year, so the loss of the timber resources, could you tell us, roughly, how many acres of logged forest has been used for regeneration or replanting programmes of timber species, and how successful?

Salleh Mohd. Nor.—There are three categories of regenerative practices, viz. natural regeneration silviculture, enrichment planting and plantations. To date over half a million acres have been treated thus. Preliminary results appear very successful but only time will tell, when the second crop matures.

C.H. Leigh.—Could you please tell us the source of the delightful poem?

Salleh Mohd. Nor.—1st Watershed Management Conference, Pakistan.

Kwiton Jong.—I am perturbed at learning that logging is going on in Ampang Catchment area! How wide-spread is this kind of logging operation in this country and what controls are prescribed?

Salleh Mohd. Nor.—It is not widespread but some states such as Selangor and Kedah do permit logging in catchment areas. Controls such as proper alignment of roads, a higher allowable diameter limit for logging, permissible logging distance from streams, and limit on number of workers are some of the conditions prescribed.

K.G. Singh.—Would you like to comment on the life span of the MUDA dam in Kedah?

Salleh Mohd. Nor.—I am very sorry that I have insufficient knowledge of the project and the logging being carried in its catchment to comment.

D.W. McCredie.—Would you like to comment on the percentage of area of forest affected by logging roads (In Sabah I have calculated a percentage in area of 3-4%).

Salleh Mohd. Nor.—A study being carried out by FAO sponsored project in the Department indicates that an intensity of roads (all logging and haulage roads) can average around 15 miles per square mile of forest logged, which is about 2 chains per acre.

Langham.—Does Malaysian silviculture maintain a species diversity similar to that in the original forest before logging?

Salleh Mohd. Nor.—No. It attempts to reduce the heterogeneous natural forest to a more uniform and homogeneous forest of the main economic species.

Malaysian Tropical Forest: An Underexploited Genetic Reservoir of Edible-fruit Tree Species

KWITON JONG¹, B.C. STONE² AND E. SOEPADMO²

INTRODUCTION

It is generally acknowledged that the tropical rain forests constitute one of the most complex terrestrial ecosystems known; it is also recognised that species diversity within a vegetation zone reaches its zenith in such an ecosystem, and the Malaysian lowland rain-forests are in this sense probably the richest in the world.

At the same time, these facts imply that the number of species is very large while the number of individuals per species within these forests is rather low. In 4 acres of primary lowland dipterocarp forest at Sungei Menyala (Negri Sembilan), for example, are found 210 different species, and the ratio of individuals to species varies (inversely with girth class) from 3.8 to 2.8 (Wyatt-Smith, 1966). In terms of natural distribution this means that individual plants of a given species may be very distant from each other, and it is often wondered how they are able to maintain breeding contact. In the case of timber species, the bulk of preferred species come from the family Dipterocarpaceae which characterise lowland evergreen rain-forests. But for other kinds of utilization, it must be realised that the total number of individuals is often small (Ho, 1971; Whitmore, 1971).

It is clearly necessary in view of the continued erosion of Malaysian forest resources, first that known useful or potentially useful rarer species be brought into cultivation to ensure their preservation; and second, that considerable tracts of virgin forest must be retained under reserve status to enable scientific studies to be carried out on further potentially useful species, and to serve as a basic comparison and data base of ecological understanding of the ecosystem itself. What is important to remember in this context is that realistic total areas must be placed in this reserve category so that even quite rare species will be retained. In particular, the spatial distributions of some of the currently valuable species can be assessed to act as guidelines in helping to determine minimal areas.

It is however not sufficient merely to call for conservation of such areas. Under present conditions it is obvious that the clear need for such areas, and for other projects such as we recommend, must be firmly justified. The mere act of setting aside certain reserve areas, while a vitally necessary first step, is also only a first step. It is the subsequent study of such areas, and for that matter of as many of our biological resources as can be implemented, that is of crucial importance. A nation with biological resources has potential wealth; it is however research, technology, and proper use, that provides actual wealth. Such activity must be undertaken with a sound scientific understanding of all the fundamental biological aspects, so that these so-called renewable resources are *in fact* renewed. It is *use*—not *using up*—that constitutes economic welfare.

It is within this context that we wish to discuss one of the presently underexploited and imperfectly understood categories of forest resources, the actual and potentially valuable edible-fruit tree species that are indigenous to this region. The banana, for convenience, is left out of the present consideration, but its importance, however, is fully appreciated, and in fact, some of the remarks in this paper are also relevant to it.

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FOREST FRUIT TREES AS AN UNDEREXPLOITED RESOURCE

Fruit-tree species with a wide range of flavours, textures, and nutritive values may be grouped into three somewhat arbitrary categories: totally domesticated species; partly domesticated species; and "harvested" but essentially wild species. Plentiful examples of all three categories still persist within Malaysia.

The main proportion of locally grown fruit from fruit trees is either destined for home-use or is internally traded or sold often within the same State or even the same *mukim*.

An important factor is quality. In certain species, e.g. *rambutan* (*Nephelium lappaceum*), a number of different strains exist, and there has been some Government supported research involving selection of strains. Even so, quality control and reliability are not always satisfactory. In other fruit types quality may vary too greatly to allow other than home use. This is of course not merely a problem of superior strains needing to be standardized, but also of grading and selection of single-strain harvests.

At least as important as quality control is dependability of supply. Many of our best fruit-trees are seasonal, and two crops, a major and a minor, are normally to be expected. But in some years further crops appear, or the main crops vary greatly. Part of this is attributable to weather and climatic variation, but some is due to differential responses in various strains of the different species. It seems possible that carefully planned breeding and selection experiments will permit in some cases an extension of the productive season and improvement in the keeping quality of fresh fruits. This together with improvement in marketing techniques should contribute to movement of fruits from one distant area to another, thereby ensuring continuity of supply. The canning of local fruits should also be properly explored (see Whitehead, 1959 for experiments with the rambutan).

Breeding programmes require stock, and this must be acquired from as wide an array of sources, and cover as broad a spectrum of genetic variation, as can be obtained. Malaysia is fortunate in having within its own lowland forests wild progenitors and relatives of cultivated fruit-trees, as well as semi-domesticated and wild locally adapted strains in mixed *dusuns* or orchards in rural areas. These represent a valuable reservoir of genetic variability which ought to be utilised and preserved for future use. It is here that the most immediate significance of genetic conservation becomes apparent. A successful and progressive breeding programme must have ready access to this reservoir. Although many wild relatives produce non-edible fruits, they may possess instead other desirable qualities such as pest or disease resistance which could be transferred to susceptible domesticated species by judicious cross breeding. With the cutting down of lowland forest proceeding at an accelerating pace, there is a very real danger of loss of such valuable and other potentially valuable breeding stock.

It is therefore a matter of great urgency that we should enquire into the extent (in terms of number of species, their abundance and frequency) of genetic resources of Malaysian indigenous wild fruit trees.

DISTRIBUTION AND ABUNDANCE OF FRUIT-TREES

Some brief and selected figures on distribution and density of a few genera and species with actual or potential value as fruit-trees are presented in Tables 1-4.

A perusal of these tables discloses some significant facts. In the first place it must be stated that we have drawn our data from four sources; these were originally obtained

for different purposes, and in trying to make them comparable we have had to extrapolate, average, and otherwise adjust the data. Despite inevitable margins of error which have entered because of such adjustments, it appears possible to make certain remarks on the basis of these Tables.

First, it is obvious that the vast majority of all individual fruit trees, regardless of genus, rarely exceed 4 ft girth (Table 1), except for *Artocarpus* and *Durio*, and perhaps *Mangifera*. On the other hand, when the data includes smaller trees down to 3 ft girth, abundance rises sharply, except for *Parkia*, *Lansium*, and *Sandoricum* (Table 2). And when trees down to 1 ft in girth are included in enumerative surveys (Table 3), several of the genera yield rather similar figures approaching or exceeding 200 individuals per 100 acres. The situation can be seen at a glance in Table 4, where the comparable figures are displayed.

TABLE 1. Number of individual trees 4 ft girth or more in certain genera in certain localities in Malaya. Density of trees expressed as an average per 100 acres.

Genus*	Pahang ¹	Ulu Kelantan ²
<i>Artocarpus</i>	17.4	7.5 (4 spp.)
<i>Durio</i>	14.0	3.7 (2 spp.)
<i>Mangifera</i>	6.0	6.7 (several spp.)
<i>Parkia</i>	3.3	8.8 (2 spp.)
<i>Baccaurea</i>	1.3	2.3 (as "tampoi")
<i>Garcinia</i>	1.1	0.9 (several spp.)
<i>Nephelium</i> + <i>Xerospermum</i>	0.2	5.9 (as "rambutan")
<i>Lansium</i>	0.2	0.2 (as "langsat")
<i>Sandoricum</i>	0.2	0.8 (as "sentol")

* Species data summed.

¹ Modified from analysis of Ho (1971), 2484 acres.

² After data of Whitmore (1971), 1672 acres.

TABLE 2. Number of individual trees 3 ft girth and more in certain genera in Jengka Forest Reserve study site; modified from data of Poore (1968).

Genus	Indiv. in 57.6 acres*	Transformed to /100 acres
<i>Artocarpus</i> (7 spp.)	82	142
<i>Durio</i> (2 spp.)	8	13.9
<i>Mangifera</i> (6 spp.)	21	36.4
<i>Parkia</i> (2 spp.)	4	6.9
<i>Baccaurea</i> (6 spp.)	39	67.7
<i>Garcinia</i> (4 spp.)	11	18.2
<i>Nephelium</i> (4 spp.) and <i>Xerospermum</i> (1 sp.)	12	20
<i>Lansium</i> (1 sp.)	5	8.7
<i>Sandoricum</i> (1 sp.)	2	3.5

*Including those trees given by Poore as in swamp areas within study site.

We are, however, scarcely in a position to understand these figures fully, because: there is as yet hardly any data on what constitutes maximum and normal adult (i.e. reproductive) size in many of these species; nor is it known what proportion of each girth class is composed of individuals which have already reached maximum size; nor is it known what the rate of attribution is and what proportion of each girth class drops out. What we do know is based primarily on data obtained mainly for other purposes.

It is obvious that Forest Resources Reconnaissance Survey records are of limited value for assessment of fruit trees resources. (As Ho (1971) points out these surveys are designed to provide data for timber utilization and usually include only trees 4 ft girth and above, thus leaving out a large proportion of fruit trees in the enumerations). Exploratory surveys specially conducted so as to include smaller girth classes will be required in order to quantify precisely the basic information on distribution and abundance for most fruit tree species.

Equally lacking is a sufficient array of such surveys to indicate variation from habitat type, altitudinal zonation, and climatic regime.

Thus it is important to emphasize *strongly* that the data we present is sketchy at best but more detailed analyses are underway. Obviously for the present it cannot be used other than to demonstrate our main contention, which is simply that available information is inadequate, and would lead to an erroneous estimation of potential genetic wealth.

SPECIFICS OF FUNDAMENTAL BIOLOGICAL RESEARCH

The role of basic investigations must now be spelt out. Some of the general questions that must be considered are the following:

(i) How many kinds of wild fruit trees and their relatives occur in Malaya/Malaysia? How many individuals are there? Where, exactly, do they occur?

(ii) How big an area is necessary for individual species to survive and to interbreed, set seed, and successfully propagate themselves without the aid of man?

TABLE 3. Number of individual trees of 1 ft girth or more in PASOH FOREST RESERVE. Data extracted from Ashton (1971) extrapolated to 100 acres.

Genus	Actual No. in 25 acres	Extrapolated
<i>Artocarpus</i> (8 spp.)	58	232
<i>Durio</i> (3 spp.)	44	176
<i>Mangifera</i> (8 spp.)	39	156
<i>Parkia</i> (2 spp.)	9	36
<i>Baccaurea</i> (8 spp.)	75	300
<i>Garcinia</i> (10 spp.)	37	148
<i>Nephelium</i> & <i>Xerospermum</i> (6+3 spp.)	44	176
<i>Lansium</i> (2 spp.)	58	232
<i>Sandoricum</i> (1 sp.)	8	32

TABLE 4. Comparison of data from Tables 1, 2 and 3 showing numbers of individuals per 100 acres in three girth categories.

Genus	1 ft & over	Girth Class 3 ft & over	4 ft & over
<i>Artocarpus</i>	232	142	17.4/7.5*
<i>Durio</i>	176	13.9	14.0/3.7
<i>Mangifera</i>	156	36.4	6.0/6.7
<i>Parkia</i>	36	6.9	3.3/8.8
<i>Baccaurea</i>	300	67.7	1.3/2.3
<i>Garcinia</i>	148	18.2	1.1/0.9
<i>Nephelium</i> & <i>Xerospermum</i>	176	20	0.2/5.9
<i>Lansium</i>	232	8.7	0.2/0.2
<i>Sandoricum</i>	32	3.5	0.2/0.8

*The first figure before the / is from Pahang data, the second figure from Ulu Kelantan data (of. Table 1). Data are kept separate to show variation but also certain very similar results.

- (iii) What are the ecological requirements for these species?
- (iv) What are the variable features and the patterns of variation (e.g. chromosomal status, breeding system, etc.) that exist, and how important are these for the conservationist, the taxonomist, the cytogeneticist, and the plant breeder?
- (v) Can we successfully grow them in cultivation, and under what conditions?
- (vi) What are the normal natural processes of pollination, seed production, seed dispersal, and germination? Can these be carried through in cultivation?
- (vii) What are the data on reproductive age and longevity, size of crop, seasonality, and other parameters of importance for utilization?
- (viii) What are the modes of reproduction? Are asexual as well as sexual modes occurring? Can these be controlled or modified experimentally?
- (ix) What are the disease vectors and syndromes of these plants? How can they be controlled? Are there disease-resistant strains among wild congeners of cultivated varieties? Can plant breeding promote resistance to pests and pathogens?

These and still other problems must receive the urgent consideration of all who are concerned with agricultural diversification and development. Academic institutions such as the University of Malaya have a definite role to play in conducting research into some of the basic questions mentioned above. A few aspects from studies currently in progress are discussed below to draw attention to the considerable scope for fundamental investigations which, we are confident, would yield results of significance not only for the plant breeder, but also for the advancement of tropical biology.

A NEW SPECIES OF CITRUS

It will be noticed that no data on *Citrus* is found in the frequency tables (Tables 1-4). The reasons for this are twofold: firstly, most *Citrus* species seldom reach 3 ft girth and secondly, they tend to occur in submontane forests, not in the lowlands. It is furthermore apparent that they are comparatively rare, although in a few localities *C. macroptera* may be slightly gregarious. Nevertheless, Malaya is an important region for a study of *Citrus*, as is exemplified by the recent identification of a new species, *C. halimii* (Stone, 1972). This, one of the larger species, can reach 70 ft height and just over 3 ft girth, but is restricted to hill forest (at least in Malaya) mostly around 3000 ft altitude (but it occurs at lower elevations in the northern half of its range, i.e. in the South Kra Peninsula of Thailand). Other *Citrus* species in Malaya tend to occur in the drier areas in the north, and are often of smaller dimensions than would be included even in a forest survey of trees 1 ft in girth and over. Hence the paucity of data. Judging, therefore, only from available herbarium collections, we find that *Citrus* appears to be very rare outside of cultivation. The chromosome numbers of *Citrus* and closely related genera are mostly $n = 9$, but triploids and tetraploids are known in a few cultivars. For *C. halimii* the diploid number is $2n = 18$ as determined recently by Scora and by Jong.

CYTOLOGICAL ASPECTS

Cytogenetic data form the basis of a rational approach to any modern breeding programme and provide valuable guidelines to taxonomic research. Up to the present there has been extremely little cytological work done on indigenous fruit trees. It may be said that tree species in general tend to possess rather small chromosomes; further, in some cases at least, for example, the *langsat* (*Lansium domesticum*) and the mangosteen (*Garcinia mangostana*), the number of chromosomes may be very high. They are therefore

difficult to study. Partly for this reason, perhaps, there is a dearth of published cytogenetic information. Worse, what has been published is sometimes discordant and may be unreliable; this is especially true of the older literature. Again, this data, little as it is, is based on very limited materials. The proportion of species known cytologically to the total number of species in that genus is usually very small...often less than 5%. As a summary of this data, see Table 5. The current state of cytological knowledge in two of the genera, *Nephelium* and *Garcinia* will now be considered.

Nephelium. In the group including the "rambutan" are several species of major and some of minor importance; all must be brought into renewed study to determine their cytological and taxonomic relationships. The "mata kucing" (which belongs to the related genus *Dimocarpus*) and the "pulasan" (*Nephelium mutabile*), both delicious but not widely cultivated Malayan fruits are unknown cytologically. The single published chromosome number of the "rambutan" (*Nephelium lappaceum*) is $n = 11$ which is widely divergent from $n = 15$ for the "longan" (*Dimocarpus longan* ssp. *longan*). Our own preliminary observations for a cultivated variety of "rambutan" is definitely $2n = 32$ (hence $n = 16$) which does not agree with any of the previous counts listed in Table 5. Further work is in progress. Whitehead (1959) gives a total of 32 known registered cultivars of "rambutan". It would be interesting to ascertain whether varietal differences are correlated with chromosomal variation. Corner (1952) states that the genus *Nephelium* includes 70 species, with 16 in the lowlands of Malaya. The proportion studied is therefore c. 4%.

Garcinia. The cytology of this genus is poorly known but enough has been published to suggest that it is quite variable, with counts of $2n = 44, 48, 54, 55, 58, 76, 80,$ and 96 (all of which are unconfirmed) for different species. The mangosteen itself (*Garcinia mangostana*), the best-known and most important of the edible-fruit species, has been studied very little and the published data disagree; a count of $2n = c.76$ and another of 96 representing either real and major variation within the supposedly uniform "clone" or difficulties of interpretation, or both. As all the mangosteens in cultivation are considered to have originated from a single clone (Horn, 1940) the indicated variation in chromosome number would seem inconsistent with this idea. Unpublished counts made by one of the authors (K. Jong) are in the order of $2n = 120$ to 130. It is clear the mangosteen is a very high-level polyploid; it would be of considerable interest to look into its evolutionary history and if possible discover its hereditary precursors. Except for *G. xanthochymus* and *G. mangostana* none of the other counts in *Garcinia* are on Malaysian species. The genus is large and the proportion of species to species examined cytologically is under 5%.

In elucidating the evolutionary origins of many important cultivated crop plants, for example, the wheats, the bananas, cotton, the contribution made by cytogenetical research is now widely recognised. The scope for fundamental investigations of this nature on Malaysian fruit trees, therefore, need hardly be stressed.

CONCLUSION

The whole field of research on native fruit tree resources remains wide open. As part of one of the major world centres of genetic diversity, Malaysia has a responsibility to safeguard its precious genetic resources; to encourage and undertake exploratory surveys and basic research so that the best strategy for their conservation and fuller exploitation can be established.

TABLE 5. Chromosome Numbers of some fruit trees and their wild relatives*.

Species	n	2n	Author
Family: MORACEAE			
<i>Artocarpus</i>			
<i>canoni</i>		28	Krause, 1931
<i>integer</i> (Chempedak)		56	EJK
(as <i>integrifolia</i>)		56	LeCog, 1963
(as <i>integra</i>)	28		Nanda, 1962
<i>communis</i> (Breadfruit)		56	EJK
(as <i>incisa</i>)		54	Nishiyama & K, 1942
Seedless		c.81	" "
<i>bonneti</i>		28	LeCog 1963
<i>laboocha</i>		56	Banerji & H. 1954
Family: BOMBACACEAE			
<i>Durio</i>			
<i>zibethinus</i>		56	Mangenot & Mangenot, 1958
Family: SAPINDACEAE			
<i>Nephelium</i>			
<i>lappaceum</i>	11		Ramirez, 1961
<i>Litchi</i>			
<i>chinensis</i>		28	Chaudhuri, 1940
		30	EJK
<i>Dimocarpus</i>			
<i>longan</i> (as <i>Nephelium longana</i>)	15	30	Guervin, 1961
Family: GUTTIFERAE			
<i>Garcinia</i>			
<i>hanburyi</i>		44	Tixier, 1953
<i>indica</i>		c.54	Krishnaswamy & R, 1949
<i>speciosa</i>		c.55	" "
<i>mangostana</i>		c.76	" "
		96	Tixier, 1960
<i>cambogia</i>		c.58	Krishnaswamy et al. 1954
<i>xanthochymus</i>		c.80	" "
<i>benthamii</i>		48	Tixier, 1960
Family: MELIACEAE			
<i>Lansium</i>			
<i>domesticum</i> (Langsat)	72		Bernardo & Ramirez, 1959
<i>Sandoricum</i>			
<i>koetjape</i>	11		Ramirez, 1961
	22		
	16		Tixier, 1958
<i>indicum</i>	32		

*Compiled from Darlington & Wylie (1955), Index to Plant Chromosome numbers, and from other published sources.

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DISCUSSIONS

- J.A. Bullock.*—I would like you to clarify what market you envisage for improved fruit crops. Their export potentials as fresh fruit seems slight.
- E. Soepadmo.*—Such an improvement is to provide, first of all, sufficient local demands, and then if the improved quality is of a good enough standard the excess supply could be exported either as fresh or canned fruits (e.g. papaya, rambutan, orange, mangosteen, etc.). Countries such as England and Holland are possible markets for such products. Furthermore, even if we could not export the products, sufficient supply of these fruits at home will be enough to reduce import of foreign fruits thus saving the country valuable foreign exchange.
- R.B. Lulofs.*—Have any collections of wild fruit-tree material been made at centralised stations for study and screening?
- E. Soepadmo.*—Yes, to some extent, namely at Serdang and a few other stations now under the care of MARDI.
- K. Jong.*—Most of the collections at Serdang according to Dr. Ho's survey which will be published soon are local clones from within the country. *Mangifera indica*, the mango, being the prominent exception where there are clones from Siam, Ceylon and Indonesia.
- There was a large *Citrus* collection at Serdang which I believe is now diminished.
- Dr. K.G. Singh.* (Comments).—The material at Serdang has been collected from different parts of the country, as far as Malaysian fruit trees are concerned. Of course, some other trees have been imported from other countries as well. Serdang still has a large collection of *Citrus*. The Serdang collection has been for propagation purposes only.
- Wong Yew Kwan.*—We seem to be somewhat confused over the objective of collecting plants. Are we collecting wild species or are we collecting cultivars? If we are collecting wild species, what do we have in mind for their uses? I don't think we can hope to use them to improve our cultivated varieties because the latter have been selected for a long time. However, if it is to build up a gene pool for disease resistance then that is a different matter.

E. Soepadmo.—No, I do not think there is any confusion. As has been mentioned earlier, one of the main purposes of this study is to collect and preserve as much as possible valuable genetic characters/stocks of our fruit-trees. This collection is vital for any future breeding and other related experiments. Therefore we should collect as many as possible cultivars and their wild relatives.

Apart from those characters pertaining to disease resistance, there are many others which could be taken into consideration in any breeding programme. For example those genes controlling texture, colour, taste, flavour, and thickness of edible parts, etc.

Ho Coy Choke (Comments).—Conservation of a genetic reservoir of indigenous fruit trees is important for breeding against microbial pathogens and possibly hybridization between distant species (e.g. wild with cultivated) leading to seed abortion desirable for arillous fruits.

Lesser Known Timber Trees of Malaysia

K.M. KOCHUMMEN¹

Malayan forests are rich in good timber producing trees which are well known to local and overseas markets. Such trees are present in abundance in the various forest types throughout the country so that sufficient supply is available. These well known timbers have been tested for their timber and utilitional properties so that there is adequate literature available for their multiple uses. All the Malayan timbers of commercial interest are listed out in the Malayan Grading Rules 1968, and this list is reproduced here as Appendix I. There are 402 species of timbers covering 71 genera. In the Malayan Grading Rules (M.G.R.) the timbers are grouped under 53 timber groups and classified into 4 divisions depending upon the density and durability of the timber.

In Malaya a total of about 677 species of timber trees in 168 genera reach a girth of 4 ft (above breast height). As shown above most of such trees are considered commer-

APPENDIX I

Malayan Timbers of Commercial Interest

(The possible number of species utilisable is given in brackets after the generic names).

A. HEAVY HARDWOODS (Timbers weighing 50-70 lbs per cu ft at 15% moisture content).

Timber name	Botanical name
1. Balau	<i>Shorea</i> (11)
2. Red Balau	<i>Shorea</i> (4)
3. Bitis	<i>Madhuca</i> (1)
	<i>Palaquium</i> (1)
4. Chengal	<i>Balanocarpus</i> (1)
5. Giam	<i>Hopea</i> (6)
6. Kekatong	<i>Cynometra</i> (1)
7. Keranji	<i>Dialium</i> (8)
8. Merbau	<i>Intsia</i> (1)
9. Resak	<i>Cotylelobium</i> (2)
	<i>Vatica</i> (8)
10. Tembusu	<i>Fagraea</i> (1)

B. MEDIUM HARDWOODS (Timber weighing 45-55 lbs per cu ft at 15% moisture content).

11. Kapur	<i>Dryobalanops</i> (2)
12. Kasai	<i>Pometia</i> (3)
13. Kelat	<i>Eugenia</i> (2)
14. Keledang	<i>Artocarpus</i> (9)
15. Kempas	<i>Koompassia</i> (1)
16. Keruing	<i>Dipterocarpus</i> (29)
17. Kulim	<i>Scorodocarpus</i> (1)
18. Mata Ulat	<i>Kokoona</i> (2)
19. Mengkulang	<i>Heritiera</i> (4)
20. Merpauh	<i>Swintonia</i> (3)
21. Punah	<i>Tetramerista</i> (1)
22. Rengas	<i>Gluta</i> (3)
	<i>Melanochyla</i> (3)
	<i>Melanorrhoea</i> (5)
	<i>Dillenia</i> (5)
23. Simpoh	<i>Koompassia</i> (1)
24. Tualang	

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C. LIGHT HARDWOODS (Timber weighing 25-45 lbs per cu ft at 15% moisture content)

25. Bintangor	<i>Calophyllum</i> (23)
26. Durian	<i>Coelostegia</i> (2)
	<i>Durio</i> (8)
27. Geronggang	<i>Cratoxylon</i> (1)
28. Gerutu	<i>Parashorea</i> (3)
29. Jelutong	<i>Dyera</i> (1)
30. Kedondong	<i>Canarium</i> (5)
	<i>Dacryodes</i> (4)
	<i>Santiria</i> (6)
	<i>Scutinanthe</i>
	<i>Triomma</i> (1)
31. Kungkur	<i>Pithecellobium</i> (1)
32. Machang	<i>Mangifera</i> (7)
33. Medang	<i>Actinodaphne</i> (2)
	<i>Alseodaphne</i> (3)
	<i>Beilschmiedia</i> (3)
	<i>Cinnamomum</i> (4)
	<i>Cryptocarya</i> (3)
	<i>Dehaasia</i> (4)
	<i>Litsea</i> (14)
	<i>Nothaphoebe</i> (2)
	<i>Phoebe</i> (3)
34. Melantai	<i>Shorea</i> (1)
35. Melunak	<i>Pentace</i> (10)
36. Mempisang	<i>Alphonsea</i> (2)
	<i>Mezzettia</i> (1)
	<i>Monocarpia</i> (1)
	<i>Platymitra</i> (1)
	<i>Polyalthia</i> (6)
	<i>Xylopia</i> (5)
37. Meranti Bakau	<i>Shorea</i> (1)
38. Meranti Dark Red	<i>Shorea</i> (16)
39. Meranti Light Red	<i>Shorea</i> (16)
40. Meranti White	<i>Shorea</i> (7)
41. Meranti Yellow	<i>Shorea</i> (7)
42. Merawan	<i>Hopea</i> (17)
43. Mersawa	<i>Anisoptera</i> (7)
44. Nyatoh	<i>Ganua</i> (1)
	<i>Palaquium</i> (16)
	<i>Payena</i> (4)
45. Penarahan	<i>Gymnacranthera</i> (3)
	<i>Horsfieldia</i> (8)
	<i>Knema</i> (8)
	<i>Myristica</i> (8)
46. Perupok	<i>Lophopetalum</i> (8)
47. Pulau	<i>Alstonia</i> (3)
48. Ramin	<i>Gonystylus</i> (5)
49. Sepetir	<i>Sindora</i> (4)
50. Sesendok	<i>Endospermum</i> (1)
51. Terap	<i>Artocarpus</i> (4)
52. Terentang	<i>Campnosperma</i> (3)

D. SOFT WOODS

53. Malayan Kauri	<i>Agathis</i> (1)
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cially important, leaving a balance of 275 species distributed in 101 genera which are given in Appendix II, which can be called lesser known timber trees.

The distinction between commercially important and unimportant trees as defined by whether they appear in the MGR is slightly blurred by the fact that a few of the trees which appear in the MGR such as "kelat" (*Eugenia* spp.), "penarahan" (*Knema* spp; *Horsfieldia* spp.) are in fact seldom exploited while a few which are not considered commercial and not included in the MGR such as "penaga" (*Mesua* spp.), "tempinis" (*Sloetia* spp.) are exploited.

APPENDIX II

List of Lesser Known Timber Trees

Malay name	Botanical Genus (Number of species in brackets)	Family
Antoi	<i>Cyathocalyx</i> (1)	Annonaceae
Ara	<i>Ficus</i> (5)	Moraceae
Babi kurus	<i>Crudia</i> (3)	Leguminosae
Balek angin	<i>Mallotus</i> (1)	Euphorbiaceae
Batai Hutan	<i>Albizzia</i> (2)	Leguminosae
Bayur	<i>Pterospermum</i> (3)	Sterculiaceae
Bayur Bukit	<i>Schoutenia</i> (1)	Tiliaceae
Bebatu	<i>Chaetocarpus</i> (1)	Euphorbiaceae
Bebusok	<i>Cassia</i> (1)	Leguminosae
Bekak	<i>Amoora</i> (3)	Meliaceae
Bekoi	<i>Crypteronia</i> (2)	Crypteroniaceae
Bengang	<i>Neesia</i> (5)	Bombacaceae
Berangan	<i>Castanopsis</i> (14)	Fagaceae
Berembang bukit	<i>Duabanga</i> (1)	Sonneratiaceae
Biku-biku	<i>Bhesa</i> (3)	Celastraceae
Buah keras laut	<i>Hernandia</i> (1)	Hernandiaceae
Bungor	<i>Lagerstroemia</i> (3)	Lythraceae
Chempaka hutan	<i>Aromadendron</i> (1)	Magnoliaceae
Chichah	<i>Stereospermum</i> (1)	Boraginaceae
Dedali	<i>Strombosia</i> (2)	Icacinaceae
Delek	<i>Anisophyllea</i> (3)	Rhizophoraceae
Derum	<i>Cratoxylon</i> (2)	Hypericaceae
Dungun paya	<i>Engelhardtia</i> (3)	Juglandaceae
Ekor	<i>Dacrydium</i> (3)	Podocarpaceae
Gaham badak	<i>Blumeodendron</i> (3)	Euphorbiaceae
Gegatal	<i>Schima wallichii</i> (5)	Ternstroemiaceae
Gelam	<i>Melaleuca</i> (1)	Myrtaceae
Gerok	<i>Symingtonia</i> (1)	Hamamelidaceae
Hampas tebu	<i>Gironniera</i> (3)	Ulmaceae
Inggir burung	<i>Ixonanthes</i> (2)	Linaceae
Ipoh	<i>Antiaris</i> (1)	Moraceae
Jalong	<i>Adinandra</i> (3)	Ternstroemiaceae
Jelawai	<i>Terminalia</i> (5)	Combretaceae
Jintek	<i>Baccaurea</i> (1)	Euphorbiaceae
Karas	<i>Aquilaria</i> (1)	Thymeleaceae
Kasah	<i>Pterygota</i> (1)	Sterculiaceae
Kayu arang	<i>Diospyros</i> (7)	Ebenaceae
Kekabu hutan	<i>Bombax</i> (1)	Bombacaceae
Kelempayan	<i>Anthocephalus</i> (1)	Rubiaceae
Kelumpang	<i>Sterculia</i> (4)	Sterculiaceae
Kembang semangkok	<i>Scaphium</i> (2)	Sterculiaceae
Kemenyan	<i>Styrax</i> (1)	Styracaceae
Kenanga	<i>Cananga</i> (1)	Annonaceae
Kerepal	<i>Kostermansia</i> (1)	Bombacaceae
Kundang	<i>Bouea</i> (2)	Anacardiaceae
Lotong	<i>Nephelium</i> (4)	Sapindaceae
Ludai	<i>Sapium</i> (1)	Euphorbiaceae
Mahang	<i>Macaranga</i> (6)	Euphorbiaceae
Malabera	<i>Fagraea</i> (1)	Loganiaceae
Marajali	<i>Trigoniastrum</i> (1)	Trigoniaceae
Mata keli	<i>Gynotroches</i> (1)	Rhizophoraceae
Mempening	<i>Lithocarpus</i> (35)	Fagaceae
	<i>Quercus</i> (5)	Fagaceae
Mendong	<i>Elaeocarpus</i> (10)	Elaeocarpaceae
Mengkal	<i>Nauclea</i> (2)	Rubiaceae
Mengkundor	<i>Tetrameles</i> (1)	Datisaceae
Mensirah	<i>Ilex</i> (1)	Ilicineae
Mentulang	<i>Alangium</i> (2)	Alangiaceae
Meransi	<i>Carallia</i> (1)	Rhizophoraceae
Merbatu	<i>Parinari</i> (4)	Rosaceae
Mertas	<i>Ctenolophon</i> (1)	Linaceae
Minyak berok	<i>Xanthophyllum</i> (12)	Polygalaceae

Malay name	Botanical Genus (Number of species in brackets)	Family
Nipis kulit	<i>Memecylon</i> (2)	Melastomaceae
Nyalas	<i>Parastemon</i> (1)	Rosaceae
Nyatoh nangka	<i>Pouteria</i> (2)	Sapotaceae
Otak udang	<i>Buchanania</i> (2)	Anacardiaceae
Pasak	<i>Aglala</i> (2)	Meliaceae
Pauh kijang	<i>Irvingia</i> (1)	Simarubaceae
Pelawan	<i>Tristania</i> (2)	Myrtaceae
Pelong	<i>Pentaspodon</i> (2)	Anacardiaceae
Penaga	<i>Mesua</i> (1)	Guttiferae
Pepauh	<i>Euodia</i> (2)	Rutaceae
Pepijat	<i>Prunus</i> (1)	Rosaceae
Perah	<i>Elateriospermum</i> (1)	Euphorbiaceae
Perah ikan	<i>Pimeleodendron</i> (1)	Euphorbiaceae
Petai	<i>Parkia</i> (3)	Leguminosae
Petaling	<i>Ochanostachys</i> (1)	Oleaceae
Podo	<i>Podocarpus</i> (3)	Podocarpaceae
Pupoi	<i>Sarcotheca</i> (1)	Oxalidaceae
Putat	<i>Barringtonia</i> (2)	Lecythidaceae
Saga	<i>Ormosia</i> (4)	Leguminosae
	<i>Adenanthera</i> (2)	Leguminosae
Samak pulut	<i>Gordonia</i> (1)	Ternstroemiaceae
Sentang	<i>Azadirachta</i> (1)	Meliaceae
Sentul	<i>Sandoricum</i> (1)	Meliaceae
Sepul	<i>Parishia</i> (4)	Anacardiaceae
Setumpol	<i>Hydnocarpus</i> (10)	Flacourtiaceae
Surian	<i>Cedrela</i> (2)	Meliaceae
Surian batu	<i>Chukrassia</i> (1)	Meliaceae
Tempinis	<i>Streblus</i> (1)	Moraceae
Teruntum	<i>Lumnitzera</i> (1)	Combretaceae
Tulang daing	<i>Millettia</i> (2)	Leguminosae
Ubah	<i>Glochidion</i> (2)	Euphorbiaceae
—	<i>Dysoxylon</i> (2)	Meliaceae
—	<i>Helicopsis</i> (4)	Proteaceae
—	<i>Mastixia</i> (2)	Cornaceae
—	<i>Neoscortechinia</i> (3)	Euphorbiaceae
—	<i>Norrissia</i> (1)	Loganiaceae
—	<i>Tristira</i> (1)	Sapindaceae
—	<i>Walsura</i> (1)	Meliaceae
—	<i>Weinmannia</i> (1)	Cunoniaceae

For silvicultural purposes the Forest Department has classified most of the timber trees into 4 major classes as follows:—

Class A Heavy Hardwoods

Class B Preferred species of Medium and Light Hardwood

Class C Desirable species

Class D Acceptable species.

Silvicultural treatments in felled areas are aimed at producing a new crop which should consist mainly of preferred or desirable species and if none of the species in such classes are found in the area, which is very unlikely, then to look for the species grouped in Class D—Acceptable species.

Most of the species in the Class D and a number of unclassified trees constitute the lesser known timber trees of Malaya. The abundance of these lesser known timber trees in different vegetation types throughout the country is given in Table 1. The data in Table 1 is obtained by going through a selection of Forest Resources Survey Reports chosen to represent a cross-section of the forests of the country. It can be seen that 28.71% of total volume per acre of exploitable trees in the lowland forests belong to the lesser known trees while in the hill forest it is 40.4% and in the swamp forest 42.6%.

TABLE 1. Frequency of Class D and Unclassified Species

(A) Lowland Forest Type

District	Volume per acre in cu. ft.				
	Class A	Class B	Class C	Class D	% of Class D
Kota Tinggi	172.25	964.25	254.25	895.25	39.1
Segamat	252.3	447.3	367.0	755.4	39.3
Ulu Selangor	498.0	1919.3	416.3	1680.0	37.2
Temerloh	236.6	2205.0	171.0	287.4	9.9
Pekan	145.73	1210.42	245.25	545.2	25.3
Kuantan	401.6	1607.0	219.0	590.4	20.9

Average percentage of Class D species and Unclassified species = 28.71

(B) Swamp Forest Type

District	Volume per acre in cu. ft.				
	Class A	Class B	Class C	Class D	% of Class D
Ulu Selangor	84.3	1149.6	203.3	100.5	41.1
Pekan	20.36	90.8	319.0	319.4	44.1
Kuantan	186.0	683.6	99.3	727.3	42.7

Average percentage of Class D and Unclassified species = 42.63

(C) Hill Forest Type

District	Volume per acre in cu. ft.				
	Class A	Class B	Class C	Class D	% of Class D
Kota Tinggi	242.0	596.0	220.6	605.4	36.3
Ulu Selangor	123.3	226.4	498.0	1789.6	38.3
Kuala Lumpur	95.5	606.7	225.6	1155.7	56.5
Temerloh	511.0	1372.0	300.0	1185.0	35.1
Pekan	583.5	1480.8	220.2	730.5	24.2
Kuantan	1041.6	2135.5	378.5	1015.4	22.2

Average percentage of Class D and Unclassified species = 40.4

There are a number of reasons why these lesser known trees are not exploited. Malaya is rich in timber trees which are well known in local and overseas markets. As long as there is a plentiful supply of these well known trees, there is very little chance for the lesser known timbers to come to the market, unless, by research and publicity, it is proved that some of the trees in the lesser known trees are equal or better in certain respects for a particular use. The lesser known trees, although they form a good percentage of the volume of timber in the forests, its importance has become insignificant due to the abundance of well known trees. We may not be able to get large quantities of any single group of timber of the lesser known trees from one area to meet the demand if an enquiry comes for such timbers. There is not much information on the prop-

erties and usefulness of these timber trees. Also it is not easy to change the attitudes of the consumers by asking them to use the lesser known timbers instead of the well known traditional timbers, unless one can prove the usefulness of the lesser known timbers when compared to traditional woods.

If the lesser known trees are also exploited and utilised for various purposes this will automatically bring in a better revenue from the forest exploitation than hitherto. If it can be proved that the timbers from lesser known trees are of the quality of the traditional woods they can be used for various purposes locally and export more of the traditional woods overseas which will help to increase our country's foreign exchange. In order to make a better utilisation of the natural forests, uses for these lesser known timber trees will have to be found. The following suggestions are made to promote the exploitation of these species:—

- (1) Carry out research on the timber properties of the lesser known trees and suggest possible utilisation in the form of timber, fibre wood, chip board, match stick, etc.
- (2) Classify the timbers of different botanical groups into timber classes having similar density and colour features. In this way it is possible to supply enough timber of one group to the consumers.
- (3) Publish information on the utilisation of these timbers so that it is easily available to the consumers.
- (4) Give incentive to loggers in extracting these timber trees by charging a substantially low royalty.

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DISCUSSIONS

E. Soepadmo.—What are the prospects of using this type of timbers in paper manufacture?

K.M. Kochummen.—The Chemistry Division of the Forest Research Institute at Kepong is now actively engaged in the study of the possible utilisation of some of the lesser

known trees for paper and particle board. In a few years time, it is hoped, that we will know the prospects of using this type of timber for paper manufacture.

It is possible to make paper from a mixed supply of timber of differing composition but it is difficult to control the quality of the pulp. Similarity of density and chemical composition of the timber is necessary to obtain acceptable pulp. But pulp for corrugating medium can be obtained from mixed timbers of different consistency.

J.A. Bullock.—I believe that for paper making it is necessary to have a supply of wood of consistent composition. Hence a mixed supply of 'lesser known timbers' would be unsatisfactory.

R.B. Lulofs.—Balsa has been grown on a small commercial trial basis but the colour of the final product being yellowish was unacceptable on the conventional market.

"Kenaf" is generally being used as a substitute for timber in paper manufacture.

Is there any research being done on the use of by-products of timber mills, i.e. sawdust and chipping?

K.M. Kochummen.—No.

B.C. Stone.—*Macaranga* and other spontaneous small trees pioneering waste lands, e.g. tin-tailings, might be resource for paper pulp.

B.C. Stone.—Can advance notice of foreign timber importer's *future needs or demands* be obtained or guessed at?

K.M. Kochummen.—It is difficult to predict the future needs or demands of foreign timber importers. However it is possible for us to suggest the utilisation of certain types of timber which are not in the market yet for particular uses provided we have enough information on the utilisational properties of these timbers.

Lee Peng Choong.—On question by Dr. Stone regarding predicting trends in utilisations of heavy hardwood:—

The tendency is for demand of species of the less dense timbers to continue to grow because of their general utility. Heavy hardwood species were preferred 30 to 40 years back because of their natural durability. Now they are in demand for specialised uses, but for specific uses, demand is naturally small. It is unlikely that demand for heavy hardwoods will come to the forefront again.

Anonymous.—Can balsa wood (*Ochroma*) be grown here on a commercial basis?

K.M. Kochummen.—No. From trial plantings at F.R.I. Kepong, balsa has attained a growth rate of about 40 inches girth in 6 years. The growth figures indicated stagnation. The timber was of poor quality, the outer wood being hard and heavy.

The Impact of Commercial Forestry on the Hill Forests of the Malay Peninsula

P.F. BURGESS¹

INTRODUCTION

It is necessary first to examine in very general terms the history of forest working in the Peninsula since the war. Until 1960 timber production and the area of Forest Reserve regenerated both rose fairly steadily. From 1960 to 1967 (the last year for which a Forest Department Annual Report has been published), however, the rise was accelerated until in the last year timber production had reached about two-and-a-half times that of the mean level of the first decade since the war. The area of Forest Reserve opened to fellings shows violent fluctuations up to 1956, largely because of enforced openings and closures due to terrorist activity, but thereafter the rise has been of the same order as that of timber production (see Fig. 1).

There were severe restraints on the timber industry after the war and in the immediate post-war period the greater part of hauling was still done by buffalo, the logs being split by handsaw at stump to make them light enough to haul by a single beast. At this time, too, there was a well-developed panglong or hand-logging trade, particularly on the east coast and in Johore, where the big Singapore and Johore sawmills needed large kapur (*Dryobalanops aromatica*) logs. By 1949 at least one operator, for example, Lee Sawmills in the Panti Reserve in Johore, had developed extraction by ex-military winch lorry (later known as "san tai wong"), and had built an extensive network of lorry roads, all by hand labour. There was at this time also one crawler tractor at work yarding logs in central Johore. Then came the communist insurrection, and tractor logging could make no further progress since the machines moved too slowly to be brought back to logging camps at night, and had they been left in the forest over-night the bandits would have destroyed them. The more mobile *san tai wong*, however, spread and developed fast, being not only a very adequate machine for hauling the 16 ft. long logs in general demand by sawmills, but also cheap, a fast mover on logging roads, and a useful 'bus' to get the loggers into the forest each day. Road making, however, still had to be done almost entirely by hand. The end of the communist insurrection in 1959 was the prelude to the rapid development of the timber industry indicated by the production curve in Fig. 1. Tractors became usable for road-building, and even for yarding in difficult terrain, so that distance and steepness virtually ceased, almost overnight, to restrict the logger. This development was accompanied by the general upsurge of planting activity in rubber and oilpalm which followed independence, and by the sudden emergence of Japan as a buyer of almost all the timber Malaysia could produce, log exports, formerly entirely prohibited, commenced under licence at first for species which were un-saleable locally. The next spur to forest exploitation was the development of the light one-man chainsaw, which started to come in to use by about 1962; no longer was out-turn limited by the skills of the axe faller.

That then is the background, and the pressure on the magnificent forests of the Peninsula will continue to increase as other countries log out their forests, and the world timber famine predicted long ago for the year A.D. 2000, grows ever nearer.

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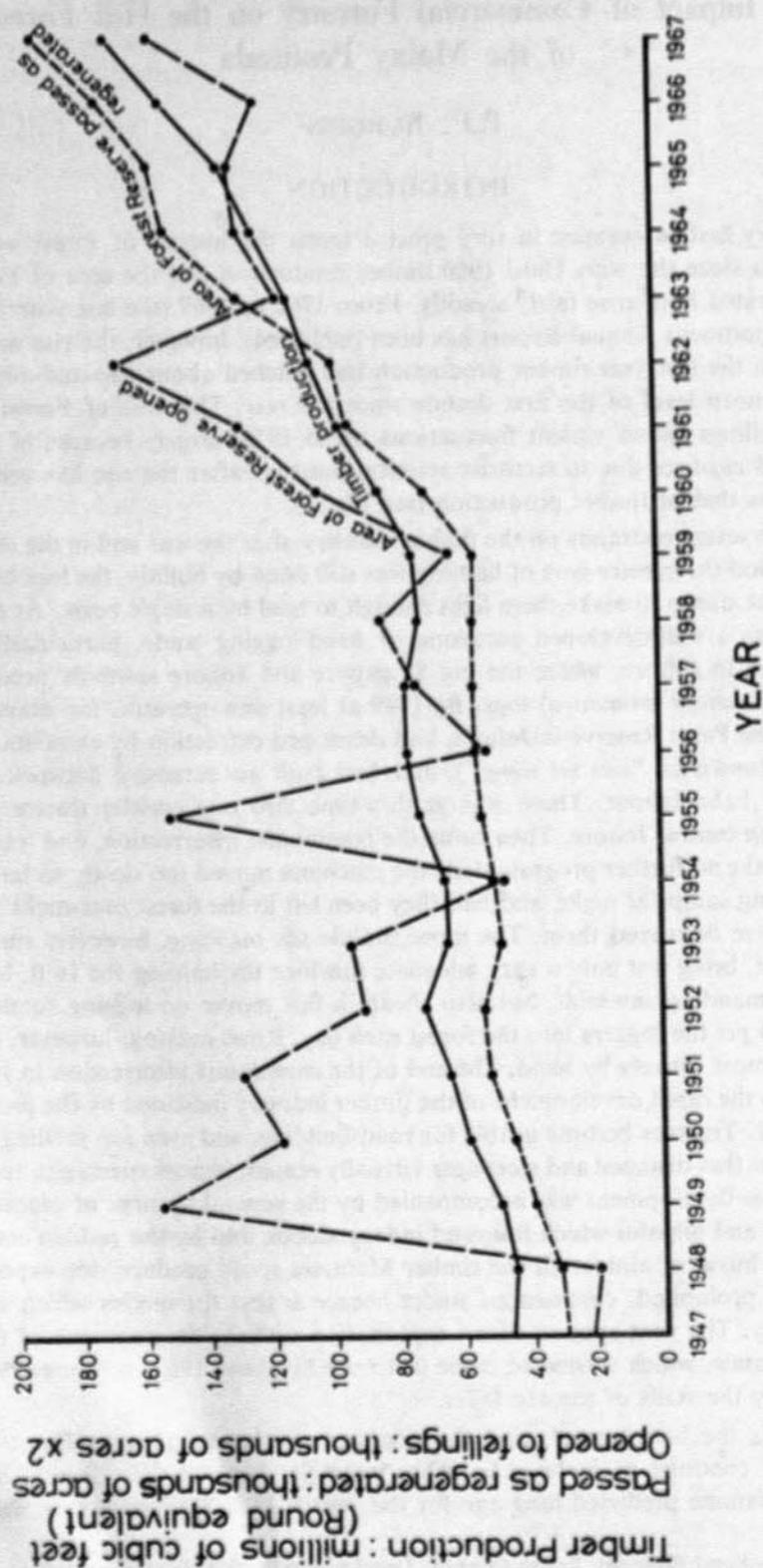


FIGURE 1. West Malaysia Comparison of timber production, regeneration of forest reserves & opening of forest reserves felling.
Source: Forest Department Annual Reports.

We now come to the real subject of this paper, which is the effect of logging and regeneration operations on the hill forests. I am not here concerned with the rate of exploitation and whether it is within a sustained yield coupe; it is sufficient to say that the fellings are very extensive and likely to increase as long as uncommitted forest remains.

THE FORESTS

Hill forest in the present context means forest on land above the steepland boundary where most slopes exceed 20°, and with an upper altitudinal limit at about 4000 ft where the dipterocarps run out and are replaced by oak-laurel forest which at present has no commercial value. Below about 750 ft altitude hill forest is similar floristically to lowland forest, and the fast-growing red meranti species of *Shorea* constitute the bulk of the timber stand. Though these species continue in the valleys above this altitude, the ridges as they become drier and sharper are increasingly stocked with almost pure stands of seraya (*Shorea curtisii*), which often produces a dark red meranti timber and is probably the most sought-after species in the log markets of the Peninsula today. In the steep country of the seraya zone the ridges often carry almost all the timber there is, the valleys and lower hill slopes being very poorly stocked, particularly in granite country, due partly at least to intermittent slipping of the soil mantle on hillsides. Another very valuable dark red meranti, *Shorea platyclados* comes in with the montane forest at about 2500 ft (though it is often much lower on rich soils) and is found distributed from ridge crest to valley bottom up to about 4000 ft.

SILVICULTURAL TREATMENT BEFORE TIMBER WORKING

Successful natural regeneration of Malayan hill forests depends absolutely on the presence of adequate young regeneration of the valuable dipterocarps before the seed source is removed in the timber felling. Unfortunately dipterocarps seed very erratically, and we cannot rely on seed production by the important hill species more frequently than every five years. In unopened forest about half the young seedlings die in the first two years, and after that about 10% of the remainder continue to die each year. Seedlings can be induced to live much longer if they are given more light and less root competition so that they can develop more photosynthetic area, and pretreatment of the forest to achieve this appears to be essential if heavy seedling mortality is to be avoided. Pretreatment will consist of the poisoning of the stemless palm bertam (*Eugeissona tristis*), and a poison girdling of about one-quarter of the basal area of the currently non-commercial trees of the main story of the forest, and this treatment will be carried out about ten years before commercial fellings start. As a market for wood chips for rayon manufacture develops it is likely that the girdling will be replaced by a seeding felling in which a similar proportion of the main story trees will be felled and removed.

REMOVAL OF THE TIMBER STAND

Under current conditions pretreatment will not disturb the forest very greatly, though there will be a risk in entering it while the girdled trees are falling. If fellings replace girdling as a pretreatment operation there will be considerable early disturbance especially by road building, since it seems likely that the road system for the eventual re-

removal of the main timber stand will in practice be installed some ten years before logging so that the preparatory fellings can be carried out. If this is done, the road system will have to be much more carefully designed than it is under present conditions so that damage by erosion is checked. The logging roads built at present are invariably unmetalled, and are about twelve feet wide. In order to gain height at a reasonable gradient the roads are benched into the sides of valleys at first and then run along spurs or ridge crests; gradients with the load of nearly 30° are not uncommon for short distances. About 27 miles of road are needed to exploit every square mile of forest, and this means that the actual road surface alone covers about 40 acres in every square mile, or 64% of the land area. Spoil from sidelog earth cutting can run up to ten chains down a slope in steep country, and generally destroys all the regeneration in its path. If to the actual road surface is added the land disturbed by earth works associated with road making, and also log-dumps or landings, an average of 12% of the land surface is disturbed by earth moving in steep hill country. Road specifications are low, since the *san tai wong* is very easily manoeuvred and can negotiate very steep slopes; drainage is almost always sadly neglected. Steep gradients result in high drainage water velocity, and unless check dams are built on drains, culverts properly constructed and kept clear, and drains, constructed on the inside edge of the roads erosion will be severe; it is often particularly bad where two roads meet. During logging the roads are maintained and any severe erosion checked, but after logging is complete the operator ceases to have responsibility for the area and erosion continues unchecked until a vegetation cover has established itself in about ten years after logging. Gullying along the inner edges of roads is frequently severe, and particularly in granite country will eventually result in whole sections of the road slipping. Proper maintenance of roads and drains, after logging has ceased, would do much to reduce this damage, and help to protect the considerable investment in road works which the licensee hands over to Government at the conclusion of logging.

Felling and hauling of the timber, by comparison with road making does little damage to the land on which the forest grows, but it does mean that all the magnificent emergent trees are felled, the canopy is broken, and especially near landings and along roads the forest is replaced by regrowth of fast-growing secondary tree species which, near streams is often tied up with a dense growth of *Mikania scandens* and other climbers. This is inevitable if the forest is to yield its wealth for man's use, and it is an overwhelming reason for the preservation of representative areas of virgin forest for recreation and scientific study. Substantial islands of forest escape disturbance in most logged compartments, since they carry no timber, but on average about 70% of the area is either felled over or destroyed by exploitation operations. Even in the felled areas a substantial relic stand of non-commercial trees remains after logging, and while this varies from almost nothing where the crown of a large tree has fallen, to average of about 100 sq ft of basal area per acre, which is between 50 and 60% of the original stand.

SILVICULTURAL TREATMENT AFTER TIMBER WORKING

The relic stand which remains after logging impedes the development of the young regeneration and it is unfortunately necessary to remove almost all of it if the new forest is to be satisfactorily regenerated with trees of commercial value. This operation is carried out by poison girdling and the rung trees will remain as an ugly reminder of man's influence for up to ten years after exploitation. Caution is necessary in girdling operations, and it is essential that the presence of adequate regeneration is verified by

sampling before girdling is undertaken. Girdling in forest which lacks regeneration is not only a waste of money and an unnecessary disturbance to the ecosystem, but it can also result in the complete elimination of the valuable timber species over considerable areas of forest. Dipterocarps in general have a poor range of seed distribution, and once eliminated from any extensive area it may be a matter of many hundreds of years before they succeed in re-invading it.

After girdling the forest remains untouched apart from periodic samplings and minor operations to free the developing timber trees, until the end of the second rotation, some 60 years hence.

DISCUSSIONS

C.H. Leigh.—You mention that erosion, especially along the logging roads, continues after logging has been completed. The contractors presumably make a considerable profit, could they not be asked to maintain the roads in order to prevent erosion for a number of years after logging?

P.F. Burgess.—One would have thought so, and this suggestion has been made many times. The short term nature of many of the logging operations is one of the main objections, and there is a much greater chance of effective control under long-term licence. Even so, I can only say that I have yet to see road maintenance by a logger in worked out compartments operate satisfactorily.

Lee Peng Choon.—How serious is the problem of bamboo in regeneration of hill forests?

P.F. Burgess.—Locally very serious, especially in lower montane forest where *Schyzostachyum grande* is present. "Buloh akar", that is all species of bamboo which rely on the surrounding forest to support the culms, is particularly harmful to regeneration and it must be poisoned a sufficient time before exploitation commences to enable the culms to fall and rot.

A. Manaf Ahmad.—Even in primary forest there are areas in the hills where there is an insufficient stand of commercial trees. This may suggest that the trees may not be able to regenerate on their own, and the areas may be too steep to support big trees. Can you suggest any use for such areas?

P.F. Burgess.—I agree with you that it is unwise to attempt to regenerate large-growing trees in forest which naturally contains no big trees. In my experience poorly stocked forest rarely occurs purely through chance, and unless there is a clear reason for the low stand, such as a history of shifting cultivation, I can only suggest that such forest should be devoted to the growth of small-sized material such as pulpwood. The erosion problems of growing trees on short rotation on unstable slopes would, however, be considerable, and it may be that such forests should be considered to be of purely protective value.

D.W. McCredie.—In Burma I understand the forests are regenerated with teak by the "taungya" system, where shifting cultivators plant and tend the teak before opening new clearings. Could this not be done in the hill forests of the Peninsula?

P.F. Burgess.—I think you may be referring more to Sabah than to the Peninsula; shifting cultivation is not nearly so prevalent in the hills here as it is in Sabah. I do not think that taungya methods can have any place in the regeneration of forest which

carries a high enough timber stand to be worth logging. It is often most unwise to let cultivators in to logged over forest since it is virtually impossible to get them out again. There are very few examples of successful taungya plantations in the Peninsula, partly because of the heavy weed growth, and also because of lack of seed supplies; once a taungya scheme is started one is committed to the almost endless supply of land for cultivation and of seedlings for planting.

Waste Recovery As An Aid to Conservation of Natural Resources

W.R. STANTON¹

Concurrently with this Symposium, there is being held in the University of Malaya a Regional Work-Study² on the use of microorganisms in waste recovery, attended by specialists from the various territories of the Region and serviced by a number of overseas experts. This paper considers the implication of the techniques under study to the subject of the present Symposium.

Present methods of agriculture are remarkably inefficient, both at the production and harvest phases. These phases are followed by a system of processing and product distribution in which as much as 80% of the harvested material is rejected before it reaches the consumer to become a burden to the community in the form of pollutants. This rejected material is burnt, dumped on the land and in the waterways, discharged into the air, or drained into the sea if such a body of water is conveniently at hand. The polluting effects of all but the first named disposal process are self-evident. However, it is important to stress that burning itself causes secondary pollution of the atmosphere and also contributes to heat pollution, which is an insidious but growing menace to our environment and thus to the organisms living in it apart from being a method of disseminating toxic residues and heavy metals into the air.

The pattern of recurrent resources production has developed on the basis of the assumption that: land is cheap and fresh and is always available; fertilisers are cheap; our crop plants and trees can be further protected from the general biota by increasingly heavy doses of insecticides, fungicides, even mammalicides, or other types of biocide against specific animal or plant life forms.

The conservationist must fight this method of production with very limited resources and only a moral advantage against the enormous economic and financial wealth of the enemy which is gradually eliminating diverse life from the planet or reducing the size of the gene pools.

Comments from conservationists about the longer term economic hazards of present day methods of agro-technology and the fact that increasing productivity in one area may be a menace to the quality of life in another part of the Globe largely fall on deaf ears. Governments are extremely reluctant to hang millstones of legislation around the necks of their main providers of funds for current development, although individual members of government may admit in private that this should be done. We have only to look at a typical case such as that of the tobacco industry, in which it is admitted that there are gross hazards in tobacco consumption, not only directly to the smoker, but also to others who have to suffer the environment created by smoking. Yet, in spite of this we see in current issues of the newspapers that farmers are urged to grow tobacco to supplement their limited income from the rice crop. We also have visual pollution in the fact that the biggest and most abhorrent advertisements on our highways are provided by the tobacco companies.

One possible solution to this impasse (felling of helplessness) faced by the conservationists is to demonstrate by pilot-scale developments that pollution control is good

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² The Use of Microorganisms in Waste Recovery. A Work-Study sponsored by UNESCO/ICRO and operated jointly with the University of Malaya. May 1-17th, 1972.

long-term economics. In other words, it is necessary to show that it is profitable to treat a much greater fraction of the total biomass harvested from agriculture or forestry than has hitherto been the practice, or to modify the methods of biomass extraction to improve the percentage useful product recovered from the total by the processing.

Various new physical and chemical techniques have become available in the last few years, which make types of processing possible that were not economically feasible in the past. These include industrial-scale dialysis, reverse osmosis, and industrial-scale ion exchange processes, in which a whole variety of special chemicals, not just only salts or metals, can be recovered by the use of specific adsorbent resins. Industrial-scale chromatography electrostatic precipitation, counter-current extraction, freeze drying and vacuum distillation are other methods.

In the physico-chemical field, new methods of utilising loose chemical bonds, or even molecular traps (molecules which entrain without bonding) have proved of value in processing. However, the most exciting advances are being made and yet to be made, in the microbiology field, in which microorganisms are themselves used as the bio-engineering units for conversion of raw materials. The microorganisms itself has enormous advantages over the equipment of the macro-chemist in that each microorganism consists of a specially arranged and structured biochemical processing system, which, with the aid of modern genetic techniques, can be tailor-made to perform a wide variety of selected processes. Microorganisms can even be manipulated so that they will process chemicals not normally found in nature. Furthermore, these organisms are already equipped with fully operational membranes the function of which (as molecular sieves) is aided by the living systems supporting them. The physical chemists are so far unable to imitate the properties of 'living' membranes.

As biochemical systems, microorganisms also have the great advantage that they contain built-in repair systems and scale-up systems to build up the stock of highly expensive processing chemicals, which, if purchased as separate items for a large scale but low unit value, would make the product prohibitive in cost.

The more complex physical and chemical processes now currently used for the refinement and separation of natural products depend on scale for achievement of economy of operation. By contrast, this element of large scale is not necessarily in many of the processes involving the utilisation of microorganisms in natural product processing, so that in fact we find a diversity of village industries traditionally operating biologically quite complex microorganism utilising systems for the treatment of natural products. The contribution of modern technology to extending this range of processes of benefit to village industries is dependent on the fact that one way transplant fermentation techniques from one geographical region to another where they are unknown; that additives may be used, which can create new environments for the microorganisms and that sterilants can also be used to allow a particular microorganism to have a head start in the fermentation system. Additionally, by production of standard inoculum of an elite microorganism, the advantages of advanced biochemical systems can be brought to the village factory. Where the advantages of large-scale production already exist, such as in the rubber factory, the oilpalm factory, the tapioca and pineapple factory, then of course it is appropriate to make use of that advantage. However, in the case of timber processing, the by-products of this industry are scattered over a much larger number of small units and therefore the individual processes must be operated on a relatively small-scale.

Part of the economic problem, to which we are paying a particular attention during the Work-Study, is the question of acceptance of the new processes and the marketing of the products resulting therefrom. One of the great mistakes of industries which have concerned themselves with the chemical and microbiological processing of natural products to produce human food, has been the failure of the development experts to recognise and overcome the difficulties associated with innovation of a new product. The argument has been that the production of foodstuffs for human use directly from raw natural products make the food recycling chain as short as possible and this is a benefit of paramount consideration. However, current thinking is reverting to favouring the technological applications to lower value products which can be applied to animal feed, to overcome expensive imports of high-protein animal feed, and to let the animal be an intermediate phase in the application of high value foodstuffs to human use. Amongst the more recent enquiries into the utilisation of low value wastes, as an alternative to improving their food value for animals or humans, is that of converting these materials to other organic chemicals. These waste-derived chemicals, include the raw materials for the plastics, pharmaceutical and industrial chemical industries. In contrast to the animal feed and even human food industries, however, these by-product processing units need to be operated on a large-scale. But their operation can be envisaged for instance for the timber industry and for the processing of the waste materials of the sugar industry, and even the rice industry, now that it is operated collectively in very large units.

In this whole question of processing of waste materials, it is not always appreciated locally how much other countries, particularly Japan and some of the other developed countries, are keenly interested in the waste natural products from Malaysia and hold the key information on their utilisation which may be withheld from scientists in this country. This is particularly unfortunate. It is a necessary part of the solution to the whole question of conservation of local natural resources to build up the body of expertise to a critical mass amongst local scientists in order to enable the direction of resource utilisation, of which waste product recovery forms a part, to be controlled from within the Region. When it is considered that, of the agricultural harvest, on average 60% is currently waste, then utilisation has the attributes of a major industry. Further, from the point of view of making a real contribution to the reduction of pollution and the conservation of resources arising therefrom, it is necessary to reduce the percentage of waste to something like 15% of the harvested biomass. It may thus be realised that perhaps there is an imbalance of scientific manpower in the natural product industry. At present the scientific effort is grossly biased towards increasing the actual production and harvesting whereas in terms of the total application of the harvest at least 30% of the scientists concerned with the processing could be applied to the processing of current waste products.

DISCUSSIONS

J.A. Bullock.—I have enjoyed your paper greatly; the concept of reutilising waste products is a sound ecology. No ecosystem can exist that habitually jettisons its waste into other systems. Can you tell us how soon such recycling could be introduced commercially in Malaysia?

W.R. Stanton.—Some of the processes discussed in our Work-Study, e.g. algae from rubber effluent, are ready for pilot-plant testing and could be operational in 2-3 years.

E. Soepadmo.—We have been told by our panels of the forum on the "Blue Print for Survival" that, if we are careless in utilising our presently available resources, within 100 years from now or so, this earth will have far too many human beings to support and too little food materials available for its inhabitants.

Will the waste recovery technology be able to cope with the problems in the near future? If so to what extent and how soon?

W.R. Stanton.—Provided that population growth is curbed and consumer's demand (per-capita usage of energy/water/plastics & metals) levelled off, the answer is that the problem of survival is soluble with the current level of technology, but biological re-cycling will not avert catastrophe on its own.

K.G. Singh.—What sort of waste of natural products from Malaysia is Japan interested in?

Regarding the point made by the speaker, that tobacco growing is being encouraged in this country, inspite of its harmful effect, I don't think it is proper to blame anyone. We have to follow the national objectives as well which is the creation of more jobs to lessen unemployment. Otherwise subversion is bound to increase as has been the experience in neighbouring countries. A balance therefore, has to be drawn.

W.R. Stanton.—Cellulosic wastes (for the manufacture of plastic and re-structured, i.e. fibre reinforced, materials) sources of fermentable carbohydrates, substitutes for biochemical transformations.

I was mainly concerned with the tourist and overseas image of visual pollution on our highways and airport approaches. The hasty choice of tobacco, as a diversification crop, is partly the result of delay in implementing research here on other possible diversification crops in the last decades.

R.B. Lulofo.—Can the present methods of waste recovery be applied at normal estate level?

W.R. Stanton.—Yes (see my answer to Dr. Bullock).

D.W. McCredie.—What advances in microorganism research have been made in getting rid of the most common human waste products such as polythene and aluminium cans?

W.R. Stanton.—Comminuted plastics are useful as soil conditioners and land-fill. If finely disintegrated, they are generally slowly degraded, though polythene is one of the slowest to degrade and also one of the most difficult to disintegrate, not being susceptible to brittle fracture. Aluminium cans are not biodegradable but aluminium can be burned to a non-toxic residue, if not retrieved in sorting processes.

The Values of Fauna Conservation

MOHD. KHAN BIN MOMIN KHAN¹

The success of conserving wildlife depends on the value of the species. People from all walks of life have to be convinced that whatever sacrifice made towards such value, for the course of wildlife conservation, is justified. Wildlife value can be recognised by understanding the main groups that make up the public concerned with wildlife.

The professional scientists belong to one distinct group. Professional scientists are persons who study critically and systematically some aspects of the natural sciences. These scientists publish or teach their findings and conclusions, and are the authority in that particular discipline. The opinions of this group are often given due consideration in Government decisions.

Apart from other considerations, the scientific value of wildlife justifies its place in the world. Of major significance in this respect is the biological value of wildlife. More, however, has been written about the harmful than the beneficial effects of wildlife. Also as a rule the damages are less complex and easier to see than are the benefits.

Many species of birds disperse seeds of large tree species and they also forage for insects. The wood-peckers hunt for wood boring insects, and the flycatchers and warblers are well-known feeders on leaf-dwelling and flying insects. The mammals, particularly the small insect-eating species, are no less important in removing large quantities of forest insects. We are a long way from understanding the dynamics and balance of the natural communities that we have modified into agricultural lands. Wildlife is a part of the biological community that keeps soils productive. It must therefore be maintained in those areas that we would study and keep as standards against which to measure change and deterioration in those lands that we use directly for commercial production.

The amateur hunter is defined as one who is interested in game for the love of sport rather than as a means of livelihood. As a group, amateur hunters are exceedingly interested in conserving and improving the particular form or forms of sport around which their interests converge. They are very observant during the short period they spend in the field but are inclined to accept completely what is seen with the eyes or what is said by fellow sportsmen, in preference to the carefully documented conclusions of the scientist. This group believes strongly in legal control of the harvest but will recognise and accept new facts.

In the State of Malaya hunters are not uncommon. On week-ends hunting parties may be found scattered in the rural areas actively pursuing their favourite recreational sport. Wild pigs, squirrels and game birds are among the popular game. Many thousand of dollars are collected by State Game Department as fees for the licences issued.

In many countries the recreational value of wildlife is even higher economically than its commercial value. In the United States for example, more than thirty million people spend billions of dollars on hunting and fishing. This support major tourist and recreational industries. The demand for space for the pursuit of fish and game justified the setting aside of large areas of public land where other competitive land use is excluded. Because of the high economic value cattle ranches were converted into fishing lodges by private landowners. Even high-value crop lands have been sold, in some places, to provide space for still higher-value private hunting clubs.

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When hunting of wildlife becomes a primary attraction, the economic value of animals can be realised in many ways. In much of United States wild animals are public property and their direct sale is not permitted. The landowner however, may sell "trespass rights", the right to hunt on his land. Private landowner have found this to be very profitable and the money obtained exceeds any income that could be derived from the direct marketing of meat or hides of game. It can be imagined from what has been mentioned that other industries such as the sporting arms and ammunition industries, the manufacturers of camping equipment and other conveniences also benefitted.

The value of Wildlife that is most recognised is commercial in the direct sense of contributing material things that are sold in the market place. The high commercial value of ivory threatens the future of elephants and the preservation of rhinoceros is very difficult because of the great demand for its horn. Primitive people have exploited the meat of wild animals and those who live in wild country also knew the value of wild animals as a meat source. Recently studies in Africa have shown that wild game can often produce more meat and other products of value from the land than can domestic livestock using the same area. The meat value of game alone in these places would preclude the conversion of game lands into ranches for domestic livestock if the competitive monetary worth were given due consideration. Furthermore, the possible value of wild game as a source of new domesticated species of livestock needs much more exploration if we are truly interested in producing maximum amounts of meat and other animal products as sustained crops from the land.

More than one hundred thousand animals and their skins were exported from West Malaysia in 1968. A modest average cost of ten dollars per head of animal brought in one million dollars in foreign exchange for that year. The wild pig is very popular as a game animal. In the State of Perak a total of 442 wild pig licences were issued last year. A very rough estimate gives a hunter success of two pigs a month or 66,264 pigs a year for the States of Malaya. The meat value is considerable. Deer is easily the most popular game in this country. The hunter success for the State of Perak for the year 1958 was 0.552 animal per hunter. A total of 101 deer was killed in that year with an average total dressed weight of 30,098 pounds. A great many other species of animals are also hunted and provide no doubt many thousand pounds of meat. Many species of birds are equally popular with a few species seriously depleted. Edible bird-nests and turtle eggs are significant contribution both in food and monetary value by the species producing them.

The aesthete sees wildlife as something to enjoy, observe, and study, but not to take for use. This group is sometimes inclined to feel that all species need full protection.

There has been a general belief that wildlife can never be significant in terms of tourism. This unfounded theory had done a lot of harm to wildlife conservation, which will continue as long as the tourist value of wildlife is not realised. It must, however, be stressed that it takes time to increase animal populations once they have been seriously depleted.

Hunting is not permitted in National Parks and Wildlife Reserves. It is the aesthetic appeal of wildlife that attracts people. Thousands of people visit these parks and reserves annually to see and photograph wildlife in its natural surroundings. If wildlife had no other value and were an economic detriment, it would still be worth preserving for its sheer beauty and appeal to the human spirit.

The Taman Negara is an excellent example. The wildlife in general and the seladang herd in particular have lost fear of humans and they breed naturally and increase in

numbers. The value of Taman Negara as a sanctuary and a tourist attraction is immensely important. Each foreign tourist spends an average three hundred and fifty dollars for an average four day visit. Working on this figure the foreign exchange value for last year exceeds three hundred and fifty thousand dollars. A lot of tourists have to be turned away every year due to insufficient accommodation. With proper planning and control of incoming tourist there should be no difficulty for Taman Negara to receive ten thousand tourists each year. This is a small figure compared to the several millions who visit the Yellowstone National Park in America. The difference in size of these two parks is small.

The professional Game Warden predominantly enforces the law and controls harvests of game. This group has deep convictions as to the essential worth, or controlling place of their work in the field of management.

It is clear from the preceding paragraphs the term "value" of natural resources is interpreted differently by different people. To some it means use only in economic terms. To them good conservation is practised only when a game population is used and converted into products of commercial value. Others disagree with this view. To them a magnificent elephant standing in a park is used more than one that is converted into ivory and meat, in the sense that more people benefit from the animal. In this sense also a wilderness is used without being destroyed or modified in the process.

Each group has strongly marked characteristics. Each differs from the others and some of the differences become rather sharp. The common over generalisation of the hunter is a challenge to the scientist's systematic basis for his own findings of facts and conclusions. The hunter is likely to be impatient at the slowness of scientific research, the warning of the trained scientist in drawing conclusions, and his habit of girding them about with qualifications and exceptions. The aesthete's point of view is that of sentiment combined with moral superiority because of the assumed greater virtue of observing rather than killing. He regards the hunter as a menace. The hunter tolerates the aesthete as long as no attempt is made to interfere with what he considers his rights and privileges. The wildlife officer is often in the best position to appreciate and understand the conflicting attitudes of others. Because of his unique position, the wildlife officer has an excellent opportunity to build bridges between the groups and help in the process of welding them into an effective team.

Wildlife is a renewable natural resource having many similarities with timber. Harvests are possible and it will reproduce and replace itself indefinitely through management. Each individual animal has a short life span. Natural mortality will remove it if man does not. In the conservation and management of wildlife there are excellent reasons for total protection of a population at a particular time, and equally good reasons for heavy cropping of population at other times. The Sumatran Rhinoceros, for example, if it can be saved at all, will need the protection of the individual animals and their habitat. The few surviving rhinoceroses need undisturbed conditions, if they are to breed and reproduce, raise young and increase. But to apply such complete protection to sambar deer in the forests like the Cameron Highlands is to invite destruction of these populations. The latter species has the capacity to destroy its own habitat and thus to destroy itself.

The fate of wildlife and that of other living resources are intricately tied together. Considerable care is given to the conservation of wild animals by nations practicing a high level of conservation of land and its renewable resources. Nations in which wild animal populations are depleted and on the verge of extinction are usually those in

which the state of soils and farmlands, and forests is also precarious. Wildlife conservation, therefore, must be associated and treated as part of the general subject of natural resource conservation.

It is essential to conserve and to manage all survivors of wildlife. With the exceedingly high human-population growth it seems unlikely that any area will remain unaffected by the activities of man. It would be a tragedy if future generations were denied the variety of animals which have accompanied and influenced man throughout his evolution and spread over the earth. There is a strong feeling that for the preservation of man himself wild land and wildlife are essential. The pressures on the human spirit is becoming more tense with the growth of technological civilization and specialisation. Until a more sane way of life is achieved, man needs a refuge, a place of escape from artificiality and confinement, where he can come to grips with his own still-primitive self. So long as wild places and animals are preserved, a sanctuary for man also remains.

DISCUSSION

E. Soepadmo.—We have been told by Dr. Lee Peng Choong that disturbance of our forest ecosystems (in the form of logging, etc.) will not affect the survival of wildlife. Could you please comment on this statement?

Mohd. Khan b. Momin Khan.—Work on a specific nature has not been carried out to measure accurately the effects of disturbance of the ecosystem of our forest through logging. My personal observation appears to show extensive disturbance to wildlife by way of poaching and loss of habitat. Timber tracks have made formerly inaccessible forests become accessible to poachers. Night shooting is common and the steel-wire snare which is set as a result is perhaps the most difficult problem that has to be efficiently dealt with. Animals and possibly birds become scarce in areas where exploitation was in progress indicating either they have left such areas for neighbouring undisturbed areas or they may have been shot up or both. Wildlife densities in neighbouring undisturbed areas are known to be greater which is evidence of the former but at what stage of exploitation do animals and birds leave and when they return after exploitation is not clear.

Anonymous (Comments).—The disappearance of animal species in deforested areas depends greatly on the extent of the deforestation.

J.A. Bullock.—The export figures for crocodile skins has dwindle rapidly in last ten years. Also until recently, reports indicate that there were large populations of crocodiles on the western seaboard of West Malaysia. This seem to be not so now. Is this due to hunting or other causes?

Mohd. Khan b. Momin Khan.—The Game Department does not have records of crocodiles killed in the States of Malaya and as such I am not in a position to comment when crocodiles were abundant in this country and when the decline was felt. Most if not all crocodiles exported from this country were first imported from neighbouring countries like Indonesia and Thailand and then raised in farms until they have reached economic size. Quite a lot of crocodile farms still exist in our country and many hundreds are exported yearly. It is interesting to note that Thailand has successfully bred crocodiles and it is a big business.

J.A. Bullock.—Recently we have heard much of the export of butterflies. I am concerned that this will cause a decline in populations. What action can be taken?

I am perturbed by the thought that people may not be allowed to collect butterflies for personal pleasure. I believe that act should be involved only against commercial collection.

Mohd. Khan b. Momin Khan.—Under the new Wildlife Act No. 76 of 1972 a schedule of protected Insects has been provided which makes it possible to protect as many insects as needed. Raja Brooke Bird Wing is the only species of butterfly that is given protection and consideration will be given to many hundreds of species as to whether or not they should be protected. A number of suggestions from keen conservationists were received and their views vary. One line of thought is to protect all species and introduce licencing; another is to ban the export of butterflies and still another is to protect only threatened species. Whatever action is taken it must be practical from the point of view of implementation.

J.A. Bullock.—I have noticed stuffed animals on sale in shops, whose provenance is doubtful. Can anything be done against such people?

Mohd. Khan b. Momin Khan.—Most of the stuffed animals and birds are from neighbouring countries. Many dealers were arrested and at least one person was sent to prison on conviction. The State of Perak has about fifteen cases pending court action. Other States are taking similar actions. Except totally protected animals and birds the others may be sold in shops by persons legally licenced with their articles for sale properly accounted for in registers.

N. Langham.—In the new wildlife ordinance for Malaysia, it appears that the opportunities for scientists to visit game parks is too restricted to allow them to do valuable research. Will it be possible to alter this arrangement?

What is the basis of your choice of allowing scientists to visit game parks for only one week per month?

Mohd. Khan b. Momin Khan.—A number of amendments will be made to the new Wildlife Act and one of them is the point in question. The purpose of a wildlife sanctuary or a wildlife reserve is quite obvious. We want the animals and birds to be left undisturbed. A lot of scientists do their collecting regularly throughout the year and for obvious reasons we cannot allow scientists to collect animals or birds throughout the months of the year.

Anonymous.—Can the monitor lizard (*Varanus salvator*) in West Malaysia survive the great influx of commercial demand?

Mohd. Khan b. Momin Khan.—There is no indication to show that the species is on the decline inspite of the ruthless exploitation of its meat and skins. There is little variation in the number of skins exported in each year (average for five years 1963–1967 is 38,647). I am inclined to believe that the species is holding its own.

R.B. Lulofs.—Has any work been done to breed species which are declining in number with a view to distributing such species to depleted areas?

A suggestion to introduce aspects of conservation, particularly studies of rare animals—into schools, in order to involve the total population in conservation.

Mohd. Khan b. Momin Khan.—A start has been made to breed mouse-deer and Sambar deer in captivity with very encouraging results. Some work has also been done on seladang in the wild, and plans are being made to breed seladang and the other species in captivity. Apart from domesticating these animals many will be released to fill up depleted areas.

The Game Department has this in mind but due to shortage of staff no effort has been made to introduce conservation subjects in schools.

The Importance of Marine Reserves to Tourism

RICHARD B. LULOFS¹

The resources of a country are traditionally tallied in terms of mineral wealth, agriculture and industry; but over the last century, the smaller countries of Europe who were unable to compete in the Industrial Revolution discovered that scenic beauty was an asset as valuable as any industry. And so tourism grew into the industry it is today, an indispensable part of any country's economy.

In the last two decades, individual leisure and prosperity has greatly increased. Travel has become simpler, faster and relatively cheap; once remote areas are now accessible and the traditional tourist centres are no longer limited to Europe. It is becoming apparent to an increasing number of countries that tourism can earn considerable amounts of foreign capital, while encouraging distribution of the national wealth from the high income urban regions to the less prosperous rural areas.

In the East, the tourist trade has a tendency to ignore its often exceptional native resources, and in the race to acquire the international paraphernalia considered essential to the trade, overlooks or undervalues its indigenous assets. This may be true of the Malayan islands and their fringing reefs, for their rich potential as underwater recreation centres has not yet been fully recognized or evaluated.

MALAYAN REEFS

"While Malaysian coral reefs in their natural state carry a rich and spectacular fauna and flora, and diving conditions off the coasts of the Peninsula are in general excellent, the reefs themselves are limited in distribution and extent and often isolated from each other by considerable distances of sea unsuitable for reef formation" (Annual Report Selangor Branch, *Malay. Nat. J.* 24, 40, 1970).

In variety of coral and diversity of population, the reefs in Malayan waters compare favourably with most in the tropical world. They have the added advantage of embracing the three distinct biotic zones of the Indian Ocean, Malacca Straits, and South China Sea. They are nevertheless limited in extent, and peculiarly susceptible to damage.

In general, marine animals have a larval stage which may be widely dispersed by ocean currents; thus a population which has been depleted in one area can usually be re-established by immigration of larvae from relatively distant sources. Unfortunately, the Malayan Peninsula is effectively screened by land masses from the main oceanic streams, and the minor currents that remain exert little influence in the regions where reefs occur. Consequently where depletion or damage does occur, repair is likely to take considerably longer than is usual on oceanic reefs. Regrettably, the Malayan reefs have already suffered severe damage in many areas.

UNOFFICIAL MARINE RESERVES

Over the last seventeen years, Malaya has seen the sport of scuba diving gradually develop into the familiar and popular recreation it is today. In 1959, the first diving club in Malaya and Singapore, the Malayan Sub Aqua Club, was formed in Kuala Lumpur.

¹ Batu Pekaka Estate, Kedah.

To explorers in the new dimension a whole new aspect of Malayan fauna was revealed, unexpected in its richness and variety. The number of divers increased rapidly, and by 1971 the number of diving clubs in the two countries had reached eleven.

Inevitably, as with any intrusion of man into virgin territory, the development of the new sport was not achieved without some disruption of the marine environment. By 1965 it was apparent to observant divers that the overall population of fish and shells had been seriously diminished. Surveys carried out by concerned divers in 1966 and again in 1967 unfortunately confirmed their suspicions.

Responsible diving circles realised with concern that the delicate beauty of a unique underwater environment was being threatened with extinction. They responded with a spontaneous effort to protect and conserve. In 1966, divers of the Malayan Sub Aqua Club agreed to a self-imposed ban against spearfishing and shell collecting on certain reefs and islands, and in 1967, the club officially adopted four areas as marine reserves, which were to be totally unmolested by divers; this resolution was circulated to other diving clubs with a request to observe these restrictions under an informal gentlemen's agreement. This was aimed principally at the service clubs stationed in Singapore, who have been responsible for much of the observed damage.

In 1970 the Malayan Nature Society passed the following Resolution:

"That the Malayan Nature Society actively support the Malayan Sub Aqua Club in its programme of conservation of the coral reefs in Western Malaysia, by joining in the submission of a memorandum to authority, urging:

1. official designation of the National Underwater Reserves in selected coastal areas, and
2. legislation for limitation and control of exploitation of reef resources."

The areas selected by the Malayan Sub Aqua Club as interim Marine Reserves are as follows:

West Coast: 1. Four islands off Kuala Kedah: Pulau Lembu, Pulau Kaca, Pulau Paya and Pulau Segantang; 2. One island in the Sembilan group: Pulau Lallang.

East Coast: 1. Pulau Lang Tengah; 2. Tanjong Genting on Pulau Perhentian Besar.

This choice of reservations was determined by several requirements;

- a. that the islands be uninhabited
- b. that the selection represent each of the three biotic zones encompassed by Malayan waters
- c. that they include the principal types of marine environment to be found in Malayan waters.

DAMAGE TO MALAYAN REEFS AND THEIR ENVIRONMENT

The surveys conducted by individual groups of divers in 1966 revealed that there were two basic forms of reef destruction involved.

1. Blasting of reefs by fishermen
 2. Depletion of reef population by commercial collectors and sport divers.
- Of the two, blasting is the more destructive.

Reef Blasting

The results of blasting can be observed on the reefs of every island off the coast of Malaya. Some areas, for example Pulau Redang, have been blasted so often that craters have formed and the reefs have been totally destroyed. Many bays which only five years ago were filled with excellent stands of staghorn coral are now reduced to banks of coral rubble covered with grey algae. Such areas harbour few fish.

Although reef blasting has always been a problem here, the use of explosives has been recently boosted by the introduction of scuba gear. In the past it has not been a particularly profitable exercise since the number of fish which rise to the surface, and are thereby recoverable, is only a fraction of the total kill. But equipped with aqualungs, present day reef blasters can now gather the entire kill, and the return can be enormous. It would be reassuring to be able to state that the boats responsible were of foreign registration. Such boats do come in from Thailand and Singapore, but divers have also observed and examined boats registered in this country fully equipped with aqualungs & air compressors, used expressly for gathering blasted fish.

The economics of this new development are simple. Diving gear is readily available, and compared with the cost of trawl nets, relatively cheap. Blasting guarantees a reasonably large haul, which compared with the uncertainty of trawling is obviously attractive. The fact that fishermen equipped with scuba gear can first search the reefs for the most densely populated areas makes this form of fishing extremely efficient, resulting in maximum hauls for minimum effort.

Unfortunately, the effect of blasting on a reef is totally destructive and quite unselective. It kills not only the commercially acceptable fish, but also the juveniles, the breeding ground, and destroys the entire structure of the interdependent reef ecosystem.

The end result of this will be the decimation of inshore marine life, a radically reduced income for the inshore fisherman, and the loss of a natural asset before its potential for recreation or research has even been assessed.

Although thorough policing of coastal waters is almost impossible, this form of fishing could be greatly reduced, if not entirely prevented, by the provision of legislation which not only prohibits the sale of blasted fish, but cancels without right of appeal the licenses of those dealing in blasted fish. Blasted fish can be identified, and once the sales outlets are removed, the operation becomes pointless.

Commercial Collectors and Sport Divers

The sport of snorkel and scuba diving is seldom sufficient in itself, and inevitably becomes the means of extending the pursuit of various hobbies underwater. The majority of divers either become enthusiastic spear fishermen, shell collectors, marine aquarists or underwater photographers. Under normal circumstances, and if reasonably controlled, such activities have little impact on a healthy reef. But if accessible reefs are limited, or already depleted, and collecting and shooting intensive, deterioration can be rapid. These inroads into reef ecology generally reach serious proportions only when such hobbies become money-making ventures.

Commerce invaded sport diving in about 1966, when overseas servicemen from Singapore were offered cash for every shell taken along the East Coast, which helped to defray the not inconsiderable cost of diving expeditions. Not only were whole stretches of island coasts stripped of their most decorative shells as a result, but every moveable slab of coral and rock on the reefs was overturned in the search, destroying the vulnerable eggs

and small reef dwellers they normally protect. In consequence, much of the underwater landscape of those islands nearest to Singapore has been reduced to virtual desert.

The dealers and traders who sustain this market do not generally dive, or collect themselves in this country; but where they do, they tend to be more thorough and more selective than the average diver, taking only perfect specimens of the more striking species.

The results of the 1966 and 1967 surveys showed a drastic reduction in the shell population, particularly of the more colourful cowries and cones. By 1969, in the northwest of Malaya, the once abundant Mourning cowrie, *Cypraea mauritiana*, had been completely wiped out by collectors.

Spear fishermen have systematically hunted and shot every large grouper to be found on the reefs. Certain large algae grazers such as the Bumpfish, *Bolbometron* sp., and the Hump-headed wrasse, *Cheilinus undulatus*, have been scared off the east coast reefs, and the great herds grazing like buffalo are now seldom seen in Malayan waters.

Marine tropical fish collectors have found lucrative markets in Penang and Singapore, and have denuded several reefs of the most decorative species, notably the Pomacentrids—the damsels and anemone fish. Due to their territorial habits, these are easy prey.

As recently as 1971, the spiny lobsters on Pulau Segantang were so tame that they could be handled by divers. These have been shot out by a small group of divers, and the island is now devoid of lobsters. Being a relatively isolated rock, it is likely to remain so for some time, unless the population can be re-established from other sources.

Still other, and more subtle forms of destruction are unwittingly devised by the very agencies concerned with promoting tourism and industry.

Unintentional Damage

The collection of reef fish is obviously essential to maintain the national aquaria. Scientifically very little is yet known of the interdependence of the diverse parts in a reef ecosystem, but the following observations illustrate the type of disruption which can be caused by ill considered collecting.

"It is only fairly recently that biologists have begun to realize the important role played by cleaners in the sea. C. Limbaugh and the Pederson brothers have kept so-called cleaner stations, or prominent positions on the reef where several cleaners gather together, under continuous observation. Within a period of six hours of daylight they counted three hundred customers for a single cleaner fish. As an approximation, this means that in twelve hours a hundred cleaners would attend to some sixty thousand customers who come to this cleaner station. These divers also saw that sick and wounded fish come for cleaning several times a day. To provide further evidence, Limbaugh caught up all the cleaners known to him on two small isolated reefs in the Bahamas. In a few days, the number of fish in the area fell rapidly; they simply wandered away, so that the previously populated reefs in the vicinity were largely denuded of fish life. After two weeks there remained a few stubborn occupiers of territories, with conspicuously damaged fins, ulcers, white fungus infections and open wounds. Later on, cleaner prawns and young cleaner fish did come in, but the old visitors to the reef did not return. On the other hand, the visits of young customers did increase. From these observations it has been suggested that many very productive fishing grounds off islands, coastal shallows and wrecks are actually cleaner stations, at which deep water and pelagic fish, and also wandering shoals regularly assemble". (Wickler, *Marine Aquarium*, p. 103).

"Short of catastrophic effects, other aspects of human interference, actual or potential should be noted. One such case came to my notice too late for thorough documentation, and is at the level of an interesting suspicion. We had erected at Heron Island for some five years, a static, large-sized fish trap. This either fished out a local population which fed mostly on algae, or (more likely) these fish learnt to avoid the area. When, later on, the traps were removed, the reef flat appeared overgrown with sizeable algae, and the corals less obvious. By an extension and continuation of the process of netting fish, one could possibly swing the balance from a coral-dominated reef to a seaweed bed". (Stephenson, 1969)

It is obvious that we need to know a great deal more about the sea and its ecosystems than we now do.

The underwater world is probably the most fragile of all environments. By nature an incredibly efficient conductor, water is capable of carrying and diffusing over amazing distances materials quite incompatible with the marine population it supports. The clarity of the waters around Pangkor and the Sembilan Islands has visibly deteriorated in the last twelve years. Underwater visibility in Emerald Bay to one time averaged 40 feet, and the reef population flourished. Today 10 foot visibility is considered good, for the sandy floor of the bay, the reef and the rocks are covered in a fine deposit of silt. The source of the silt is probably to be found in the large agricultural projects drained by the Perak River. When it is a question of priorities, industry may take precedence, but better controls can be devised.

RESERVATIONS

The logical solution to these complex and interwoven problems is the establishment of officially gazetted marine reservations and underwater parklands. It is principally thoughtless destruction that is so rapidly reducing the future potential of the Malayan underwater environment, and if some control can be introduced now, the great majority of reefs will survive. Some areas have now been so ravaged that it will take a long time to effect a recovery. But given a protected environment in which to regain their natural equilibrium, recovery will be assured, while the relatively richer reefs will regain their former luxuriance. Conservationists have generally recommended establishing two types of reservations.

- 1) Marine Reserves which are set aside for scientific reference, as a scale against which the denudation of other islands can be judged, and for the conservation of the species generally. Many countries recommended that a percentage of the larger islands be designated Marine Reserves, leaving the remainder open. Such Reserves can provide nurseries from which denuded areas may be repopulated.
- 2) National Underwater Parks which are areas selected for their scenic value, are designed to ensure maximum utilization by the public, and are maintained for the recreation and aesthetic enjoyment of the visitor.

The establishment of reserves and parklands would ensure that an important income earning asset deteriorates no further, and would secure for the future a unique region of the underwater world, so much of which has yet to be explored.

DISCUSSION

E. Soepadmo.—Concerning the legislation to preserve the coral resources, how far has the proposal gone?

What steps have been taken by local Government concerned to prevent or reduce the damaging activities now going on?

R.B. Lulofs.—The Kedah State Government was contacted in February 1972 concerning the protection of the islands off Kuala Kedah. The State Government expressed considerable concern about the damage occurring on these islands. It was discovered, however, that the islands come under Federal jurisdiction and so protective laws could not be established by the State. However the State secretary requested that I obtain examples from other countries of legislations specifically formulated to establish marine reserves. These would then be used by the State Legal Adviser as a guide in drafting legislation for presentation to the Federal Government. Copies of legislation on Marine Reserves have been obtained from a number of countries; some more are yet to come.

As far as I am aware no actual steps have, or are, being taken by local Governments to prevent destructive exploitation of reefs.

A.J. Berry.—Seasonal cycles of accumulation and removal of silt are known to occur in several shallow seas (off S.W. India, W. Africa). Might the silting that you describe off the Sembilan islands be seasonal or is it a gradually worsening, permanent accumulation?

R.B. Lulofs.—A certain amount of the sediment observed could have been due to a cyclic movement of silt, but the overall impression is one of progressive deterioration in underwater visibility over a number of years. From personal observation it would appear that the silt deposits around the Sembilan Islands are the result of new sediments coming from as yet unknown sources and that the present conditions are more likely to deteriorate than improve.

Protected Habitats for Protected Animals¹

FRANCIS C. CADIGAN, JR.² AND LIM BOO LIAT³

The recent enactment of much stricter laws in Malaysia on the killing, capture or possession of either live or dead wild animals is to be greatly applauded. This is an improvement on the previous less stringent limitations particularly in respect to the totally protected species (Table 1). These 34 species should benefit by being so designated not only

TABLE 1. Totally Protected Animals

Orders	Type of Animals	No. of Species
Primates	Gibbons	3
	Slow Loris	1
Pholidota	Pangolin	1
	Flying-lemur	1
Dermoptera	Cats	4
	Bearcat	1
Carnivores	Civet	3
	Dog	1
	Marten	1
	Weasel	1
	Flying Squirrels	11
	Long-tailed Porcupine	1
	Malayan Tapir	1
	Rhinoceroses	2
	Banteng	1
	Serow	1
Total	7	34

by removing the negative aspects of hunting, but hopefully on a positive basis for attention to the factors which may increase their numbers. Our title is meant to emphasize this latter aspect. It is obviously absurd to totally protect an arboreal creature such as flying squirrels or gibbons and then cut down all the trees. It would be like prohibiting fishing in a pond to save the fish, and then draining the pond. On the other hand it must be equally stressed that preserving the habitat for animals does not mean banning all logging, agriculture or other use of land. Conservation is not antithetical to development. In fact, some of the protected species require some "development" of land. Some of these species (such as the slow loris) do just as well or better in secondary forest which tends to have more diversity of fauna and flora and thus wider food range. There are protected species which are primarily secondary forest dwellers such as the brush-tail porcupine and the giant squirrels. Some animals require areas which are almost completely cleared of trees and which become pastures. For example, seladang are grass grazers and do best where there are some open fields in which to feed in the evenings and also forest in which to shelter during the day. Thus, removing trees from an area, provided that some forest is left, will increase their numbers. This is very dramatically

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shown by the experience in some of the eastern states of the United States of America which, although in the most heavily populated part of that country, have much larger numbers of deer than in the far past and indeed show a steady yearly increase.

Of the 34 totally protected species, 15 presumably require primary forest, the others do not appear to have any marked preference. Some need a "quiet" habitat and thus are more common in primary forest but probably do not need primary forest.

What then do we mean by protected habitat? We do not mean that it cannot be cut or disturbed in any fashion. On the contrary, we mean only that it be kept in its optimum condition. For those animals which do better in secondary forest, the habitat *requires* periodic logging (of the selective type usually done in Malaysia, not the total stripping done elsewhere). We do not mean that there need be twenty parks the size of "Taman Negara". Not only the country cannot reserve such large amounts of land, but it is not necessary. Probably the number of large parks and reserves presently established are adequate, but there is a need for additional small reserves. These need not be large and they could be used for multiple purposes. We would like to cite two examples of what small areas can be used and how multiple usage can be made of areas.

At Kuala Selangor, there is a park which, including some government officers' houses, measures about 44 hectares. In that area there are three troops of silvered leaf monkeys numbering over 100 animals which live exclusively in the park. (In addition, there are two troops which occasionally overlap). Thus a small area preserves a national historical site (where a Dutch invasion was resisted), a pleasant park for the town of Kuala Selangor and a species of monkey. None of these uses interfere with the others. Parenthetically one should mention that numerous birds nest there and many small mammals. We cite the monkeys because they are easily seen.

A second area which comes readily to mind is at the Lima Belas Estate of the SOCFIN corporation. On a cluster of hills measuring some 75 hectares there exist gibbons, two species of leaf monkeys, two species of macaques, wild boar and a variety of squirrels. This area was considered less suitable for planting, so the officials' houses and club were built on part of it. The remainder has been left alone. The animals have been cut off from the rest of the forest for about forty years, so they are obviously well established and reproducing well. The SOCFIN management reports that although the monkeys occasionally go into the oil palm to eat nuts, it is only an occasional foray (which is to be expected since primates prefer a varied diet) and that the estate records do not show any difference in the yield of the areas close to these hills in comparison to those further away. This company is to be congratulated on their interest in preserving the wildlife of Malaysia and for not succumbing to the common failing of shooting any monkey seen near a tree. Because they are easily seen and readily identified in a tree, monkeys are frequently blamed for the damage done by rats (which is considerable) but which is easily distinguishable. This blame on the monkeys occasionally reaches a ridiculous level of anthropomorphism as in a quote published in the Straits Times commenting on damage to new seedlings. "In these instances there appeared to be little purpose in the action other than wanton destruction." It is possible for private corporations as well as federal and local governments to assist in the preservation of Malaysia's wildlife. There is little cost to the organization and a large amount of both enjoyment and satisfaction from participation in this important work.

It is necessary that different kinds of forests be kept as preserves for different animals. One would expect that a fair amount of montane forest would be left alone as economically unfeasible to use. It should be noted in Figures 2 and 3, that upper montane forest will

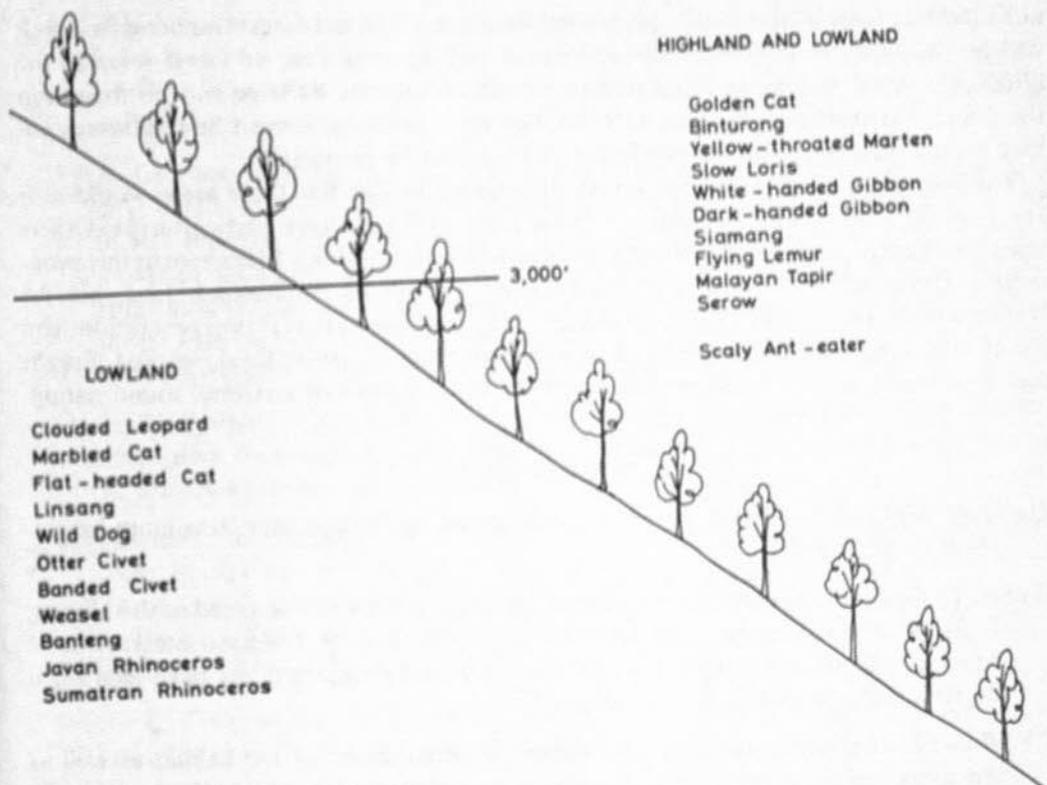


FIGURE 1. Habitats and Altitudinal Distribution of Totally Protected Animals. (Rodents Excluded)

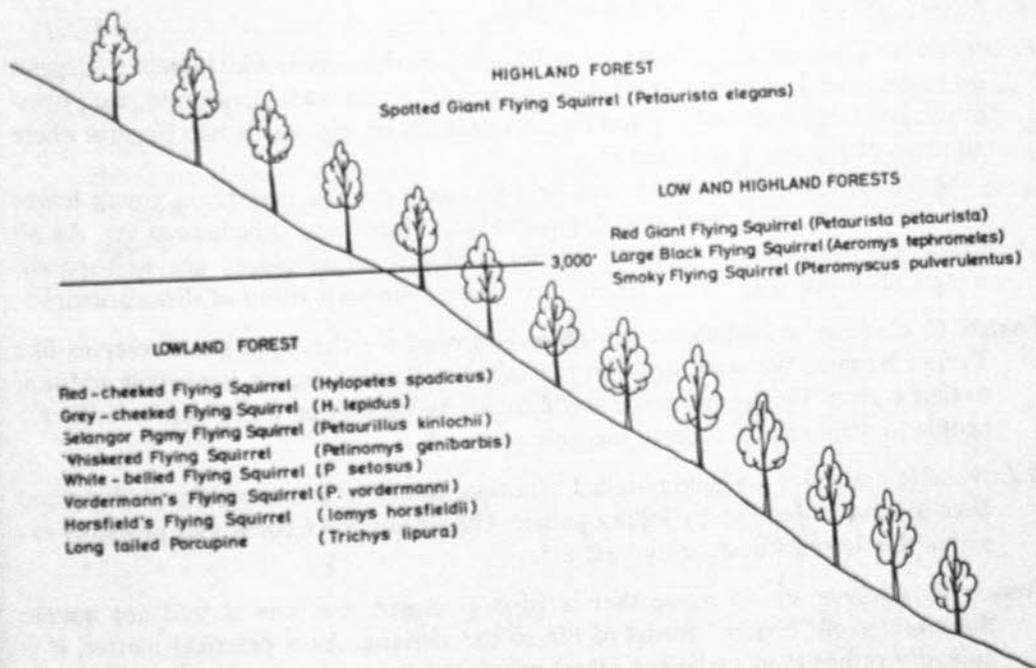


FIGURE 2. Habitats and Altitudinal Distribution of Totally Protected Rodents.

not suffice as most of the totally protected species are lowland forest dwellers. Research will be necessary to determine the minimum and optimal sizes of forest reserves for different species, bearing in mind that forests must not only be large enough to sustain the fauna, but their own flora as well. At the very minimum, it must be able to sustain that protein necessary for the particular animal(s) to be protected.

We have mentioned the conservation of animals so far, but these areas would also conserve the flora as well and act as a "gene reservoir" for future horticulturists. Others have commented on the value of such areas as tourist attractions. Elsewhere in this programme, the need for such areas in flood prevention will be emphasized. Last, but far from the least, these areas will preserve Malaysia's heritage so that future generations can see at least a part of the jungles and fields where their ancestors lived, worked, fought and died in the cause of independence and the development of a strong, sound nation.

DISCUSSION

David W. McCredie.—How far apart must branches be for optimum/maximum brachiation of gibbons?

Francis C. Cadigan, Jr.—Optimum distance depends on the size and speed of the gibbon. In large cage situations, they seem to prefer the bars at 7-8 foot intervals but I have seen them swing twice that distance. I would estimate that I have seen them do about the same distance in the wild.

J.A. Bullock.—I strongly support the concept of preservation of the habitat as well as the protected animals. This is important to preserve the unconsidered species of arthropods, etc.

I question, however, whether the small areas are floristically self sustaining. Would Dr. Soepadmo comment on this?

E. Soepadmo (Comments).—Elephants and Sumatran rhinoceros which seem to depend on leaves and fruit of various species of palms, Rubiaceae, *Artocarpus*, etc., obviously need large tracts of lowland forest, say about the size of Taman Negara, where all these plants are mainly found.

Similarly, siamangs, gibbons and leaf-monkeys depend mainly on young leaves and fruits of various species of Leguminosae, Moraceae, Dilleniaceae etc. As all these trees are basically lowland species, and individual plants are well-spaced, a tract of forest of at least 5 sq. miles is needed for each troop of these primates.

Francis C. Cadigan, Jr.—This is why there is a need for the large game reserves like Taman Negara. We wish to point out that small areas are an important addition to that system. Furthermore the small areas can be located more conveniently for people to visit and to observe the animals.

B.J. Wood (Comment).—The long-tailed Macaque comes into young palm planting and does economic damage by killing palms. This is not for feeding and probably explains the 'wanton destruction' attitude.

Francis C. Cadigan, Jr.—I agree that is what is meant, but one should not impute the motives of "higher" forms of life to the simians. As a practical matter, it is curiosity rather than malicious intent which result in damage. Macaques are "explorers" of their environment and are quickly drawn to anything new, which must

then be picked up, turned over, smelled, bitten, tasted etc. It is very much like the behaviour of a human toddler. If the animals are kept at a distance for a short while by watchmen or watchdog then the sight of the plants is no longer novel and thus no more attractive than any other plants.

N.P.E. Langham (Comments).—It is dangerous to assess areas in terms of species density, especially the 'islands' of trees that you speak of, since as the islands decrease in size the edge gets proportionally larger. In birds for example, some species increase to quite high densities where two habitats border on one another and therefore small islands would appear to have a very high density in proportion to large areas. I suspect the same effect may operate with some mammals, yet at the same time may preclude the existence of other species, as it does in birds.

Francis C. Cadigan, Jr.—I agree. We do not wish to imply that the number of species or relative frequency will be unchanged. The small reserves are specifically aimed at preserving certain animals.

K.N. Samuel.—Is there any possibility of trapping badly threatened species and rearing them in captivity in place like the Zoo Negara with the possibility of re-introducing them to their natural habitats in National Parks, etc.

Do our conservation efforts receive any support or advice from the I.U.C.N. or is it part of its programme.

Francis C. Cadigan, Jr.—In answer to your first question this would be thought of only as a desperate "last ditch" stand. It appears that this may be the only way in which the orang-utan is going to survive for example and if the swamp forests are further reduced or if hunting is not completely stopped it may be the only way in which rhinoceros will survive.

A.J. Berry.—Do we know just how small an area of forest will suffice to support populations of the different species of primates?

Francis C. Cadigan, Jr.—No, we do not. We only have the data which we mentioned. These may or may not be minimum size or even unique situations. We believe that this is a necessary and very important matter for research. At the same time it will be necessary to determine whether the necessary part of the flora will be self-sustaining in the optimal area for the animals to be protected.

Mount Kinabalu and Development in Peripheral Districts in Sabah: A Review of Progress of the Sabah National Parks

DAVID W. MCCREDIE¹

The author at this time does not intend to describe Mount Kinabalu or the history of the National Park which is now known widely throughout Southeast Asia and the world. These have been adequately documented in previous issues of the *Malayan Nature Journal* and the *Sabah Society Journal*.

Taking Mount Kinabalu in its physical setting one must remember that the massif is one of the biggest biological resources in this part of the world by the uniqueness of its sheer size, height, botanical and zoological phenomena. It stands out like a canine tooth above the peneplain summit accordance of the Crocker Range. To quote Alexander Dalrymple, one of the earliest explorers of the region, over two centuries ago:—

"Though perhaps not the highest mountain in the world, as some of the Spaniards reckon it, it is of an immense height."

It features highly in the tourist attraction of Sabah and it is perhaps safe to say that it is Sabah's greatest asset. The Kinabalu National Park visitor figures and annual revenue have been showing a steady increase (Figs. 1 & 2) with the improvement in visitor facilities and road conditions.

The road northwards from the State capital is sealed as far as Tamparuli and the hill road from there on is now considerably improved with re-alignment and widening. Such improvement has brought in conjunction an increase in the viability of highland vegetable farming on the southern flanks of Kinabalu. There has recently been a Farmers' Association set up to facilitate the initial investment, growing and marketing of these vegetable products. The almost complete (and now quite passable) trans-Sabah Highway has enabled marketing of the vegetables to go eastwards and westwards to the two main ports of Sandakan and Kota Kinabalu with relative ease.

Road access to the Ranau area has been upgraded by Japanese interests in developing the copper lode on the southwestern flank of the Kinabalu massif. Prospecting is now complete and the removal of the overburden is well under way for the eventual refining of the copper ore on site to be exported as 30% Cu concentrate from a new port at Usukan near Kota Belud. Such works in the headwaters of the Sungai Mamut has brought about pollution problems lower in the Lohan and Poring Plains. However, adequate piping of clear water supply for human consumption has been installed and assurances given over safety measures due to spillage, wastage and filtration through the projected tailings area in the Lohan Plain. The main result is an increase in the diversity of the economy of the rural Ranau area. This spills back into the Park in form of revenue taken as bathing fees from a steadily increasing number of local visitors at the Hot Springs Station at Poring.

The Board of Trustees accepted in principle last year that a new headquarters area be established on the Pinosuk Plateau—a dissected piedmont on the southern flanks of Mount Kinabalu. More diverse facilities are envisaged here such as a golf course in-

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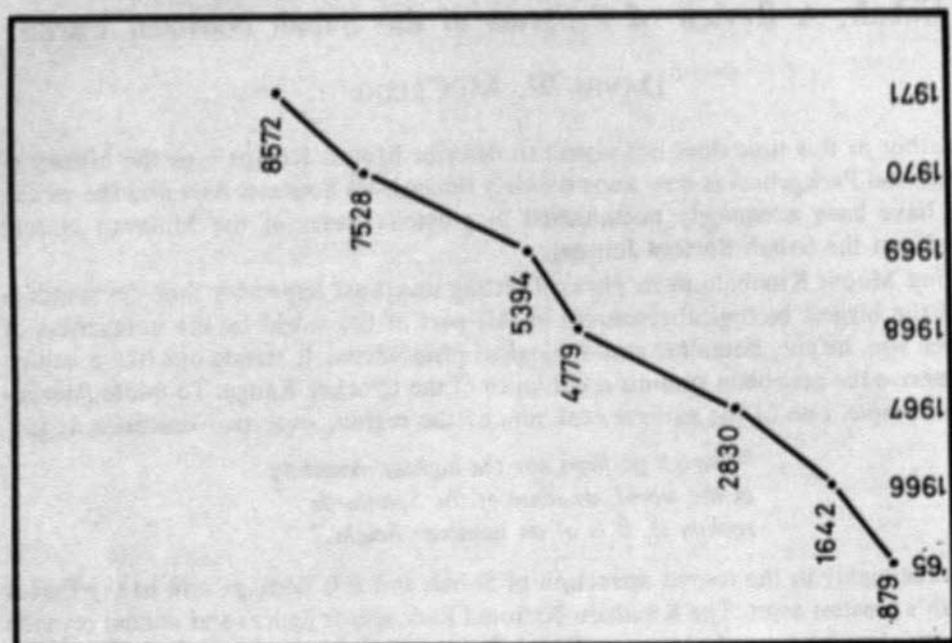


FIGURE 2. Visitor Figures, 1965-1971.

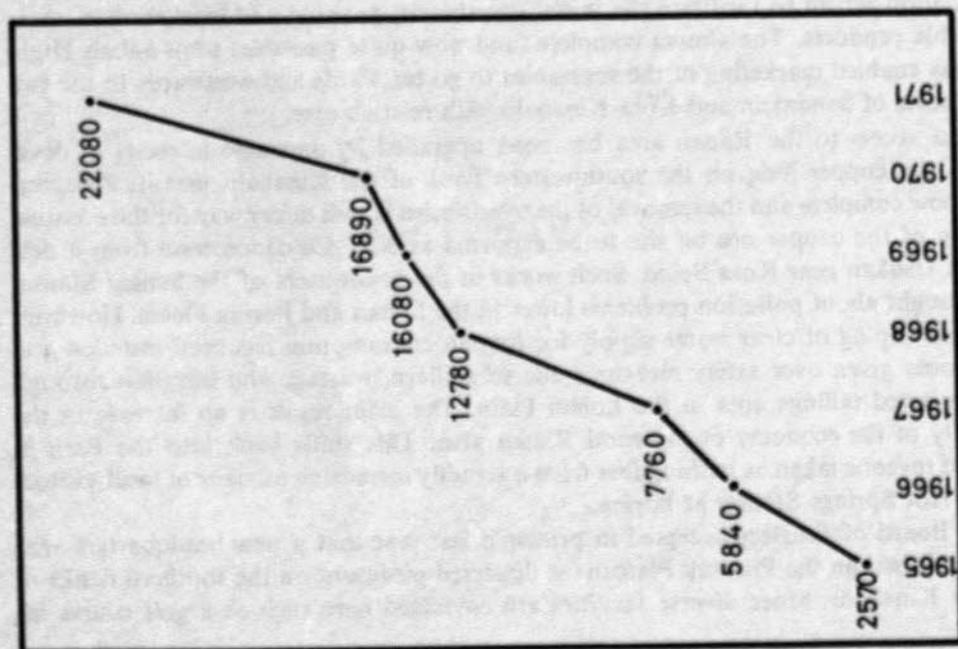


FIGURE 1. Revenue (Accommodation and Rest House Fees) for Kinabalu National Park, 1965-1971 (Expressed in Dollars).

cluding a small airstrip, a full-scale hotel and a visitor centre-cum-field museum and other attractions. A grant has been received from the State Government to go ahead with feasibility studies, quite a lot of encouragement having been given by the P.A.T.A. delegates earlier in 1972.

To compensate for the loss due to copper mining of some 10 square miles of the original gazetted area of the Kinabalu National Park, a proposal has been favourably received to include Mount Templer Forest Reserve contiguous with the Park to the north in Kudat District. This provides for the preservation of the lowland hill Dipterocarp forest of the Crocker Range and further enlarges the biotopic spread of the natural phenomena. Administration of this northern part of the Park (a huge task even now over its 265 square miles) will be facilitated by building of a new road from Ranau to Bandau, on the northeastern flank under the Second Malaysia Plan.

As the capital Kota Kinabalu spreads out and becomes more and more the hub of commercial and administrative activity in the fast moving pace of Sabah's development, so it is necessary that some of the immediately surrounding natural beauty should be preserved. A proposal is with the State Government for the incorporation of nearby Pulau Gaya, Pulau Sapi and associated coral reefs into the Sabah National Parks. It is certainly the case—as in West Malaysia—that early protection of the coral and beaches is very necessary and an opportunity can be taken to preserve the still splendid stand of primary forest from the sea shore to an altitude 1000 feet on Pulau Gaya. It is intended to call the Park after the former Prime Minister of Malaysia, Tunku Abdul Rahman.

To summarise in conclusion, it is fair to say that the Sabah National Parks Board of Trustees is well aware of the situation of the counter-play of biological resources and national development by making the former an integral part of the latter in science and recreation for posterity. It is hoped that some day it can be said, "Let's go to Sabah to see and appreciate all that is wonderfully preserved from the tropical coral reefs to arctic mountain top!"

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DISCUSSION

M.S. Barlow.—Is there any possibility of establishing in the Kinabalu National Park, a regional S.E. Asian Field Centre on the lines of Flatford Mill? (U.K.).

D.W. McCredie.—There has been a recent policy statement by the Chairman of the Sabah National Board of Trustees that future development of the present headquarters area would include a research facility along such lines. I am sure that if a concrete proposal was put to the Board, this would be forwarded to higher authorities quite enthusiastically and with some hope of success.

E. Soepadmo.—Have the roads and transport facilities been improved? 3-4 years ago these facilities were very inadequate?

D.W. McCredie.—Yes. The road has had considerable improvements with the development of the Copper Mine and the tour of the P.A.T.A. delegates earlier this year.

E. Soepadmo.—How effective is the protection on the boundary of this park?

D.W. McCredie.—There is a broad rentice around the whole of the boundary with trees marked with red paint and plates at regular intervals. Ranger patrols go out periodically to maintain this and report ingressions or disturbances. I think these are minimal considering the vast size of the park and steep terrain. The emphasis in local government is to shift rural kampong groups nearer town centres on more suitable land (assisted settlement schemes) and I would say that pressures of disturbance will not get heavier for the main part and patrolling will be stepped up where necessary.

E. Soepadmo.—Is there any plan of extending the park to include N.E. slopes of Mt. Tambuyokan?

D.W. McCredie.—These slopes are already within the present National Park Boundary. There is a proposal from the State Forest Department to include the Mount Temppler (36 sq. miles) and the Tagaroh (4 sq. miles) Forest Reserves in the Park. This will somewhat compensate for the loss of the Mamut Copper Mine area and increase the biotopic range of the Park.

H.M. Samuel.—Is there any species of migratory birds using the park as a nesting ground?

D.W. McCredie.—I believe this is not the case as most birds seem to migrate to Sabah to winter only. Not enough ornithological research has been undertaken to be definite on this point.

Land Settlement and National Development in Malaysia

TUNKU SHAMSUL BAHRI¹

Since the end of the Second World War practically all the national governments in Southeast Asia have emphasised the relevance of and need for developing new lands for distribution to those who are either landless or who have insufficient land to cultivate to support the basic needs of their families. In this respect, Malaysia is no exception. During the past 15 years Malaysia have increasingly emphasised the importance of the role of land development within the context of its national development programmes. Since independence in 1957, Malaysia has prepared four five year Development Plans i.e. the First and Second Malaya Development Plans (1956-1960 and 1961-1965) and the succeeding First and Second Malaysia Plans (1966-1970 and 1971-1975). During the First Malaya Development Plan, the national government had plans to open up some 100,000 acres of new land through the Federal Land Development Authority (F.L.D.A.) and the various State Governments. By the end of the Plan period only 30,000 acres of new land had been cleared of which only 50 per cent was actually planted. Despite the smallness in achievement, the Government increased its target for land development to a total of 330,000 acres during the 1961-1965 Plan period. Again the achievements fell by about 30% short of the targets. For the First Malaysia Plan Period, (1966-1970) the Government intended to open up a total of 450,000 acres in West Malaysia and another 140,000 acres in East Malaysia. It has been claimed that during 1966-1970, about 330,000 and 164,000 acres were actually developed in West and East Malaysia respectively. (Second Malaysia Plan, 1971-1975, p. 125). On the strength of the above claim, the Government proceeded to increase the target of land development over a million acres during the Second Malaysia Plan, 1971-1975. This target, it must be noted, is larger than all the acreages actually developed during the previous three Development Plans. Given the above trend and the increasing dependence on land development in the thinking and minds of the politicians and planners in this country, it is fair to conclude that it will continue to be equally important during the next two decades or so.

On the basis of the various statements issued by the government from time to time, one is tempted to conclude that the shortfalls in land development experienced during the past 16 years were not due to the shortage of funds but more to the shortage of personnel and expertise. In view of this, we can safely say that the ability of the government to implement the current gigantic land development target depends on its ability to train and recruit sufficiently qualified personnel during the next few years. Given these circumstances, one would have expected the government to consolidate and utilise all available personnel to the maximum but instead it continuously acts to the contrary i.e. by increasing the number of implementing agencies and thus spreading out very thinly whatever limited available personnel. On the other hand, one has also to consider and sympathise with the government, at least politically, that with the increasing dependence on the vote, the electorate and the number of people that have to be pleased and consoled, it has little choice but to repay them for the various services that they have rendered to the party. It is thus little wonder why many of these newly established land development agencies are being headed by politicians or their close associates. It is partly because of the strong political factor involved that many of the physical, social

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and economic implications of rapid land development tended to be relegated as secondary.

One of the physical effects of rapid land development in the country is flooding. There is little doubt that the removal of the natural cover from large acreages of land has been partly responsible for the spate of floods in West Malaysia during the past few years. The relationship between land clearing and flooding have been long recognized, but until recently no attempt was made to study the actual causes and the ways of reducing such occurrences quickly and effectively. Given the direct relationship of flooding and land clearing, let us attempt to examine how the gigantic land development programmes of the Second Malaysia Plan will aggravate the situation if no serious checks are introduced immediately. This problem is closely associated with the principles and bureaucratic procedures of land development adopted in this country. Before any area can be developed, approval has to be given by a number of technical departments. For example, the Department of Agriculture's approval has to be sought as regards to the suitability of the soil; the Department of Mines must also ensure that the area is free of deposits of economic minerals such as tin, bauxite etc. This is to ensure that economically workable mineral deposits are not lost as a result of agricultural development. In addition, clearance must also be obtained from the Department of Forestry whose duty is to see that all valuable timber must be carefully harvested before the area is released for agricultural purposes. This is the essential procedure that has to be followed in the opening of every scheme. Considering the number of areas or projects to be developed during the next few years by as many as 15 different agencies, the questions would then arise: Is there sufficient coordination and cooperation among all the various implementing agencies and the technical departments regarding the need for a planned and controlled forest clearance? Besides is there enough personnel in the various technical departments to see that every area earmarked for development would be adequately assessed and scrutinised to ensure that floodings will not occur? Haphazard surveys and forest clearance will no doubt result in increased flooding. The magnitude of this crisis cannot be fully realised on the basis of one year's activity or from the activity of only one Department. It would be necessary to recognise the problem on the basis of the activities of all the Departments over the years.

The impending physical crises, however, have to be considered together with the urgency and need to overcome rural poverty and general landlessness. Even with the current rapid rate of land development, there are more landless people in the country today than it has ever been in the past. This arises from the fact that the increase in the population of the country outpaces the ability of existing industrial and rural development projects to provide employment for the people. Industrialisation and urbanisation at current rates cannot and may not be able to keep pace with the present growth in the population. The answer is still to be found in the land. The crises of unemployment, poverty and landlessness have to be adequately tackled and overcome.

Whereas in the majority of the developing countries there is a tendency to solve the above rural based problems through land tenure improvements and land development, it is the political philosophy of the existing government just to concentrate on land development and to delay, for as long as politically convenient, any interference with the prevailing tenancy situations in the country. But the time will come when land tenancy reform has to be seriously considered as a complementary solution. But until such time, it is the conviction of the government to solve the rural problems through land development. Although one may sympathise with the dilemma of the government and the plan-

ners of either to develop and open large tracts of land at the expense of flooding, one cannot avoid thinking that the two are not completely diametrically opposed to one another. In fact, we can still open large tracts of land without resulting in excessive flooding if sufficient measures can be introduced.

Developing new land is not an end by itself. It is only a means to some complex end; it has become only an instrument and a method in solving the earlier mentioned rural and national problems. Besides these general objectives, it is also the intention of the government and the planners that the rural population which have been denied all those community facilities and social amenities enjoyed by their urban counterparts could be easily extended to them. In short, there is the implied intention of 'urbanising' the rural population through the introduction of such facilities in the rural areas. It is thought that one of the best and easiest methods of injecting this "urban" element is through the creation of new nucleated settlements. The rationale behind this kind of thinking is that when people are settling in a new area, the economic and social situation are still very fluid and therefore, they are considered to be more open to social and economic changes. In fact a well planned land settlement project can lead to rapid social and economic development, which in present day is often interpreted as either 'modernisation' or 'urbanisation'. Besides it being beneficial to the settlers themselves, the new settlement can also act as a good example, for the surrounding old established population and villages. This is again a very noble intention and could probably be done. But intention and implementation are often two very different things altogether.

It would probably be most surprising to note that only a very small portion of the current land development and settlement projects in Malaysia can actually be said to conform to this kind of expressed intention. In this respect, the FLDA project comes to the forefront. Within its new settlements there are definite programmes of extending the so-called urbanising or modern facilities and amenities which would probably create a favourable environment for the injection of modern ideas and attitudes. The environment and atmosphere must be prepared first; and this is being done in the FLDA even though not completely satisfactorily. In the other projects, such modernising environments are completely absent, and thus land development more or less becomes an end by itself. Land under those circumstances are distributed without any concerted effort being made by the government and the agencies concerned to bring about changes in attitudes and environments. Sometimes, when such efforts are being made, there seems to be greater interest in infra-structural improvements like roads, mosques, water supply, houses etc. Whereas these are essential and necessary, they are not sufficient to create attitudinal and mental changes. This has been learnt by the FLDA, because after opening large tracts of land and resettling people, it was suddenly realised that the settlers have not improved or changed as expected and for this reason they established a Settler Development Division in 1967. Whatever it is, before the introduction of such changes, there must be sufficient research and understanding of the problems and areas that require changes. The policies guiding such changes must be based on intensive research and deep understanding and not mere impressions. Here again, it is most unfortunate that the people doing the research and those involved in making the policies oftentimes belong to different institutions with the minimum contact and communication. This is a very disheartening state of affairs which when remedied can be of great benefit to everybody concerned.

Although we have repeatedly been given the impression that there is no shortage of money in the country to finance the projects, money is a very serious matter and a source

of problem in most land development schemes. Although there may be money available for initiating projects, the financial problem among the settlers are tremendous. Many may have the impression that the settlers are being resettled completely at the expense of the government. This is far from the truth. Although the government provides the infrastructure and administrative services free of charge, the actual cost of developing the land and the crops during the immaturity period is still being burdened and paid for by the settlers. In other words the settlers have eventually to pay for all the costs of development. All that the government is doing is to advance the money to the settlers which have to be repaid in-toto. These advances made during the immaturity period of the crops are not given free of interest. The interest rate currently being charged by the government on advances and loans made to the FLDA settlers stands at $6\frac{1}{2}$ per cent. Although this rate of interest is lower than the market rates, it is definitely lower than what the government usually pays for their international loans. Secondly, this rate is very much higher than those charged by the government for loans given to the Government Servants (including high-ranking politicians) to assist them in building houses or buying cars etc. The normal rates charged for these loans are usually 4 per cent. It is most ironical that a government which is so committed in trying to narrow the gaps between the haves and the have-nots should adopt this inverted differential policy of charging interests. Under all circumstances, it is definite that the needs of the settlers are far greater than those of the government servants. Although owning houses may be necessary at one stage or another but it is not a real necessity especially considering the fact that the housing element is already provided for in the salaries. More serious is the fact that the purchase of big cars is a luxury. Considering all these in relation to the resettling of the very poor farmers, both items become luxuries, and yet the settlers are being charged higher rates of interest for very much smaller loans. A government housing loan may be as much as \$70,000 dollars whereas the development loan of an average FLDA settler is around \$13,000. The irony of the problem is too obvious to require further elaboration.

The land settlement and development programmes have been operational for nearly 15 years and if things are going on smoothly as planned, the settlers in some of the earlier schemes would probably be in the last stages of their repayment schedule. Within a few years, the settlers and the schemes would logically be independent from the respective agency administration and be treated like any other village and settlement. At this very stage, one may ask a few relevant questions: Has the original aims and objectives of the government for the settlers been successfully met? If they have, then it is logical for us to conclude that the land development programmes in the country will have a bright future. If they have not, then probably the time has come for a serious review of the programmes, targets and manner of implementation of these projects. Out of the many projects on land settlement, there should be enough evidence to indicate which type has provided the best benefits and thus expanded; and which others have not been successful and thus quickly abandoned. It is not too early to make these assessments i.e. if it is already not too late.

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DISCUSSION

Haji Hamdan b. Sheikh Tahir.—The speaker has approached the subject mainly from the angle of a geographer and land development student with the result his comments may be applicable to land development in general. His remarks on the defective machinery of cooperation among government and private bodies for the land development schemes are worth looking into with care to ensure their success in the future.

I am happy to have had the opportunity to listen to this short address.

Peter Wilkins.—To gain a perspective on the problem of the multiplicity of agencies involved in land development, could the speaker indicate the proportion of land developed by FLDA relative to the other agencies.

Tunku Shamsul Bahri.—We can safely say that the FLDA has been responsible for the opening of between 35-40% of all the area developed by government agencies since 1956.

Peter Wilkins.—As the largest agencies in land development using perhaps the most advanced methods, what is the actual success of their schemes? In particular could the speaker comment on the problems such as retention of the children of settlers, and the dependence of very large schemes on a single crop.

Tunku Shamsul Bahri.—It is not easy to assess the actual success of the schemes implemented by the FLDA. For example, it has been able to open up land according to the programme, but due to a number of ground problems, it has not been able to physically resettle the actual projected number of families. Of course there are a number of critical problems related to the children of the settlers. Sometimes there are insufficient school and other educational facilities in the schemes and thus they have to be sent out of the schemes. As a matter of fact, it should be a wrong policy to retain all the children in the schemes especially those that can obtain better job opportunities elsewhere. The advantages or disadvantages of depending on a single crop in all these schemes completely depend upon the world prices of the produce and this is usually beyond the power of either the FLDA or, for that matter, of the National Government.

K.N. Samuel.—Is there any recruitment of skilled personnel from overseas or training of local personnel to compensate for the lack of skilled man power in implementing the settlement programmes?

Tunku Shamsul Bahri.—As far as I am aware, there is no specific policy of recruiting expatriate personnel in implementing land schemes outside those "employed" through inter-governmental aid programmes etc. and those insisted by agencies from where the government obtained their loans. Since the type of skill required in implementing settlement projects are rather varied, it can be said that all the

institutions of higher learning in this country are involved, in one way or another, in training such personnel. In addition to that, the various agencies have their own training programmes.

J.A. Bullock.—In view of the financial implication, is there any difficulty in recruiting settlers?

Tunku Shamsul Bahrin.—There is no difficulty, whatsoever, in recruiting settlers for the various projects. In fact, the FLDA has recently announced the temporary closure of new applications. This could, however, be interpreted in two ways. Firstly, it is either that the various agencies cannot cope with the demand for land in this country, or the situation of the common rural farmer is so bad that, despite the financial implications involved, they still preferred to be resettled in these schemes.

Population and Family Planning

S. ZECHARIAH¹

Man is the victim of the excessive multiplication of his own species. Unbridled population and environmental problems over an increasingly large part of the world defeating the legitimate aspirations of mankind.

For a proper understanding of population, population changes and their interrelationship with social attitude changes some elementary knowledge of demography is needed. This need not be a mathematical exercise because we are trying to reach not only all those interested in social studies, who are not necessarily specialists but also all those who share a common need to understand population movements, which, so often, determine social change. This population change is the net effect of births, deaths and migration. The experts, having determined the various factors governing births, deaths and migration can estimate past and future changes. Population education is now emerging as the problem oriented and inter disciplinary approach to making the school education more relevant to life situations. The aims are to create informed people capable of making responsible decisions regarding population policy matters, and to develop responsible fertility behaviour as might be decided by the needs of society.

Let us then take a look at man's demographic history. From figures used by the United Nations we find that it required perhaps 200,000 years for the human race to number 1000 million by 1830, while it only took another 100 years to add the second 1000 million, 30 years to add the third 1000 million and the fourth 1000 million is coming at the rate of 70 million a year, a mere 14 years time.

Malaysia's own population in 1970 census was 10½ million and with the present rate of 3% the population will have increased by 3 million by 1985. The 2% birthrate target rate set by the Government, if unchanged from 1985, will be sufficient to double the 13 million by the turn of the century. Of this, 45 to 50% will be under 15, posing serious problems of unemployment, housing etc. It has been estimated that at least two thirds of the population will be young and dependent on the remaining one third of the working adult population. This dependant population will naturally drain away the economic resources of the nation. It would thus seem that these resources are required merely to provide for a population increase, leaving little scope for improvement to individual welfare, to bring productivity up to a level per head that may give a reasonable standard of living. The reverse is of course true in countries where populations grow slowly and this growth turns out to be the widening gap between the rich and the poor.

When Thomas Malthus published his treatise in 1798 he defined the population primarily in terms of food supplies and the threat to famine. Ever since the threat of over population has been largely in his terms. He is also the one who said that the increase of population will take place, if unchecked, in a geometrical progression while the means of subsistence will increase at only an arithmetic progression. In the sixties, when leaders of the world were concerned with food shortage in the developing countries the population problem was regarded as virtually synonymous with the food problems. Now in the seventies we are faced with the need to redefine the population problem and bear in mind two factors. The first the agricultural break through in the poorer countries where, although it may not be a solution to the population, it is diminishing the pros-

¹ Highlands Malaya Plantations Ltd.

pects of famine. While this threat is diminishing, the number of young people entering the labour market is rising rapidly. This is the second factor. This has resulted in the food—population problem becoming the employment population problem. Feeding the increased populations is a big task for the agriculturists and the technologists, but it is likely to prove much more manageable than providing jobs. For the labour force explosion could prove an even greater threat to peace and stability than did the threat of famine.

Since the Industrial Revolution, the most enduring social change everywhere has been the steady movement of population from the rural areas to the cities with the possibility of these cities becoming human trash heaps, the very opposite of the centres of civilisation envisioned by the philosophers. Whether in route to New York, Calcutta or Kuala Lumpur thousands are voting with their feet for almost any alternative to remaining in the countryside. The results are the ghettos, the beggars and the squatters. However, the loss to urban migration is more than compensated by the rapid growth of the rural population. The world's population remains predominantly rural. More than half the world's people live in rural Asia.

The increase in population as you have seen we have to face, but it is all too clear that it cannot be allowed to continue. If it is not to be stopped through famine, pestilence and war it must be solved through conscious policy. This policy should be based on the fertility, mortality and human needs together with all the social sciences for, social systems must change with population change. Change in human affairs never comes easy as governments and Family Planning organisations are finding out much to their detriment.

In the past, family planning programmes in the developing countries were started and handled by voluntary bodies consisting of a handful of well meaning people who, depending on grants and donations were not able to undertake forceful programmes requiring break through of culture, religion, customs and traditions. When family planning became national policy and part of various countries' development plans it has become easier to reach the masses with the help of government machinery, medical personnel, clinic facilities, cheaper contraceptives, research and follow up. However, the efforts of the educator, the social worker, the nurse and the doctor are not sufficient as time is running short, new thinking is needed by those in a position to influence population policies and by population education.

A major programme of research is needed, both in the factors influencing parents in their family building and into the profitable effects of various measures of State policy.

Changes such as the following are worth studying:—

- a) limitation of maternity leave and benefits to all female employees
- b) reconstruction of tax rates
- c) re-thinking on the matter of allocation of public housing
- d) subsidised confinement fees in Government Maternity Hospitals to be modified to act unfavourably for each subsequent child.

Most important of all if, with better health facilities and less malnutrition, much larger number survive and assured food supplies are becoming a precondition for the wide spread adoption of family planning, then it is only right in the light of all that has been said that family planning should become a precondition to employment.

Asian countries may not be prepared for these, what may seem 'drastic' measures, we are even less prepared for the consequences of an explosive and uncontrolled rise in

population resulting in serious development problems, rooted in the desire of all peoples to share in the benefits of economic progress. When aspirations are aroused, and the relative prosperity in society begins to change the resulting dissatisfactions may lead to violence.

As I said before, change never comes easy but change there has to be if we want to belong to a world community. This touches upon all our lives whether we believe our countries are overpopulated or underpopulated. We need to look at it not as a problem but something to be understood. Then with understanding will come change.

DISCUSSION

- B.J. Wood.*—Planning of families is different from population control. When the birth-rate is reduced in regulating family size, the per capita income remains the same to keep a small family. They then tend, in fact, to get bigger, e.g. Europe is producing more children now than earlier this century. Population control is what is needed now. Would the speaker care to comment?
- S. Zechariah.*—Planning of families is different from population control but people, particularly in developing countries can be made to understand the problems of large families rather than that of large population and can therefore be motivated to do something about it.
- Peter Wilkins.*—The suggested possible measures of State policy are what I would term negative incentives, which will have doubtful success, and have undesirable side-effects in the creation of poverty class.
- Could the speaker discuss the relative success of more positive incentives, for instance the use of material gifts to encourage family planning? Further, do incentives of either kind represent a successful or desirable method of motivation?
- S. Zechariah.*—Measures of state policy are often termed negative incentives. As a social-worker I am against any form of material gifts to encourage family planning. Man must be motivated by education and understanding.
- Lee Toh Ming.*—In your talk you mentioned one of the changes worth studying is: reconstruction of tax rates. Do I take it that you advocate a reduction in Income Tax for bachelors and spinsters?
- S. Zechariah.*—I cannot advocate reduction in tax rates for bachelors and spinsters. I am advocating reconstruction of tax policy and if necessary limitation of tax relief to three children and not five as is allowed at present.
- K.N. Samuel.*—Is it men who are difficult to be taught about the benefits of family planning or women?
- S. Zechariah.*—It is women who, owing to ignorance and fear do not understand the implications of large families. Fear of severe side effects of contraceptives that are present available.
- A.J. Berry.*—You mentioned many factors which impede population control: social, religious and others. Could you tell us which factors have proved the most difficult to overcome in your own experience in family planning work in this country?

S. Zechariah.—The biggest problem is indifference and I speak for estate workers. In the past they have had little to worry about that they have forgotten to use their minds.

Haji Hamdan b. Sheikh Tahir.—The speaker has prepared her paper well and covered the subject quite thoroughly in that short address.

Her reference to the use of 'Population Education' interested me for she stressed its importance in its ability to educate the young population of the country. I have commented that this suggestion would definitely contribute to improving the situation, i.e. family planning and population control in Malaysia, but it could not be expected to solve all the problems of population increase.

S. Zechariah.—It is only by education, sex education, population education that understanding will come and as I said in my concluding paragraph, with understanding will come change slowly but surely.

Closing Speech

by J. A. BULLOCK

Honourable Minister, Distinguished Guests, Members of the Malayan Nature Society, Ladies and Gentlemen, welcome to the closing ceremony of our symposium on Biological Resources and National Development.

We have had a wide ranging discussion on a variety of topics including:—

- (i) agriculture, particularly pest control, land utilisation and soil erosion,
 - (ii) hydrology, pollution and fish-culture, including discussion of the factors involved in flooding,
 - (iii) forestry, in which we particularly considered the need for greater utilisation of the forest products, including lesser known timber species, and fruit species, and the need for management for multiple uses of managed forest as well as the need to preserve forest for the protection of slopes.
 - (iv) economic values of conservation policy, including particularly the conversion of organic waste into useable by-products, the touristic value of wild life and coral conservation, and the intrinsic value of habitat conservation,
- and (v) aspects of the human population, particularly the social impacts of land settlement and the problems of population control.

In addition, we held a forum on the 'Blueprint for Survival' (published by The Ecologist, January, 1972). In this, there was a marked divergence of opinion between *the optimists*, who believed that technology would provide an answer to the needs for energy, food, etc, *the pessimists*, who believed that unless action was taken, a global disaster would result, *the utopians*, who considered that the problem was that of the industrial nations and that they should and would act to ameliorate the situation while aiding the development of developing countries, and *the cynics*, who doubted the premises of the document, or felt that mankind should continue his progress until caught in the cataclysm of over-population, after which the residual population would sort out the mess.

It is not possible to fully summarise all the deliberations of the Symposium in a few minutes, but I shall attempt to synthesise the main features as I see them.

The symposium did not doubt the need for national development. Having recognised the need for economic occupation, the need for industrial and agricultural development is obvious. We have also noted the incipient dangers stemming from development. These include the proximal dangers of increased flooding and soil erosion through land clearance with the concomitant problems of silting of dams and waterways, and of pollution of land, water and air with waste of industries and agriculture, and with agro-chemicals. We have noted also that in all cases, prevention is better than cure, since prevention is more effective and less expensive, and in particular I appreciated a paper dealing with the recycling wastes by micro-organisms, thereby improving industrial efficiency.

We have also noted that it is intended to leave considerable tracts of up-land forest undeveloped for catchment and land protection, and that the remaining up-land forest is to be managed to give a constant supply of timber. If we accept that the excision of lowland forest is inevitable, with some possible exceptions, this seems the best possible scheme. We have, however, noted with concern, that there is little knowledge of the management of these up-land forests and that much research is required before effective management practices can be introduced.

In accepting that lowland forest must be cleared for agriculture we are concerned not only about the danger of floods but also at the destruction of the flora and fauna. Several speakers have dwelt on the advantages of retaining portions of the lowland forests, as a gene-pool for our indigenous fruit-trees, for presently unexploited timber species and other species which may be exploitable in the future, and as sources of insects, etc., for the biological control of pest species, in addition to their role in land stabilisation, flood control and aesthetic and recreational value. Two speakers spoke in terms of preserving small areas (perhaps of less than 100 ha), and one adduced evidence that many species of mammals are able to maintain themselves in such an area. Others, however, considered that, bearing in mind the low stocking rates of some important plant species e.g. rambutan and langsat, there was a great need to maintain larger areas which would also serve for the maintenance of the larger and the more wide-ranging species. Again, it was apparent that far too little is known of the organisms in these forests as well as the processes operating therein. The actual effects of forests in flood control is poorly understood. There is thus an outstanding need for research into this ecosystem. This has so far not been achieved on a coordinated basis, and it seems doubtful whether this can be achieved without establishing a special agency with full-time research staff to study, experiment and advise.

We have heard with pleasure of the progress in the National Parks in Sabah but noted with some concern the implication expressed in one paper that lands unsuitable for any other form of utilisation were suitable for catchment control, conservation of species, etc. Various speakers emphasised that, in addition, there was a need to conserve other areas which were representative of all types of vegetation. In the context of conservation, the symposium learned with concern of the considerable damage to coral reefs caused by dynamiting for fish. This had led to the destruction of many reefs which could have served as tourists attractions, and as permanent sources of fish.

I think we can claim a reasonable success with this symposium. The films and exhibition have attracted many people and the symposium and forum have attracted much attention. We have been disappointed by the lack of interest shown by some departments and by the commercial sector, but nonetheless, we hope that the publicity given to this symposium through the national press, and the forthcoming special issue, will reach to these places.

In conclusion, I should like to thank all those who have contributed to this symposium and to express our gratitude to you, Honourable Minister, for kindly coming to close the Symposium.

Closing Address

by DATO ONG KEE HUI

The Honourable Minister of Technology, Research and Local Government.

May I first of all thank you all for the honour you have accorded me by inviting me to close this symposium which was opened by my colleague the Minister for Primary Industry, Y.B. Enche Abd. Taib Mahmud. It is perhaps apt that both of us should be concerned with conservation as changes in the environment are brought about in the course of development of both primary and secondary industries for which our two ministries are largely responsible. I have the disadvantage of not being able to follow your discussions but I have had the benefit of the summing up given by your Chairman.

The popular concept of a Nature Society is a preservation of nature and the maintenance of the *status quo* in the environment. It is therefore regarded as a body of conservative men and women who are resistant to any change in the environment. Yet we know that we cannot have development without changing the environment. The process of agriculture itself, and other human activities involve deliberate interference with nature and the natural environment. The fact that this symposium is sponsored by the Malayan Nature Society is indicative that you do not take such a conservative stand.

The Malayan Nature Society is to be congratulated on shedding its image of extremist conservationism, and on adopting a more realistic approach to the problems of this country. The theme of this conference shows a clear appreciation that we must develop, but that at the same time we must retain our natural heritage. This is a wise and sensible approach. For the well-being of our people we must develop but we must not at the same time damage the heritage of our children.

A particular feature of your symposium has been the emphasis placed by your contributions on research findings. All too often, governments are beset by speculative assessments of a situation. To be told that 'If you do this, that may happen' provokes the immediate response 'But it may not'. It is far more helpful to have definite statements backed by facts and figures. For example, many people have hypothesised on the causes of floods and on methods for prevention. But far too little information is available to draw satisfactory conclusions. We must attempt to find remedies urgently, basing our approach on those found practicable in other countries, and using the limited data available. This is by no means ideal, but, in the circumstances, this is the most that can be done.

In the same way, we have far too little information on the effects of development of land for agriculture. What will be the consequences of deforestation and development of plantation crops on flooding, on soil structure and on pests and diseases? Unless there is an adequate body of research, we cannot predict and must continue, as at present, on the lines which seem most appropriate. This is not because we wish to do thus, but because the scientists can give us no factual answers to our questions.

One of the prime purposes of conservation is to obtain basic data on the natural processes. It is encouraging to know that a start has been made on unravelling the complexities of the natural systems on land principally at the Pasoh and the Ulu Gombak field research centres, in freshwater at Tasek Bera and various water bodies around Kuala Lumpur, and in mangrove along the Selangor coast. That these studies are based in the University of Malaya is entirely appropriate, since the major role of Government

research sections is more intimately concerned with short-term exploitation problems. Nonetheless, these sections have acquired much useful and vital data, particularly in fisheries, forestry and drainage, on natural systems.

Pollution is also a major problem of development. Pollution as a concept—a change induced in an environment by the introduction of an excess of a chemical or physical factor which is injurious to the organisms in the system—is readily understood. But the difficulty is in determining what constitutes injury. Environmentalists have become very quick to cry 'pollution' at every instance where the environment is changed, without studying whether injury is caused or not. Similarly polluters have retorted that there is no evidence of injury basing this usually on the fact that no immediate toxic effects occur. This is, of course, oversimplifying the situation, but nonetheless, before one can legislate against pollution, there is a need to demonstrate its actual occurrence.

I do not doubt that you have already considered this problem, but I would urge upon you the thought that it is a negation of knowledge to argue and discuss problems without obtaining the facts on which to base argument and discussion. Unless such problems are researched fully and effectively we cannot evaluate claims of pollution and there will be little inducement to effect controls, which may be extremely costly. Once again, we need to have a thorough understanding of the basic biology of a system before we can comprehend the impact of pollution.

This is not to say that we must obtain all the data ourselves. We can argue from experience elsewhere, but unfortunately, most research on both natural systems and on pollution is being conducted in the temperate regions. To what extent may we assume that findings there are applicable to our equatorial land? Perhaps much of it is, but almost certainly, the break-down of some pollutants will be more rapid in our higher temperatures but at the same time, their toxicity to living organisms could be increased.

I am sorry to see that no papers have been presented on land reclamation. And yet one of the most unpleasant sites in this country are the tin-tailings around Kuala Lumpur and Ipoh in particular. Recent investigations by NISIR indicate in these tin-tailings there is a wealth of rare metals and elements which are contained in the ores present in the tailings. It is likely that it would be feasible to reprocess these tailings, and while doing so, to work out a scheme for turning these scars in our environment into more pleasant surroundings. It is surely not beyond the ability of biologists in this country to apply their expertise to methods by which such lands can be reclaimed and made into parks for the enjoyment of the people, even if they cannot be exploited as agricultural land. There is a shortage of land for housing in our urban areas, and we are faced with a serious squatter problem. We are building a large number of multi-storey flats to resettle these squatters. This, however, is not an ideal solution to this social problem because many of the squatters prefer to stay in houses with a bit of land around it on which they can do a little market gardening to supplement their income. Thus, these areas that are now left derelict scars on our landscape can become in time suburbs of our towns and cities. This to my mind is a more constructive approach to conservation in the course of development. Even though we preserve areas such as the Taman Negara, such places can only be visited on an extended and fairly expensive holiday. What are badly needed are pleasant parks for the pleasure of the urban dweller, easily and cheaply accessible.

I believe that your choice of the 'Blueprint for Survival' as a topic for discussion is very apposite. We are not beset by such pressing problems of population, pollution and production as are the industrialised nations. Nonetheless, there is much food for thought.

Over exploitation of the resources of the world, whether they are Malaysian or not, presents a grave problem for us all. Pollution by some countries affects us all, and population growth is a world problem. We cannot stand aloof from these problems and participate in decision making. The 'Blueprint' is by no means a finished document. The solutions which it offers are jejune and naive in some respects. Nonetheless, it is certainly worthy of consideration and, by constructive criticism, to develop it into a meaningful document.

In conclusion, let me congratulate you on organising this symposium. I am sure from what Dr. Bullock has just summarised your discussions have been fruitful and will help all participants to have a better perspective of these problems. I now have the pleasure in declaring this symposium closed.