

TRANSACTIONS
of the
NATIONAL ACADEMY
of SCIENCE and TECHNOLOGY

VOL. IV, 1982

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FOREWORD

Through the years, our national scientists and Academicians have engaged very actively in various scientific researches and activities. Some of their works have found way among scientific journals while others have found presentation in associations' or institutions' periodic conferences. Seldom, however, have papers become the subject of discussions among congregated scientists of various ranks and disciplines. This brings into focus the existence of an information gap among these specialized professionals — a gap which for the past three years since its establishment the Academy has sought to reduce by staging annual scientific meetings through which scientists and researchers can exchange valuable knowledge and information on scientific developments in their respective fields.

And because of their values to the scientific community, the Academy for the fourth time decided to publish in its "Transactions" the papers, including the comments of the discussants, presented during its last 4th Annual Scientific Meeting.

We hope readers specially people who are engaged in similar pursuits will find this a valuable reference and will actually find this to be of use in their work.



PAULO C. CAMPOS
President

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LET'S BRING S & T TO THE SERVICE OF OUR PEOPLE

By Emil Q. Javier, Academician

Honorable National Scientists, Fellow Members of the Academy, Distinguished Members of the Scientific Community, Beloved Guests, Friends, Ladies and Gentlemen:

Allow me, first of all, to express my personal thanks to the venerable members of the Academy for admitting me to the select circle of our country's most outstanding scientists. It is an undeserved honor which I would nevertheless cherish and shall strive, to my utmost, to live up to, the rest of my life.

I am tempted to address you on the discipline I have been most associated with professionally, i.e., plant breeding and genetics, its prospects and continuing contributions to man's well-being. However, I have the feeling that the Academy would rather prefer that I speak on my views on the state of science and technology of our country and, now that I am Director-General of the reorganized National Science and Technology Authority, express publicly what I intend to do about it. I still hope though that I will be given the privilege to address the Academy on the first topic at some other opportunity.

Technological Development

Let me begin by underlining the very utilitarian view of science which perspective I must perforce adopt in my current official capacity. I have been appointed director-general of the Authority with the equivalent rank of minister of science not to expand further the frontiers of knowledge *per se* but primarily to bring science and technology in the service of the Filipino people.

This is not to deny that the pursuit of science for its own sake is a calling worthy of the talent and effort of the best among us. As a professor of the university, I used to enjoy the privilege of looking at science from the perspective of a mental adventure, an exhilarating experience which one shares with fellow academics and students. Like many others I pursued our vocation as scientists with dedication and commitment comfortable in the thought that a better understanding of the world we live in could not but help people. That our contributions, however modest, shall in time find their way in the marketplace of ideas and eventually in the marketplace of goods and services for people.

The issue in its most simplistic presentation boils down to whether science could and should be directed. I am afraid it will take us the whole day to explore the pros and cons. But to make it brief, my position is: for most of our scientific effort, yes. However, there ought to be a residual effort where our scientists could be encouraged to give free rein to their imagination and creativity.

I will speak, therefore, of technological development instead of science development, fully conscious, however, that technological development is not possible without science.

Technological development means essentially the building up of a basic capability for decision making and implementation in the generation and application of scientific knowledge in the daily lives of people and in the affairs of enterprises and the state. It is a continuous process which includes the stages of generation (research), diffusion (technology transfer), and application of knowledge (technical innovation).

Technological development takes place only when the three stages are harmoniously developed and linked.

Creation of new knowledge constitutes a "supply" that should be followed by their application. The capacity to apply knowledge, on the other hand, exerts a powerful "demand" effect that promotes internal creation of knowledge and importation of technology.

Preoccupation with the "supply" function is a sterile exercise unless the knowledge is incorporated into the production system. On the other hand, exclusive concern for the promotion of technological change to the exclusion of developing a domestic capacity for generating knowledge will only lead to total dependence on foreign technology and inability to adapt technology effectively under local conditions.

In the past we have tended to look at our lack of technological progress in terms of "insufficient application of science and technology." This follows the classical supply-push approach that has dominated science policy thinking in developed countries.

We have tended to equate "science policies" with "research policies"; the premise being, if we promote research, the economy will sooner or later absorb the new knowledge into the production system.

We have for the most part given insufficient attention to the diffusion, innovation and application stages much less to the regulation of transfer of foreign technology.

We have assumed that knowledge would automatically find its way with the marketplace. We know now that it is not necessarily so. And that we have to work as hard generating knowledge as making use of that knowledge.

In the current reorganization of NSDB into the National Science and Technology Authority we have therefore attempted to incorporate features into the system which would provide impetus to a *demand-pull* approach to technological development to complement with the present *supply-push* efforts.

The demand-pull orientation will manifest itself in many forms. To begin, our activities should start from what private industry and what our people demand or require. Our individual researchers and our R & D institutions should be in close touch with the sectors they are supposed to serve. To this end we are asking each R & D institution in the system to establish technology transfer units to provide a link between the institution and the private sector. Where appropriate, each R & D institution is encouraged to have an advisory board composed of representatives of lead agencies of government and representatives of private industry to provide direction and feedback to the programs and activities of the R & D institution.

To make clear sectoral responsibilities, we have created under the new NSTA a system of councils composed of PCARRD, PCIERD, PCHRD and NRCP which have primary responsibility for integrating, coordinating, setting directions and priorities, funding, monitoring and evaluating S & T activities within their respective areas of concern. (Note that the word 'development' had been appended to the title of PCARR to make clear that the Council's mandate goes beyond research per se, consistent with the demand orientation.)

The former three councils are agencies of government. The fourth council, the National Research Council of the Philippines, which is a collegial body of scientists is asked to assume its place in the system of councils to take primary responsibility for promotion and coordination of research of a more fundamental nature which normally would have lower priority among the other three councils and to support the natural sciences, the social sciences and the humanities.

This configuration of councils relates back to the issue whether science could and should be directed: The first three councils shall be primarily concerned with mission-oriented, directed and for the most part applied research. NRCP is expected to fulfill the role for autonomous, self-regulated, and, for the most part, fundamental or basic research.

The deputy ministers of the lead line ministries and very knowledgeable representatives of private industry sit in each of three sectoral councils to articulate the 'demand' for research and technology support of the ministries and the private sector in the workings of the councils.

The inputs of career scientists and professionals are coursed through the secretariat and the technical panels which assist the secretariat in preparing the documentation for deliberation by the councils.

Still in pursuit of the demand approach we have opted for the establishment of authority-wide regional offices to assist in the dissemination and transfer of technology and for general science promotion activities.

Formulation of a Comprehensive National S & T Plan

We assert that technological backwardness is part of the broader issue of underdevelopment. The building up of that technological capability should therefore constitute an additional dimension of development efforts.

In many developing countries, including our own, the national science and technology plan is taken to be implicit in the economic development plan. Most of the time in effect this means there is no S & T plan at all.

In a way what we are saying is that science and technology is not an exclusive domain or concern of its practitioners — us scientists and technologists. Science and technology is everybody's concern. If we continue to allow science and technology to remain in the backwaters of our national consciousness, S & T will never get adequate support and we shall always remain backward technologically.

In fact to my mind this is the greatest challenge for us science leaders and administrators. If we look all around us, our society, our institutions, our enterprises and the country-side is undergoing technical change. The influx of machines, equipment, utilities and other amenities of modern living are evident in our daily lives.

However, the question remains to be asked whether in fact we have internalized these technical changes within our institutions and systems.

The truth of the matter is that for the most part these technological changes which come from without flow directly into the domestic production system without involving the local S & T system.

In other words, for a lot of our major industrial projects and activities, the local science community has no input and therefore irrelevant. Yes, our country is undergoing technical change. Our economy is "industrializing" but we are not "technologizing."

This, therefore, is the greatest threat to our efforts to develop indigenous technological capability.

We in the science community should recognize this tendency to marginalize the local S & T system and should make every effort to expose this trap.

Short-term "industrialization" targets are often much more attractive politically than long-term "technologization" goals. Since the local S & T community has, as yet, limited capability, it is very tempting to dismiss us as obstructive in order to hasten the putting up of industries and enterprises.

We have to point out to the national leadership, the captains of industry and to our people, that, as we are now finding out, the technological requirements increase dramatically along the path of industrialization. And as we shift from an import-substitution to an export-promotion strategy of industrialization in the absence of a realistic and determined effort to develop national S & T capability, our dependence on foreign technology can only become more acute.

The consequences of this problem can be observed in increasing pressures on the balance of payments. The cost of technology tends to increase progressively along the path of industrialization as technological requirements become more sophisticated. Thus the importation of technology by the less developed countries has been increasing at the rate of two and a half times the average of industrial growth.

As in the political field, the key is technological independence and self-reliance.

Instead of allowing the national S & T system to be bypassed or sidetracked, we should make every effort to involve the local S & T system in the technology transfer process in order to develop, in time, domestic capability to evaluate, select, adapt and to improve upon imported technologies and eventually to generate indigenous technology.

We should, therefore, project science and technology in the forefront of national consciousness. The first obvious step in this direction is to articulate a comprehensive national S & T plan which shall be a formal part of the five-year national economic and social development plan.

Even now we devote quite a bit of resources, including human, fiscal and physical resources, in S & T activities. These activities spread across the different ministries, in both public and private universities, and in the private sector. Some amount of planning is desirable to make the most productive use of the scarce resources now devoted to S & T development.

Therefore, there is an actual need for a single, coherent and comprehensive national S & T development priorities plan which could provide the overview of the total S & T effort.

In the reorganization of the NSTA, therefore, we are putting a lot of emphasis on the mandate of the Authority to provide the focus and initiative for S & T planning. Fortunately, the NEDA

and the Budget Office had been very supportive and we expect to work closely with these two bodies.

Let me take this opportunity, therefore, to exhort the members of the Academy and the members of the national science community here present to join hands with the different sectoral councils and with NSTA itself to articulate this document this national S & T plan which shall express our wisdom, our aspiration, our mandate, and most significantly, our deliverance.

Providing an Environment Hospitable to Science

One of the main issues raised during the series of workshops and dialogues we conducted late last year was the lack of proper environment for the growth of science in our country. Low salaries, antiquated equipment, lack of logistics and bureaucratic procedures were cited as contributory factors to the sad state of the science community.

We intend to attack these problems from different sides. First in the matter of incentives to scientists. The executive order reorganizing NSTA recognized the need for a career service for scientists. This is one of the topics to be discussed during this week's celebration. We are now in the process of discussing with the Civil Service Commission, the Budget Office and the Reorganization Commission the features of the scientific career service.

From our end, we have in mind at least three prominent features: first, a parallel career path for scientists and research administrators; second, fixed tenure for research administrators like in academe; and third, a more realistic wage scale for scientists.

We also intend to push for a policy whereby R & D institutions in each of the different ministries shall be treated as largely self-regulating, autonomous entities, attached to a ministry for purposes of coordination but not supervised and controlled directly by the ministry.

We also found strong justification to bring together R & D agencies into residential scientific communities where they could share facilities, libraries, computers and equipment and scarce personnel. And where scientists could have ready access to their laboratories and ample opportunity to react with like-minded colleagues.

We intend to pursue the development of initially three residential scientific communities, i.e. an energy, atmospheric and earth sciences complex in Diliman; an industrial research community in Bicutan, and a food, agriculture and life sciences complex in Los Baños.

Finally, most of the woes we have been experiencing could be traced directly to the insufficiency of resources. Our latest figures indicate that the total R & D budget from the public

and private sectors amount to approximately 0.26 per cent of GNP. We intend to keep pushing for one per cent of GNP for R & D purposes.

Basic Research and Manpower Development

I said at the outset that the greater part of our efforts ought to be mission-oriented, directed research. This point of view derives from the conviction that the crushing problems of poverty, disease and hunger still afflicting substantial sectors of our people, the lack of productivity and uncompetitiveness of some of our industries, and the escalating deterioration of our physical environment which challenge the very survival of our people and integrity of our nation demand answers not tomorrow or some distant future, but NOW. And I believe, as I know all of us here now believe, that a greater part of the answers to these problems will have to be based on superior and more appropriate technology.

And yet we are only too aware of the fact that some of the greatest contributions in science did not come about from some purposeful search to existing problems. Rather they came as original contributions from scientists who had for their purpose simply advancing the frontiers of knowledge and exploring further the depths of the unknown.

It is really a matter of arriving at a judicious balance between our efforts to meet present challenges and to build up our intellectual capital for the future.

I propose, therefore, that we set aside a certain proportion of our resources to basic research. I propose further that the conduct of basic research be undertaken in conjunction with training of high level manpower in the sciences.

Our requirements for high level manpower will have to be supplied mainly from within. We will continue to send people abroad for formal advanced training for selected fields. But the bulk of our high level expertise will have to be trained in our national universities. The cost of sending too many people abroad for long-term formal degree training will strain further our all-too-meager resources.

The scholastic rigor and academic discipline which high-level scientific training requires are best developed into the young scientists through fundamental research. In order to maximize therefore the use of scarce resources, we intend to encourage and support the universities both public and private to engage in basic research in linkage with training of masters and doctoral students.

Private Sector Involvement in Science and Technological Development

If one compares the sourcing of funds for research and development between developed and developing countries, the most obvious difference is the degree by which private industry supports R & D. In the U.S., Japan and the Western European countries, as much as 50 per cent of funds come from the private sector.

Whether one could establish a cause-and-effect relationship between private sector investments in R & D and technological progress is immaterial at this point. But what is obvious is that it is a desirable state of affairs.

We shall, therefore, explore further possibilities of providing additional incentives to the private sector to set aside corporate funds for local R & D activities. Where desirable and mutually advantageous we intend further to go into joint R & D ventures with the private sector using government research personnel and facilities. Alternatively we may commission research by the private sector subject to certain protocols.

A significant source of funds for S & T development at present are the research foundations. For the past two years the foundations had been providing about ₱90 million annually for various S & T activities. We intend to help the foundations locate relevant, viable projects through linkage between them and the universities and research institutions. And likewise assist them expand and make more stable their capital base.

Science Promotion

Finally, I would like to mention briefly the need to strengthen science education at the primary and secondary levels. It is common knowledge that except for some well-run church schools and few public institutions, the level of science education at these levels are woefully inadequate. No less than the MEC itself had recognized the problem and had accorded top priority to the improvement of teaching at the primary level.

Our support to MEC would come by way of training science and mathematics teachers and the development of more appropriate science teaching materials and scientific equipment. The NSTA had been supporting projects along these lines for a few years now. And we are now anxious to have these projects evaluated, improved upon and expanded.

The promotion of science consciousness among our people particularly the young continues to be a primary concern of the NSTA. As you know the old Science Foundation of the Philippines had been abolished but in its place we created the

Science Promotion Institute with expanded responsibilities and additional funding. The conduct of science fairs and quizzes and the organization of science clubs have proven to be a very stimulating medium through which we could promote science awareness.

We are enlisting the support of non-government entities, the school system and other organizations in this enterprise. Just yesterday the MEC, the Jaycees and the SPI launched the search for TOYS — the outstanding young scientists — a promotional effort comparable with the TOYM.

SUMMARY

Finally, allow me once more to thank the members of the academy for the signal honor they have conferred on my person and for this excellent opportunity to express publicly my thoughts and predispositions regarding the manner by which we should organize and direct our efforts to move science and technology in our country.

Summing up, the following are the major issues/considerations which to my mind ought to influence our national efforts in S & T.

1. Our primary task is to bring science and technology in the service of our people.
2. Generating new knowledge is not an end by itself. We should work as hard acquiring knowledge as making use of that knowledge.
3. The present reorganization of the NSTA draws inspiration for the pressing need of providing the strong link between our scientific base and innovation and productivity.
4. It is incumbent upon us academic leaders and administrators and practising scientists to bring to the forefront of our national consciousness the importance of science and technology. If we allow S & T to remain in the backwaters of our national consciousness, S & T will never get adequate support and we shall always remain backward technologically.
5. To this end we should strive to make organic into the national development plan, a formal declaration for S & T development.
6. The national S & T plan should include positive steps to provide an environment hospitable to science, incentives to scientists and academicians, increased logistics to S & T efforts and incentives for private sector participation in the R & D.

I deliberately refrained from speaking out on research priorities. Obviously I have my own personal opinions on where our

priorities may lie. But I firmly believe that these priorities ought to be discussed thoroughly and openly among the different sectors in order to arrive at the optimum direction and allocation of the priorities. I trust that each of us will make serious attempt to make a contribution in this exercise.

(The above remarks were taken from an address, Dr. Emil Q. Javier gave to the National Academy of Science and Technology during the Investiture of its new Academicians and its 4th Annual Scientific Meeting. This was held at the Philippine International Convention Center on July 14, 1982.

Chancellor Javier of the University of the Philippines at Los Baños is currently Director General of the National Science and Technology Authority. — The Editor)

THE REINFORCEMENT OF BEHAVIOUR: THEORETICAL AND PRACTICAL ISSUES IN AN EXPERIMENTAL CONCEPT

By Alfredo V. Lagmay, Academician

Abstract

The principle of reinforcement, which originated with the experiments of Pavlov on reflex responses, and, later, extended to operant behavior by Skinner, was a real scientific advance in the biological formulation of learning phenomena in a broad range of vertebrate and invertebrate organisms. However, the experimental concept of reinforcement for operants, as an analytical principle, has been considerably weakened in both laboratory and non-laboratory practice by calling a reinforcer a *reward*. This prevailing ethos in behavioral psychology of using the term *reward* has had adverse effects: in limiting the analytical potential of the concept of reinforcement and therefore the interpretive possibilities of the science of behavior itself. More importantly, the extensive use of the principle of reinforcement in psychology has tended to amplify certain practices associated with the notion of reward which oftentimes are undesirable. A case is made for adhering to the scientific formulation in order to show that the experimental concept of reinforcement has a versatility, so often demonstrated in the history of science, that is directly applicable to regions of analysis not accessible to the layman's term *reward*. Finally, some basic problems in cognitive and humanistic psychology are seen as related to the technical definition of reinforcement and of behavior as a response of the whole, intact organism.

Introduction

It has been some over fifty years since Skinner (1931), inspired by Ernest Mach's *Science of Mechanics* and P. W. Bridgeman's *The Logic of Modern Physics*, discovered a method for describing the behavior of the whole intact organism as a function of stimuli and environmental operations. The history of the discovery and its subsequent development are described in his *A Case History in Scientific Method* (Skinner, 1958). He found quite by accident the basic idea that a crucial dependent variable in the study of the behavior of the organism is rate of responding. In his formulation, the behavior under study is deliberately simplified, the record of its occurrence is plotted cumulatively and continuously as a function of time, so that the slope of the curve becomes a measure of the strength of the behavior at any given moment. Alternatively, one may state the same idea this way: How strong or probable a response is can be described in terms of frequency of its occurrence in time; the more frequent per unit time, the stronger the behavior; the less frequent per unit time, the weaker the behavior; and the limiting case is zero frequency per

unit time, which means the behavior does not exist within that time.

The above formulation now has become the basis for the systematic study of the effects of various experimental treatments on laboratory animals the most important of which is that of consequating the behavior of the organism with an event, a reinforcer, in order to increase the future frequencies of the behavior. (Skinner, 1983; Morsè, 1966). This is the familiar principle of reinforcement of operant behavior (instrumental conditioning). For example, an animal press on a lever is followed by food, and the rate of the pressing response increases. Or, as in ordinary life, a man comes for a visit and if the visit is appreciated, the subsequent frequency of visits now increases. Thus, in this approach, frequency or rate of responding, thus becomes the fundamental datum in experimental analysis of behavior and is a technical idea which can be applied irrespective of the topography, magnitude or intensity of the response, under a great variety of conditions in time, space, and circumstance, and within a fairly broad range of animal species (Denny, 1970).

Changes in rate of responding are directly observed, they have dimensions appropriate to a scientific formulation, and under skillful experimental control they show the uniformity expected of biological processes in general. (Skinner, 1966)

Now the foregoing is but a thumbnail stroke presentation of a principle out of which a large and complex behavioral science and technology has been spawned in modern times. There are omissions and forshortenings: but all I want to state is the rate of responding as a dependent variable has proved itself to have a versatility and elegant simplicity which has been surprisingly equal to some of the most challenging problems of the laboratory and literally almost all fields of psychology.

No branch of psychology is today untouched by the concepts of operant conditioning. Most obviously, experimental studies of learning and performance have been vastly facilitated by Skinner's box; but the other traditional fields of motivation, emotion, language, and thinking owe as great a debt, although it is as yet largely unrecognized and unpaid. Even students of perception, that obdurately most mental of the disciplines, have insights from the proper formulation of the discriminative functions of the stimulus. Outside the psychologist's laboratory, education and training have been offered hope of revolution by programmed instruction, a direct outgrowth of operant principles. Develop-

ment theorists are increasingly grounding their concepts from the discovery that the consequences of even innate behavior patterns contribute to the form and future fate of such patterns. And the psychotherapeutic process has undergone radical reappraisal in the light of the insistence of operant conditioning that actual changes in patient's behavior are the only valid index of cure or improvement. This basic approach to mental illness has, in fact, crystallized into a successful behavior therapy. (Reynolds, 1968)

Alternative Versions: "Rewards" for Reinforcers

Somewhat later experimental work on learned behavior, also along Pavlovian lines, had formulated the principle of reinforcement in terms of drive or need reduction, i. e. that habit strength is a function of physiological (drive) discharge, such as when food or water is given as a consequence of behavior (Hull, 1943). A very influential generation of students carried on research within a conceptual framework laid out by Hull of Yale University and many others, which stated the principle of instrumental conditioning (operant reinforcement) in terms of rewards instead of the more general concept of reinforcers. Rewards to this group of workers are events that strengthen the connection between stimulus pattern and the response. The important point to note is the use of lay term *reward*. While it is true that this term is defined objectively in terms of laboratory operations and should be understood as thus defined, words such as *reward* have other connotations within the culture which directs or guides scientists and laymen alike in their work of utilization of the concept.

The older experimental statement from the principle of operant reinforcement dates back to Thorndike who formulated the Law of Effect, which states:

Of several responses made to the same situation, those which are accompanied or closely followed by satisfaction to the animal will, other things being equal, be more firmly connected with the situation, so that, when it recurs, they will be more likely to recur; those which are accompanied or closely followed by discomfort to the animal will, other things being equal, have their connections with that situation weakened, so that, when it recurs, they will be less likely to occur. The greater the satisfaction or discomfort, the greater the strengthening or weakening of the bond. (Thorndike, 1911)

One need not point out that this formulation is anthro-

pomorphic, subjective and hedonistic. The pleasure-pain principle of course is very much alive in Thorndike's statement and the Hullian term *reward* is but a variation of this idea. Hullians and others worked with mazes and memory drums, and only later, with the free operant in the Skinner box, in recognition of the advantages of the concept of rate of responding as a fundamental datum in experimental work of this type. But they have persisted to use the term *reward* instead of reinforcers for nearly 40 years as almost all of the papers by Hullians in the journals attest to.

The lay term *reward* of course is easier for the layman and scientist to use because this vocabulary is more easily recognized in actual practice, either in the laboratory or in the natural setting. Rewards in the form of food, water, praise, attention, money, candies and the like are given in order to strengthen behavior. In education and clinical practice, rewards tend to be the usual culturally accepted reinforcers such as money, privileges, cigarettes, attention, praise and the like. It was only lately that biofeedback stimulation was recognized to be a reinforcer in an operant conditioning paradigm (Kamiya, 1962), although Lindley (1962) about the same time was doing work along similar principles under what he termed as *conjugate* reinforcing conditions. In both of these experimental work, forerunners of the biofeedback movement in behavioral medicine, there was continuous reinforcement in a cybernetic loop, but obviously the term *reward* could not be used in place of the more technical and general word *reinforcer*, in this case a continuous feedback reinforcer.

Adverse Impact of "Reward" Orientation

It is only natural that scientific design in laboratory work should simplify experimental situations for the purpose of analysis. This is the very heart of method in the natural sciences: one starts with simpler situations, laboratory analogues of real life processes that are too complex for experimental control. The choice therefore of reinforcer events are of those that are easily identifiable and standardized, such as food, water, or any discrete object or stimuli which can be counted and measured. As analysis progresses into firmer ground, the experiments become more complex. The use of the term *reward* was understandable for identifying these reinforcers, but since the principle had already been extracted and extended rather widely to many other kinds of experimental situations, there was no need to retain the lay term. But in fact it has stayed on.

The flow of knowledge from the laboratory to classroom and field setting has been characterized by a singular obduracy to

being guided by the language of the scientific community. Popular culture in turn has reciprocated in confirming by actual usage its recognition of the pleasure principle embedded in the use of the term *reward*.

It is not any cause for surprise therefore that educated groups in the humanist tradition see in the principle of reinforcement, or operant conditioning, elements of an idea that are associated with aspects of current material culture which are in bad repute. Rewards have been interpreted as bribes. Food, personal recognition, money and sex as rewards generate their own problems. They are reinforcers in the true sense of the word generally, but not always. Token economies work essentially along reward conditions in the foregoing sense, psychotherapies employ attention and praise giving procedures, and clinical visualization techniques implement the pleasure-pain criterion in order to reinforce or condition the human response. Behavior modification in educational settings utilize attention, praise, grades, and graphs and counts as discrete feedback rewards. There is in general perhaps basically no objection to these methods, but they have kept us from realizing some of the deeper significance of the principle of reinforcement in human life. The general definition which states that reinforcement occurs when behavior is followed by events that strengthen behavior should permit us to explore the farther reaches of human reinforcers that are not rewards in the usual sense of that word.

Covert Reinforcers

Reinforcers that had their origins in the external world such as foods, diplomas, person presence, praise, and so forth eventually find a counterpart in the covert, non-observable response of the organism: in imagination, visualizations, fantasy, dreams, and thinking. Cautela (1979) and numerous other workers have shown that one can obtain reinforcing effects by following a response with an imagined reinforcing experience. For example, an hour's work on the typewriter could be reinforced by following it with a visualization of an eating session or a scene on the sunny beach with the cool winds blowing on one's face. Or an aversive experience can be reconditioned by imaginatively pairing it with a pleasant episode in one's life. The point is that this is still the principle of reinforcement operating on covert operants. Thinking, visualizations, problem solving, creative reflection and fantasy are true behaviors or responses because they may, for scientific reasons, be assumed to obey the laws of reinforcement, extinction, reconditioning, discriminative control, and all the concepts of the laboratory in the study of visible, learned overt behavior. And the

chief criterion for this point of view is a pragmatic one: it enables us to handle our data more effectively and to integrate many diverse phenomena into something understandable and controllable.

Extending our Range of Reinforcers

Reference was made previously to modern biofeedback procedures as a reinforcement technique that does not need or deserve to be called a reward. There are many situations of this nature that occur in human life which has the property of strengthening the human response that are generally not recognized as reinforcers, let alone as rewards. For example, when one *recognizes* a match between a tone that one produces with another tone that he has heard elsewhere, there is reinforcing effect on the production of the matching tone. When a problem solver senses a structural fit of a solution to a problem, there is also a reinforcing effect which leads to further problem solving behaviors. The recognition of fit in structure or quality of a response is automatically reinforcing phenomena of this sort are not rewards in the ordinary meaning of that term. They are in fact reinforcers with a complex history of social interaction in the life of the person, but they have achieved a functional autonomy that now seems to separate them from their historical origins.

The list of such kinds of reinforcers are numberless: being able to find your way around in unfamiliar environment, being able to see things more clearly, to recognize a good fit in our perception of apparently disorderly displays, experiencing new perspectives in ordinary routine affairs, being able to manipulate new verbal structures in speech and writing, all these generate high probability responses so long as they are consequent upon these prior responses. It is easy to identify all these as the domain of the artist, of the intellectual and, just as much, of the ordinary person. These of course have not been set up in the laboratory with the appropriate experimental design simply because of the exceeding complexity of the situations represented by these reinforcers. But our account is plausible in that the main outlines of the principle of reinforcement are recognizable. And we only need to try them out for ourselves in order to get some feeling for the reality of this statement.

Old Horizons and the Scientific Temper

We find it easier perhaps to understand some themes from both the traditions of the East and West which have come to us every now and then as persistent echoes from the distant past.

Pain and suffering is a never-ending problem of philosophy in the classical sense, when psychology had not as yet then separated from it as an independent discipline. The ancients several thousand years ago evolved a teaching of indifference or non-attachment to worldly concerns and the fruits of action, all of which are reinforcers or *rewards* within the workaday world of us ordinary men. Success and failure, especially in competition, may thus not affect the person whose belief system does not consider success and avoidance of failure as important to their lives.

By the same token, ego-strengthening procedures, so dear to psychoanalysis and self-concept theories of personality, may not be utilized as reinforcers in belief systems and practices that uphold self-renunciation, because all ego-enhancing behaviors, according to these beliefs, merely multiply problems even if they permit a temporary remission of difficulty or symptom.

So the question is where are the reinforcers of self-renunciation and non-attachment styles of living? You do not get an answer so long as reinforcers are rewards that are objects and proferments of the material culture in the sense that we practice it in the present century. But if the reinforcers are in the recognition of fit in quality and structure of our own educated perceptions, then the principle of reinforcement in operant conditioning may yet be seen as furnishing one possible humanistic insight arising from scientific work with animals.

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**DISCUSSION ON
THE REINFORCEMENT OF BEHAVIOUR:
THEORETICAL AND PRACTICAL ISSUES IN
AN EXPERIMENTAL CONCEPT**

Virgilio G. Enriquez, Ph.D., Discussant

A basic theoretical and practical issue which needs to be discussed is whether indeed a reward is not a reinforcer and analogously if a reinforcer is not in effect a reward. In addition, we can talk about the problem of choice of appropriate terminology. The choice of labels naturally involves the question of connotation as a point to consider in developing a technical terminology or any specialized lexicon for that matter. However, the primacy of the denotation in scientific discourse makes it definitely more important than the connotation of a term.

Are we in a position to claim with some degree of certainty that either some reinforcers are non-rewarding or that some rewards are non-reinforcing or both? If in fact it can be shown that indeed we can talk about "rewards" in technical work -- as if we cannot distinguish it from reinforcers, then probably we can say that we do not have a prior ontological problem, it is just that we do not like the word "reward", because of its connotation. Dr. Lagmay gave some examples in his paper which suggest that possibly the two are logically different.

Considering the task of utilizing and developing psychology in the Philippine context, one has to grapple with the problem of terminology in the Filipino language. It makes sense to discuss the term, label or the name itself, and the issues that relate to the name. For practical reasons, a name can be as important as the concept named. The oft-quoted phrase "a rose is a rose by any other name", does not really make psychological sense. If you give people the wrong name, somehow people react to them the wrong way. The name has psychological significance. We know that technically it makes no difference; scientists can agree to call one thing by another name and so long as they are clear about the agreement, no problem ensues. This is just exactly what we do in scientific discourse. However, we have to proceed with caution in as much as we are interested not only in communicating with fellow scientists but also with the layman.

In fact, one can turn the table around and ask why we object to the word "reward", when we have more reason to object to the unwanted connotation of the word "reinforcement." With

“reward” one worries about unintended moral implications. The experimental psychologist is not at all saying that one pigeon is better than another because it pecks at the key and therefore deserves a reward with mongoes. By choosing the word “reinforcer”, we are using a term with another connotation. When one grapples with this problem in Pilipino, the word “pampatibay” comes to mind. Mind you, the word is not a happy one and it is not any better than “gantimpala”.

Ang pagbibigay ng pagkain sa hayop para “tumibay” ang kanyang kilos ay nakakatuwang pakinggan pero tila mali ang gamit ng salitang “tumibay”. Wari’y mas magandang salita talaga ang salitang “gantimpala.” Kapansin-pansin na iba ang konotasyon ng “reward” sa “gantimpala.” Para sa mga Pilipino ang “gantimpala” ay isang bagay na talagang nakukuha sapagkat ito ay hindi lamang nararapat bagkus ay “nakatadhana.” Mayroon kaunting ideya ng “immanent justice.” Ang salitang “reward” ay higit na nauunawaan kapag may taong nakakakontrola sa sitwasyon. Ang taong nakakakontrola ang siyang nagbibigay ng “reward” samantala kapag sinabi nating “napala”, hindi lamang dahil sa ito ang nararapat niyang makuha dahil sa kanyang kagandahang asal kundi iyon talaga ang dapat mangyari sa kanya.

Different cultures have different ways of interpreting what’s “actually” happening when a behavior is reinforced. I agree with Dr. Lagmay that to avoid unnecessary connotations, we must as well avoid using a term such as “reward” which have that excess baggage of “moral” meaning. Similarly, the question: “why use the term “reinforcer” can also be raised. Why can’t we just as well use Braginsky and Braginsky’s term in *Mainstream Psychology* such as “zog” the meaning of which, by the way, is exactly what is meant by “reinforcer” in learning theory. I must thank Dr. Lagmay for his stimulating paper. It makes one think anew regarding the problem. If only by way of a remark, I should like to share with you the decision that seemed feasible in our work. Instead of using “gantimpala” or even “pampatibay”, we simply use the word “reimporsment.” Of course we spell reimporsment with an “m” and a “p”. And it appears in sentences like “Nakakareemporse ka naman” or Nakakareempors and kanyang ginawa”.

Thank you very much.

Horacio R. Estrada, M.D., Discussant

I cannot overemphasize Dr. Lagmay’s plea to return to the old term “reinforcer” instead of the popularly-understood term, reward. I remember two instances during the earlier year of my clinical practice when the term reward got me into serious trouble.

One was before a class of interns and residents, whose background is mainly psycho-analytic (ego — super-ego) — and I was trying my best to impress them with the simplicity, economy, and facility with which behavioral methodology is recorded and evaluated. I did not make any impact on the class because they were immediately put off by my use of the word reward — For such young and idealistic students, UP students at that, such unethical practice cannot be tolerated. They were equating the word reward — with “lagay” — which they claim is a great behavior modifier to many government officials. The second was a patient with matrimonial problems. As I was explaining, the strategy and technic of treatment to the couple, such strategy and technic involved — approach behavior by the wife — for behavior from the husband, I wanted reinforced. I wrongly used the word reward once more, and immediately the hostile and sensitive wife remarked — “kung sino ang may sala, siya pa ang prepremyuhan.” In another part of Dr. Lagmay’s paper, he mentioned the covert reinforcers of “Cautela” and I should share with you — a fortunate circumstance I am in. My office-clinic is quite near the Department of Pathology, wherein is displayed a beautiful museum piece of a lung ravaged by bronchogenic — carcinoma. Without fail, I conducted all my patients who wish to quit smoking for a 3-to 5-minute viewing of said museum piece and monitor very fastidiously with a patient diary — I provide a patient diary card — how obedient they are in following my instructions — to imagine said museum piece everytime they draw a stick of cigarette. I must confess my cases may not be amenable to statistical analysis, but my percentage of success in my few cases have been quite high. Thank you so much.

Jaime Bulatao, S.J., Ph.D., Discussant

Dr. Lagmay’s paper seems to me to be showing a new development of behaviorism. In fact, the first part of his paper also mentions the original formulation of Thorndike, and how it was a very highly mechanistic approach. Behaviorism itself grew out of a certain feeling of inferiority on the part of psychologists, a fear that they were not scientific enough. So they had to insist that they were scientific, which meant at the time that they followed the model of the Physicists. Since that was 1911, the physics that they modelled themselves on was Newtonian physics. This was before the advent of Einstein or of quantum mechanics. So, to make behaviorism “scientific,” they eliminated one big aspect of human life, namely *consciousness*.

But then as behaviorism developed, we find this growing need continually, somehow or other, to bring back by the backdoor the very element which they had eliminated in the first play. Thus, when first formulated, it was SR, Stimulus Response. In time, cognitive behaviorism came in and we got a new formula, SOR: Stimulus-Organism-Response, because of the fact that the organism itself modifies the response. Dr. Lagmay then brings in the Cautela approach where he has man reinforcing himself by images which he himself creates. We begin to see here how behaviorism has changed and developed from the old Thorndike thing to a new approach which seems to want to include consciousness.

Now what Dr. Lagmay has done in his paper is to make this approach even more concrete where, for example, he says that a sound for a child is reinforcement. When a child seeks to imitate a sound he is reinforced when he can make a sound similar to it. Now I am glad to see behaviorism developing this way. However, under these circumstances, is it economical still to use the conditioning model, rather than another which could be more economical. In the case for example of the sound for the child, should we use the conditioning model to understand that phenomena of the child imitating the sound or should we use the social psychologists' idea of "modelling?" Or in the Cautela experiment, should we use the conditioning model or should we use rather the transpersonal model. Cautela's students (cf. Fareyt, J.P. (Ed.). *Behavioral Treatment of Obesity*. Oxford: Pergamon Press. 1977.) did experiments to try to find the answer to this particular question: In behavioristic treatment of obesity, was it the conditioning with an image that made that person give up overeating or was it the relaxation that accompanied the imagery? The result of that particular experiment was it was more than relaxation that brought it about. I bring this up because there are new aspects that are coming up very strongly on this matter of consciousness that one could still explain by conditioning but only at the price of forcing the data into rigid categories. Take for example, the Simonton research (Simonton, O. Carl; Mathews-Simonton, Stephanie; and Creighton, James. *Getting Well Again*. Los Angeles: Tarcher, 1978.) on terminal cases of cancer, where he has a patient put himself in the very relaxed state and then imagines his own blood cells like soldiers fighting the cancer. Such a process could still be conceived as reinforcer, i.e., you could sort of say that you are reinforcing the killing of cancer cells. But you could conceive it another way, the way the consciousness people do it now: just as Einstein saw that mass and energy are continuous, so also now we begin to conceive of mind and matter as continuous and that

therefore the mind has control over the body. A limited control, of course, but there is something it can effect. Consciousness has an important part to play and need not be eliminated as in the behavioristic model.

These are some of the questions, then, that I would like to bring up because the behavioristic model has some shortcomings. For instance, freewill according to Skinner simply does not exist. He envisioned Utopian societies which were motivated solely by the manipulation of what he called positive and negative reinforcements. The problem then, is that one can become very pessimistic. In fact, that was what happened to Skinner himself in his old age. Here is the recent interview of Skinner by the New York Times with the headline: "B.F. Skinner Now Sees Little Hope for the World's Salvation."

This interview comes only ten years after he wrote "Beyond Freedom and Dignity" which he still believed in the possibility of world change by reinforcing the good and deinfencing the bad. Now, in his interview he says---well people just won't take it up. People react rather than initiate. Dr. Skinner finally concludes that people will not act to preserve the world until it is too late. "I don't see any hope for it"—those are his own words.

To sum it up, I am wondering if maybe—in the course of the development of behaviorism—it is reaching the point where it is incorporating consciousness into its paradigm. If it does so, I think it will be a real advance. And it will be a big change because up to now, psychology is known in the freshmen's textbooks as "the science of human behavior." But is moving towards "psychology, the science of mind."

THREE LETTERS OF APOLINARIO MABINI

By Encarnación Alzona, Academician

At this fourth annual meeting of the National Academy of Science and Technology, I am presenting three letters of Apolinario Mabini (1864-1903) to Cayo Alzona (1869-1927), rather than let them slip into limbo or to be devoured by termites or destroyed by fire, as it has happened to the other letters.

Mabini needs no introduction to a Filipino. Every school boy or girl had heard of him and his place in our national history.

Mabini and Cayo Alzona met as students at the College of Law (*Facultad de Leyes*) of the University of Santo Tomás (*Real y Pontificia Universidad de Santo Tomás de Manila*). Mabini was highly admired by his classmates for his extraordinary brilliance. Many years later, in 1926, one them, Felix M. Roxas (1865-1936), well-remembered mayor of the city of Manila from 1905 to 1917, wrote in his column in *El Debate*,¹ *De Ayer a Hoy* (From the Past to the Present) about a *Promoción Notable* (A Notable Class). It was about the class in "Ecclesiastical Discipline" conducted by Father Nozaleda. In his previous classes he never gave more than three grades of "Excellent" (*Sobresaliente*); but this time he had to give seventeen. He declared emphatically, striking the table with his fist, that never before had he seen such a thing happen at the University. Roxas mentioned that the members of that class were Mabini, Aquiles Luzuriaga, Julian Gerona, Magalona, Goyenchea, José Varela Calderon, Roberto Moreno, Francisco Santamaria, Bartolome Revilla, Francisco Villanueva, Gregorio Singian, Cayo Alzona,² Eugenio Arnedo, and others he could no longer recall. Out of modesty he did not mention himself as a member of that notable class.

Both Mabini and Alzona, during their student days, taught at the *Escuela Privada de Segunda Enseñanza* (Private Secondary School) in Manila whose director was Raymundo Alindada, later one of the members of the Malolos Congress.

The first of these letters is dated 13 of September 1899 at Rosales, Pangasinan³, and deals about his election as President of

¹*El Debate*. Year IX, No. 397, p. 8, A Filipino newspaper in Spanish.

²Cayo Alzona, Licentiate in Jurisprudence (Master of Laws) 1896, Meritissimus Sobresaliente, which is equivalent to *summa cum laude* of the universities in the United States of America.

³First published in the *Philippine Social Science Review*, Nov. 1938, pp. 330-336.



APOLINARIO M. MABINI
23 July 1864 — 13 May 1903

the Supreme Court by the Congress. The government of the Philippine Republic had already moved to Tarlak, fleeing from the advancing American attackers.

The original letter is in Spanish. Here is my English translation:

Rosales, 13 September 1899

Mr. Cayo Alzona

My dear friend and colleague:

I received your letter of the 6th instant. I have been told already about that document, for Panganiban came to see me when he passed through this town and he related to me the same thing he told you. The nullity

que no podría desempeñar, porque
yo he desempeñado el cargo de Pre-
sidente del Consejo y Secretario de
Nuestro Excmo. Sr. Ministro, a pesar de la in-
capacidad que me atribuyen. La ley
dice solo incapacidad física, pero
no dice en que consiste, porque
si tengo incapacidad física para
ser juez puede que no sea in-
capaz para otro cargo, porque puede
escribir y pensar como ^{un} hombre or-
dinario. Ahora si dice la ley que los
paralíticos son incapaces ^{formalmente} para todo
cargo judicial, podría todavía ambar-
se la elección. Continúa que no que-
do yo defendiendo y viendo que un
uno que sepa resolver no podría
haber sido.

Amigo mío,

Agustín Mabini

Bohales 13 de Septiembre de 1899.

Dr. Cayo Alzona.

Mi querido amigo y compañero:
no me poder en parte del 6. Ya me
han dicho algo de ese escrito, pues
Pangasinan vino a verme al pasar
por este pueblo y me contó lo mismo
que a U.

La nulidad que persiguen es in-
fundada. La elección se hizo por el
poder legislativo en concordancia con
el ejecutivo, y dicha elección por con-
siguiente si no esta conforme con
alguna ley derogará la anterior,
por no podrá ser nulo el acuerdo.
Si la Justicia hecha el poder exe-
cutivo, cuya obligación es ejecutar



CAYO ALZONA

1869-1927

(Photo taken at Hong Kong in 1900)

that they are seeking is groundless. The election was done by the legislative power in concurrence with the executive and consequently that election, if it is not in conformity with any existing law, will repeal the former, but the resolution cannot be null and void. Had it been done by the executive power whose duty is to enforce the law, it can be declared null and void; but the resolutions of the legislature, which makes the laws, do not infringe them, but abrogate them partially or totally, whether forever and in a general way or temporarily and for a particular case, as it happens now.

Moreover, the incapacity they allege applies to prosecuting attorneys and judges whose duties cannot be performed by persons who cannot walk, because many times they have to be in various places to conduct investigations. This is not so in the case of the President of the Supreme Court who can direct and dictate his orders without leaving his office and delegate certain duties that have to be done outside.

They cannot allege that there is no justifiable reason for the law not to be enforced, because there is no other reason more justifiable than the sovereign will of the Congress which has elected me.

Moreover, let them cite to me a function of the President of the Supreme Court that I cannot perform, because I have held the post of President of the Cabinet and Secretary of Foreign Affairs despite the physical handicap they attribute to me. They allege only physical incapacity, but they do not say what it consists of, because if I am physically handicapped to perform the duties of a judge, I cannot be necessarily incapable of performing the task of another post, for I can write and think as a healthy man. Now, if the law says that crippled men are unqualified for all judicial posts, my election could be annulled. What a pity that I cannot defend myself! They would see that they cannot do anything to one who knows how to reason.

Most affectionately yours,
Ap. Mabini

Mabini was crippled by poliomyelitis in January 1896. Despite this physical handicap, in June 1898 President Aguinaldo invited him to serve as his private adviser; and then after the approval of the Constitution of the Republic, the first cabinet was established with Mabini as president and secretary of foreign affairs. The Mabini Cabinet assumed office on 4 January 1899 and resigned on 4 May 1899. He was out of the government when he was elected by the Congress President of the Supreme Court of Justice, who was also Vice President of the Republic in accordance with the Constitution. The Paterno Cabinet opposed his appointment and President Aguinaldo listened to it.

Although he was no longer in the government, Mabini was pursued by the Americans and finally captured him at Kuyapo, Nueva Ecija, on 10 December 1899. They imprisoned him in the Estación de Calle Anda, Intramuros, until 3 October 1900.

The following letter was written in that prison.

Manila, 5 February 1900

Mr. Cayo Alzona
Hong Kong

My dear friend and colleague:

I received your letter of 20 January and your account of what you have seen on that rock gave me much satisfaction. I am very much surprised that it took you 55 days to reach Hong Kong. I attribute it to a slip of the pen, because I suppose that the trip would not take more than 5 days. Some say that it takes only three days. I am not surprised at your seasickness, because they say that it happens to those who sail the high seas for the first time.

Aquilino⁴ tells me that he has received a letter from there informing him of the receipt of my replies to Wheeler.⁵ I had to rewrite them, because I have not received the first ones. I have just received a letter from Wheeler dated there asking me to send to Washington a list of the members of the two cabinets of Aguinaldo. I have already sent it together with a statement for the Senate, commenting on the bases presented by Senator Bacon and published in *The Hong Kong Telegraph*.

Corrales came here with your trunk, because there they kidnapped Adolfo Castillo. He told me that he has a letter of Ñor Bosiong⁶ addressed to his clients there, advising them to reveal my hiding-place to the Americans. Notwithstanding, I bear no grudge at that dotard who is proud like a child of his post as judge of the Court of First Instance of Pangasinan.

Singian⁷ has not yet come back to see me. Thank Kahukom for his regards to me, which I return very

⁴Dr. Aquilino Calvo, a mutual friend.

⁵Gen. Joseph Wheeler of the American Army who asked him to answer eleven questions about the Philippine Revolution and the aspirations of the Filipinos. His replies may be found in T. M. Kalaw *Las Cartas Politicas de Mabini*, Manila 1930, pp. 261-264.

⁶Ambrosio Rianzares Bautista, president of the Congress and Mabini's political adversary. Ñor is colloquial for *señor*.

⁷Dr. Gregorio Singian, noted surgeon and mutual friend.

affectionately. For the present I have nothing notable to tell you. Greet on my behalf our compatriots there.

Wishing you rapid progress in your studies.

Your friend at your command,
Ap. Mabini

Cayo Alzona had gone to Hong Kong with some messages of Mabini for the Central Filipino Committee established there under the direction of Galicano Apacible. He remained there for a few months and enrolled in the Victoria School to study English.

The third letter was written after his return from his exile in Guam. It was typewritten.

Manila, 26 April 1903

Mr. C. Alzona
Ilagan, Isabela

My dear friend and colleague:

I have just received your letter of 23 March and everybody in the house as well as I are most grateful for your compliments.

Buencamino with Abreu⁸ did see me in Guam; but I could not tell him if it would be convenient for me to return or not to the Philippines, because I had not yet read the Proclamation of Amnesty. When I found out its terms, I requested that I be permitted to take the oath here in Manila, after having ascertained that I could do it without remorse. I waited five long months for the decision that I was free to go anywhere, except the Philippines, without first taking the oath of allegiance.

As it was necessary for me to know the prevailing conditions here, having received no information about them for two years that they held me there, I had no alternative but to comply with the requirement.

My only plan is to withdraw from politics, because my illness requires a more peaceful life. I do not intend to re-enter into politics, unless I see that my cooperation would be indispensable.

⁸Felipe Buencamino was secretary of foreign affairs in the Paterno Cabinet. Jose Abreu was a Filipino lawyer.

With regard to my health, I am as before. I am glad that you are there with your family and I wish success in your office.⁹

If Don Gracio Gonzaga¹⁰ lives there, please greet him in my behalf.

Needless to say, you may command me as before.

Your most affectionate friend,
Ap. Mabini

After taking the oath of allegiance, he was offered the post of register of deeds; but he declined it with statesman-like dignity.

The harsh climate of the tiny Pacific island of Guam and the monotonous diet of canned food provided by the American army for the prisoners wrought havoc upon Mabini's poor constitution. Two months and seventeen days after his return from Guam, at eleven o'clock at night, he died. It was the 13th of May 1903.

To the Filipinos in general Mabini was the brilliant, consistent and tireless defender of their human rights, of their political independence. To the Americans he was a thorn in their side. General E. S. Otis, the American military governor, called him "the most dangerous insurgent". General Arthur MacArthur, his successor, decided to deport him, along with other Filipino patriots, to the forbidding Island of Guam. Civil Governor Wm. H. Taft reported to Washington that he was "a consistent opponent of American sovereignty and a persistent inspirer of rebellion and insurrection, and the most prominent irreconcilable among the Filipinos."

What they did not say was that the Republican administration of President McKinley was determined to hold our beautiful and rich Archipelago to serve as an American foothold in the Far East. Lying next door to the vast market of China our country was also alluring to the American capitalists. Already on the road to becoming a super power, America must not lag behind Great Britain and France, and even Holland, which held important territories in this part of the world.

Thus, with her superior military force, aided by the enforcement of a sedition law, censorship of the press, prohibition of the display of the Filipino flag, concentration camps, and other repressive measures she was able to remain in our country; and she is still here. (1982).

⁹Cayo Alzona was then prosecuting attorney or provincial fiscal of the Province of Isabela.

¹⁰Gracio Gonzaga was secretary of development (*fomento*) in Mabini Cabinet.

DISCUSSION ON THREE LETTERS OF APOLINARIO MABINI

Serafin D. Quiazon, Ph.D. Discussant

It is to Dr. Encarnacion Alzona that singular compliments be given for bringing to light some inner thoughts of Mabini expressed in three letters written sometime after he left the government service.

These letters, never before published, form a part of a private collection which, I presume, belongs to the Alzona family of which our distinguished resource person is a proud scion.

To begin with, Apolinario Mabini and Cayo Alzona met in the Faculty of Law, University of Santo Tomas during their student days and together taught during their spare hours at the Escuela Privada de Enseñanza in Manila.

Later in the course of their professional lives as lawyers, Mabini, in a note to President Aguinaldo on the composition of the Audiencia, proposed Don Cayo Alzona as one of the 13 members and hold one of the positions of Attorney-fiscals. That letter although undated was written according to T.M. Kalaw on March 12, 1899, two months before Mabini resigned as President of the Cabinet on May 4, 1899.

Seeking a cure for his health and upon invitation of the Municipal President of Rosales, Pangasinan Mabini went there and stayed in Balungaw, a barrio of the town where there was a hot-spring. That was in June 1899. Cayo Alzona, who was his private secretary stayed with him until they parted ways, partly attributable to the fact that the Americans were pursuing Aguinaldo up the north of Luzon.

Later, contact between the two was made by the first letter. Here Mabini explained to his friend the legal angles and his defense on the controversy raised by his detractors on his (Mabini's) appointment as President of the Supreme Court.

His opponents opposed because of his paralytic condition. But the real reason could be that, and this is not expressed in any of the letters of views of the oppositors, Mabini as president of the Supreme Court would also be, according to Article 40 of the Malolos Constitution, the Vice President of the Republic who would have presidential functions too "in the meantime, while the choice of the President of the Republic has not yet taken place."

The consequence of this was that the nation would be led in its struggle for independence—and during the times of the Fil-American hostilities—by a paralytic. The question that nagged, supposedly was: How effective can a paralytic discharge one of the main presidential functions in such circumstances. For according to Article 65 of the same Constitution, “The President shall command the army and navy, declare war . . . and Article 67, no. 6 which says the President was to “preside over national ceremonies and to receive envoys. . . .

This line of thinking show somehow the Paterno cabinet was totally wrong and therefore Aguinaldo rightfully listened to it.

The second letter in relation to the Republic is not very significant because by that time it no longer existed, as the Philippines was already occupied by the Americans.

What it reveals was the heroic forbearance Mabini had for one of his strongest opponents—Ambrosio Rianzares Bautista, CFI Judge of Pangasinan whom he called Ñor (short for Señor) Bosiong. Bautista in effect wanted him captured by the Americans and thereby silence his opposition to the American occupation.

Here Mabini also revealed his humanity. He said he bears no grudge at him but in the same breath he called him dotard— an imbecile or one of advanced age attended by enfeebled mentality and childishness. Let us take note of the translation phraseology: “I bear no grudge at the dotard who is proud like a child of his post. . . .”

But let us bear in mind Mabini wrote this letter in prison, two months after his capture by the Americans, to Alzona who was then in Hongkong.

Written in his residence at Nagtahan, Manila, the 3rd letter found Alzona in Ilagan, Isabela as provincial fiscal. It revealed Mabini’s delicate patriotic conscience. He wanted to be sure that remorse would not follow him to the grave if he were to sign the oath of allegiance to the American flag. It was a farewell letter to politics; he even declined the post of register of deeds in the American regime government. A certain premonition of death was surely in his mind for in two week’s time he breathed his last. It was the 13th of May 1903, 14 days after his arrival from his exile in Guam.

MABINI SHRINE

In this house as in the hearts of all Filipinos is enshrined the memory of Apolinario Maranan Mabini. In this house were penned by him brilliant essays, letters and documents that served as guides for his contemporary Filipino leaders in the early struggles for national independence.

Born in poverty but endowed with a vastly superior intellect, Mabini stayed in this nipa house as a boarder from 1888 when he entered law school. Owned by a couple, Cecilio del Rosario and Maxima Castañeda, the humble dwelling stood on # 23 Nagtahan, Sampaloc on a lot portion of the estate of the Tuazon-Legarda, to whom the del Rosarios presumably paid rents.

It was in that house that on 23 July 1892 Emilio Jacinto consulted Mabini, then a law student, on the preparation of a draft for a newly organized secret society. He agreed and drafted in Spanish a blueprint of the organization which Jacinto later translated into Tagalog and became the Katipunan's constitution.

On Christmas day of 1893, Andres Bonifacio came here to ask advise on a planned purchase of arms for the Katipunan which he formally organized at about this time. This plan was deferred until 1895 when Mabini, already a lawyer, drafted the credentials of the Katipunan representatives to Japan to pursue Bonifacio's plan.

Undoubtedly, the house at Nagtahan sitting on a rented lot from an *ilustrado* became the birthplace of the Katipunan for here the seeds of its organization were sown.

Two months after the Cry of Balintawak, and the start of the struggle for national independence in August 1896, Mabini was paralyzed in both legs. The Spaniards arrested and brought him away from the house but not to a prison cell. Instead he was placed "under house arrest" at the San Juan de Dios Hospital until 5 July 1897.

Despite his physical handicap he continued writing; before and after his stint in the Malolos Congress he served as a paramount intellectual powerhouse of Aguinaldo's shortlived republic. Mr. Cayo Alzona was Mabini's private secretary.

During the American regime he was rearrested in Jan. 1901 and exiled to Guam only to be returned to this house in 1903 where he died, victim of a cholera epidemic on 13 May, 14 days after his arrival. He was age 39.

The house at # 23 Nagtahan Sampaloc was first located on a lot near the foot of the north approach to the old Bailey bridge (now Mabini) across Pasig going to Pandacan. In the 1930s the lot was acquired by the Ampil family from the Legarda estate, while the house passed on to Mabini's younger brother Agapito, married to Maria, a daughter of the del Rosario couple, the original owners.

At this turn of events, the memory of Apolinario Mabini was endangered of being obliterated. Whereupon President Quezon ordered an adjacent lot of the Ampil's to be bought and through Director T.M. Kalaw of the National Library and Museum, the national government acquired for ₱1,800 the house and its relics

and had them transferred to the new site which was declared in 1941 a national shrine at the instance of the Philippine Historical Committee.

Came the war and the destruction of Manila, including the Bailey bridge but the fragile shrine remained intact unlike the neighboring buildings which were reduced to ashes. As rehabilitation and progress advanced into the area the bridge was reconstructed and so expanded that its foot at the north approach at the Sampaloc side bank of the Pasig occupied a major portion of the shrine.

Decades passed and the shrine seemed to have passed into oblivion until Pres. Marcos ordered the shrine's transfer, which was completed in 23 Mar. 1966, to a 3 1/2 hectare lot located across the Pasig, opposite the old shrine site and ceded for the purpose by the Bureau of Animal Industry to the Philippine Historical Commission. On 12 Jan. 1968, the new site was finally declared the permanent shrine of Mabini.

Of thatch and pyramidal roofed and built of sturdy local materials, the house stands a few meters from the south bank of the Pasig on the Pandacan side. Its posts are of whole tree trunks, whose upper parts extend to the second floor area where their exposed portions are polished to a sheen of reddish brown. The inner walls and the ceilings are of aged sawali, partitioned by a movable divider, the spacious one-room upper floor of 15 windows is constantly wafted through by cool breezes from the Pasig; here and there are the few furnishings that served the almost heremitic needs of the intellectual Mabini: a writing desk, an aparador, a couple of thonet chairs, a chinal mirror and the familiar convalescent chair.

Except for a wooden bench in a corner and a carved wooden wreath the rest are replicas of the originals which are now on display at the Mabini Birthplace Shrine in Talaga, Tanauan, Batangas.

Today thanks to the efforts of First Lady Imelda R. Marcos, the then Chairwoman of the National Parks Development Committee, Mr. Teodoro Valencia, MH Chairman Carmen Guerrero Nakpil and Jose Guevarra, monetary contributions from civic groups and individuals and, today, with the care of the National Historical Institute, the Mabini Shrine is truly a lasting memorial, albeit with the atmosphere of fragility of relic and rusticity of scenery, yet verily reflecting the lasting ideas of an intellectual and scholar who belonged to the rare breed of the first generation of Filipino intellectuals.

Gregorio F. Zaide, Ph. D., Discussant

I would like to make a suggestion, if it is possible to make the article more interesting. I suggest that the title be like this: "The Other Side of Mabini, His Three Letters," just like the *Other Side of Midnight* and the *Other Side of Alma Moreno*.

It is my great pleasure to comment on the paper of Dr. Alzona, my beloved history professor at the old UP. Most people know her as the worthy daughter of Don Kayo Alzona, especially in Laguna. I am, of course, also from Laguna. But to me, Dr. Alzona is the top lady historian of our nation, for whom I do believe some day the bell of history shall ring an eternal salute for her wonderful achievements in Philippine historiography. She has done a wonderful job now, by preserving the three letters and translating them into English so that our people now and even historians may know them. It is a lamentable fact that Spanish is dying out and yet, it is a fact also that no historian can write the history of the Philippines without knowing Spanish unless they copy from others.

Now the first letter as read to you, is relevant and viable to history for three reasons. First, this is a brilliant defense of an intellectual giant like Mabini against the malicious protest of his enemies, against his election as chief justice of the Supreme Court of the First Philippine Republic. Why the protest was given to Gen. Aguinaldo is because Paterno himself coveted that position. He did not want Mabini, his political enemy, to get in. Unfortunately, Pres. Aguinaldo heeded the protest because Paterno was in power, being the president of the Cabinet, with Felipe Buencamino as foreign secretary. Now, the question arises, supposed Pres. Aguinaldo approved, would Mabini make a good chief justice despite his paralysis? That is of course, academic.

Now the second reason, the first letter of Mabini exposes the prevalence of dirty politics in Malolos Republic, as it is now and will be in the future and till the end of time. Politics has always been dirty as evidenced by rivalries, jealousies, and bickerings that produce disgraceful incidences, such as the feuds between Paterno and Mabini, between Gen. Luna and Buencamino, and between Gen. Mascardo and Gen. Luna. These are due to dirty politics. Third reason, this letter also reveals the break-up between Mabini and Aguinaldo till death and beyond death. Mabini, sapagkat siya'y tao lamang, resented his dismissal as adviser, president of the Cabinet and secretary of foreign affairs and the disapproval of his appointment as chief justice. No wonder, when Mabini in the last chapter of his *Memoirs* (written in Guam), he blamed Aguinaldo for the failure of the Philippine Revolution. There's a moral lesson to be heeded in this Mabini's letter that is — Do not

antagonize people because some day what you antagonize may become your enemy and will do you bad. That is why I do not antagonize people. So after I die, they cannot say anything bad against me.

Now, the second letter, that was February 5, 1900, by an American general, Joseph Wheeler who asked Mabini for the names or members of the Mabini Cabinet and the Paterno Cabinet. At the same time, he sent a questionnaire for Mabini to answer. Mabini complied although he hated the Americans. But, being broad-minded intellectually, he courteously complied with the request. He furnished the names and the answer to the rest of the questions. There should have been three cabinets, namely, the Mabini, Paterno and Luna Cabinets, but the third cabinet was aborted because Luna was assassinated in Cabanatuan on June 5, 1899. That time, he was about ready to overthrow the Paterno Cabinet and formed his own cabinet with himself as head and secretary of war. As a matter of fact, the list of the cabinet, which Luna was organizing, was published in the *La Independencia* on June 3, two days before he was killed. Had Luna not been assassinated there would have been three cabinets. But the third one, was *if*. The word *if* in history means many things.

Now the last letter is about the signing of the oath. Dr. Alzona was right that Mabini's health broke down during his exile in Guam for eating too much canned goods everyday. So he had to sign the oath of allegiance to the U.S. when he was set free, in accordance with the Amnesty Proclamation of Pres. Theodore Roosevelt on July 4, 1902.

Gov. Taft, his worst enemy, wanted to stop that, and even wrote a letter to Secretary of State Elihu Root not to allow Mabini to go home, because he was the most dangerous Filipino and was an ardent advocate of rebellion and insurrection. But Secretary Root did not mind Taft's letter because Mabini's homecoming was a *fait accompli*. The Amnesty Proclamation was already proclaimed and all the exiles in Guam had returned home.

Mabini and Ricarte together arrived at the same time aboard US Transport *Thomas* in Manila on February 26 about 1903. Mabini took the oath because he wanted to go home. Ricarte refused to take it so that he was deported to Hongkong. Now, summing up, the three letters, are valuable documents in the study of the Philippine Revolution. Historians should read and know them to write a better account of the Philippine Revolution. It is to be hoped that Dr. Alzona would reveal more historical letters, like these "Three Letters of Mabini" and her precise English Translations.

THE 1981-85 TARIFF CHANGES AND EFFECTIVE PROTECTION OF MANUFACTURING INDUSTRIES

By Romeo M. Bautista, Ph. D.

Abstract

As a result of a four-phase review of the tariff system undertaken by the Philippine government recently, a comprehensive but gradual revision of legal tariff rates has been scheduled over the period from January 1, 1981 to January 1, 1985 aimed at reducing the overall level of "effective protection" to domestic industries and making the rates more uniform across industries. This paper describes the nature of these tariff rates changes and analyzes their impact on effective protection rates in the manufacturing sector. While a significant improvement of the tariff system would be achieved by 1985, given the scheduled tariff protection and the dispersion of sectoral rationalization of the structure of tariffs. This would generally entail a further reduction in the protection of sectors producing consumer goods and raising those of the intermediate and capital goods sectors. Related trade and development issues are discussed in the concluding section of the paper, especially with reference to current industrial plans and policies.

Introduction

As previous empirical studies have amply documented,¹ tariff policy in the Philippines throughout most of the postwar period had been too strongly supportive of the development of import-substituting industries producing consumer goods at the finishing stages. Inevitably, however, high tariff rates on finished products and low rates on intermediate inputs and capital goods that characterized the country's tariff structure had the undesirable effects of inhibiting export growth and backward integration while promoting inefficiency in the use of domestic resources and slow growth of industrial employment. In the 1970s fiscal incentives granted by the Board of Investments under the Investment Incentives Act (RA 5186) and Export Incentive Act (RA 6135) and a more flexible exchange rate policy served to provide offsetting benefits to export-oriented firms. However, this did not fully neutralize the biases in the relative incentive structure due to the existing tariff system (cf. Bautista, Power and Associates, 1979).

As part of a larger program to "rationalize and restructure industry," a comprehensive review of the tariff system was undertaken by the government in 1979-80. It culminated in the issuance

¹See, among others, Power and Sicut (1971), ILO (1974) and Bautista, Power and Associates (1979).

of Executive Orders calling for gradual tariff changes over the 5-year period 1981-85 that we intended to substantially reduce the distortions in the tariff structure by the end of the period. The Tariff Commission has published recently the *Tariff and Customs Code 1982* containing a consolidated schedule of the changes in tariff rates, which actually began to be implemented on January 1, 1981.

The primary objective of this paper is to assess the impact of the on-going tariff reform on "effective protection rates" in the manufacturing sector, assuming that the scheduled tariff rate changes will be fully implemented. It is well recognized that tariffs cause a divergence between domestic and international prices and hence encourage the movement of resources into import-substituting industries rather than into export industries. As a measure of relative incentives, effective protection rates (EPRs) — or rates of protection of value added, defined as the proportionate difference between domestic and foreign value added — are more meaningful than actual (or legal) tariff rates and nominal tariff rates, representing the excess of the domestic price of a product over its international price, since it is value added rather than the value of the product that is contributed by the domestic activity being protected. More specifically, EPRs include the subsidy to domestic producers from the protection of outputs and the penalty from the protection of inputs.

Section 2 of this paper gives a comparison of tariff levels in the Philippines relative to other ASEAN countries in the late 1970s, and then describes the nature of Philippine tariff rate changes scheduled between 1980 and 1985. In Section 3 the method of estimating sectoral EPRs in manufacturing for the two years is described; the resulting estimates are presented and evaluated in Section 4. Related trade and development issues, especially with reference to current industrial policies and plans, are discussed in the concluding section of this paper.

The Tariff Reform

That legal tariff rates in the Philippines were generally higher than those of other ASEAN countries in the late seventies is evident from Table 1. Based on overall simple averages, the Philippines ranked highest (44.2%), followed by Indonesia (33.0%) and Thailand (29.4%), with Malaysia (15.3%) and Singapore (5.6%) having much lower average tariff levels. Particularly noteworthy are the higher Philippine tariff rates, compared to those in the other ASEAN countries, for manufactured products (PSSC 5-8), this is markedly so for the commodity categories consisting largely of finished consumer products (PSSC 6 and 8).

**Table 1. Comparison of Simple Averages of Tariff Rates
in Asean Countries by PSCC Grouping, 1978
(in per cent)**

<i>Group (PSCC)</i>	<i>Category</i>	<i>Indonesia</i>	<i>Malaysia</i>	<i>Philippines</i>	<i>Singapore</i>	<i>Thailand</i>	<i>ASEAN</i>
0	Food and live animals chiefly for food	42.9	10.7	67.2	1.3	42.6	33.0
1	Beverages and tobacco	46.0	346.8	82.5	458.2	62.4	199.2
2	Crude materials, inedible except fuels	14.2	2.8	27.4	0	18.4	12.6
3	Mineral fuels, lubricants and related materials	15.2	7.1	14.9	9.0	14.2	12.1
4	Animal and vegetable oils, fats and waxes	30.0	0.3	43.9	nil	24.7	19.8
5	Chemicals and related products, n.e.s.	26.8	19.2	41.1	37.2	28.1	30.5
6	Manufactured goods classified chiefly by materials	37.9	14.9	52.0	0.4	32.0	27.4
7	Machinery and transport equipment	18.0	10.7	23.0	1.4	18.0	14.2
8	Miscellaneous manufactured articles	49.9	19.0	68.9	3.4	37.8	35.8
9	Commodities and transaction not classified elsewhere in the PSCC	21.7	7.7	62.5	0	20.8	22.5
	Overall	33.0	15.3	44.2	5.6	29.4	25.5

SOURCE: Tariff Commission (1979).

The distribution of tariff rates in the Philippines by BTN product category is shown in Tables 2 and 3 for 1980 (before the tariff reform was started) and for 1985 (after its completion). The first point to note is that the highest tariff levels of 70% and 100% would no longer apply and that a new rate of 5% would be levied in 1985 on 30 items, mainly from the categories of animal and common metal products (BTN Sections I and XV). In terms of the overall average tariff rate, a much lower level would prevail in 1985 compared to 1980 (27.9% vs. 43.1%). Moreover, the degree of dispersion would also be lower, measured by either the standard deviation or the coefficient of variation.

Indeed, the average tariff rates for all but one² of the 21 commodity categories are scheduled to decline from 1980 to 1985 implying a general lowering of tariff barriers. Some of the more significant tariff reductions, i.e., by at least 25 percentage points, would apply to: animal and animal derivatives (BTN I); food, beverages and tobacco (IV); furs, hides and leather products (VIII), footwear and miscellaneous products (XII), precious stones and metals (XIV); arms and numetiars (XIX); and furnitures, toys and miscellaneous products (XX). This is due in large part to the elimination of the peak rates (70% and 100%) which were levied earlier for many items under these BTN categories. Since most of these items would continue to have the highest tariff rate (50%) in 1985, the above-mentioned BTN categories display the highest average tariff levels both before and after the tariff reform.

Estimating Effective Protection Rates

Actual measures of effective protection that have appeared in the empirical literature vary according to the purposes for which they are used. Differences in estimation methods and underlying assumptions imply noncomparability of EPR estimates derived by different investigators.³ In some studies assessment is made of the separate influences of different policy instruments on the effective protection rate. On such basis Tan (1979) has concluded that in 1974 the tariff system was the most important source of effective protection to domestic manufacturing industries, while indirect taxes and BOI fiscal incentives were relatively minor instruments affecting insubstantially the overall pattern of sectoral effective protection rates.

²BTN Section XXI (Art and antiques) would retain the uniform tariff rate of 10% for the six items under this product category.

³This is well illustrated by "the lack of harmony in the results" obtained in four independent studies of effective protection of manufacturing in Peninsular Malaysia for the same years (cf. Shepherd, (1980.)

Table 2. Distribution of Tariff Rates, 1980

BTN Section	T A R I F F R A T E S							Number of Items	Mean	Standard Deviation	Coefficient of Variation
	10%	20%	30%	40%	50%	70%	100%				
I Animals, and animal derivatives	7 (17.5)	1 (2.5)	3 (7.5)	0 (0.0)	7 (17.5)	5 (12.5)	17 (42.5)	40 (100.00)	64.5	35.1	.545
II Plant products	3 (4.1)	13 (17.8)	6 (8.2)	1 (1.4)	11 (15.1)	21 (28.8)	18 (24.7)	73 (100.0)	59.3	30.1	.507
III Fats and edible oils	2 (10.0)	0 (0.0)	6 (30.0)	1 (5.0)	6 (30.0)	2 (10.0)	3 (15.0)	20 (100.0)	49.0	26.4	.540
IV Food, beverage, and tobacco	6 (8.8)	5 (7.4)	6 (8.8)	0 (0.0)	4 (5.9)	6 (8.8)	41 (60.3)	68 (100.0)	74.4	34.5	464
V Minerals and fuels	33 (55.0)	18 (30.0)	1 (1.7)	0 (0.0)	8 (13.3)	0 (0.0)	0 (0.0)	60 (100.0)	18.7	13.2	.708
VI Nonorganic and organic chemicals	87 (43.1)	61 (30.2)	21 (10.4)	0 (0.0)	25 (12.4)	3 (1.5)	5 (2.5)	202 (100.0)	23.2	18.7	.808
VII Plastic and rubber products	0 (0.0)	8 (21.0)	14 (36.8)	0 (0.0)	15 (39.5)	1 (2.6)	0 (0.0)	38 (100.0)	36.8	13.2	.358
VIII Furs, hides, and leather products	2 (9.5)	1 (4.8)	0 (0.0)	0 (00)	3 (14.3)	8 (38.1)	7 (33.3)	21 (100.0)	69.1	28.6	.414
IX Wood and cork products	6 (16.2)	4 (10.8)	5 (13.5)	0 (0.0)	9 (24.3)	5 (13.5)	8 (21.6)	37 (100.0)	51.1	31.7	.620
X Pulp, paper and paper products	9 (17.0)	2 (3.8)	14 (26.4)	0 (0.0)	8 (15.1)	3 (5.7)	17 (32.1)	53 (100.0)	54.0	34.9	.647
XI Textiles and derivatives	12 (9.0)	13 (9.8)	25 (18.8)	4 (3.0)	18 (13.5)	26 (19.6)	35 (26.3)	133 (100.0)	56.5	31.7	.561

XII Footwear and miscellaneous products	0	2	0	0	3	6	13	24	79.6	25.6	.321
	(0.0)	(8.3)	(0.0)	(0.0)	(12.5)	(25.0)	(54.2)	(100.0)			
XII Glass and ceramic products	4	12	11	2	15	9	9	62	47.9	27.7	.579
	(6.5)	(19.4)	(17.7)	(3.2)	(24.2)	(14.5)	(14.5)	(100.0)			
XIV Precious stones and metals	1	3	0	0	0	0	15	19	82.6	33.7	.408
	(5.3)	(15.8)	(0.0)	(0.0)	(0.0)	(0.0)	(78.9)	(100.0)			
XV Common metals and products	38	31	43	1	29	13	7	162	33.3	22.7	.682
	(23.5)	(19.1)	(26.5)	(0.6)	(17.9)	(8.0)	(4.3)	(100.0)			
XVI Machinery	59	11	32	0	27	5	8	142	30.1	24.1	.802
	(41.5)	(7.8)	(22.5)	(0.0)	(19.0)	(3.5)	(5.6)	(100.0)			
XVII Transportation equipment	25	3	10	0	1	3	3	45	26.0	25.6	.985
	(55.5)	(6.7)	(22.2)	(0.0)	(2.2)	(6.7)	(6.7)	(100.0)			
XVIII Precision instruments and other instruments	20	14	16	2	7	3	1	61	26.6	18.6	.701
	(32.8)	(23.0)	(26.2)	(0.0)	(11.5)	(4.9)	(1.6)	(100.0)			
XIX Arms and munitions	0	0	0	0	0	4	3	7	82.9	14.9	.179
	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(57.1)	(42.9)	(100.0)			
XX Furniture, toys, and miscellaneous products	2	4	6	0	7	3	28	50	72.8	33.0	.453
	(4.0)	(8.0)	(12.0)	(0.0)	(14.0)	(6.0)	(56.0)	(100.0)			
XXI Arts and antiques	6	0	0	0	0	0	0	6	10.0	0.0	.000
	(100.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(100.0)			
General Tariff Schedule	322	206	219	9	203	126	238	1323	43.11	32.20	0.747
	(24.3)	(15.6)	(16.6)	(0.7)	(15.3)	(9.5)	(18.0)	(100.0)			

Source: Tariff and Customs Code of 1978.

Note: Figures in parentheses are percentages of total number of items under each BTN section.

Table 3. Distribution of Tariff Rates, 1985

BTN SECTION	T a r i f f R a t e						Number of Items	Mean	Standard Deviation	Coefficient of Variation
	5%	10%	20%	30%	40%	50%				
I Animals, and animal derivatives	17 (26.2)	11 (16.9)	1 (1.5)	3 (4.6)	1 (1.5)	32 (49.3)	65 (100.0)	29.9	20.8	.694
II Plant products	1 (0.9)	8 (7.0)	28 (24.6)	12 (10.5)	2 (1.7)	63 (55.3)	114 (100.0)	37.2	15.2	.408
III Fats and edible oils	0 (0.)	4 (11.1)	12 (33.3)	6 (16.7)	11 (30.6)	3 (8.3)	36 (100.0)	29.2	11.9	.407
IV Food, beverage, and tobacco	2 (1.8)	16 (14.4)	10 (9.0)	12 (10.8)	6 (5.4)	65 (58.6)	111 (100.0)	38.0	15.9	.418
V Minerals and fuels	0 (0.0)	60 (60.6)	29 (29.3)	9 (9.1)	1 (1.0)	0 (0.0)	99 (100.0)	15.1	7.0	.466
VI Nonorganic and organic chemicals	0 (0.0)	143 (52.4)	81 (29.7)	33 (12.1)	5 (1.8)	11 (4.0)	273 (100.0)	17.6	10.1	.575
VII Plastic and rubber products	0 (0.0)	13 (8.6)	57 (37.7)	67 (44.4)	2 (1.3)	12 (8.0)	151 (100.0)	26.2	9.5	.364
VIII Furs, hides, and leather products	0 (0.0)	11 (30.5)	1 (2.8)	12 (33.3)	1 (2.8)	11 (30.6)	36 (100.0)	30.00	15.81	.527
IX Wood and cork products	0 (0.0)	12 (24.5)	10 (20.4)	8 (16.3)	6 (12.3)	13 (26.5)	49 (100.0)	29.6	15.4	5.20
X Pulp, paper and paper products	0 (0.0)	18 (17.3)	23 (22.1)	16 (15.4)	33 (31.7)	14 (13.5)	104 (100.0)	30.2	13.3	.440
XI Textiles and derivatives	0 (0.0)	5 (1.7)	48 (15.9)	52 (17.2)	60 (19.9)	137 (45.3)	302 (100.0)	39.1	11.9	.303

XII	Footwear and miscellaneous products	0	0	2	1	1	20	24	46.25	9.04	.195
		(0.0)	(0.0)	(8.3)	(4.2)	(4.2)	(83.3)	(100.0)			
XIII	Glass and ceramic products	0	7	11	15	11	21	65	34.3	13.7	.399
		(0.0)	(10.8)	(16.9)	(23.1)	(16.9)	(32.3)	(100.0)			
XIV	Precious stones and metals	0	4	1	0	0	23	28	43.2	14.6	.339
		(0.0)	(14.3)	(3.6)	(0.0)	(0.0)	(82.1)	(100.0)			
XV	Common metals and products	10	83	56	67	14	22	252	22.5	12.8	.568
		(4.0)	(32.9)	(22.2)	(26.6)	(5.6)	(8.7)	(100.0)			
XVI	Machinery	0	78	132	104	6	35	355	24.0	11.4	.475
		(0.0)	(22.0)	(37.2)	(29.3)	(1.7)	(9.8)	(100.0)			
XVII	Transportation equipment	0	35	7	13	0	16	71	23.7	16.0	.678
		(0.0)	(49.3)	(9.90)	(18.3)	(0.0)	(22.5)	(100.0)			
XVIII	Precision instruments and other instruments	0	41	25	20	2	11	99	21.6	12.9	.598
		(0.0)	(41.4)	(25.3)	(20.2)	(2.0)	(11.1)	(100.0)			
XIX	Arms and munitions	0	0	0	1	0	8	9	47.8	6.7	.140
		(0.0)	(0.0)	(0.0)	(11.1)	(0.0)	(88.9)	(100.0)			
XX	Furniture, toys, and miscellaneous projects	0	2	6	8	3	27	46	40.2	12.9	.322
		(0.0)	(4.4)	(13.0)	(17.4)	(6.5)	(58.7)	(100.0)			
XXI	Arts and antiques	0	6	0	0	0	0	6	10.0	0.0	.000
		(0.0)	(100.0)	(0.0)	(0.0)	(0.0)	(0.0)	(100.0)			
	General Tariff Schedule	30	557	540	459	165	544	2295	27.9	15.0	.539
		(1.3)	(24.3)	(23.5)	(20.0)	(7.2)	(23.7)	(100.0)			

Source: Tariff and Customs Code 1982.

Note: Figures in parentheses are percentages of total number of items under each BTN section.

In empirical measurement of effective protection, "free trade" input coefficients are hard to come by; published input-output tables normally contain technical coefficient (a'_{ij}) expressed in domestic prices. Using the latter coefficients, we can modify (1) as follows:

$$(4) \quad v_j = \frac{1}{1 + t_j} - \sum_i \frac{a'_{ij}}{1 + t_i}, \quad v'_j = 11 - \sum_i a'_{ij}$$

and hence

$$(5) \quad E_j = \frac{1 - \sum_i a'_{ij}}{\left(\frac{1}{1 + t_j} - \sum_i \frac{a'_{ij}}{1 + t_i}\right)} - 1$$

Some of the implications of (3) or (5) are that: (1) other things the same, a higher E_j results from a higher t_j and lower t_i 's; (2) if tariff rates are uniform (i.e., $t_i = t_j$), then $E_j = t_j$; and (3) if value added is a small proportion of the product price (i.e., $\sum_i a_{ij}$ is high), a low t_j combined with lower t_i 's can lead to a very high E_j .

Equation (5) was used in the calculation of effective protection rates for manufacturing industries in the present study. Non-tradable inputs were treated as part of value added, so the a_{ij} 's used pertain only to the tradable inputs. The technical coefficients from the 120 x 120 input-output table for 1974 prepared by the National Census and Statistics Office (NCSO) were utilized, after adjusting for relative price changes between 1974 and 1980.^{5,6} Tariff rates for 1980 were drawn from the *Tariff and Customs Code 1978*, with appropriate adjustments for some changes in tariff levels during 1979-80; on the other hand, tariff rates for 1985 were extracted from the recently published *Tariff and Customs Code 1982*.

Sectoral ETPR Estimates in Manufacturing

Table 4 presents the estimated effective protection rates for 67 manufacturing industries⁷ for 1980 and 1985. It would appear that the tariff reform, if implemented fully, will significantly

⁵A less disaggregate (63 x 63) input-output table for 1978 is available from the NCSO, but which was derived also from the 1974 input-output table with price adjustment.

⁶Two Central Bank wholesale price indices were used: the home consumption WPI to adjust for input price changes and the domestic production WPI to adjust for output price changes.

⁷Corresponding to the number of sectors within manufacturing distinguished in the NCSO's 120 x 120 input-output table for 1974.

Table 4. Estimates of Effective Protection Rates in
Philippine Manufacturing, 1980 and 1985
(in per cent)

<i>I-O No.</i>	<i>SECTOR</i>	<i>1980</i>	<i>1985</i>
26	Meat products	809.5	178.4
27	Dairy products	62.3	30.4
28	Rice milling	97.8	98.0
29	Sugar milling and refining	- 1.1	- 0.9
30	Processed fruits and vegetables	223.0	72.4
31	Processed fish and other seafoods	872.9	215.9
32	Other grain mill products	176.7	74.9
33	Bakery products	127.1	44.2
34	Cocoa, chocolate and sugar confectionary	71.2	30.1
35	Desiccated coconut products	- 3.9	- 2.6
36	Other manufactured foods	94.8	36.7
37	Liquors, wines, brewery and malt products	84.7	44.3
38	Soft drinks and carbonated water	127.5	69.5
39	Tobacco products	61.8	29.7
40	Textile and knitting mill products	61.4	36.0
41	Cordage, twine and other textile products	- 9.3	- 7.4
42	Footwear	- 3.1	- 2.2
43	Other wearing apparel	-10.5	- 7.8
44	Other made-up textile goods	93.3	48.0
45	Lumber	- 1.8	1.0
46	Plywood and veneer plants	-18.1	-13.4
47	Furniture and fixtures	- 5.2	- 4.0
48	Other wood, cane and cork products	- 4.6	- 3.4
49	Pulp, paper and paperboard manufacturing	47.5	29.3
50	Articles of pulp, paper and paperboard	158.5	58.1
51	Newspaper, periodicals, books and pamphlets	27.7	17.5
52	Printing, bookbinding and other allied products	51.5	28.6
53	Leather and leather products except for footwear and other wearing apparel	-10.7	- 8.4
54	Rubber footwear	6.0	1.7
55	Tires, tire vulcanizing and recapping	54.0	39.5
56	Other rubber products	26.2	17.9
57	Basic industrial chemicals	14.0	12.8
58	Coconut oil	- 0.7	- 0.6
59	Other oils and fats	64.9	33.5
60	Fertilizer and lime	23.2	16.7
61	Paints, varnishes and related compounds	39.5	26.3
62	Plastic materials	44.3	23.2
63	Medicinal and pharmaceutical preparations	0.1	1.5
64	Soap and other washing and cleansing compounds	98.5	51.2
65	Other chemical products	47.0	34.3
66	Petroleum refineries and other petroleum products	12.4	12.6
67	Hydraulic cement	-10.1	- 8.9

Table 4 (Continued)

<i>I-O No.</i>	<i>SECTOR</i>	1980	1985
68	Structural clay and concrete products	69.4	56.7
69	Glass and glass products	54.6	41.7
70	Other non-metallic mineral products	54.3	36.7
71	Basic ferrous metal industries	19.1	12.6
72	Basic non-ferrous metal industries	15.3	16.7
73	Cutlery, handtools and general hardware	52.0	55.7
74	Fabricated structural metal products	-10.3	- 8.2
75	Heating apparatus, lighting and plumbing fixtures	83.6	63.6
76	Other fabricated metal products	68.4	50.2
77	Tractors and other agricultural machinery and equipment	27.0	13.7
78	Special industry machinery	16.3	21.0
79	General industry machinery and equipment (excluding electrical)	17.8	25.9
80	Office, computing and accounting machines (excluding electrical)	12.7	15.4
81	Electrical industrial machinery and apparatus	38.5	35.2
82	Communication equipment excluding radio, TV	47.9	10.9
83	Batteries	84.9	13.6
84	Electric lamps, fixtures, wires and wiring devices	25.5	16.0
85	Household radio, TV receiving sets, phonos	35.5	12.0
86	Refrigeration and air-conditioning equipment	76.4	44.1
87	Other household electrical appliances and wares	77.9	34.1
88	Motor vehicles, engines, bodies and parts	31.9	26.8
89	Repair of motor vehicles (nontradable)	—	—
90	Ship building and repairing	7.0	15.1
91	Other transport equipment	42.1	38.6
92	Miscellaneous manufactures	90.7	45.7
	Average	70.3	31.0
	Standard Deviation	144.3	37.7
	Coefficient of Variation	2.05	1.22

lower the average level of effective protection to domestic industries from 69% in 1980 to 30% in 1985. At the same time, disparities in ETPRs across industries will be reduced substantially, based on a comparison of the computed values of either the standard deviation or the coefficient of variation. These general findings would conform to the declared objective of tariff reform that adjustments will be made to reduce the overall level of protection to domestic industries and to even out the spread in protection rates among industry sectors.

Examining individual sector ETPR changes between 1980 and 1985, one finds a preponderance of decreasing levels with only 8 sectors⁸ showing increases in ETPR (some of which appear insignificant), as a result of the tariff reform.

The pattern of sectoral ETPR for 1980 is similar to that obtained earlier by Tan (1979) for 1974. This is not surprising in view of the dominance of tariffs vis-à-vis other policy instruments affecting relative incentives (as pointed out above) and the fact that there had not been much significant tariff rate changes between 1974 and 1980.

By end-use category, consumer goods industries on the whole continued to be highly protected in 1980 while industries producing capital goods, intermediate goods and inputs-into-construction were effectively being discriminated against, as shown in Table 5. Even after the tariff reform in 1985, however, the same direction of bias is evident from the table, notwithstanding the general reduction in the average effective protection levels for the four categories of industries. While the consumer goods sectors are seen to have the largest decline in average ETPR from 1980 to 1985, they would continue to enjoy the highest tariff protection, having an average ETPR about 12 percentage points above the average for all manufacturing.

At the other extreme, intermediate goods industries, which already were being accorded generally low tariff protection in 1980, face substantial ETPR cuts that will reduce their average effective protection rate to about one half its 1980 value and 17 percentage points below the average for all manufacturing. The capital goods sectors' average ETPR would also decrease, although not drastically, which direction again is opposite to what is warranted by a more uniform ETPR structure.

Therefore, while a significant improvement of the tariff system would be achieved by 1985 in terms of reducing the overall ETPR and the dispersion of sectoral rates around the mean value, there will still be room for additional rationalization of the structure of tariffs. This would generally entail a further reduction

⁸These are I-0 sectors, 63, 66, 72, 73, 78, 79, 80 and 90 (cf. Table 4).

**Table 5: Average Effective Protection Rates
by End-Use Category, 1980 and 1985
(in per cent)**

<i>Sectors Producing</i>	<i>1980</i>	<i>1985</i>
Consumption goods	115.0	43.2
Intermediate goods	26.8	14.0
Inputs-into-construction	31.5	24.7
Capital goods	23.9	19.6
All manufacturing	70.3	31.0

Source: Appendix Table 1-4.

in the protection of sectors producing consumer goods and raising those of the intermediate (excluding inputs-into-construction) and capital goods sectors.

It should be noted that, within each of these industry categories, there are also disparities in the estimated effective protection rates for 1985. As shown in Appendix Tables 1-4, sectoral ETPR differences are largest among the consumer and intermediate goods sectors. This is due in large part to the composition of these two industrial groupings, which include both export-oriented industries⁹ with low or negative ETPRs and import-substituting industries characterized by markedly higher ETPRs.

A final observation is that, even after the tariff reform, a number of industries would continue to be heavily protected. The extreme examples are meat products and processed fish and other seafoods with estimated ETPRs of 178% and 216%, respectively, for 1975. Post-1985 tariff revisions need to be directed to such industries if excessive profits and/or low levels of efficiency, which are associated with high ETPRs are to be discouraged.

Concluding Remarks

As pointed out earlier, the recent tariff revisions are part of a larger effort to improve the existing policy climate and make it more conducive to the efficient development of domestic manufacturing industries. The above findings point to a relatively substantial liberalization of tariff policy by 1985, given the scheduled tariff changes, in terms of the overall reduction in effective pro-

⁹Such as footwear, other wearing apparel, furniture and fixtures, certain wood products and other leader products within the consumer goods category, and sugar milling, desiccated coconut, cordage and coconut oil within the intermediate goods category.

tection and the narrowing of the disparities in sectoral rates. Of course, it remains to be seen whether the tariff changes will be fully implemented.

Also, it would appear that there is room for further improvements, i.e., in lowering the tariff rates on consumption goods and raising those on intermediate products and capital goods, if the objective is to confer equal levels of effective protection to manufacturing industries. Apropos this, two points maybe noted: 1) equal effective tariff protection rates should ideally be sought not only for manufacturing industries but for all tradable goods producing industries; and 2) other policy instruments need to provide offsetting subsidies to export industries to the extent of the nominal protection to domestic sales accorded by the uniform tariff structure. Protection policy (a more appropriate term is "promotion policy") in the foregoing sense is neutral in that it does not distort relative prices. No discrimination arises other than that which comes naturally out of the price system. According to standard economic theory, this would not only allocate resources to their most efficient uses but also distribute goods such that consumer welfare is maximized for any given distribution of income.

A distorted tariff structure could of course serve certain objectives; it could expand output in particular industries, or it could redistribute income, or it could improve the balance of payments. But even these objectives can be achieved by other means that do not have the undesirable side effects of misallocating resources and limiting consumption. Providing direct subsidies to industries could stimulate production without restricting consumption; for redistributing income within a country direct taxes and transfers are superior to tariffs;¹⁰ while balance of payments problems are better tackled through monetary and fiscal policies. In general, it is desirable to address policy instruments to problems that can be dealt with in the most direct manner.

Producers tend to prefer tariffs to subsidies. Perhaps the latter's visibility makes them less attractive; also, direct subsidies are somehow regarded as incompatible with the ethic of private enterprise but the implicit subsidy from tariff protection apparently is not. But it is precisely the fact subsidies are visible to the general public and represent a direct cost to the government that may prevent the perpetuation of a protection policy heavily biased toward certain industries.

¹⁰A differential tariff structure is also not needed as a means of taxing luxury goods. A more efficient instrument would be a set of luxury consumption taxes applicable to both imported and domestically produced goods.

Any kind of policy reform leads to differential gains and losses across both producing and consuming sectors. Resistance to a movement for a more neutral tariff system would come from producer interests in the affected industries, i.e., those being faced with a significant reduction in effective protection rates, which in view of the protracted nature of the country's import substitution policies (cf. Baldwin, 1976) might prove to be more politically powerful than producer and consumer interests in general.

Failing to stem the tide of tariff reform, vested interests could focus their attention on nontariff barriers, especially in the area of import licensing, which also lead to a divergence between foreign and domestic prices. It is however a declared policy of the government that import restrictions will be liberalized as part of the "industrial structural adjustment" program.^{11,12} To the extent that the program is faithfully implemented,¹³ domestic industries can be expected to be reoriented "toward more efficient use of resources which will make them more competitive by international standards and allow them to develop in line with the country's comparative advantage".¹⁴

The important point should be made that, in the above context, government is part of "producer interests". The last few years have witnessed a sharply increased participation of public corporations and their subsidiaries in manufacturing activities, and this is bound to increase with the active promotion of the so-called "eleven major industrial projects" (11 MIPs, for short). The latter represent a set of large-scale, capital-intensive projects expected to be established during 1983-87 "to provide the basic industrial infrastructure." About 12.5% of the 11 MIPs' total funding of \$4 billion is estimated to come from direct government

¹¹From the original list of 1,300 banned import items, 264 were removed in 1981. "Another 610 were taken off the list of last month (February 1982) and the plan is to abolish the whole list by next year" (Times Journal, March 4, 1982 issue).

¹²The program also includes other policy measures relating to export promotion, investment incentives and administration and revitalization of specific industries.

¹³That there is actual resistance of the scheduled implementation of some aspects of the trade liberalization component of the program is clear from the reported (cf. Times Journal issue cited earlier) reimposition of restrictions on imports of certain durable consumer goods, mostly household appliances, two weeks after a CB circular was issued removing the 24 items involved from the list of banned imports. According to the news reports, "the sudden policy shift was in reaction to strong criticism from local household appliance manufacturers."

¹⁴Quoted from the *Five-Year Philippine Development Plan, 1978-1982* (Updated for 1981 and 1982); p. 12

budgetary appropriations; equity contributions of the National Development Company are being provided to, among others, the \$250 million copper smelter (34.4%) and the \$336 million phosphatic fertilizer plant (60%).

It is intended that the 11 MIPs "will produce vital commodities and intermediate inputs at internationally competitive prices"¹⁵ Given this objective, it would seem necessary that heavy protection from competing imports via increased tariffs and other import barriers be avoided;¹⁶ indeed this consideration should be explicitly taken into account in the feasibility studies in order to establish *true* economic viability of the projects.¹⁷ If this is not done, the country faces the likely prospect of being presented with huge white elephants.

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¹⁵Quoted from the *Five-Year Philippine Development Plan 1978-1982* (Updated for 1981 and 1982), p. 13.

¹⁶If, on infant industry grounds, some protection (the more appropriate term is *promotion*) is warranted, it should apply in both domestic and foreign markets, i.e., the incentives should not favor domestic sales over exporting, and only over a specified period of time.

¹⁷It is to be noted that independent researchers do not have access to the feasibility studies of the 11 MIPs, a situation not contributing to an informed public discussion.

Appendix Table 1: EPR Estimates for Consumption
Goods Sectors in Manufacturing (%)

<i>I-O No.</i>	<i>SECTOR</i>	<i>1980</i>	<i>1985</i>
26	Meat products	809.48	178.45
27	Dairy products	62.32	30.38
28	Rice milling	97.85	97.96
30	Processed Fruits and vegetables	223.03	72.41
31	Processed fish and other seafoods	872.89	215.89
32	Other grain mill products	176.72	74.89
33	Bakery products	127.09	44.17
34	Cocoa, chocolate and sugar confectionary	71.18	30.13
36	Other manufactured foods	94.75	36.66
37	Liquors, wines, brewery and malt products	84.73	44.33
38	Soft drinks and carbonated water	127.52	69.50
39	Tobacco products	61.78	29.67
40	Textile and knitting mill products	61.37	36.03
42	Footwear	- 3.13	- 2.20
43	Other wearing apparel	-10.49	- 7.80
44	Other made-up textile goods	93.28	48.00
47	Furniture and fixtures	- 5.19	- 4.04
48	Other wood, cane and cork products	- 4.62	- 3.37
50	Articles of pulp, paper and paperboard	158.49	58.14
51	Newspaper, periodicals, books and pamphlets	27.70	17.53
52	Printing, bookbinding and other allied industries	51.51	28.55
53	Leather and leather products except footwear and other wearing apparel	-10.70	- 8.40
54	Rubber footwear	6.00	1.69
55	Tires, tire vulcanizing and recapping	53.97	39.53
63	Medicinal and pharmaceutical preparations	0.06	1.52
64	Soap and other washing and cleansing compounds	98.48	51.22
85	Household radio, TV receiving sets, phonos	35.48	11.96
86	Refrigeration and air-conditioning equipment	76.38	44.12
87	Other household electrical appliances and wares	77.86	34.11
88	Motor vehicles, engines, bodies and parts	31.93	26.85
91	Other Transport equipment	42.07	38.63
92	Miscellaneous manufactures	90.74	45.69
	Average	115.01	43.19
	Standard Deviation	195.52	47.44
	Coefficient of Variation	1.70	1.10

**Appendix Table 2: ETPR Estimates for
Intermediate Goods Sectors in Manufacturing (%)**

<i>I-O No.</i>	<i>SECTOR</i>	<i>1980</i>	<i>1985</i>
29	Sugar milling and refining	- 1.12	- 0.92
35	Desiccated coconut products	- 3.86	- 2.63
41	Cordage, twine and other textile products	- 9.26	- 7.40
49	Pulp, paper and paperboard manufacturing	47.49	29.29
56	Other rubber products	26.20	17.89
57	Basic industrial chemicals	13.97	12.82
58	Coconut oil	- 0.73	- 0.64
59	Other oils and fats	64.88	33.47
60	Fertilizer and lime	23.20	16.68
62	Plastic materials	44.28	23.15
65	Other chemical products	47.05	34.34
66	Petroleum refineries and other petroleum products	12.36	12.61
83	Batteries	83.91	13.64
	Average	26.80	14.02
	Standard Deviation	27.76	13.32
	Coefficient of Variation	1.04	0.95

**Appendix Table 3: ETPR Estimates for Inputs-Into-Construction
Sectors in Manufacturing (%)**

<i>I-O No.</i>	<i>SECTOR</i>	<i>1980</i>	<i>1985</i>
45	Lumber	- 1.76	1.02
46	Plywood and veneer plants	-18.07	-13.43
61	Paints, varnishes and related compounds	39.54	26.29
67	Hydraulic cement	-10.08	- 8.92
68	Structural clay and concrete products	69.40	56.67
69	Glass and glass products	54.67	41.68
70	Other non-metallic mineral products	54.33	36.70
71	Basic ferrous metal industries	19.07	12.56
72	Basic non-ferrous metal industries	15.28	16.66
73	Cutlery, handtools and general hardware	52.01	55.69
74	Fabricated structural metal products	-10.31	- 8.24
75	Heating apparatus, lighting and plumbing fixtures	83.61	63.55
76	Other fabricated metal products	68.42	50.20
84	Electric lamps, fixtures, wires and wiring devices	25.53	15.98
	Average	31.54	24.74
	Standard Deviation	32.23	25.49
	Coefficient of Variation	1.02	1.03

**Appendix Table 4: ETPR Estimates for
Capital Goods Sectors in Manufacturing (%)**

<i>I-O No.</i>	<i>SECTOR</i>	<i>1980</i>	<i>1985</i>
77	Tractors and other agricultural machinery and equipment	26.96	13.67
78	Special industry machinery	16.33	21.03
79	General industry machinery and equipment (excluding electrical)	17.79	25.94
80	Office, computing and accounting machines and apparatus	12.70	15.45
81	Electrical industrial machinery and apparatus	38.48	35.18
82	Communication equipment excluding radio, TV	47.91	10.86
90	Shipbuilding	7.02	15.14
	Average	23.88	19.61
	Standard Deviation	13.65	7.87
	Coefficient of Variation	0.57	0.40

DISCUSSION ON THE 1981-85 TARIFF CHANGES AND EFFECTIVE PROTECTION OF MANUFACTURING INDUSTRIES

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In this paper, Professor Bautista provides us with estimates of effective protection rates (EPR) for various industries along four sectors (by end-use) using the 1974 Input-Output Tables but adjusted for price differences between 1974 and 1980. EPR's for 1980 take into account (nominal) tariff levels for that year while EPR estimates for 1985 take into account the projected tariff levels as planned in the current tariff reform program. I presume, in the absence of an explanation, that no adjustment is made for possible price changes between 1980 and 1985.

I find myself in full agreement with the thrust of Professor Bautista's examination of the tariff reform and my discussion necessarily is in addition (and perhaps sometimes redundant) to his main points. It appears that even by 1985 the distortions in the protective system of Philippine manufacturing will remain the same as in 1974. What the tariff effectively does then is simply to reduce the industries that are protected in the various categories but retaining the implied misallocation of resources. Consumption goods are still accorded the highest EPR's. Indeed, as shown in Table 5, the ranking of EPR's remain the same although it should be noted that by 1985 the intermediate goods sector would have the least protection (compared with 1980). Thus, *ceteris paribus*, one can say that the tariff reform by 1985 implies greater resource misallocation (after adjustments will have taken place) but for a smaller set of industries. In short, it seems that the tariff reform program cast in nominal terms would fail to achieve the desirable correction of the protective system in the manufacturing industries.

It is expected that by 1985 the Philippines will have achieved lower average levels as well as distribution of nominal tariff rates compared with her ASEAN neighbors. While this may be considered an important result, what I think is even more important is to keep track of the result in terms of resource allocation pattern in the country.

Professor Bautista indicates there is room for further reform that would aim for a more neutral effective protection. I would second this argument. Perhaps not only in the area of further tariff cut to lower EPR disparities but even in the other policy areas it might be useful to pursue active programs aimed at counteracting the effective net result of the tariff reform.

My final note has something to do with the procedure for the calculations. The paper lays out the assumptions behind the EPR's, the limitations of the methods and other underlying structure. In a period of substantive disturbances, I think that the use of dated (and constant) $[a_{ij}]$'s will likely result in estimates which would be less meaningful than otherwise.

The paper finds that 8 sectors (actually 9 including I-O 28; Cf. Table 4) show increases in EPR and argues [the increase] them to be " . . . generally insignificant at that, as a result of the tariff reform" (p. 15). When one looks at the distribution of the increases according to the four sectors, I do not think they are insignificant. While the differences are indeed small in the consumption (other than I-O 63), intermediate, and inputs-into-construction sectors, they seem to be large in the capital goods sector. (Cf. Appendix Tables 1-4).

Given the magnitude of the disturbances between 1974 and 1980 (e.g. oil price increase) one can expect that the capital goods sector would relatively suffer more in terms of lower value added (at constant $[a_{ij}]$'s. This coupled with low t_i 's, implies high EPR's. In the tariff reform of 1980-1985, relatively low t_j 's and lower t_i 's, given the same $[a_{ij}]$'s would mean higher EPR's. Consequently, one finds increases in EPR's than what would otherwise find in the face of adjusted $[a_{ij}]$'s and the appropriate factor-proportions response to disturbances. This means that when these considerations are taken into account, the apparent bias may not be that large. Put differently, the tariff reform may actually be narrowing EPR's than what we are led to believe.

This of course does not prove any precise point against what is advanced in the paper. Rather, this is an argument for a new round of data on inter-industry transactions that reflect more accurately adjusted responses and factor proportions even if on the same isoquant.

Gonzalo M. Jurado, Ph.D., Discussant

Romeo Bautista has made a careful assessment of the likely impact of the on-going tariff reform in the Philippines upon various industries in the country's manufacturing sector. He has outlined the bases of the expectation that this liberalization, through the reduction of effective protection rates, would result in the improvement of resource allocation and the promotion of overall industrial development. Though the current reform is extensive, however, a number of additional modifications in the tariff structure can be introduced at a later date, including in particular the lowering of tariff rates on consumer goods and the

raising of those on intermediate products and capital goods, to further enhance the policy environment for industrial enterprises.

I agree entirely with the Bautista thesis, emphasizing only some points that were accorded subsidiary treatment in the study. The case for free trade has to this day constituted one of the few unchallengeably established propositions in trade theory, namely, that countries can gain in efficiency and welfare if they engaged in free trade (on the basis of comparative advantage). Yet the inclination towards protection has persisted through time among many countries, the industrially advanced ones included, and indeed has become stronger in the last three or four years. The reason for this, I think is not that policy makers have been unappreciative of the benefits that can be realized from unrestricted exchange but that they have been concerned with the costs that a movement towards a more liberal regime can inflict upon some members of the population. It is quite true that trade liberalization has the potential of promoting efficiency in resource allocation and improvement in consumer welfare but it is also a fact that unless conditions of perfect competition in the factors and commodities markets prevail and unless compensation schemes are actually carried out such a potential may not be realized. On the contrary, trade relaxation can injure some productive factors, wiping out their activities or extinguishing their jobs, as well as promote the welfare of some, not all, people.

In the Philippines, I think that the attention given to the gains that are expected to come in the wake of tariff reform must be tempered with a regard for the circumstances of those who will be disadvantaged by such reform. Economic policy must show sympathy for adversely affected groups.

Bautista has enumerated a number of measures that can be brought to bear upon the problem of sluggish industrial growth without creating the unwanted distortions that the tariff structure generates. I am in favor of systematically implementing these measures in moderation of the impact of the liberalized tariff, for the duration of the adjustment period: subsidies to affected industries in the form of fiscal privileges (tax exemptions, tax holdings, loss carry-over, etc.), direct taxes or transfers to income groups benefitted or injured by the reduced tariff, and appropriately aimed monetary and fiscal policies.

In addition, I am in favor of substantial adjustment assistance both to affected industries to enable them to overcome the difficulties of the transition and to injured income groups to make it possible for them to recover welfare losses.

In arguing this way, I am not proposing the perpetuation of internationally non-competitive industries nor justifying the inauguration of an onerous welfare program. The adjustment

assistance and compensatory measures are to be of a medium term duration, possibly four or five years. What I am suggesting is the more uniform distribution of the cost of adjustment among members of society and the more equitable diffusion of the benefits of liberal trade amongst them. This course of action is not only necessary as a way of concretizing compensation measures; it is also reasonable in the context of a second-best situation in which non-competitive conditions of distorted prices and costs already exists, to begin with.

Vicente B. Valdepeñas, Jr., Ph.D., Discussant

First, a few general comments on Dr. Bautista's paper. It is a welcome effort, mainly because it attempts to reveal what is probably the real structure of protection implicit in the tariff reform initiated in 1981. Tariff analyses tend to be usually obfuscated by differences between statutory and actual levels of the rate structure. Any initiative that is exercised to clarify this chronic obfuscation and thereby succeeds in defining more explicitly the real incidence of a tariff structure is in the right direction.

As noted by Dr. Bautista himself, the tariff reform introduced in 1981 will have cut back the average statutory rate some 35 percent over five years, from 43.11 percent down to 27.9 percent. This in itself, especially as it has been taken on a unilateral basis and applied on an mfn (most-favored-nation) coverage without so much as an effort to elicit reciprocal tariff concessions from trading partners of the Philippines in the GATT (General Agreement on Tariffs and Trade), represents a tremendous trade liberalization process. However, Dr. Bautista could have refined the magnitude of the overall tariff reduction by weighing each BTN sectional schedule by the import values that were dutiable in 1980. For the terminal year of the tariff reform, viz., 1985, the weights could have been figured out as the most probable configuration of import values by that time. This would have of course entailed a vast amount of sensitivity analysis of the import structure in relation to the tariff reform.

However, as Dr. Bautista says on page 46 of his paper, the focus of his efforts is the impact of the tariff reform on the structure of incentives available to manufacturing industries. Here he applies the apparatus of effective protection, that is, protection of value-added. In his formulation of the measurement of effective protection, from pages 46 thru 47 of his paper, Dr. Bautista makes a transition in the valuation of input coefficients from foreign to domestic prices. This is fairly understandable since the

basic input-output table he is working from values all transactions in peso prices. What seems to present some difficulty, however, is the fact that this table was first organized in 1974, with imports tabulated as a column vector rather than a row vector. Its coefficients have since been adjusted to take into account price changes up to 1980. Presumably, and as a result of discretionary management of the exchange rate in the interim, a range of effective exchange rates would have prevailed for different import transactions. This would have vitiated the assumption that the peso prices of imported inputs are directly comparable, an assumption that is implied in the way effective protection is estimated. To the extent that this assumption runs counter to the reality of varying exchange rates, the corresponding measures of effective protection are somehow flawed in the process.

Be that as it may, the estimated levels of effective protection for some 67 manufacturing industries suggest that for 1980 they have been some 60 percent higher than the simple and unweighted average statutory rate shows, and for 1985 some 9 percent higher. Moreover, there appears to be a more than 50-percent cutback in the levels of effective protection over the five-year course of the tariff reform. This is an even more considerable reduction than had earlier been noted for a corresponding cutback in the simple and unweighted average statutory rate across all sections of the tariff schedules for the same period of time.

The suggestion for further rationalization of the tariff structure by cutting further on tariffs for consumer imports and raising those for the intermediate and capital goods needs to be modified to take into account the implications of such a motion for export promotion. If such great exporting countries as South Korea, Taiwan, Brazil and Yugoslavia do not attempt a rationalization of their respective tariff structures along the lines suggested, then there seems to be little point in the Philippines taking on such rationalization motion.

On the policy alternatives suggested for protecting domestic industries, there is an immediate constraint to extending direct subsidies. It is the ability of the community to raise the resources for subsidization. At the same time, it is fairly vulnerable to such GATT sanctions as countervailing duties. As for income transfers to underwrite compensatory consumption, once more the big question is where to raise the funds to finance such transfers. As for monetary and fiscal policies, including exchange rate policy, and their ability to relieve the balance of payments problem, one should keep in mind the resurgence of strident protectionism in the key markets of the Philippines overseas, as well as the OECD economic cartel on export credits.

THE PERFORMANCE AND PROSPECTS OF SMALL AND INTERMEDIATE SIZE CITIES IN THE PHILIPPINES*

By Ernesto M. Pernia, Ph. D.

Abstract

The paper argues that small and intermediate size cities (SMCs) are essential parts of the national urban system and, therefore, an understanding of their structure and behavior would sharpen our grasp of issues concerning primacy as well as help rationalize attempts to bring about diffuse urbanization and development. A spatial-temporal framework reflecting economic policy thrusts is used in the analysis. While the few large cities (LCs) in the various regions grew consistently rapidly since the early part of the century, SMCs tended to be subject to the differential impacts of policy on the regions. Thus, those in the central industrial region (CIR) have been buoyant due to a progressive economic environment favored by policy; by contrast, SMCs in the other regions performed poorly because they tended to be sapped by LCs in the same region and those in the CIR. There is some indication, however, that SMCs in the less developed regions have recently begun to perk up — probably less due to the efficacy of regional development policy than to diseconomies of scale at the National Capital Region or more broadly the CIR. Regional policy may become more effective if it systematically considers SMCs so that at least some of them can flourish and thus spontaneously foster broader rural industrialization and regional development.

Introduction

Because urban systems in most developing countries are punctuated by primary, urban research has tended to focus on the primate city or on secondary cities as alternative centers for decentralized urbanization. Very little attention has so far been given to small and intermediate size cities, resulting in a partial view of the national urban system. In discussions of development policy these cities have been taken for granted and their potential role largely ignored.

This paper takes the position that small and intermediate size cities are essential parts of the national urban system so that an understanding of their structure and behavior would sharpen our grasp of issues concerning primacy as well as attempts to bring about diffuse urbanization and development. Accordingly, in this paper we examine small and intermediate size cities in the Philippines to see what has been their growth performance over time, what factors have underlaid their behavior, what role they might play in national development and how such role may be fostered by policy. The organization of the paper follows these questions.

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Performance of SMCs

Data compiled by the United Nations reveal the slackening growth of small and intermediate size cities (SMCs)¹ in developing countries since 1950, resulting in a diminution of their position in the national urban hierarchy (Mathur 1981). This observation can also be made regarding SMCs² in the Philippines, as can be seen in Table 1.

Table 1. Annual Percent Growth Rates of Population of Different Size Cities: Philippines, 1903-80

<i>City Size</i>	<i>1903-39</i>	<i>1948-60</i>	<i>1960-70</i>	<i>1970-80</i>
Small	1.79	2.00	2.05	2.17
Intermediate	2.57	3.11	2.11	2.57
Large	3.16	3.75	4.22	3.79
Total	<u>2.51</u>	<u>3.10</u>	<u>3.18</u>	<u>3.15</u>

Source: Annex Table 1.

We note that large (100,000+) cities consistently grew the fastest, always exceeding the national urban average, over the long historical stretch from 1903 to 1980. Especially salient among these large cities are Metro Manila in Luzon, Metro Cebu and Bacolod in the Visayas, and Zamboanga and Davao in Mindanao (see the Annex map). The overall growth rate of large cities peaked during the 60s at 4.2 percent per annum. Small (40,000-59,999) cities started out slow and hardly changed their growth rate during the 50s and 60s, but picked up somewhat in the 70s. After some burst in 1948-60, intermediate (60,000-99,999) cities decelerated in the 60s and also perked up in the 70s. A particularly noteworthy point in Table 1 is the visibly slow growth of SMCs in the 60s in contrast to a most rapid expansion of large cities (LCs) during the same period. This was the decade when several SMCs experienced absolute decreases in population (see Annex

¹SMC's are defined as urban places with population in the 20,000-100,000 range.

²For the present paper, size categories are reckoned as of 1960: small = 40,000 - 59,999; intermediate = 60,000-99,999; large = 100,000. This procedure allows for a backward and forward inspection of the performance of these different size cities.

Table 2). While SMCs had always been the sources of growth for LCs, it was during 1960-70 when the former suffered severe population losses to the latter. A final point that can be gleaned from Table 1 is that during the 70s SMCs picked up at the same time LCs appeared to be tapering off.

We argue that the growth pattern of small, intermediate and large cities can be explained by natural economic and social forces accentuated by the spatial biases of economic development policies.³ And to the extent that the large-city bias becomes established, dispersal policies designed to promote regional and rural development benefitting SMCs tend to be ineffective.

A Spatial-Temporal Framework

We attempt to explain in growth pattern of different size cities in the context of the country's four broad economic regions and four historical periods representing changing economic policy thrusts (see Pernia, Paderanga and Hermoso, forthcoming). The four regions are: the National Capital Region (NCR or Metro Manila), the Central Industrial Region excluding NCR (Other CIR: Southern Tagalog and Central Luzon), the Sluggish Region (SR: the Visayas, Bicol and Ilocos), and the Frontier Region (FR: Mindanao and Cagayan Valley). These regional divisions of the country were arrived at on the basis of the following criteria: (a) natural resource endowments or constraints, (b) spatial impacts of economic policies, (c) the distributions of rural and urban population and economic activity over time, and (d) growth rates of population and economic activity.

The four historical periods are: the Colonial Period (1903-39), Early Import Substitution Period (1948-60), Later Import Substitution Period (1960-70), and Regional Awareness Period (1970--80). The Colonial Period was characterized by preferential trade relations with the U.S. which facilitated the exportation of agricultural products from the colony to the mother country.⁴ Hence, during this period the center of population and economic activity was largely the traditional agricultural regions of the Visayas, Bicol and Ilocos (what are referred to now as the Sluggish Region).⁵

The period after World War II (1948-60) is known as the Early Import Substitution Period because industrialization policy was anchored on various kinds of import-substituting measures,

³This argument has been made by a number of scholars although in somewhat different contexts (e.g., Alonzo, 1968, Sicat, 1970, Renaud, 1979).

⁴For a review of economic policies during the Colonial Period, see Reyes and Paderanga (forthcoming).

⁵This can be seen in Annex Table 4-5.

such as exchange and import controls, tax incentives, tariffs and credit schemes. Because of the (well-known) problems that cropped up on account of exchange and import controls, there was a change in policy to decontrol and devaluation in the subsequent period (1960-70). Nonetheless, the import substitution strategy was effectively carried over with the continuation of the tariff structure and tax incentives, including wage and price policies; hence, the nomenclature Later Import Substitution Period.⁶

We have shown elsewhere (Pernia, Paderanga and Hermoso, forthcoming) that during the 50s and 60s there was massive shift of population and economic activity from the traditional agricultural regions (making them sluggish — thus the term SR) to Metro Manila, gradually spilling over into the adjacent regions of Southern Tagalog and Central Luzon (Other CIR). Thus, the trade and industrial development policies of the earlier and later import substitution periods exerted a strong impact for spatial concentration in Metro Manila and more broadly in what is now known as Central Industrial Region (see Annex Tables 4-7).

The fourth period (1970-80) can be identified by the government's conscious attempt at regional and rural development, although there were already such attempts (or intentions) earlier as exemplified by the Basic Industries Act of 1961. The objectives of dispersed development was to be pursued more vigorously this time by various investment and export promotion policies in addition to agricultural and infrastructure programs (see Reyes and Paderanga, forthcoming). However, due to the lingering spatial effects of former policies, the well-developed networks for migration, as well as agglomeration economies benefitting individual firms and households, the end of the 70s saw little departure from the concentration that had been built up in the 50s and 60s (Pernia, Paderanga and Hermoso, forthcoming).

In the context of our spatial-temporal framework which reflects policy timing and regional impact, we find that the growth of cities of all sizes was both rapid and steadily rising in the NCR, and slightly less so in the other CIR, from 1903 to 1970 followed by some deceleration in 1970-80 (Table 2). The opposite seems to be the case for the SR and the FR although the growth rates in the latter were higher during the first two periods. What is particularly striking are the peak growth rates in the NCR and Other CIR (4.8 and 3.7 percent) in contrast to the low ones in the SR and FR (1.7 and 2.5 percent) during the Later Import Substitution Period (1960-70).

⁶For a comprehensive discussion of import-substitution policies during the 50's and 60's, see op. cit.

Table 2. Annual Percent Growth Rates of Population in All Size-Class Cities by Broad Region, 1903-80

<i>Region</i>	<i>1903-39</i>	<i>1948-60</i>	<i>1960-70</i>	<i>1970-80</i>
NCR	3.13	4.04	4.78	4.10
Other CIR	1.79	2.96	3.74	2.70
SR	2.23	2.24	1.70	1.86
FR	4.42	3.68	2.53	3.78
Philippines	<u>2.51</u>	<u>3.10</u>	<u>3.18</u>	<u>3.15</u>

Source: Annex Table 3.

Table 3. Annual Percent Growth Rates of Cities by Size and Broad Region, 1903-80

	<i>1903-39</i>	<i>1948-60</i>	<i>1960-70</i>	<i>1970-80</i>
NCR	3.13	4.04	4.78	4.10
<u>Other CIR</u>	<u>1.79</u>	<u>2.96</u>	<u>3.74</u>	<u>2.70</u>
Small	1.57	2.61	3.67	2.61
Intermediate	2.16	3.45	3.84	2.83
Large	—	—	—	—
<u>Sluggish</u>	<u>2.23</u>	<u>2.24</u>	<u>1.70</u>	<u>1.86</u>
Small	1.82	1.78	1.42	1.89
Intermediate	2.59	2.41	0.89	1.66
Large	2.60	2.78	2.84	1.99
<u>Frontier</u>	<u>4.42</u>	<u>3.68</u>	<u>2.53</u>	<u>3.78</u>
Small	2.73	1.64	1.16	2.12
Intermediate	4.26	4.79	2.51	4.08
Large	5.46	4.10	3.59	4.62
PHILIPPINES	<u>2.51</u>	<u>3.10</u>	<u>3.18</u>	<u>3.15</u>

Source: Annex Table 3.

If we control for city size as in Table 3, we note essentially the same pattern as the more aggregative one in Table 2. Small and intermediate size cities in the CIR evince accelerating growth rates during the Early and Later Import Substitution Periods⁷ at the same time that those in the SR and FR were becoming depressed. In other words, regardless of size, cities tend to perform better in certain regions and periods than in others. It thus seems that insofar as the growth of cities is concerned, the key aspect is not so much size *per se* but the economic region in which cities are located as well as the relevant historical period.

The buoyancy of large cities in the SR even during the Import Substitution Period (1948-70) can be explained by the fact that they (Cebu, Bacolod and Iloilo) have been highly connected with Metro Manila (or the NCR) which was having a heyday during that era. The same is true of Davao and to some extent Zamboanga in the FR (see Annex Table 3).

In sum, small and intermediate cities (SMCs) in the CIR have been growing rapidly over time due to its progressive economic environment favored by economic policy. By contrast, SMCs in the SR and FR have performed poorly because they tended to be sapped by large cities (LCs) in the same region and by cities in the CIR. In other words, following Myrdal (1957), the process has generated mostly backwash and little spread effects to SMCs in the lagging regions. LCs in all regions have been generally buoyant on account of their connectivity with the NCR and to some extent among themselves.⁸ All this bears out the segmentation of the national urban system in line with a fragmented space economy.

Prospects of SMCs

Data on the most recent intercensal period, 1970-80, seem to signal an overall acceleration of the growth of SMCs, on the one hand, and a deceleration for LCs, on the other (Table 1). But, again this generalization does not apply when we look at cities in the context of the different regions (Table 3). SMCs in the SR and FR appear to have become resilient while those in the CIR are slowing down. Particularly resilient SMCs are Bago, Tacloban, Silay and Cauayan in the SR, and Cagayan de Oro, General Santos, Panabo, Midsayap and Pagadian in the FR (Annex Map). Could this be the result of the Regional Awareness policy or of such spontaneous market forces as diseconomies of scale at the NCR and Other CIR?

⁷Noteworthy among these SMC's in the CIR are Calamba, Cavite, Lucena, San Fernando, and Angeles (Annex Map).

⁸Five such cities stand out in recent years and currently: Metro Cebu, Iloilo, Bacolod, Davao and Zamboanga (Annex Table 3 and Annex Map).

Some manifestations of policy and economic activity do not seem to indicate an appreciable reversal of the trends established during the Import Substitution Period. Table 4 shows that the share of government infrastructure expenditures for the CIR remained at about 56 percent of total from 1959-61 to 1971-73; in fact, for most projects the shares increased. Also, during the good part of the 70s tax incentives, purportedly for regional dispersal in addition to export promotion, were mostly granted to firms and investments in the NCR or more broadly the CIR. As can be seen in Table 5, over the period 1968-77, 56 percent of new projects and 86 percent of firms benefitting from the incentives were concentrated in the CIR; as much as 73 percent of firms were located in the NCR.

There had generally been no visible response on the part of the business sector to the government's avowed initiative for the development of the lagging regions, as may be gleaned from Table 6. Business investments have apparently continued to be concentrated in the NCR and other parts of CIR — up to as much as 85 percent of total large investments by 1979 from 73 percent in 1970. The SR and FR captured average shares of only 12 and 11 percent, respectively, of these investments during the 70s.

The government has seemingly been more successful with regard to small and medium scale industries. As Table 7 shows, the proportion of loans going to these enterprises in the peripheral regions appears to have risen from one-fifth to almost one-third of total in the SR and from 15 to 19 percent in the FR during the 1978-79 period alone. The relative success of regional policy in terms of the promotion of small and medium industries (see, e.g., Pernia 1982) may well partially explain the resilience of small and intermediate cities (SMCs) in the SR and FR during the 70s. Their growth and development may have stemmed out-migration from, as well as attracted in-migration to, these SMCs. As is already known, small and medium enterprises abound in the SMCs of the relatively unindustrialized regions.

Conclusion and Implications

On the whole, small and intermediate size cities (SMCs) in the Philippines experienced depressed growth rates during the 50s and 60s, following the general trend observed in developing countries. However, when SMCs are analyzed in a spatial-temporal framework, it turns out that only those in the backward regions performed poorly, as expected. SMCs in the Central Industrial Region favored by the industrial and trade policies of the Import Substitution Period exhibited buoyancy similar to that of Metro Manila and a few other large cities (LCs) in the lagging regions.

Table 4. Allocation of Infrastructure Expenditure by Broad Region, FY 1959-61 to 1971-73
(in percent)

Region	All Infrastructure		Portworks		Waterworks		Irrigation		Flood Control and Drainage		Building, Schools and Hospitals		Highways
	1959-61	1971-73	1959-61	1971-73	1959-61	1971-73	1959-61	1971-73	1959-61	1971-73	1959-61	1971-73	1971-73
CR	56.6	56.1	70.4	64.5	54.3	92.2	25.9	63.6	61.3	67.1	70.1	60.5	26.0
SR	24.0	24.9	18.4	20.6	26.1	4.1	47.5	8.4	23.3	20.9	4.1	34.7	44.0
FR	19.4	19.0	11.2	14.9	19.6	3.7	23.5	28.0	15.4	12.0	25.8	4.8	30.0
TOTAL*	40,104.0	224,869.8	11,141.9	22,813.6	12,255.3	24,733.7	8,828.4	87,080.1	1,601.7	8,086.6	7,055.9	17,409.0	66,802.0

*Total expenditures are expressed in thousands of pesos.

Source: Javier (1976), p. 298.

Table 5. Distribution of Projects and Firms Given Tax Incentives by Broad Region

Region	Projects, 1968-74 ^a		Firms, 1970-77 ^b	
	Number	Percent	Number	Percent
NCR	*	*	379	73
CIR	167	56	66	13
SR	51	17	45	9
FR	80	27	30	6
<u>Philippines</u>	<u>298</u>	<u>100</u>	<u>520</u>	<u>100</u>

*Included in CIR.

^aUnder Investment Incentives Act, September 1967.

^bUnder Export Incentives Act, October 1970.

Source: Board of Investments.

Table 6. Distribution of Paid-in Capital of All Business Organizations by Broad Region (in percent)

Region	1970	1975	1979	1970-79*
NCR	43.9	43.9	72.5	57.1
Other CIR	29.1	29.1	12.5	20.0
SR	15.0	15.0	10.0	12.0
FR	12.0	12.0	5.0	10.9
Philippines (100%)	<u>₱438 M</u>	<u>₱1,635 M</u>	<u>₱2,250 M</u>	<u>₱15,357 M</u>

*Cumulative total.

Sources: Central Bank Statistical Bulletin, 1951-79; Bureau of Commerce and Securities and Exchange Commission.

These LCs have been well connected with Metro Manila but not with SMCs in their own region. Thus, it seems that during the 50s and 60s economic policies along with natural economic and social forces tended to further accentuate the segmentation of the national urban system or the space economy in general.

Table 7. Distribution of Government-Sponsored Loans to Small and Medium Scale Industries by Broad Region (in percent)

<i>Region</i>	<i>1978</i>	<i>1979</i>
NCR	40.1	30.0
CIR	23.9	21.4
SR	20.9	29.2
FR	15.0	19.4
Philippines (100%)	₱132.9 M	₱181.2 M

Source: Development Bank of the Philippines.

During the 70s, SMCs in the backward regions appeared to be resilient. It is difficult, however, to attribute such resilience to the government's avowed regional orientation shift because policy manifestations in terms, for example, of the shares of infrastructure expenditures and tax incentives going to the lagging regions remained low relative to the National Capital Region or more broadly the Central Industrial Region. Likewise, large business investments continued to be concentrated in the advanced regions. Regional policy, nevertheless, appears to show some initial success in the promotion of small and medium scale industries in the less developed regions. This may well explain in part the apparent resurgence of SMCs in these regions during the 70s.

In the Philippines, as in many developing countries, small enterprises hold a dominant position in the manufacturing sector (Annex Table 6). This is particularly true in small and intermediate cities outside the industrial region. It seems that providing the environment conducive for the promotion of small industries is a promising role that SMCs can play. This is because small enterprises can prosper without the advantages of agglomeration and urbanization economies present in large cities.

There is scope for government intervention in, for instance, putting up the relatively inexpensive infrastructure in SMCs so that they can offer a climate favorable to small enterprises. In addition, intervention can be in terms of technical extension services and concessionary loans, as had been successfully initiated by the Ministry of Industry about seven years ago, but in which there is still much latitude for expansion and improvement.

Recently, the government launched a huge program of local community projects (*Kilusang Kabuhayan at Kaunlaran* — KKK). The KKK approach is supposed to reach all towns in cities throughout the country in as short a time as two to three years. While the economic rationale of such an ambitious program is not yet clear, it seems logical to expect that SMCs are better placed to receive them than are small towns and barrios, and that certain SMCs are more prepared than others would be. It is important, in other words, to have a more general policy on SMCs before specific local projects are put in place.

To the extent that a policy on SMCs is correctly fashioned, they can be expected to flourish and thus spontaneously serve as agents in rural industrialization and regional development. The time may be ripe for a conscious SMC policy since the lingering concentration effects of the import substitution strategy may be starting to weaken and diseconomies of scale may be creeping up in Metro Manila and in other large cities. An SMC policy may be seen as a complement to, or even a substitute for, the well-worn alternative growth centers strategy.

ANNEX

Table 1. Population of Small, Intermediate and Large Cities: Philippines, 1903-80

<i>Size Category*/Name</i>	<i>1903</i>	<i>1918</i>	<i>1939</i>	<i>1948</i>	<i>1960</i>	<i>1970</i>	<i>1975</i>	<i>1980^a</i>
SMALL	683,206	811,074	1,358,046	1,652,325	2,367,440	2,912,901	3,233,577	3,607,819
Guagua (Pampanga)	15,151	15,962	22,331	34,738	40,126	58,270	65,336	72,609
Malalag (Davao del Sur)	—	—	—	—	40,153	34,764	44,034	44,669
Sultan sa Barongis (Maguindanao)	—	—	—	—	40,347	45,421	17,630	21,639
Camiling (Tarlac)	25,243	23,375	25,824	33,935	40,536	49,156	52,421	53,920
Bauan (Batangas)	39,094	27,729	37,043	40,168	41,147	36,862	38,200	43,543
Laoang (N. Samar)	8,636	11,508	19,736	29,748	41,158	37,382	42,498	46,883
Manaoag (Pangasinan)	16,793	22,279	29,030	34,304	41,164	48,091	48,450	36,749
Pagadian (Zamboanga del Sur)	—	—	46,262	51,913	41,810	57,615	66,062	80,519
Daraga (Albay)	18,695	—	29,484	—	41,973	58,335	63,265	73,224
Himamaylan (Negros Occidental)	14,932	15,559	28,407	33,984	41,985	53,663	65,521	70,076
Milang (N. Cotabato)	—	—	—	—	42,085	44,844	51,596	56,975
Sariaya (Quezon)	12,453	14,158	25,736	29,904	42,089	58,997	66,842	74,154
Panabo (Davao del Norte)	—	—	—	—	42,509	42,920	53,015	63,618
Tuguegarao (Cagayan)	16,105	19,298	27,643	29,083	43,074	56,956	62,513	73,529
Cauayan (Negros Occidental)	8,174	13,907	25,645	34,946	43,384	52,508	64,244	71,301
Ozamis (Misamis Occidental)	11,709	23,237	36,313	35,262	44,091	64,643	71,559	78,036
Lubao (Pampanga)	19,063	21,614	29,154	36,574	44,129	61,608	69,903	77,502
Urdaneta (Pangasinan)	20,544	24,536	29,120	35,811	44,744	58,690	65,390	71,889
Tanauan (Batangas)	18,263	22,473	26,186	30,203	44,979	61,910	66,703	74,005
Concepcion (Tarlac)	12,962	17,487	32,702	30,785	45,084	62,227	72,554	80,650
Lingayen (Pangasinan)	21,529	22,750	30,655	36,806	45,321	56,906	59,034	65,025
Olongapo (Zambales)	—	—	—	—	45,330	107,785	147,109	156,312
Bansalan (Davao del Sur)	—	—	—	—	45,360	33,374	35,558	40,671

Midsayap (N. Cotabato)	—	—	23,033	42,473	46,169	47,093	52,142	67,079
Talisay (Negros Occidental)	14,548	14,165	40,547	43,610	46,308	45,084	48,518	52,229
Tabaco (Albay)	21,946	24,812	29,957	33,209	46,416	60,572	65,254	71,928
Bulan (Sorsogon)	13,431	19,268	29,414	37,231	46,520	54,180	56,013	60,843
Manapla (Negros Occidental)	10,123	10,033	19,490	35,218	46,809	31,097	38,357	37,494
Hagonoy (Bulacan)	21,304	22,490	29,734	37,532	46,861	59,899	65,592	73,532
Janiuay (Iloilo)	20,738	24,641	38,778	44,348	46,946	34,409	39,172	39,973
Bayambang (Pangasinan)	11,093	15,260	25,578	35,171	47,490	56,415	62,808	64,044
Guinobatan (Albay)	20,207	25,113	26,419	32,280	48,157	47,190	49,724	52,477
Malolos (Bulacan)	12,575	26,109	33,384	38,779	48,968	73,996	83,491	95,641
Lucena City (Quezon)	9,375	12,108	21,675	33,092	49,264	77,006	92,330	107,872
Roxas City (Capiz)	21,472	23,022	29,021	32,353	49,326	67,648	71,305	81,183
Laoag City (Ilocos Norte)	34,454	38,469	41,842	44,406	50,198	61,727	66,259	69,648
Baguio City (Benguet)	489	5,464	24,117	29,262	50,436	84,538	97,449	118,611
Malasigui (Pangasinan)	14,550	22,747	33,660	40,786	50,736	61,423	67,489	71,801
Baybay (Leyte)	22,990	30,917	42,526	50,725	51,779	63,782	67,031	74,771
Libmanan (Camarines Sur)	17,416	11,729	23,000	43,482	52,512	62,862	66,601	68,413
Gingoog (Misamis Oriental)	2,876	5,391	16,746	30,699	52,677	65,522	66,577	81,098
Ligao (Albay)	17,687	21,467	27,927	37,331	53,376	56,765	61,548	62,860
Tacloban (Leyte)	11,948	15,787	31,233	45,421	53,551	74,391	80,707	102,609
Cavite City (Cavite)	16,337	22,169	38,054	35,052	54,891	75,739	82,456	87,813
Naga City (Camarines Sur)	17,943	9,396	22,505	56,238	55,506	79,846	83,337	90,712
La Carlota City (Negros Occ.)	13,097	20,410	26,084	45,789	56,772	38,321	40,984	42,651
San Fernando (Pampanga)	13,556	20,622	35,662	39,549	56,861	84,862	98,382	110,892
Calamba (Laguna)	8,058	18,062	32,363	36,586	57,715	82,714	97,432	121,066
Bago City (Negros Occidental)	23,630	26,262	53,874	56,693	58,834	71,653	89,213	103,116
Escalante (Negros Occidental)	12,192	29,287	60,152	56,846	59,768	52,060	53,969	69,695
INTERMEDIATE	351,726	542,460	887,942	1,138,467	1,613,051	1,997,574	2,232,201	1,573,930
Silay City (Negros Occ.)	25,214	23,328	39,483	35,70	60,324	69,200	104,887	104,018
Legaspi City (Albay)	23,255	52,756	41,468	47,171	60,593	84,090	88,378	100,488

Ormoc City (Leyte)	16,126	38,174	77,349	72,733	62,764	84,563	89,466	104,912
Dagupan City (Pangasinan)	20,357	22,4441	32,602	43,838	63,191	83,582	90,092	98,362
Toledo City (Cebu)	12,929	25,244	34,413	39,225	63,881	67,727	76,521	91,618
Lipa City (Batangas)	37,934	47,677	45,175	46,928	64,239	93,971	106,094	121,162
Calatrava (Negros Occ.)	6,385	—	38,695	53,805	65,888	53,151	58,867	59,052
Nabua (Camarines Sur)	18,893	19,314	29,433	42,946	66,657	44,417	48,635	53,292
Cagayan de Oro (Misamis Oriental)	10,937	28,062	53,194	54,293	68,274	128,319	165,220	228,409
Cabanatuan City (Nueva Ecija)	7,109	15,286	46,626	54,628	69,580	99,890	115,258	138,297
San Pablo City (Laguna)	22,612	31,399	46,311	50,435	70,680	105,517	116,607	131,686
Sagay (Negros Occidental)	8,311	17,752	53,767	67,152	71,335	79,702	95,401	98,409
Buluan (Maguindanao)	—	5,263	15,317	61,934	73,201	49,158	41,357	40,698
San Carlos City (Pangasinan)	27,166	35,780	47,334	61,671	73,900	84,333	90,882	101,254
Iriga City (Camarines Sur)	19,297	24,145	31,005	42,049	75,439	77,382	75,884	66,117
Angeles City (Pampanga)	10,646	17,948	26,027	37,558	75,900	134,544	151,164	185,995
Butuan City (Agusan del Norte)	8,207	10,875	18,295	31,628	79,770	131,094	132,682	172,404
Batangas City (Batangas)	33,131	41,089	46,164	59,582	82,627	108,868	125,363	143,554
Gen. Santos City (S. Cotabato)	33	9,787	14,115	32,019	84,988	85,861	91,154	146,550
Cadiz City (Negros Occidental)	16,429	22,183	41,905	48,960	88,542	124,108	127,653	128,839
Guihulngan (Negros Oriental)	14,415	31,069	53,582	89,745	92,993	72,969	80,041	84,147
Tarlac (Tarlac)	12,340	23,888	55,682	64,597	98,285	135,128	160,595	174,667
LARGE	974,686	869,876	1,753,079	2,513,627	3,821,499	5,828,762	7,187,789	8,450,298
Bacolod City (Negros (Occ.)	15,983	19,424	57,474	101,432	119,315	187,300	223,392	266,604
San Carlos City (Negros (Oc.)	9,749	42,453	69,990	92,250	121,756	90,058	90,982	93,268
Zamboanga City (Zamboanga del Sur)	20,692	42,007	74,823	103,317	131,489	199,901	265,023	344,275
Iloilo City (Iloilo)	52,472	77,925	116,277	110,122	151,266	209,738	227,027	244,211

Basilan City (Zamboanga del Sur)	4,480	23,089	56,632	110,297	155,712	143,289	171,027	199,029
Davao City (Davao del Sur)	8,560	21,538	95,546	111,263	225,712	392,473	484,678	611,311
Metro Cebu ^b	133,811	182,274	288,448	315,818	450,760	639,308	755,654	767,037
Metro Manila ^c	328,939	461,166	993,889	1,569,128	2,462,489	3,966,695	4,970,006	5,924,563
TOTAL	1,609,618	2,223,408	3,999,067	5,304,419	7,801,990	10,739,237	12,653,567	14,632,407

*Size categories are reckoned as of 1960: small = 40,000-59,999; intermediate = 60,000-99,999; large = 100,000+.

^aPreliminary data.

^bMetro Cebu is defined to include Cebu City, Lapu-Lapu, Mandaue, Minglanilla & Talisay.

^cMetro Manila comprises Manila, Quezon City, Pasay City, Caloocan City, Las Piñas, Makati, Malabon, Mandaluyong, Marikina, Muntinglupa, Navotas, Parañaque, Pasig, Pateros, San Juan, Taguig & Valenzuela.

Source: Census on Population (various years).

ANNEX

Table 2. Annual Percent Growth Rates of Population in Small, Intermediate and Large Cities: Philippines 1903-80

<i>Size Category/Name</i>	<i>1903-18</i>	<i>1918-39</i>	<i>1939-48</i>	<i>1948-60</i>	<i>1960-70</i>	<i>1970-75</i>	<i>1975-80</i>
SMALL	1.27	2.22	2.26	2.00	2.05	2.12	2.21
Guagua (Pampanga)	0.33	1.69	4.64	1.28	3.72	2.32	2.13
Malalag (Davao del Sur)	—	—	—	—	-1.40	4.86	0.29
Sultan sa Barongis (Maguindanao)	—	—	—	—	1.17	-17.29	4.18
Camiling (Tarlac)	-0.48	0.50	2.84	1.58	1.91	1.30	0.57
Bauan (Batangas)	-2.15	1.46	0.83	0.21	-1.07	0.72	2.65
Laoang (N. Samar)	1.83	2.73	4.30	2.90	-0.94	2.61	1.98
Manaoag (Pangasinan)	1.80	1.33	1.73	1.62	1.53	0.15	-5.38
Pagadian (Zamboanga del Sur)	—	—	1.19	-1.88	3.19	2.78	4.04
Daraga (Albay)	—	—	—	—	3.27	1.64	2.97
Himamaylan (Negros Occidental)	0.26	3.06	1.86	1.88	2.43	4.09	1.35
Milang (N. Cotabato)	—	—	—	—	0.62	2.85	2.00
Sariaya (Quezon)	0.81	3.03	1.55	3.05	3.36	2.54	2.10
Panabo (Davao del Norte)	—	—	—	—	0.09	4.33	3.71
Tuguegarao (Cagayan)	1.15	1.81	0.52	3.15	2.77	1.89	3.30
Cauayan (Negros Occidental)	3.41	3.11	3.23	1.92	1.89	4.13	2.11
Ozamis (Misamis Occidental)	4.42	2.26	-0.30	1.98	3.82	2.06	1.75
Lubao (Pampanga)	0.80	1.51	2.35	1.66	3.32	2.57	2.09
Urdaneta (Pangasinan)	1.13	0.86	2.14	1.98	2.69	2.19	1.91
Tanauan (Batangas)	1.32	0.77	1.48	3.56	3.18	1.51	2.10
Concepcion (Tarlac)	1.91	3.18	-0.62	3.41	3.20	3.13	2.14
Lingayen (Pangasinan)	0.35	1.50	1.89	1.85	2.11	1.03	1.95
Olongapo (Zambales)	—	—	—	—	8.85	6.44	1.22

Bansalan (Davao del Sur)	—	—	—	—	-2.96	1.28	2.72
Midsayap (N. Cotabato)	—	—	6.48	0.74	0.19	2.06	5.17
Talisay (Negros Occidental)	-0.17	5.40	0.75	0.53	-0.26	1.48	1.49
Tabaco (Albay)	0.78	0.95	1.06	2.99	2.64	1.50	1.97
Bulan (Sorsogon)	2.31	2.14	2.45	1.98	1.50	0.67	1.67
Manapla (Negros Occidental)	-0.06	3.38	6.26	2.53	-3.92	4.30	-0.45
Hagonoy (Bulacan)	0.34	1.41	2.42	1.97	2.43	1.84	2.31
Janiuay (Iloilo)	1.10	2.29	1.39	0.50	-2.99	2.63	0.41
Bayambang (Pangasinan)	2.03	2.62	3.32	2.68	1.70	2.18	0.39
Guinobatan (Albay)	1.44	0.25	2.08	3.58	-0.20	1.06	1.19
Malolos (Bulacan)	4.72	1.24	1.55	2.07	4.12	2.45	2.76
Lucena City (Quezon)	1.63	2.95	4.44	3.56	4.47	3.71	3.16
Roxas City (Capiz)	0.44	1.17	1.12	3.78	3.14	1.06	2.63
Laoag City (Ilocos Norte)	0.70	0.42	0.61	1.08	2.04	1.43	1.00
Baguio City (Benguet)	16.47	7.71	2.00	4.90	5.18	2.89	4.01
Malasigui (Pangasinan)	2.86	1.98	1.99	1.94	1.89	1.91	1.25
Baybay (Leyte)	1.89	1.61	1.83	0.18	2.06	1.00	2.21
Libmanan (Camarines Sur)	-2.47	3.42	6.75	1.67	1.78	1.17	0.54
Gingoog (Misamis Oriental)	4.05	5.83	6.41	4.86	2.16	0.32	4.03
Ligao (Albay)	1.23	1.32	3.02	3.19	0.60	1.64	0.42
Tacloban (Leyte)	1.78	3.47	3.92	1.46	3.26	1.66	4.92
Cavite City (Cavite)	1.95	2.74	-0.84	4.02	3.20	1.72	1.27
Naga City (Camarines Sur)	-4.00	4.46	9.85	-0.16	3.62	0.86	1.71
La Carlota City (Negros Occ.)	2.84	1.23	5.94	1.91	-3.62	1.36	0.80
San Fernando (Pampanga)	2.69	2.78	1.07	3.24	4.00	3.01	2.42
Calamba (Laguna)	5.23	2.96	1.27	4.09	3.58	3.34	4.44
Bago City (Negros Occidental)	0.67	3.66	0.53	0.33	1.95	4.49	2.94
Escalante (Negros Occidental)	5.69	3.66	-0.98	0.44	-1.34	0.73	5.25
INTERMEDIATE	2.83	2.50	2.98	3.11	2.11	2.25	2.89
Silay City (Negros Occidental)	-0.49	2.67	-1.06	4.75	1.35	8.70	-0.17

	1903-18	1918-39	1939-48	1948-60	1960-70	1970-75	1975-80
Legaspi City (Albay)	5.31	-1.20	1.33	2.23	3.26	1.00	2.60
Ormoc Leyte (Leyte)	5.59	3.59	-0.63	-1.29	2.96	1.14	3.24
Dagupan City (Pangasinan)	0.62	1.89	3.08	3.27	2.77	1.52	1.77
Toledo City (Cebu)	4.32	1.56	1.35	4.38	0.57	2.48	3.67
Lipa City (Batangas)	1.32	-0.16	0.39	2.80	3.79	2.46	2.69
Calatrava (Negros Occidental)	—	—	3.44	1.80	-2.08	2.07	0.06
Nabua (Camarines Sur)	0.14	2.13	3.95	3.94	-3.89	1.84	1.85
Cagayan de Oro (Misamis Occ.)	6.13	3.25	0.21	2.04	6.37	5.20	6.69
Cabanatuan City (Nueva Ecija)	4.95	5.73	1.64	2.15	3.60	2.91	3.71
San Pablo City (Laguna)	2.10	1.96	0.88	3.01	4.00	2.02	2.46
Sagay (Negros Occidental)	4.91	5.70	2.31	0.53	1.09	3.67	0.62
Buluan (Maguindanao)	—	5.49	15.41	1.48	-3.82	1.21	-0.32
San Carlos City (Pangasinan)	1.76	1.41	2.75	1.60	1.30	1.51	2.19
Iriga City (Camarines Sur)	1.43	1.26	3.18	5.27	0.25	-0.39	-2.72
Angeles City (Pampanga)	3.35	1.88	3.88	6.38	5.76	2.36	4.23
Butuan City (Agusan del Norte)	1.79	5.48	2.44	8.47	4.98	0.24	5.38
Batangas City (Batangas)	1.37	0.58	2.65	2.92	2.74	2.87	2.75
Gen. Santos City (South Cotabato)	43.27	1.85	8.77	8.96	0.10	1.21	9.96
Cadiz City (Negros Occ.)	1.92	3.23	1.61	5.35	3.36	0.57	0.19
Guihulngan (Negros Oriental)	4.97	2.76	5.43	0.31	-2.35	1.87	1.01
Tarlac (Tarlac)	4.26	4.32	1.54	3.76	3.16	3.52	1.69
LARGE	2.65	3.57	3.77	3.75	4.22	4.29	3.29
Bacolod City (Negros Occ.)	1.24	5.57	6.00	1.44	4.51	3.60	3.60
San Carlos City (Negros Occ.)	9.74	2.53	2.87	2.69	-3.14	0.21	0.90
Zamboanga City (Zamboanga del Sur)	4.97	2.93	3.37	2.14	4.18	5.82	5.37

Iloilo City (Iloilo)	2.53	2.02	-0.56	2.83	3.25	1.60	1.47
Basilan City (Zamboanga del Sur)	10.91	4.59	7.08	3.08	-0.77	3.61	3.08
Davao City (Davao del Sur)	6.00	7.73	1.57	6.42	5.56	4.32	4.75
Metro Cebu	1.97	2.32	0.93	3.18	3.48	3.41	0.30
Metro Manila	2.16	3.91	4.80	4.04	4.78	4.63	3.58
TOTAL	2.15	2.80	3.02	3.10	3.18	3.34	2.95

Source. Annex Table 1.

ANNEX

Table 3. Annual Percent Growth Rates of Population in Small, Intermediate and Large Cities by Broad Region: Philippines, 1903-80

<i>Region/Size/Name</i>	<i>1903-18</i>	<i>1918-39</i>	<i>1939-48</i>	<i>1948-60</i>	<i>1960-70</i>	<i>1970-75</i>	<i>1975-80</i>
NCR (Metro Manila)	2.16	3.91	4.80	4.04	4.78	4.63	3.58
OTHER CIR	1.52	2.01	1.67	2.96	3.74	2.85	2.55
<u>SMALL</u>	<u>1.07</u>	<u>1.96</u>	<u>1.64</u>	<u>3.61</u>	<u>3.67</u>	<u>2.94</u>	<u>2.27</u>
Guagua (Pampanga)	0.33	1.69	4.64	1.28	3.72	2.32	2.13
Camiling (Tarlac)	-0.48	0.50	2.84	1.58	1.91	1.30	0.57
Bauan (Batangas)	-2.15	1.46	0.83	0.21	-1.07	0.72	2.65
Sariaya (Quezon)	0.81	3.03	1.55	3.05	3.36	2.54	2.10
Lubao (Pampanga)	0.80	1.51	2.35	1.66	3.32	2.57	2.09

	1903-18	1918-39	1939-48	1948-60	1960-70	1970-75	1975-80
Tanauan (Batangas)	1.32	0.77	1.48	3.56	3.18	1.51	2.10
Concepcion (Tarlac)	1.91	3.18	-0.62	3.41	3.20	3.13	2.14
Hagonoy (Bulacan)	0.34	1.41	2.42	1.97	2.43	1.84	2.31
Malolos (Bulacan)	4.72	1.24	1.55	2.07	4.12	2.45	2.76
Lucena City (Quezon)	1.63	2.95	4.44	3.56	4.47	3.71	3.16
Cavite City (Cavite)	1.95	2.74	-0.84	4.02	3.20	1.72	1.27
San Fernando (Pampanga)	2.69	2.78	1.07	3.24	4.00	3.01	2.42
Calamba (Laguna)	5.23	2.96	1.27	4.09	3.58	3.34	4.44
Olongapo (Zambales)	—	—	—	—	8.85	6.44	1.22
<u>INTERMEDIATE</u>	2.26	2.08	1.71	3.45	3.84	2.72	2.93
Lipa City (Batangas)	1.32	-0.16	0.39	2.80	3.79	2.46	2.69
Cabanatuan City (Nueva Ecija)	4.95	5.73	1.64	2.15	3.60	2.91	3.71
San Pablo City (Laguna)	2.10	1.96	0.88	3.01	4.00	2.02	2.46
Angeles City (Pampanga)	3.35	1.88	3.88	6.38	5.76	2.36	4.23
Batangas City (Batangas)	1.37	0.58	2.65	2.92	2.74	2.87	2.75
Tarlac (Tarlac)	4.26	4.32	1.54	3.76	3.16	3.52	1.69
<u>SLUGGISH REGIONS</u>	1.98	2.46	2.17	2.24	1.70	2.27	1.45
<u>SMALL</u>	1.24	2.32	2.53	1.78	1.42	1.91	1.87
Manaoag (Pangasinan)	1.80	1.33	1.73	1.62	1.53	0.15	-5.38
Laoang (North Samar)	1.83	2.73	4.30	2.90	-0.94	2.61	1.98
Himamaylan (Negros Occ.)	0.26	3.06	1.86	1.88	2.43	4.09	1.35
Cauayan (Negros Occidental)	3.41	3.11	3.23	1.92	1.89	4.13	2.11
Urdaneta (Pangasinan)	1.13	0.86	2.14	1.98	2.69	2.19	1.91
Lingayen (Pangasinan)	0.35	1.50	1.89	1.85	2.11	1.03	1.95
Talisay (Negros Occidental)	-0.17	5.40	0.75	0.53	-0.26	1.48	1.49

Manapla (Negros Occidental)	-0.06	3.38	6.26	2.53	-3.92	4.30	-0.45
Janiuay (Iloilo)	1.10	2.29	1.39	0.50	-2.99	2.63	0.41
Bayambang (Pangasinan)	2.03	2.62	3.32	2.68	1.70	2.18	0.39
Roxas City ((Capiz)	0.44	1.17	1.12	3.78	3.14	1.06	2.63
Laoag City (Ilocos Norte)	0.70	0.42	0.61	1.08	2.04	1.43	1.00
Baguio City (Benguet)	16.47	7.71	2.00	4.90	5.18	2.89	4.01
Malasigui (Pangasinan)	2.86	1.98	1.99	1.94	1.89	1.91	1.25
Baybay (Leyte)	1.89	1.61	1.83	0.18	2.06	1.00	2.21
Tacloban (Leyte)	1.78	3.47	3.92	1.46	3.26	1.66	4.92
La Carlota City (Negros Occidental)	2.84	1.23	5.94	1.91	-3.62	1.36	0.80
Bago City (Negros Occ.)	0.67	3.66	0.53	0.33	1.95	4.49	2.94
Escalante (Negros Occ.)	0.67	3.66	0.58	0.44	-1.34	0.73	5.25
Daraga (Albay)	—	—	—	—	3.27	1.64	2.97
Tabaco (Albay)	0.78	0.95	1.06	2.99	2.64	1.50	1.97
Bulan (Sorsogon)	2.31	2.14	2.45	1.98	1.50	0.67	1.67
Guinobatan (Albay)	1.44	0.25	2.08	3.58	-0.20	1.06	1.19
Libmanan (Camarines Sur)	-2.47	3.42	6.7	1.67	1.78	0.17	0.54
Ligao (Albay)	1.23	1.32	3.02	3.19	0.60	1.64	0.42
Naga City (Camarines Sur)	-4.00	4.46	9.85	-0.16	3.62	0.86	1.71
INTERMEDIATE	2.78	2.20	2.21	2.41	0.89	2.11	1.21
Silay City (Negros Occ.)	-0.49	2.67	-1.06	4.75	1.35	8.70	-0.17
Ormoc City (Leyte)	5.59	3.59	10.63	-1.29	2.96	1.14	3.24
Dagupan City (Pangasinan)	0.62	1.89	3.08	3.27	2.77	1.52	1.77
Toledo City (Cebu)	4.32	1.56	1.35	4.38	0.57	2.48	3.67
Calatrava (Negros Occ.)	—	—	3.44	1.80	-2.08	2.07	0.06
Sagay (Negros Occ.)	4.91	5.70	2.31	0.53	1.09	3.67	0.62
San Carlos City (Pangasinan)	1.76	1.41	2.75	1.60	1.30	1.51	2.19
Cadiz City (Negros Occ.)	1.92	3.23	1.61	5.35	3.36	0.57	0.19
Guihulgan (Negros Oriental)	4.97	2.96	5.43	0.31	-2.35	1.87	1.01

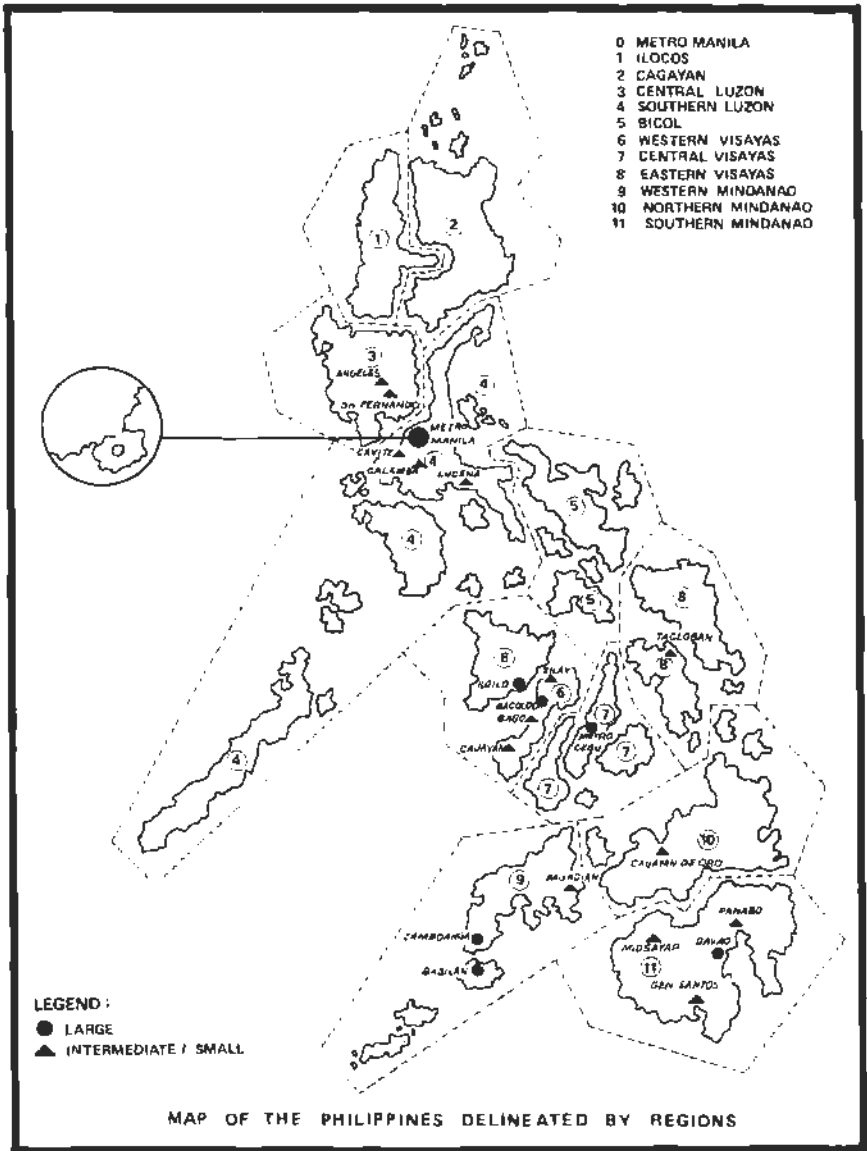
	1903-18	1918-39	1939-48	1948-60	1960-70	1970-75	1975-80
Legaspi City (Albay)	5.59	3.59	-0.63	1.29	2.96	1.14	3.24
Nabua (Camarines Sur)	0.14	2.13	3.95	3.94	-3.89	1.84	1.85
Iriga City (Camarines Sur)	1.43	1.26	3.18	5.27	0.25	-0.39	-2.72
<u>LARGE</u>	<u>2.68</u>	<u>2.54</u>	<u>1.57</u>	<u>2.78</u>	<u>2.84</u>	<u>2.87</u>	<u>1.12</u>
Bacolod City (Negros Occ.)	1.24	5.57	6.00	1.44	4.51	3.60	3.60
San Carlos City (Negros Occ.)	9.74	2.53	2.87	2.69	-3.14	0.21	0.50
Iloilo City (Iloilo)	2.53	2.02	-0.56	2.83	3.25	1.60	1.47
Metro Cebu	1.97	2.32	0.93	3.18	3.48	3.41	0.30
FRONTIER REGIONS	5.08	3.94	3.90	3.68	2.53	0.90	4.66
<u>SMALL</u>	<u>2.86</u>	<u>2.64</u>	<u>2.42</u>	<u>1.64</u>	<u>1.16</u>	<u>1.10</u>	<u>3.14</u>
Milang (N. Cotabato)	—	—	—	—	0.62	2.85	2.00
Panabo (Davao del Norte)	—	—	—	—	0.09	4.33	3.71
Tuguegarao (Cagayan)	1.15	1.81	0.52	3.15	2.77	1.89	3.30
Ozamis (Misamis Occidental)	4.42	2.26	-0.30	1.98	3.82	2.06	1.75
Bansalan (Davao del Sur)	—	—	—	—	-2.96	1.28	2.72
Midsayap (N. Cotabato)	—	—	6.48	0.74	0.19	2.06	5.17
Gingoog (Misamis Oriental)	4.05	5.83	6.41	4.86	2.16	0.32	4.03
Sultan sa Barongis (Maguindanao)	—	—	—	—	1.17	-17.29	4.18
Malalag (Davao del Sur)	—	—	—	—	-1.40	4.86	0.29
Pagadian (Zamboanga del Sur)	—	—	1.19	-1.88	3.19	2.78	4.04
<u>INTERMEDIATE</u>	<u>6.07</u>	<u>3.18</u>	<u>6.11</u>	<u>4.79</u>	<u>2.51</u>	<u>1.77</u>	<u>6.44</u>
Cagayan de Oro (Misamis Oriental)	6.13	3.25	0.21	2.04	6.37	5.20	6.69

Buluan (Maguindanao)	—	5.49	15.41	1.48	—3.82	1.21	—0.32
Butuan City (Agusan del Norte)	1.79	5.48	2.44	8.47	4.98	0.24	5.38
Gen. Santos City (South Cotabato)	43.27	1.85	8.77	8.96	0.10	1.21	9.96
LARGE	6.14	4.93	—0.75	4.10	3.59	4.60	4.63
Zamboanga City (Zamboanga del Sur)	4.57	2.93	3.37	2.14	4.18	5.82	5.37
Basilan City (Zamboanga del Sur)	10.91	4.59	7.08	3.08	—0.77	3.64	3.08
Davao City	6.00	7.73	1.57	6.42	5.56	4.32	4.75
TOTAL	2.15	2.80	3.02	3.10	3.18	3.34	2.95

Source: Census on Population (various years).

ANNEX

MAP: Large Cities, Small and Intermediate Cities (SMC's) in CIR Brisk During the Import Substitution Period, and SMCs in SR and FR Resilient During 1970-1980.



ANNEX

Table 4. Distribution of Total, Urban and Rural Population by Broad Region, 1903-75 (in percent)

<i>Region</i>	1903	1939	1948	1960	1970	1975
<u>CIR</u>						
Total	27.1	27.3	28.6	29.8	32.8	34.2
Urban	45.7	38.8	40.9	46.3	51.8	52.6
Rural	24.2	24.4	24.6	23.2	22.1	21.9
<u>SR</u>						
Total	59.6	54.2	52.1	45.9	40.9	39.5
Urban	52.4	46.2	42.1	37.4	31.8	31.3
Rural	60.8	56.2	55.3	49.3	46.0	44.9
<u>FR</u>						
Total	13.3	18.5	19.3	24.3	26.3	26.3
Urban	1.9	15.0	17.0	16.3	16.4	16.1
Rural	15.0	19.4	20.1	27.5	31.9	33.2
<u>PHILIPPINES (100.0%)</u>			(in thousands)			
Total	7,635	16,300	19,234	27,088	36,684	42,071
Urban	1,026	3,272	4,615	7,731	13,211	16,878
Rural	6,609	12,728	14,619	19,356	23,473	25,192

Notes: CIR — Central Industrial Region, SR — Sluggish Region, FR Frontier Regions.
Source: NCSO, Census on Population (various years).

ANNEX

Table 5. Growth Rates of Total, Urban and Rural Population by Broad Region, 1903-75 (in percent)

<i>Region</i>	1903-39	1948-60	1960-70	1970-75
<u>CIR</u>				
Total	2.11	3.44	3.99	3.65
Urban	2.82	5.80	6.54	5.36
Rural	1.87	1.94	1.45	1.21
<u>SR</u>				
Total	1.81	1.91	1.85	2.06
Urban	2.93	3.55	3.71	4.74
Rural	1.63	1.47	1.22	0.94

FR

Total	3.04	5.15	3.81	2.80
Urban	9.41	4.24	5.50	4.59
Rural	2.57	5.38	3.38	2.25

Philippines

Total	2.09	3.06	3.01	2.78
Urban	3.29	4.64	5.38	5.04
Rural	1.85	2.50	1.91	1.43

Note: CIR — Central Industrial Region, SR — Sluggish Regions,
FR — Frontier Regions.

Source: NCSO, Census on Population (various years).

ANNEX

Table 6. Number of Establishments, Employment and Value-Added in Small, Medium and Large Industries, Philippines 1967 and 1975

<i>Establishment Size*</i>	1967	(% Share)	1975	(% Share)	% Growth Rate
<i>A. Number of Establishments</i>					
Cottage	34,995	(77.8)	59,251	(76.6)	} 72.3
Small	9,343	(20.8)	17,153	(22.2)	
Medium	278	(0.6)	401	(0.5)	
Large	384	(0.8)	486	(0.6)	
TOTAL	<u>45,000</u>	<u>(100.0)</u>	<u>77,291</u>	<u>(100.0)</u>	
<i>B. Employment</i>					
Cottage	85,083	(16.4)	121,832	(16.9)	} 56.6
Small	127,529	(24.6)	211,186	(29.4)	
Medium	38,407	(7.4)	56,371	(7.8)	
Large	267,685	(51.6)	329,625	(45.9)	
TOTAL	<u>518,704</u>	<u>(100.0)</u>	<u>719,014</u>	<u>(100.0)</u>	
<i>C. Census Value-Added (₱000 at 1965 prices)</i>					
Cottage	111,870	(1.8)	113,983	(1.8)	} 77.0
Small	1,571,344	(25.6)	836,759	(13.2)	
Medium	482,138	(7.8)	1,154,861	(18.3)	
Large	3,978,858	(64.8)	4,219,054	(66.7)	
TOTAL	<u>6,144,210</u>	<u>(100.0)</u>	<u>6,324,657</u>	<u>(100.0)</u>	

*Cottage refers to establishments with 1-4 workers, small 5-99 workers, medium 100-199, and large 200+ workers. References to small enterprises in the text concern cottage and small establishments combined.

Source: NCSO, Census of Establishments.

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DISCUSSION ON THE PERFORMANCE AND PROSPECTS OF SMALL AND INTERMEDIATE SIZE CITIES IN THE PHILIPPINES

Alejandro N. Herrin, Ph. D., Discussant

My comments will focus on two aspects of Dr. Pernia's important paper; first, on his description of the differential growth rates of cities by size and region, and second, on his explanation of these differential growth rates. While agreeing essentially with the general findings and conclusions of the paper, I would like to suggest a slightly different approach to the analysis of the data, the aim of which is to facilitate the linking of Dr. Pernia's data on what is known about the broad patterns of Philippine migration in this century, as well as to provide a broader basis for identifying additional factors that may explain more fully the observed differential growth rates presented in the paper. Needless to say, Dr. Pernia's highly aggregative description of the performance of small and intermediate size cities is but an opening gun in what is hoped to be a series of serious studies on the spatial aspects of Philippine economic development.

On the basis of the growth rates of cities by size and regions shown in Table 3, Dr. Pernia finds that (a) the growth of cities of all sizes was both rapid and steadily rising in the NCR, and slightly so in the other CIR from 1903 to 1970, followed by some deceleration in the 1970-80 period; (b) the opposite is true for the cities in the SR and FR where the growth rates tended to be low and declining during 1903 to 1970 but perking up in the 1970-80 period; and (c) controlling for city size, SMCs in the Other CIR show accelerating growth rates during the 1948-60 and 1960-70 periods at the same time that those in the SR and FR were becoming depressed. Thus, Dr. Pernia concludes, regardless of size, cities tend to perform better in certain regions and periods than in others.

An alternative approach to the analysis of the same data is to consider the city growth rates in relation to the estimated rates of natural increase. This involves decomposing the city growth rate into its components, namely, natural increase or the balance between births and deaths, and net migration or the balance between in-and out-migration. Between these two components of change, net migration is the more relevant variable to look at in analyzing the performance of cities. For example, cities of a given size in a particular region may exhibit relatively high growth rates,

but such rates may still be lower than the rate of natural increase, hence in effect these cities are in fact losing population in relative terms, that is, relative to what they could have had due to natural increase alone. Using the data in Table 3, I estimated the net migration rates for each city size and region by subtracting from the overall growth rate the estimated rate of natural increase. In the absence of readily available information, the expected rate of natural increase may be taken to be equal to the growth rate of the entire Philippine population in the respective periods. Although urban areas are expected to have lower fertility relative to rural areas, they also may have lower mortality, hence the average annual national growth may still reasonably reflect the rate of natural increase in cities. The following observations may be noted:

(a) In the 1903-39 period, the NCR and the intermediate and large cities in FR were growing over and above the expected rate of natural increase. The cities of all sizes in the SR region, on the other hand, showed growth rates less than the natural increase signifying a relative loss of population mainly to the NCR and to the FR. These observations are consistent with the broad patterns of migration during this period which was mainly frontierward, i.e., to Mindanao and Cagayan Valley, and to a lesser extent but significant nonetheless to the NCR.

(b) In the early import substitution period 1948-60, the NCR and the intermediate and large cities in the FR continued to draw in migrants, again mainly from the SR regions. In addition, intermediate cities in the CIR also began to pick up population both from the SR and the spill over from the NCR. The spill over to the CIR accelerated in the 1960-70 period so that even the small cities gained population more than its natural growth rate. In the FR, only the large cities gained. The loss of population in the SRs as well as of the SMCs in the FR is consistent with the shift in migration patterns from the early frontierward to the more recent urbanward migration especially to the NCR and other CIR and to the large cities of the FR.

(c) In the 1970-80 period, the NCR and the intermediate cities in other CIR gained population but at a slower rate, while the intermediate and large cities in the FR gained at a faster rate than the previous period. Of interest is that the losing regions were losing population at a rate less than the previous period.

What might be possible explanations for these differential patterns of excess growth (i.e., growth over the expected rate of natural increase). Dr. Pernia's analysis regarding the shift in economic activities from the SRs to the NCR and Other CIR during the import substitution periods appears reasonable. The excess growth approach that we adopt here, however, suggests the need

for a broader interpretation. The rapid growth in the NCR and the intermediate cities of the Other CIR during the early import substitution period is consistent with Dr. Pernia's analysis. However, it does not explain why the intermediate and large cities in the FIR also grew, in fact, much faster than in the NCR and CIR. The reason may be that while the impact of the import substitution policies began to shift economic activities to the NCR and CIR regions, agricultural land was still available in the frontiers and hence continued in-migration to these areas was to be expected. In the later import substitution period, however, two factors seemed to have played important and reinforcing roles: (a) the more rapid shift in economic activity to the NCR and CIR, given the momentum generated in the earlier period, and (b) the vanishing of the frontiers. The link between the large cities in the FR to the economies of the NCR and CIR as Dr. Pernia suggested may only be part of the reason for their growth performance. The other factor, it would appear, is that with the vanishing of the frontiers and the relative neglect of agriculture, people began to move from the small and intermediate cities in the FR either to the large cities in the same region or to the cities in other regions, in search of non-agricultural employment.

What happened in the last period 1970-80? The rapid growth of NCR and the intermediate cities in the CIR continued but at a decelerating rate. The intermediate and large cities in the FR now grew at a much rapid rate than the previous period. And finally, the cities of all sizes in the losing region, SR, are losing at a slower rate. Dr. Pernia's analysis alluded to the possible impact of the regional thrust of development policy during this period, but finds that in terms of such indicators as the distribution of expenditures for infrastructures, number of firms given tax incentives, etc., the thrust does not appear to be substantial in favor of the SR and FR regions. This seems to be a reasonable conclusion. Going further however, even the distribution of government-sponsored loans to small and medium scale industries by region, which Dr. Pernia suggests has been more successful, do not appear in my view to be significant if we consider this in comparison with the distribution of population in these regions. Hence, some other forces may be at work that explains what Dr. Pernia called the resiliency of the cities of all sizes in the SR and of the small cities in the FR. One possible factor that I would like to suggest for future investigation is the impact of agricultural and rural development programs during the 1970s (i.e., land reform, price support, input subsidies, credit and extension services, rural electrification, etc.) which may have increased productivity in the rural areas with spill over effects to the cities. Additionally, the high growth rate in the intermediate and large cities in the FR may be partly due to the

“refugee problem” arising from the deteriorating peace and order conditions in the rural areas during the 1970s.

In summary, our proposed “excess growth analysis” to the same data provided by Dr. Pernia supports his main conclusions about the performance of the cities by region during the various development periods in the Philippines. At the same time, the approach provides a basis for identifying additional sources of the differential growth performance of cities, one of which is the impact of rural development programs.

With respect to strategies for development, we find that past policies have had important spatial biases, the recognition of which has led to the recent regional thrust in development planning. A question arises as to the effectiveness of the instruments used, for which answers must await careful studies. For example, is the program of industry dispersal beyond the CIR effective? One may speculate, in the absence of more complete information, that the promotion of large-scale, resource based, export-oriented industries in the lagging regions may fail to create enough opportunities for employment in the receiving areas, if such industries tend to have limited backward and forward linkages, in the input-output sense. For example, one immediately has in mind the large sintering plant in Northern Mindanao where the major inputs are imported, and where the outputs are directly exported. Very little multiplier effects in the local economy can be expected to generate additional employment opportunities in the area.

In another vein, one could ask whether agricultural modernization may not be a more effective basis for generating non-farm employment in the rural areas as well as in small and intermediate size cities. New activities may be directly needed to support such agricultural modernization. Indirectly, the resulting increase in farm incomes due to modernization would generate additional non-farm output and employment.

These and other questions, of course, still need to be studied carefully. In the meantime, I would like to congratulate Dr. Pernia for generating interest among researchers and policy makers on the spatial and urban aspects of Philippine development.

Lita J. Domingo, Ph. D., Discussant

The spatial-temporal framework adopted by Pernia “reflecting policy timing and regional impact”, provides a fresh and innovative approach to the analysis of spatial development in the Philippines. By bringing context into the analysis, this study has given new vitality to an analytic theme which has long been dormant in research — it acknowledges the importance of historical

time, the events and changes occurring within the time frame, in the interpretation of variations in spatial development.

The four historical periods used in the study identify segments in the course of this nation's economic development marked by important shifts in industrial and economic policies. Furthermore the typology adopted to categorize regions meaningfully and comprehensively discriminates the areas.

In addition to this, while most studies usually end up with a section called "policy implications", perhaps to make them sound relevant, this study takes a bold approach of using policies not only to help define the context within which change occurs but suggests treating them as explanatory variables that can help account for the differences in the recorded patterns of growth of cities in the country.

I would now like to make a few observations which I believe might be helpful if refinements (further work?) in the application of the framework be attempted. These comments are based on what I suspect the framework used in the analysis demands.

First, a simple observation on the presentation of results. If we examine the growth rates as presented in the appendix tables, one is immediately struck by the wide range of values not only among the various regions during various time periods but also within these regions in specific time periods. For example from Table 3 and for the section on Sluggish Regions, the growth rates for small cities between 1975 to 1980 range from -5.38 to 5.25; for the intermediate sized cities, the corresponding values are -2.72 to 3.67 while for large cities, they vary from -0.30 to 3.60. The summary figures presented which served as basis for the discussion conceals such variability. I feel that the variability of estimates is an interesting statistical phenomenon which may actually be reflective of differing consequences of natural, economic and social forces and policies.

Second, a point has to be made regarding the use of growth rates in this study. Growth rate is a complex measure, the basic components of which are the rate of natural increase and net migration rate. It is even suggested by Pernia elsewhere that in the case of the Philippines, we should consider a third component — the effect of net rural to urban reclassification.

Considering that the paper focuses on the pattern of growth of cities, one would expect that in the study, the relevant component is the rate of growth attributable to net migration as it may *partly* reflect movements of labor or of people who have been attracted to specific places as a response to the "spatial biases of economic development policies". We emphasize the word *partly* since migration studies have shown that although the motivations of people who migrate are highly economic in

nature, there are other social or non-economic motivating forces. By not isolating this component of the growth rate, in effect the rate of natural increase which is the difference between the birth and death rates and the net effect of reclassification are controlled for these various regions and through time. Given the variability of the rates makes this unacceptable. To illustrate these points we quote the results from Pernia's work in 1977 where he shows the components of urban growth in the Philippines. We select data which can be comparable to the classification utilized in this present study. Between 1903 and 1939, for Metro Manila, 33.9% of the urban growth is attributable to net reclassification, 55.1% to natural increase and 11.0% to migration. For the same years and for the frontier regions, 89.4% was due to net reclassification, 7.8% natural increase and 2.7% due to net migration. For a later period 1960 to 1970, the distribution for Metro Manila is 8.2% due to net reclassification, 54.3% natural increase and 37.5% due to net migration. For the Frontier region, 31.6% is due to reclassification, 51.9% due to natural increase and 16.5% accounted for by net migration. With these observations, as we examine the rates presented in the summary tables in the text keeping in mind the historical perspective defined for us by the author, one becomes less confident in interpreting the figures and in directly linking the observed changes to the economic-oriented policies operating during those periods.

Thirdly, timing is a very important element in the framework adopted. While the author acknowledges the fact that there are "lingering spatial effects" of policies, it is not clear from the paper what attempts have been made to make allowances or adjustments to accommodate the lag effects.

Given all these comments, I still go back to my original observation that the strength and value of this paper lies in the perspective that the author has offered us which I believe does much to sensitize us to the need of "bringing back context" in research.

Leandro A. Vilorio, Ph.D., Discussant

1. Prof. Pernia's paper is thought provoking in at least two ways. Firstly, he provides us with a new way at looking at our urban areas and their performance over time. Secondly, he builds up our expectation for what small and intermediate size cities could do for rural industrialization and regional development.

2. Since he has relied mainly on census data in depicting historical growth of urban areas, Prof. Pernia has to introduce a spatial-temporal framework to explain the performance of his

three types of cities, over four epochal periods, by his four-way classification of regions (why not three?). The major lesson from this exercise, using his own words, is: "regardless of size, cities tend to perform better in certain regions and periods than in others." The hypothesis that may be derived from this study then is: "insofar as the growth of cities is concerned, the key aspect is not so much size *per se* but the economic region in which cities are located as well as the relevant historical period." (p. 7).

3. Prof. Pernia's finding in this regard seems to confirm parallel studies (also using census data) made earlier on internal migration patterns in this country, whereby some provinces previously tagged as losing ones became receiving ones later.

4. The intriguing question such findings suggest is this: To what extent does international factors affect apparently "national events" as migration, growth of cities, etc.? This is critical if indeed Myrdal's backwash effects may be successfully reverted to a spread effect, particularly in favor of particular regions. In this regard, one may also speculate to what extent may the strategy of "regional closure" espoused by regional planners from the U.N. Centre for Regional Development at Nagoya, Japan, help in a situation like this.¹

5. Let me now move on to the possible developmental role of small and intermediate size cities. What is significant here is that in at least two countries subscribing to the capitalist system and the democratic ideology, it has been proven beyond doubt that market towns or central places served as vehicles for transforming stagnant agricultural societies to progressive rich industrialized countries today.

6. The first great example is the role played by the castle towns of Tokugawa Japan. Several studies leave little doubt that the additional income that members of Japanese farm families received as wages in the small industrial establishments of the castle towns provided the increments of additional spending powers that, on a national scale, widened the effect demand for all manner of consumer goods and thereby stimulated industrial capital formation, inter-regional movement of goods, and the progressive modernization of the whole Japanese economy.² More importantly, the availability of industrial employment in the castle towns introduced millions of farms boys and girls

¹See Fu-chen Lo, Kamal Salih and Mike Douglas, *Uneven Development, Rural-Urban Transformation, and Regional Development Alternatives in Asia*, Nagoya, UNCRD, 1978, p. 83 ff.

²E.A.J. Johnson, "The Integration of Agrarian, Commercial and Industrial Activities in Functional Economic Areas," in *March Towns and Spatial Development*, New Delhi, National Council of Applied Economic Research, 1972, p. 58.

to the rudiments of modern technology. Thus while still living in their farm homes, they were being trained for a widening variety of occupations, and in the process, their latent talents, skills, and aptitudes, which might have been largely wasted in simpler village cultures, were released, to the advantage not only of the individuals themselves but to the benefit of the whole economy and the Japanese nation.³

7. The other outstanding example is provided by the Commonwealth of Puerto Rico. In a single generation the per capita gross product in this country increased from less than \$100 to over \$1000. This was accomplished through the systematic industrialization of central places in all the 77 municipalities of the Commonwealth. The use of Government-built industrial estates has been the means of transforming the stagnant over-populated rural communities in Puerto Rico into pulsing hives of industry today.⁴

8. It is not suggested of course that we should copy the approaches illustrated in our two examples. We still have to learn a little more about the spatial pattern of development and the settlement system in each region of the country before we may suggest appropriate development strategies. At least we have a good example of this study we have in mind. I refer to a study conducted in 1978 for USAID by the Center for Policy and Development Studies (CPDS), U.P. Los Baños entitled *Urban Functions in Rural Development: A Research Project in Spatial Analysis and Planning*.

9. The Bicol River Basin is the focus of this study. It is a part of the Bicol Region which is considered as one of the poorest regions in the country. The economy is predominantly agricultural. The median annual family income is only one-third of Metro Manila. There is a maldistribution of income as 10 per cent of the households mostly living in urban areas, get 43 per cent of total income while the bottom 50 per cent of rural income-earning families received only 13 per cent of household income in 1971.⁵ The great irony is that while most Bicolanos live in dire poverty their land has abundant natural resources. For instance, it is envisioned that with proper irrigation and correct agricultural practices the Basin could sustain an additional million people. Moreover, there is a host of untapped mineral resources in Bicol — about 30 per cent of marble deposits, 75 per cent of perlite and

³Ibid., p. 59.

⁴Ibid., p. 68.

⁵Junio M. Rragio, "The Design and Application of a Manual Scalogram Method for Spatial Analysis in the Bicol IAD Area" unpublished master's thesis, U.P. Institute of Environmental Planning, 1981, pp. 33-35.

about 20 per cent of coal resources in the Philippines, not to mention the proven geothermal capacity there.

10. Why then poverty amidst plenty? Analysis of the spatial pattern of development and the regional settlement in the Bicol River Basin shows trends similar to those of the nation as a whole as painted quite broadly by Prof. Pernia. Thus the CPDS study finds great intraregional urban-rural disparities, weak linkages among settlements, and a weak market system. Services, facilities and economically productive activities are highly concentrated in only 6 of the 54 municipalities. These half dozen urban municipalities account for 45 per cent of all municipal government revenues collected in the Basin. On the other hand the 38 predominantly rural municipalities are subsistence agricultural areas forming the periphery of the Basin in which more than half of the population lives. They have a far smaller portion of facilities, services, educated manpower, financial resources, and productive economic activities than their share of population. Their residents are scattered in numerous small barangays. Only 8 per cent of households receive water and less than 6 per cent have electrical power. Only five of the 38 municipalities have post-secondary educational or vocational training institution, nearly 40 per cent have no markets of any kind, and 8 contain no financial institutions. These municipalities collect less than 2/5 of all municipal revenues and on the averages depend on the national government for nearly a third of their municipal income. As a group, these municipalities contain less than one-quarter of the manufacturing, commercial, financial and service establishments, only more than a third of agro-processing, storage and commercial establishments and one-fourth of health facilities.

11. The linkages among settlements are very weak indeed. For instance an intermodal transport study found that most travel within the Basin is highly localized. About 85 per cent of all trips taken within the Basin are among places within the same municipality and 99 per cent are within the same province.

12. Analysis of commodity flows and market functions of the six largest centers within the Basin and six of the prominent periodic markets indicate that a "market system" does not really exist. Nearly all commodities traced within the markets surveyed are obtained from and sold to people who live within the municipality. Except for manufactured consumer goods, which are imported from Manila for resale through the Naga and Legaspi markets, even the two largest market centers serve primarily their immediately surrounding territory.

13. In this context, the American consultant to this study provided this sobering analysis: "Traditionally macro-economic approaches to accelerating development will have little effect on

ameliorating poverty in regions with spatial patterns such as the Bicol River Basin. Simply reallocating investments more equitable among regions of favoring those previously given low priority, while necessary, are not sufficient to reduce spatial inequalities and increase the access of the rural poor to resources necessary to ameliorate their poverty." "Similarly", he says, "growth center development strategies are likely to exacerbate already severe urban and rural differences within regions."⁶ As an alternative he proposes "a strategy combining regional reallocation of national investment and selective location of physical infrastructure, social services, facilities, and productive activities."⁷ According to him this strategy consists of four components. First, deconcentrate important development investments from already burgeoning cities and metropolitan centres to other less developed regions, so as to provide the opportunities for developing potential resources in those regions and to create a more articulated and integrated national spatial economy. Secondly, careful location and "decentralized concentration" of high population threshold investments in intermediate and secondary cities, which would serve as inter-regional production centers, act to counter-balance continued rapid growth in Metropolitan Manila and become part of a network of domestic exchange and market centers. Third, locate infrastructure investments and productive activities within regions in such a way as to articulate the spatial system and integrate urban centers and rural hinterlands. Articulation of the spatial system implies the development of at least three "levels" of settlements within regional economies: rural service centers, market towns (small cities) and regional centers or intermediate cities. Finally, strengthen linkages among rural settlements and between them and urbanized centers within regions through farm-to-market roads and all weather arterials between market centers and larger towns and cities.

14. This four-pronged strategy, it is argued, would promote greater spread effects from development in larger urban centers and generate more diversified economic growth in smaller rural villages. It is further argued that this strategy, combines "bottom up" and "top down" development strategies to forge an integrated national economy in which the benefits of accelerated growth could be more equitably distributed.⁸

⁶Dennis A. Rondinelli, "Regional Disparities and Investment Allocation Policies in the Philippines, Spatial Dimensions of Poverty in a Developing Country", *Canadian Journal of Development Studies*, Vol. I, No. 2 (1980), p. 281.

⁷Ibid., p. 282.

⁸Ibid., p. 284.

15. Our two final questions then are: Who shall take the lead in the adoption of this suggested strategy and over-see its implementation: the Cabinet, the NEDA or the MHS? Pushed to its logical conclusion, doesn't a strategy like this require as a pre-condition for real success a careful review of present areal division of powers, i.e., between the central government, on the one hand, and, local governments on the other? Perhaps more autonomous regional governments in the future?

POLLUTION CONTROL A CATALYST FOR MORE EFFICIENT PROCESS: THE PALM OIL INDUSTRY AS AN EXAMPLE

By E.A.R. Ouano, Ph. D.

Abstract

The pollutant generated from an industry is part of the raw materials purchased by the industry. The higher the pollution generated from an industry the higher is the raw material wastage and pollution control cost. The cost of pollution control could be reduced by improving the process efficiency of the conversion of raw materials to useful products or by-products.

Industrial processes are often developed by mere mechanization of primitive practices. A typical example of which is the palm oil industry. For every ton of fresh fruit, 0.7 to 1.0 ton of waste materials are discarded to rivers and streams in terms of Biochemical Oxygen Demand (BOD). The wastewater are very strong with BOD concentrations of 20,000 to 30,000 mg/l which is 100 to 150 times stronger than ordinary sewage. An average palm oil processing mill with a capacity of 1000 tons/day dumps to the river, a pollutant load equivalent to a city with a population of 2,500,000 persons. The oil palm industry is a major pollution source in Malaysia exceeding the total organic wastes generated from other sources. The Philippine oil palm industry is still in its infancy but next two or three years it will be a major source of water pollution which will surpass current pollution sources.

A critical review of the existing palm oil extraction process is made with regards to sources of pollution or materials wastage. Current attitude has been to treat the wastewater or recover the by-products from the wastewater which could be inefficient due to the dilution and presence of a wide range of impurities. A new method of sterilizing the fresh fruit bunch, and oil is presented. Instead of generating wastewater, a 0.2 to 0.3 ton of animal feed with composition similar to copra meal cake could be recovered. The oil recovery is increased by 10-15% since hydrolysis is minimized. The test has been carried out in the laboratory and Pilot plant testing maybe required before further commercial application is possible.

With the pollution requirements on the industrial discharge, the need to reinvestigate the rationale of the different industrial processes has to be carried out.

Introduction

For every ton of fresh fruit bunch (ffb) of palm oil processed 0.700 to 1.0 ton of wastewater is generated from sterilizer condensate and sludge separation. The wastewater organic content is 100 times stronger than sewage in terms of BOD or Biochemical Oxygen Demand. Hence, a typical 50 t/hr palm oil processing mill will generate 200 tons of wastewater per day with a total BOD load of 24,000 kg/day. The pollutant load from this factory is equivalent to the total untreated sewage from a city with a population of 2,500,000 people discharged at one particular point in a river.

The environmental degradation caused by palm oil is one of the major constraints the Malaysian government had considered in the development of new plantation in Pahang State in 1975. The environmental controls for new plantation were enforced stringently such that some foreign companies' plans for expansion were transferred to other countries where palm oil pollution is unheard of like the Philippines and Papua New Guinea.

EXISTING OIL PALM EXTRACTION PROCESS

In order to appreciate the wastewater pollution problem of an oil palm processing mill it is worthwhile to review the evolution of the current process used in Malaysia, Indonesia and African Guinea. The process is most likely the same process that will be used in the Philippines in the near future when the existing plantation reaches productivity.

Palm oil is extracted from the pulpy portion (mesocarp) of the fruit *Elaeis guineensis*, which is a native of the West African Guinea Coast. The tree was introduced by the British and Dutch into Southeast Asia in the 19th century. Today most of the world's palm oil are produced in Malaysia, Indonesia, Thailand and African Guinea. The plant has been used for oil and food by African natives of Guinea long before the colonization of the West African coast in the 16th century. The extraction process was developed through experience and intuition with the skills passed on from one generation to another.

The African natives cook the fresh fruit bunch in boiling water for two to three hours right after harvesting the fruit. If the fruit is not cooked right after harvesting, the oil content declines and the oil extracted contains more fatty acids. In fact 48 hours after harvesting almost all the oil in the mesocarp are hydrolyzed to glycerol and fatty acid due to the presence of hydrolyzing enzymes in the mesocarp. Bruises in the fruit accelerates the release of the hydrolyzing enzymes to the oil globules.

After the cooking operation, the mesocarp is separated from the kernel. The floppy mesocarp is mascerated and pulped to a slurry consistency. The slurry is allowed to stand for an hour or two so that the oil will float and separate from the denser sludge. After separating the oil, the sludge is discharged.

The boiled water used for cooking the fruit and the discarded sludge are major sources of wastewater. However, on a family scale processing of palm oil the wastewater volume is very low that it could be discarded without any problem.

The process commonly used today is a simple mechanization of the same process used by the African natives. Initially, the fresh bunch is subjected to steam under a pressure of 2.5 to 3.2 kg/cm²

for 50-70 minutes to loosen the fruit from the bunch and deactivate the enzymes. After the cooking operation the bunch and the cooked fruit are separated in a rotary drum. The bunches are used for fuel in the boilers and furnaces, which is often more than sufficient to meet the energy needs of the plant.

The cooked or sterilized fruit is converted to an oily mash by a series of rotating screws. The mash is then passed through a centrifuge to separate the oil from the mash. The mash is discharged as wastewater together with the sterilizer condensate. The processing operation is shown in Fig. 1. For each ton of fresh fruit bunch 230-250 kg. of oil is recovered.

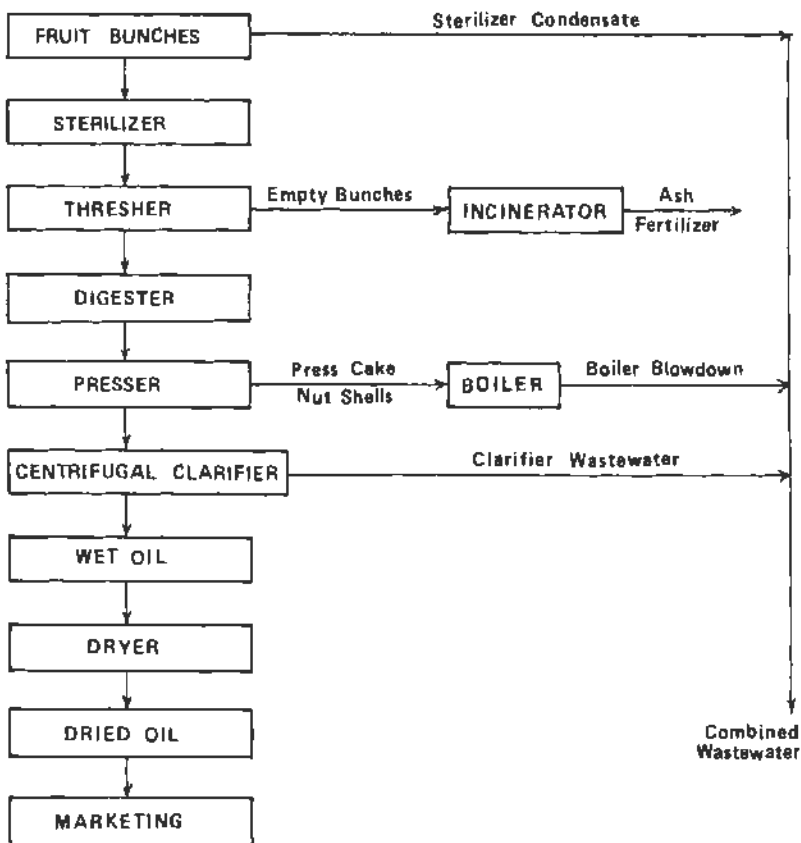


Figure 1. Palm Oil Extraction Processing in Malaysia.

WASTEWATER CHARACTERISTICS

The palm oil wastewater is difficult to treat using conventional biological wastewater treatment process for the following reasons:

- a) The waste is highly deficient in nitrogen in comparison to the organic impurities expressed in terms of BOD. The ideal N to BOD ratio for aerobic biological treatment should be 5:100 whereas on the palm oil mill wastewater the maximum nitrogen to BOD ratio is only 1.6 to 100.

Although the nitrogen deficiency could be alleviated by adding urea or other nitrogen fertilizer, 1 kg of urea will be required for every ton of wastewater or approximately 4 kg of urea will be required to treat the wastewater generated in producing one ton of palm oil. Considering the existing cost of ₱3.00/kg of urea, it would cost ₱12.00 of urea/ton of oil produced.

- b) Very High BOD — The organic concentration is very high that to use anaerobic/facultative lagoon system, 0.20 ha of land would be required for the wastewater treatment process for every hectare of land cultivated for oil palm. If a surface aerator is used 40 kg of oxygen is required for every ton of wastewater produced or 160 tons of oxygen for every ton of palm oil produced. With the present aerator oxygenation capacity of 1 kg of O₂ per kw-hr, 160 kw-hr will be required for every ton of oil produced or approximately ₱80/ton of palm oil.
- c) The wastewater contains a high concentration of volatile fatty acid and has a very low alkalinity for buffering. The pH of the wastewater varies from 3.7 to 4.8 when the required pH for biological degradation is from 6.5 to 8.0. Even when lime is added for pH adjustment for anaerobic degradation, the pH will return to acidic conditions due to poor buffering capacity. The wastewater treatment process is very unstable due to high BOD and low buffering capacity.
- d) The excess nitrogen and phosphorus will have to be removed otherwise the effluent could cause eutrophication problem specially in lakes and closed bodies of water.

Typical wastewater characteristics of the palm oil mill is shown in Table 1.

Table 1. Characteristics of Palm Oil Wastewaters

Characteristics, mg/l (except as indicated)	Sterilizer Condensate		Clarification Sludge		Combined Wastewater		
	<u>1/</u>	Present Study	<u>1/</u>	Present Study	<u>1/</u>	<u>2/</u>	<u>3/</u>
	BOD	18,000		20,000		18,000-20,000	19,8000
COD	55,000	59,700	60,000	87,760	40,000-58,000		29,000-40,000
Suspended Solids	15,000	10,600	35,000	11,000	30,000	15,420	4,800-5,400
Dissolved Solids	25,000		25,000		35,000	23,500	16,000-27,000
Oil(%)	0.7		0.7		0.7	.57	
pH	4.5	4.75	4.5	3.7	4.5	4.8	4.4-4.5
NH ₃ -N	—		—		30	25	39
NO ₃ -N	—		—		9.3	41	9.3-10.4
Org-N	—		—		576	522	
Total-N		700		756			
Phosphorus		150		150	200		
Temperature, °C					80-90		
Volatile Acids		2820		3990			
Alkalinity		1400		nil			

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^{1/}MA, A.N. (1975), Agro-Industrial Waste Problems in Malaysia, Proceedings of the Agro-Industrial Waste Symposium, Kuala Lumpur.
MUTHURAJAH, K.N. (1975), Some Aspects of Palm Oil Mill Effluents and Possible Methods of Treatment, Proceedings of the Agro-Industrial Symposium, Kuala Lumpur.

^{2/}SINGH, K. and NG, S.H. (1968), The Malaysian Agricultural Journal, v. 46, no. 3, Jan., pp. 316-323.

^{3/}AZIZ, A.B. (1974), Palm Oil Processing Effluent Treatment, v. 1, Factories and Machinery Department, Kuala Lumpur.

CURRENT WASTE TREATMENT PROCESS

From Table 1, the wastewater has a high concentration of suspended solids which varies from 15,000 to 33,000 mg/l depending on the in plant water consumption and availability. Most of the organic pollutants are in the form of suspended solids rather than in colloidal or dissolved form. Air flotation have been utilized to remove the solids. From 60-40% of the organic pollutant is removed with the suspended solids but from 40-50% of the pollutant remains in solution or colloidal dispersion. The process is useful in pretreatment and reduction of the organic pollutant but the equipment is quite expensive and difficult to operate. In addition coagulant aid and coagulating agents are required in substantial concentration for the process to function satisfactorily. For this reason the process have not been utilized extensively except in pilot plant scale.

Irrigation or land disposal of the wastewater have been tried in Malaysia. The wastewater could be dosed on land up to 4 cm deep once every four months without any noticeable effect on the soil quality even after 2 years of operation. However, plantations are often located in rolling hills and hilly terrain that extensive piping and pumping is required.

A complex integrated process known as CENSOR (Centrifugal Solid Recovery) has been proposed by researchers at the University of Malaya. The process involves the reduction of the wastewater moisture content from 95-90% using conventional plate centrifuge "Westphalia" or a three stage decanter centrifuge "Sharpless". The moisture in concentrated sludge is reduced by adding cassava meal and palm oil kernel meal as an absorbent, carbohydrate and protein base. The mixture is dried at high temperature using a high air speed injection type rotary drum drier. The final product is pelletized and marketed as animal feed.

In 1975 it has been estimated that the investment from such process could be recovered in 2 years for a factory processing 20 tons of ffb/day. To meet the cassava requirement of the process approximately 0.1 hectare of land will be cultivated per hectare of palm oil cultivated. The processing and production of cassava starch is not pollution free. The upper Gulf of Thailand is polluted mainly from cassava processing waste which is as difficult to treat as the palm oil wastewater. Hence, the process does not solve the problem but merely shift the palm oil pollution to cassava pollution.

DEVELOPMENT OF A NEW PROCESS

The major shortcomings of the present approaches for pollution control of the palm oil mill wastewater has been to consider

the wastewater as an essential component of the palm oil processing operation. As described before, the present palm oil extraction process is nothing more than a mechanization of the traditional process evolved by the natives of African Guinea. Due to the low production cost, the incentive to improve the oil recovery process is minimal. The external cost due to environmental damage brought by the uncontrolled discharge of the palm oil wastewater, could exceed the existing production cost and has become the constraint on future expansion as have taken place in Malaysia today.

Boiling water and steam is only one method for deactivation of the enzymes which hydrolyzes the oil to fatty acid and glycerols. Other methods of enzyme deactivation are available notably heated air which could be used on the existing sterilizer equipment using steam. The oil palm fresh fruit bunch could be dried within two hours using air heated to 140 – 160°C and operating at a pressure of 28 psig. The process could be carried out at atmospheric condition but it is preferable to carry out the sterilization at higher pressure to minimize burning the skin of the fruit before the inner portion of the mesocarp have been sterilized. The higher pressure suppressed the boiling point of the fruit moisture content, resulting to more uniform sterilization or enzyme deactivation. The term sterilizer or sterilization is retained although this is a misnomer. Early workers in oil palm processing attributes oil hydrolysis in the palm oil mesocarp to bacteria and microorganism, hence, the cooking process was called sterilization rather than enzyme deactivation.

The fruit will shrink in size by 15% due to dehydration during the sterilization process. The skin and mesocarp becomes brittle and when pressed it dissociates into oily pieces 1-1.5 cm in diameter. The sterilized fruit dissociates easily from the bunch upon shaking.

After sterilization the dried fruit could be segregated from the bunches using the thresher used in existing plants. Unlike the steam sterilized fruits, the dried fruits could be stored up to one week without any deterioration in the oil quality. In the early stages of this study, the fruits were sterilized in Kuala Lumpur and processed in Bangkok.

This would allow better flexibility in mill operation than currently possible. The steam sterilized fruit has to be processed within 24 hours otherwise, microorganism will start growing on the cooked and moist mesocarp to destroy the oil. With heated air sterilized fruit, the equipment could be sized at capacity slightly bigger than the average production capacity, hereby reducing the initial capital cost.

The dried mesocarp after being separated from the kernel by the rotary screw is passed on to a high pressure pressing machine commonly used for coconut oil extraction from copra. Using a laboratory pressing equipment with 30 psig pressure, 50% of the oil in the dried mesocarp could be extracted. For full scale operation higher oil yield could be obtained with higher operating pressure than those possible using the laboratory scale pressing unit.

The remaining 50% of the oil could be extracted by solvent such as hexane. Approximately, 300 kg of palm oil could be extracted per ton of fresh fruit bunch using the process described compared to 250 kg oil per ton of ffb using the existing processes. The higher oil recovery of the process is due to the following reasons: a) in the conventional process, during the cooking operation a large amount of oil forms colloidal emulsion with the condensed water which ultimately ends up in the wastewater. Up to 20 kg of the palm oil/ton of ffb are lost in wastewater. b) the sterilization process with steam, the heat hydrolyzes portion of the oil. From 30-40 kg oil/ton of ffb are lost through the sequence.

The spent cake after hexane extraction could be used as an animal feed supplement; the composition of the cake after hexane extraction are as follows:

Oil	—	2- 5%
Protein	—	12-18%
Ash	—	2- 4%
Carbohydrate	—	30-40%

The above analysis is very similar to copra meal cake which is used extensively for animal feed.

The process diagram is shown in Fig 2. The process does not generate any wastewater and the recovery of the organic constituents of the mesocarp for animal feed is facilitated since the solids does not have to be separated from water and dried. In addition, up to 20% more oil could be recovered, with a process that does away with a serious pollution control problem.

Conclusion

A number of industrial processes were developed when concern for the environment, raw materials, power and by-product utilization was minimal. The waste material or pollutant discharge was once part of the raw materials purchased by the industry. Treatment of the polluting effluent from an industry should be considered a priority for an existing plant. The development of more efficient processes could be stimulated by a properly motivated environmental program.

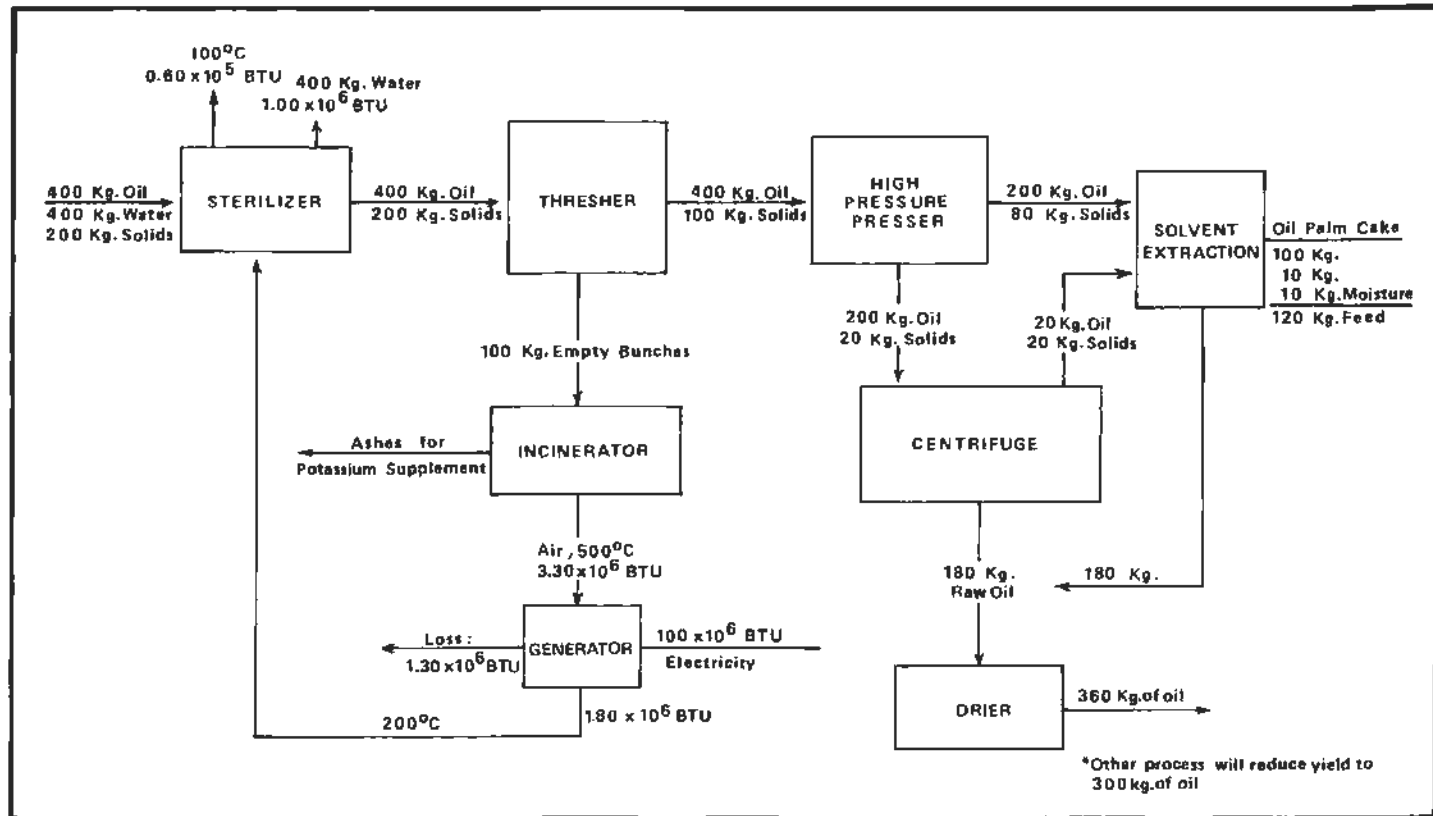


Figure 2. Process Flow Diagram.

Acknowledgement

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DISCUSSION ON POLLUTION CONTROL A CATALYST FOR MORE EFFICIENT PROCESS: THE PALM OIL INDUSTRY AS AN EXAMPLE

Veronica Villavicencio, Ph.D., Discussant

It certainly augurs well for the cause of environmental protection that a prestigious group such as the National Academy of Science and Technology has devoted one session of its annual scientific meeting to Pollution Control. And I feel that it is also in the right direction, when the topic attempts to view pollution control not as an added cost or a problem area, but as an incentive and a challenge as stated in the title of Dr. Ouano's paper. Too long have we held the view that pollution control measures are purely money down the drain. That they are too expensive and non-economical. For many developing countries that are pursuing the path of industrialization, government planners more often than not have held the view that environmental quality, clean air and water is a luxury which a hungry man or a poor man cannot afford. We certainly sympathize with this view for who can argue that alleviation of poverty must be a priority of the first magnitude. But what is sad is that even as the problem of poverty is alleviated and attitude of resignation and acceptance that pollution is a price that one must pay for industrialization, still continues to prevail. Seldom are the economic gains derived from industrialization funneled back to enhance environmental quality. This has been the trend. So this trend continues until there is public outcry or when really the water is so polluted that people cannot use the receding waters, or if there is a health hazard. So it is within this attitudinal setting which I hope is in the past, that it is encouraging to see emerge, a view of pollution control in terms of cost output equation, a view of pollution control which works towards process efficiency in industries, and a view of pollution control as a source of raw materials.

So here as well as in the international community, this challenge is being met by attempts to develop and apply "low-waste technologies" and residue utilization. It is only recently that this concept of residue utilization has been recognized as a component of waste management or pollution control policy. Because in the past the idea has been — you produce the waste and then you treat it, but now the emphasis is emerging that we should view the waste as a resource. The view is also emerging that waste recycling

or re-utilization should be incorporated into the process that there should be an attempt to integrate the pollution control measures into the system rather than waiting for the waste to be produced and then trying to treat the waste. These are what we consider very hopeful measures that are emerging.

The UN Environment Program (UNEP) has a program on industry and environment which has documented case studies of companies like the 3M Company that has been able to reduce 70,000 tons of noxious gas and 500,000,000 tons of waste water and saving in the process some US\$70,000,000 per year. Dow Chemicals, ICI and others have also been able to successfully retrieve pollutants to make profits. These examples illustrate that pollution control through waste re-utilization can become economical.

This concept of re-use of waste is also being done in Japan. As of April, 1979, we have some 23,000 firms using industrial wastes or, channelling waste back and using it as a resource. Agriculture and agro-industry offer potentials for residue and waste utilization specially because of the quantity and volume of waste, and this was pointed out in Dr. Ouano's paper. Residue utilization programs would accomplish not only environmental and pollution control but also better management of resources which are being depleted by population pressure. It would also evoke more efficient techniques in processing, thereby increasing production. Dr. Ouano's paper illustrates and attempts to evolve a process or a technology that will do both: 1) reduce the waste water before it is discharged and in the process increase efficiency and increase the retrieval of the oil: 2) re-use the waste to generate a raw material. In this case he cites the example of using the palm oil waste for animal feeds.

Here in the Philippines, we are not too unfamiliar with the palm oil industry because we are familiar with some of the pollution effects of the coconut industry from the production of coconut and corn oil which we produce in large quantities. We are not unfamiliar with these processes. There are studies now also along the lines of Dr. Ouano's paper that attempt to introduce pollution-control technologies for existing plants. But I think the focus of Dr. Ouano's paper is more for new plants so that the pollution control measures can be incorporated into the operations and the process itself. And I think the main point that Dr. Ouano is trying to make in his paper is that we should not presume to consider that the waste needs to be produced. In his paper, he was able to point out that through solvent extraction and mechanical extraction, the waste water could be reduced to a very great extent preventing waste water from being dumped into the rivers and other waters.

One last point, I do not know whether there is already a decision on the palm oil industry, I had reservations on whether the Philippines would indeed become a major palm oil producing country, I feel that the support base in agricultural development would be evolutionary — very slow and also subject to world market prices. It becomes a very political and economic issue, because of its implications on our coconut industry — but I don't know whether that is part of the scope of our discussion this afternoon. However, if this decision has already been reached, as Dr. Ouano cited that so many hectares have already been planted to palm oil, I would just like to say that we hope that the suggestions presented by Dr. Ouano in his paper are seriously considered in order that we can incorporate the pollution control measures right into the early stages of the planning of the factory and the processes itself. We feel that this is one way, in fact, probably the only way at the moment that we can prevent the massive pollution effects which are being predicted by Dr. Ouano. I thank you.

Dr. Edwin Lee, Environmental Engineer, Discussant

First, I want to congratulate Dr. Ouano for his excellent paper. And second, to try to make a few comments on the paper itself. And with the time constraints I will make it as brief as possible. I do not want to focus on the technical aspects of his paper, because his paper stands pretty well by itself. As an innovative and technical approach to a very difficult pollution problem — a problem, as he had mentioned has boggled many countries that are presently in the palm oil business.

My remarks will be centered mainly on the concepts and approach that his paper so well present. The paper like that one is an excellent example what I call innovative approaches much needed today in pollution control technology. This requires the difficult task of innovative thinking and an alternative evaluation. However, I must report that today, many technicians and engineers in our field of pollution control limit the alternative evaluation only to the waste treatment process, and frequently avoid in-depth evaluation of alternatives in controlling waste within the industrial process itself. Dr. Ouano have brought us back to this basic fundamental so often overlooked by engineers in their singular approach in addressing solutions to waste water problems by only looking at treatment technology. This paper is a strong reminder to those of us working in the profession, to take a broader and more innovative approach to pollution control, that includes not only consideration for pre-plant processing of raw materials; in-plant processing of products; as well as post-plant

treatment of wastewater and disposal processes and reclamation systems.

Only by this holistic and systematic approach can the total economics of pollution control and the industrial enterprises itself be evaluated and optimized effectively. We have been presented by Dr. Ouano of an example wherein the considerations for alternative to in-plant products processing, a very difficult pollution control problem, that have confronted the palm oil industry for many years can be solved. The proposal will not only solve a very difficult waste water treatment problem but it will also result in by-products that can be contributory to the income of the industry as well as benefit users of the by-products. These benefits from the by products will give cause for industry to view pollution control, not as annoying needs for compliance with regulatory agencies, but as income generation which also benefit the industry itself. In this case, industry would have no cause for fearing that pollution control requirements, would detract from the economic success of the enterprise itself. In a period of rising cost and increasing competition of trade and commerce, this broad approach which can have significant economic implications to the industry, is the approach that have long term implications to socioeconomic development programs of the nation and ultimately to the well-being of the people themselves.

This ultimate goal is the real objective of national development in which industries can play an important role, and engineers as well as industrialists, economic planners can more use the example that Dr. Ouano has presented, as a guide for other industries disposing problems.

Benedicto Adan, Discussant

When I read the paper of Dr. Ouano I find myself agreeing with what he said, hence I perhaps have very little things to say. But since I was invited here to say something so I have to strive to find words to comment on his paper, so without further preliminaries I would like to read what I have noted when I read the paper.

It is a common knowledge, particularly among pollution control specialists and industrialists, and also perhaps scientists like yourselves, that it is always expensive, if not very difficult to treat wastewater once it is generated. It is always better if wastewater can be tackled at its source by modifying the process and that is the suggestion here of Dr. Ouano, thereby eliminating discharges without affecting the quality of the final product — should treatment be undertaken. However, because of lapses of some of the

industrialists, the resources expended for controlling pollution become a very significant loss to the industry. This loss is reflected ultimately on the higher price of the product. In a competitive economy like ours, this could mean loss of market, which our developing country or any other country for that matter can ill-afford. It is incumbent on industry therefore to seek means by which material losses are reduced and consequently, the cost of pollution control is reduced correspondingly. In achieving this goal the product remains competitive in the market and the industry prospers. It is also a common knowledge that industry is reluctant to invest in an innovative process and even more reluctant in investing in pollution control, that is an experience. For the money invested in controlling pollution brings no return. Industry may be induced to invest resources, nevertheless if the change brings material benefits to the industry or the regulatory agencies like NPCC obliges the industry to do so. This might be effected thru imposition of stiff effluent charges or fines or even closures. These prospects will certainly induce industries to review its processes to cope with water quality and effluent standards of the regulation authority. It should be worth mentioning therefore, that there is no reason to believe that rules and regulations will not be more stringent in the future, in view of the government's thrust on industrialization.

To lift the country's economy at this very early period of the palm industry, proponents under the regulatory agencies should take stock, seriously review the future outlook to cope with the problems that may eventuate. One will look at the suggested solution in the paper to induce more efficiency in the oil extraction process. In the case under study the wastewater from the palm oil industry has been characterized to be a very strong, and stable wastewater. It is very high in BOD, as explained by Dr. Ouano and very low in pH. It has been also reported that some elements such as cadmium, iron, copper and manganese were found in the wastewater in appreciable concentrations. The very high organic matter content of the wastewater when subject to a very efficient secondary treatment process, the process could not reduce the organic content to acceptable limits and therefore, it should not be discharged into the environment. The very low pH requires a great quantity of chemicals for neutralization — all of these of course cost money.

The approach suggested by Dr. Ouano found to be quite attractive, as the process changed other known and tried methods which industry can avail of: i) water conservation and (2) wastewater string reduction. Description of these methods abounds in literature and have been explained already. And string water levels which could be managed by the conventional wastewater

treatment processes in addition to the recovery and re-use of the reusable fractions of the wastewater which otherwise would have been gone with the plant effluent to be classified as waste and therefore a lost material. The conventional waste process mentioned in the paper and is a universal application in Malaysia, Thailand and other countries which produce palm oil, generates very strong wastewater as had already been stated. And this was found to be the major cause of gross wastewater pollution in places where the palm oil industry is established. The pollution from this source has reached a point already that expansion of palm tree plantation or the start of a new plantation is not being encouraged. For the industry to survive a very careful review of the oil extraction process to minimize material wastage, and the method of wastewater treatment is very imperative. Studies have been undertaken to remedy the situation. One of the studies have been mentioned in the paper and it proposes to change the process at one from the production stages from wet to dry by replacing steam with the hot air at the sterilization stage of the extraction process. It is in this stage of the process where most of the wastewater is generated. This suggested process modification had not been applied on a full scale but pilot scale studies according to Dr. Ouano, indicates its high potential for coping with the problem of wastewater and pollution control.

Recently, a report states that hot air is in use at the Dulson Durian oil mill in Malaysia to separate the fiber from the nuts, and the broken shell from the kernel. It had been reported also that hot air application, in addition to the other advantages already mentioned in the paper tends to reduce the moisture content of the nuts, facilitating the cracking process. Experience has shown also that it takes time before results of experimentation find their acceptance and hence, their application. Moreover, the suggested process change although seemingly attractive and superficially uncomplicated may cause problems in subsequent process operations.

Additionally, the proposed process change may require considerable study and testing at an early start is therefore advised. First, to iron out kinks during trial runs. Second, to afford longer period for personal training.

The selection of the subject for discussion in this 4th Annual Scientific Meeting of the National Academy of Science and Technology is indeed most fortunate. First, the palm oil industry in the Philippines is needed and just taking off the ground so to speak.

This is relevant at this point in time, therefore to assist the potential of this new industry in the Philippines for its contribution to the worsening pollution of the waters of the country.

Second, it delivers clear and loud a message, to decision makers to initiate the review of its staunch stand on oil processing

methods and wastewater treatment processes employed by the industry and similar industries today with a view to adopting a process system or systems with the attributes of minimizing material losses and subsequently reducing the volume and strength of waste to be managed.

Third, some scientists in this audience or the NAST itself, may find the problem challenging and worthy of support to initiate, perhaps and carry out researches in this regard. Since there are no palm trees or nuts at present to process in the Philippines nor waste from the industry to treat, the researcher made them first in literature collections and reviews and/or conduct experimentation on the treatment of desiccated coconut waste — this had been mentioned, which has similar characteristics as the palm oil in wastewater in terms of BOD, and low levels of pH values. This latter suggestion is wastewater treatment and not a process change. The literature research uncovers a method by which wastage of material can be minimized so that in the end the goal of pollution control is achieved. Thank you.

THE ANTIBIOTIC AND ANTITUMOR ACTIVITIES OF SELECTED PHILIPPINE THALLOPHYTES

By Patrocinio Sevilla-Santos, Ph. D.

Abstract

Out of a total of 905 Streptomycetes studied, 466 showed varying degrees of activity against the gram positive, gram negative and acid fast bacteria, the yeast and yeast-like organisms, plant pathogens and Ehrlich ascites tumor cell.

Streptomyces culture S-62-30, S-67-3 were isolated from soils. The active brew was produced in a large scale by submerged fermentation. The antibiotic substance was isolated and purified and was identified as belonging to the Actinomycin group. *In vitro* studies showed significant activity against ascitic tumors, *Mycobacterium* 607 and the gram positive bacteria. *In vivo* studies in Swiss mice showed inhibition of Ehrlich ascites carcinoma (EAT) and leukemia L1210. Isolate S-A-15, a natural variant of S-62-30, was identified as *S. parvus*, Philippine strain. It also produced an actinomycin complex with same activity as the parent strain.

An initial survey of 172 basidiomycetes gave 169 sporophore aqueous extracts which inhibited mainly the gram positive test bacteria. Subsequent samples also indicated the same inhibitory activity.

Five basidiomycete species namely *Polyporus cinnabarinus*, *P. sanguineus*, *Lentinus squarrosulus*, *Calvatia lilacina* and *Psathyra umbonata* were successfully grown in the laboratory and were found to produce the antibiotic substance.

Some 40 basidiomycete samples were shown to have inhibiting property on Ehrlich ascites tumor cell (EAT).

Ether extracts of Sargassum samples and *Chlorella pyrenoidosa*, showed inhibitory activity on the gram positive bacteria. Some species gave indication of antitumor activity.

Out of 33 lichens, 30 showed antibiotic activities against gram positive and *Mycobacterium* 607. Usnic acid, an antitubercular substance, was isolated in pure form from lichens *Usnea montagnei*, *Ramalina farinacea* and *Crocynia membranacea*. Polysaccharides from the first two of these lichens showed promising results when tested on Leukemia L1210 and P 388 experimental tumors.

Introduction

Going over the discovery of antibiotics, one can observe that practically every discoverer was a man ripe in years. Almost all discoveries in the antibiotic field have been made by man between the ages of 45 and 60. This fact must please us all — the YOUNG, because it confirms that scientific creation has no age limit; the MATURE, because it proves that they can still accomplish. The maturity of antibiotic scientists is a symbolic herald of our geriatric era.

Dr. Benjamin Duggar, 76 years old, led a team of Lederle scientists and isolated the organism *Streptomyces aureofaciens* which yields the golden antibiotic aureomycin. The late Dr. Selman A. Waksman, soil microbiologist and professor of Microbiology in Rutgers University, at about the age of 65, screened more than 10,000 isolates of *Actinomyces* and *Streptomyces* before he discovered *Streptomyces griseus*. The microorganism is now commercially used for the production of an antibiotic known as streptomycin.

Antibiotic research has changed. Originally there were innumerable lone investigators but today the work is done in teams. Also the fact that a discovery is a lucky accident has been replaced by discovery as the result of planning and organization. It has been fifty two years since the discovery of penicillin by Fleming and thirty two years since the broad spectrum antibiotics became available for clinical use. Let us note the difference between the two achievements of the antibiotic age. The first was accomplished by one man alone as in the days of Pasteur; the second by a team of men dedicated to tracking down an antibiotic. This marks the development of a new mental and social attitude in research.

Brief History of Antibiotics and Definition (7, 18)

A brief history of antibiotics is traced back to more than a century ago. In 1876, Tyndall, a physicist, described the antagonistic action of a species of *Penicillium* to bacterial growth. A year after in 1877, the first scientific demonstration of bacterial antagonism was recorded by Pasteur and Joubert. In 1889, Vuillemin used the term "antibiosis" to describe antagonism among bacteria, for the first time. Olitsky reported the antagonism of *B. fluorescens liquiefaciens* towards *Staphylococcus* strains and *B. anthracis* in 1891. Muljutin (1893) described inhibition of growth of a number of microorganisms by *Vibrio cholerae*. Metchnikoff (1894) and Kitasato (1889) noted the strong antagonism of *Pseudomonas aeruginosa* toward *Vibrio cholera*. In 1889 Emmerich and Low isolated from *Pseudomonas aeruginosa*, pyocyanase the first drug produced by microorganisms and introduced into therapy. A seldom mentioned scientist Ernst Augustin Duchesne preceded Fleming by about 31 years. In 1897 he presented his doctoral thesis on the antibacterial action of Hypomycetes. He demonstrated by experiment that cultures of *Penicillium glaucum* decreased the virulence of *Bacillus coli* or *Eberthella typhosa* in inoculated animals. In 1908, the antimicrobial properties of molds were recognized by rural folks. They treated a small cut or wound with a piece of mold, resembling a ball the size

of a lemon found in fields and pastures. Usually the grandmother kept these molds in bread or rye ready to apply to infected wounds and sores of the children. It was recorded that in 1911-1913 a laboratory attendant collected molds growing in old pieces of shoe leather, made this into a salve and used this as medicine for wounds. In 1928 Sir Alexander Fleming noticed a species of penicillium that made Staphylococcus colonies surrounding it transparent. In 1939 Rene Dubos undertook methodical, biological and chemical studies on the antibiotic Tyrothricin produced by *Bacillus brevis*.

1939-1959 marks the golden era of antibiotic research. The turning point in the history of antibiotics was the isolation of penicillin by Florey *et al.* (1939) from cultures of *Penicillium chrysogenum*. The period was called the Golden Era of antibiotic research. It was during this time that the main therapeutic antibiotics presently used namely benzyl penicillin, streptomycin, chloramphenicol, tetracycline and erythromycin were discovered.

The antibiotic era and the period preceding it are an outstanding phase in the history of medicine during which impressive advances in theoretical and applied science were made.

1959-1960 — Chemical modifications of natural antibiotic molecules were studied to obtain new, semisynthetic and modified antibiotics.

After 1959 interest in chemotherapeutic antibiotics waned and renewed in 1965.

Definition of Antibiotics

The first definition of antibiotics was that of Waksman (1945), who defined antibiotics as "chemical substances produced by microorganisms possessing the ability to kill or to inhibit the growth of bacteria and other microorganisms".

In 1960 Abraham and Newton proposed this definition, "Antibiotics are compounds of natural origin, produced mainly by microorganisms, characterized by high activity against pathogenic microorganisms, relatively low toxicity for humans and animals, and resistant to inactivation by enzymes and body fluids".

However, in 1976, Abraham and Newton's definition was modified (Kurlowicz *et al.*) as follows. "Antibiotics are natural compounds produced mainly by microorganisms, or are compounds obtained by chemical or microbiological modification of natural compounds".

Origin of Antibiotics

In the search for new antibiotics, it became apparent that, although microbes are the main producers of these compounds,

other organisms such as algae, lichens, green plants and even animal cells produce antibiotics.

More than 50% of all antibiotics (7) are elaborated by actinomycetes (Streptomycetaceae) 10 to 11% by fungi imperfecti (Aspergillales) and nearly the same number by bacilli (Bacillaceae-Bacillus). About 6% of antibiotics are synthesized by Basidiomycete and ascomycetes, less than 1% by lichens, and about 14% by green plants. About 2% of antibiotics are of animal origin. (Figure 1).

The search for antibiotic substances is world-wide and microorganisms producing them have been discovered in several countries. Table 1 gives the national trends in antibiotic discovery. Figure 2 shows that the highest number of antibiotic producing strains belong to the Streptomycetaceae (7).

Production of Antibiotics

About 2,700 antibiotic substances were produced by microorganisms, approximately 85% of those for therapeutics were produced by actinomycetes, 11% by fungi and 4-5% by bacteria. In 1978 the world-wide bulk sales of the 4 most important groups of antibiotics — the penicillins, the cephalosporens, the tetracyclines and erythromycin amounted to \$4.2 billion.

A list of important antibiotics produced by fermentation processes for the year 1977 is given in Table 2.

Local Importation of Antibiotics

Since the time antibiotics were discovered and marketed our importation of antibiotics has progressed to enormous amounts. Central Bank figures show that from 1970 up to 1974 the amount was steady up to about 6 M dollar mark while in the succeeding 5 years there was a progressive annual increase of 1.5 to 3 M dollar until importation reached almost the 20 M dollar mark in 1979. Figure 3 shows the trend. This value comprises about 25% of the total Philippines imports of both medicinal and pharmaceutical products. Drug surveys show that majority of sales fall in the category of antibiotics and antibiotic preparations.

Local Attempts at Establishment of an Antibiotics Fermentation Plant

Way back in 1951 the establishment of an antibiotic fermentation plant in the Philippines was the subject of a bill passed by Congress. Unfortunately it did not pass the Senate so this bill did not materialize.

In 1969, the administration officials showed an interest in the establishment of a plant and Mr. Lopez, the V.P. at that time

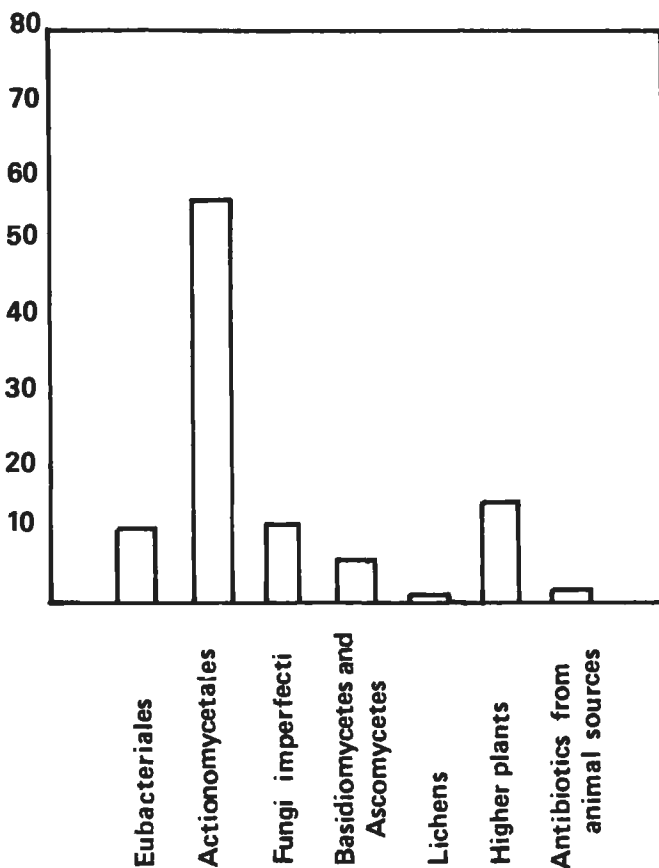


FIGURE 1 ORIGIN OF ANTIBIOTICS

exhorted traders on this particular investment area.

The Saturday Mirror Nov. 8, 1969 quoted:

“V.P. exhorts traders in investment areas”

. . . Antibiotics. Lopez indicated deep interest in the establishment of antibiotic fermentation plants to supply the big domestic demand. He pointed out that the total supply of the all-important drug in the local markets is wholly imported. Lopez said that with antibiotic fermentation plants here, the country will save no less than \$26 million annually. The vice president also said that the establishment of these drug plants will complement plans for an expanded national health program. “I have complete faith in the capacity of our drug firms here both foreign and Filipino-owned to go into this important venture,” he said.

Table 1. Showing National Trends in Antibiotic Discovery.

Country	Producing microorganisms				Total
	<i>Streptomyces</i> <i>sp.</i>	Rare <i>actinos</i>	Fungi	Eubacteria	
Japan	1210	98	308	236	1852
USA	677	162	244	163	1246
USSR	261	42	34	39	376
UK	48	8	206	46	308
West Germany	110	6	28	23	167
Switzerland	68	1	84	1	154
Italy	53	47	14	6	120
France	58	2	32	27	119
India	55	13	18	30	116

It was about the same year that the United Laboratories planned to put up an antibiotic fermentation plant for some antibiotics. In addition, Rachele Laboratories had a full page publication in one of the local dailies about the antibiotic fermentation plant that they planned to build in the Philippines.

The sad fact is that to-date more than thirteen years have passed, and our dreams of such a plant is not yet realized. It is hoped that at some future time some progressive drug companies will enter into this venture.

Problems Facing the Antibiotic Era

The new problems facing us in this antibiotic era are 1) antibiotic resistance 2) metabolic attack 3) biological symbiosis, 4) new sources of antibiotics. Another present-day problem is to find antibiotics that will attack the microbic forms of life still immune to them. The answer might be to discover new kinds of metabolic attack against such organisms, to study more about their biological cycles, or to develop a greater biological immunity in the human body. We might also end up by reducing to the essentials the drugs now being used, which reminds us of Osler's words: "The young physician starts life with 20 drugs for each disease, and the old physician ends life with one drug for 20 diseases". This reminds me of the late Dr. Daniel de la Paz, a U.P. Pharmacology professor in the 1930's, whose students commented that he prescribed only one medicine (i.e. sodium citrate) for all diseases.

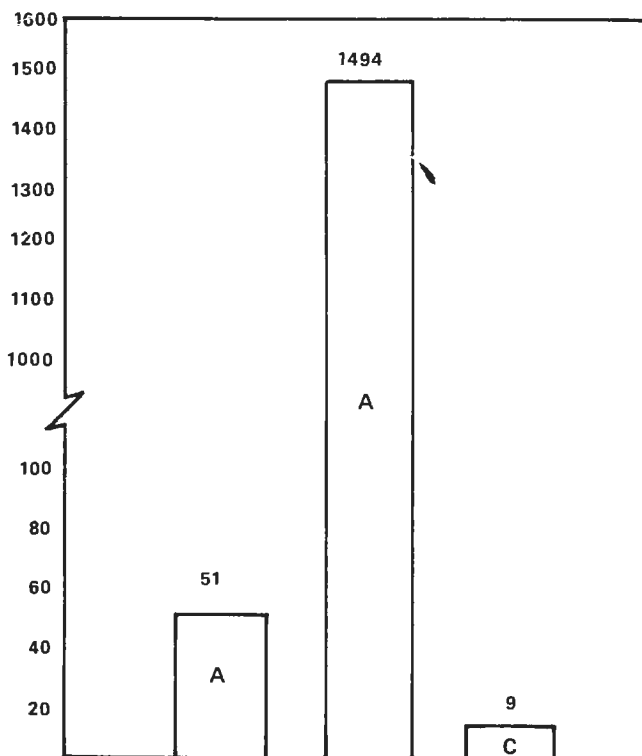


Figure 2. Showing the number of antibiotic-producing strains in the Actinomycetaceae, Streptomycetaceae and Actinoplanaceae

Legend:

- | | |
|-----------------------|-----------------------|
| A — Actinomycetaceae | C — Actinoplanaceae |
| Actinomyces — 21 | Actinoplanes — 3 |
| Nocardia — 30 | Streptosporangium — 6 |
| B — Streptomycetaceae | |
| Streptomyces — 1467 | |
| Thermoactinomyces — 6 | |
| Micromonospora — 21 | |

In the search for new sources of antibiotics, it may be mentioned that the human body and its intercellular or inner sea and humors probably contain defensive powers. It is also necessary to verify how and where the antibiotics work and how much of their action is exerted on the microbe and how much on the surrounding cells and humors. One may ask, "Do antibiotics create a system of chain reactions involving the antibiotic, the microbe and the humoral system?"

Table 2. List of Antibiotics Produced by Fermentation (1977)

Adriamycin	Griseofulvin	Pristinamycins
Amphotericin	Hygromycin B	Quebemycin
Amphotericin B	Josamycin	Ribostamycins
Avoparcin	Kanamycins	Rifamycins
Azalomycin F	Kasugamycin	Sagamycins
Bacitracin	Kitasatamycin	Salinomycin
Bambermycins	Lasalocid	Siccanin
Bycyclomycin	Lincomycin	Siomycin
Blasticidin S	Lividomycin	Sisomicin
Bleomycin	Macarbomycin	Spectinomycin
Cactinomycin	Mepartricin	Streptomycins
Candidin B	Midecamycin	Tetracyclins
Candidin	Mikamycins	Chlortetracycline
Capreomycin	Mithramycin	Demeclocycline
Cephalosporins	Mitomycin C	Oxytetracycline
Chromomycin A	Mocimycin	Tetracycline
Colistin	Monensin	Tetranactin
Cycloheximide	Myxin	Thiopeptin
Cycloserine	Neomycins	Thiostreptin
Dactinomycin	Novobiocin	Tobramycin
Destomycin	Nystatin	Trichomycin
Enduracidin	Oleandomycin	Tylosin
Erythromycin	Oligomycin	Tyrothricin
Fortimicins	Paromomycins	Uromycin
Fumagillin	Penicillin G	Validamycin
Fungimycin	Penicillin V	Vancomycin
Fusidic acid	Penicillins	Variotin
	(semisynthetic)	
Gentamicins	Pentamycin	Viomycin
Gramicidin A	Pimaricin	Virginiamycin
Gramicidin J (s)	Polymixins	

Now-a-days there is a growing interest in the utilization of Philippine Medicinal Plants as shown by numerous researches that are now being heavily funded and conducted on the higher plants. What have we done about our lower plants as source of medicinals? Fresh sources of antibiotics should be developed. The cure for many infections may perhaps lie in the depths of the sea or in the unexplored Thallophytes.

Thus, we enter into the subject of my talk, "The Antibiotic and Antitumor Activities of Selected Philippine Thallophytes".

This work summarizes over 20 years of investigations on the biological activities of bacteria, fungi, algae and lichens. The selected species namely the streptomycetes, basidiomycetes, algae and lichens were tested for their inhibitory activities. Some species were worked out to isolate and characterize the chemical components responsible for their antibiotic activities.

\$ Millions

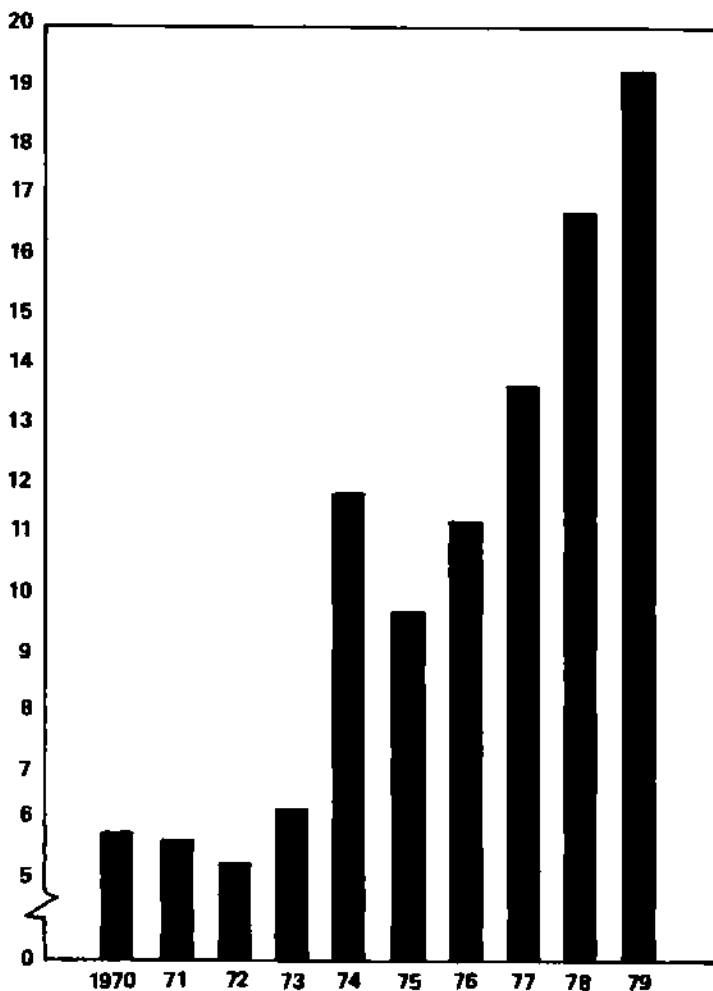


Figure 3. Graph Showing the Importation of Antibiotics from 1970-1979

Figure 3a. Graph showing the importation of individual antibiotics from 1970-1979

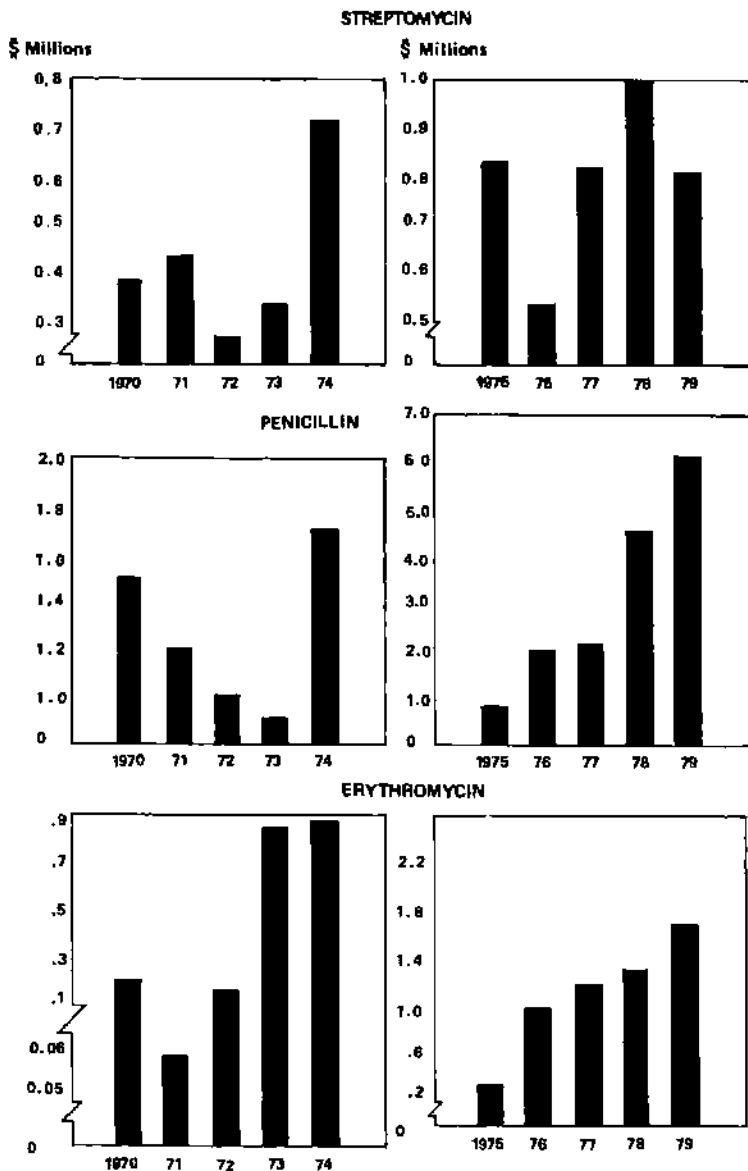
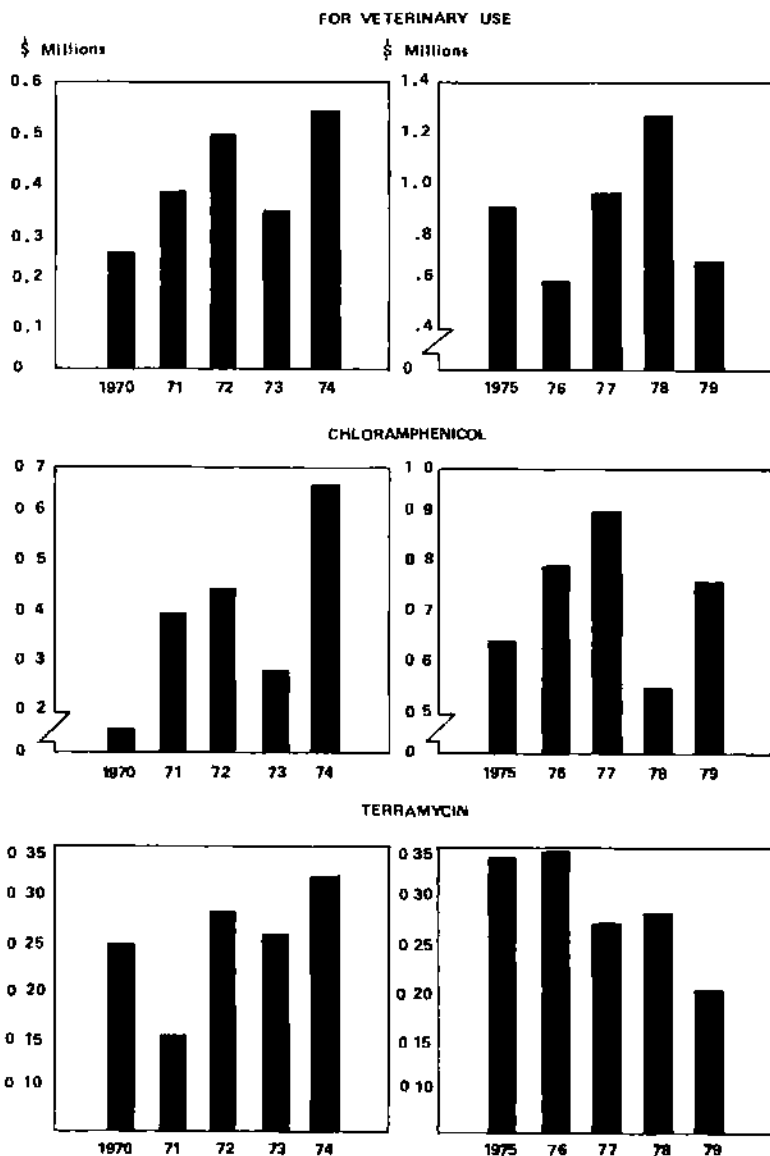


Figure 3b. Graph showing the importation of individual antibiotics from 1970-1979



OTHERS:

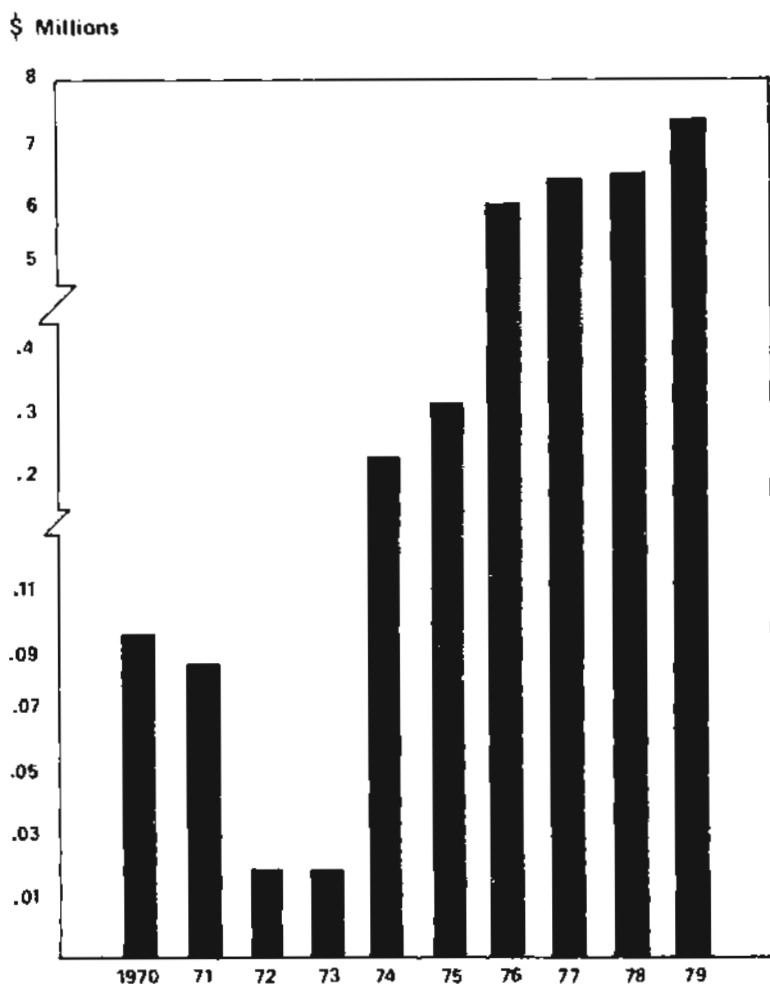


Figure 3c. Graph showing the importation of other antibiotics.

Methods of Testing and Test Organisms

Any of the following methods were used for the screening tests: On solid media (a) cross streak (b) agar plug (11).

On liquid media: Diffusion methods using a) stainless steel cylinder b) paper disc c) agar well d) broth dilution.

These assay methods have been reported previously. For the isolation of the streptomycetes from soil samples, any of the following methods were used: 1) simple dilution and plating out technique (11) 2) agar piece method (14) 3) selective method by antibiotic incorporation (15).

The following test organisms and tumor systems were used:

Gram positive: *Micrococcus pyogenes* var. aureus 209 P, *M. var. aureus* (Penicillin resistant), *Bacillus subtilis* FDA 219,

Gram negative: *Escherichia coli*, *Salmonella gallinarum* (Copenhagen strain), *Pseudomonas aeruginosa*, *Alkaligenes faecalis*, *Paracolon aerogenic*.

Acid-fast: *Mycobacterium* 607.

Yeast and fungi: *Candida albicans*, *Saccharomyces cerevisiae*, *Ceratostomella paradoxa*, *Fusarium moniliforme*,

Plant pathogenic fungi: *Pyricularia oryzae* and *Xanthomonas oryzae*.

Experimental tumors: Ehrlich ascites tumor cell, Leukemia L 1210 (L1210), P 388, Sarcoma S-180 (S-180).

I. Streptomycetes

For this study members of the genus Streptomycetes have been selected as the representative of the Bacteria. Attention to this group of organisms has increased over the past several years because almost all antibiotics except a few are produced by them.

Streptomycetes are a group of branching unicellular organisms belonging to the family Streptomycetaceae now generally accepted as bacteria. They were once considered as fungi by the mycologists and as higher bacteria by the bacteriologists or even as an intermediary group between the fungi and the bacteria. They are found in large numbers in the soil, in fresh waters, in lake and river bottoms, in dust, in manure, in compost and even on food products. They are generally aerobic, some are anaerobic and other spores are microaerophilic.

The search for potential antibiotic producers among microorganisms is worldwide and has been active for more than 50 years. The antibiotic properties of actinomycetes have been thoroughly investigated by several researchers, among them are Waksman (17), Benedict (2), Schatz and Hazen (16), Chua (4), Landerkin (8), Celino (3) and Sevilla-Santos (11-15).

It is noteworthy to mention that *Streptomyces erythreus* (9, 20) and *S. filipinensis* (22) which were both isolated from Philippine soil samples are producers of the antibiotics Ilotycin or Erythromycin, and filipin, respectively.

The initial survey of Philippine Streptomycetes was carried out in surface cultures in agar media and secondary screening in submerged cultures in shake flasks and production of large amounts in stirred and aerated fermentors.

An initial screening of 294 streptomycetes cultures (11) in solid medium gave 80 potential antibiotic producers with anti-

biotic spectrum of activity against *M. pyogenes aureus* 209 P. and *B. subtilis* FDA 219. The sensitivity of *Ps. aeruginosa* to the action of the antagonistic actinomycetes was quite remarkable. For although reported to be resistant to known antibiotics, it was found to be more sensitive than *E. coli* and *S. gallinarum*. Forty six (57.5%) was found inhibitory to *Paracolon aerogenic*, a hemolytic strain of paracolon isolated at the Bureau of Research and Laboratories. Fifty six (70%) and 41 or (51%) of the active isolates were found inhibitory to *S. cerevisiae* and *C. albicans* respectively. Thirty three (41%) were inhibitory to *Myco* 607. The most active isolates and their sources are given in Table 3.

Ninety (90) cultures of streptomycetes were grown in submerged cultures in shake flasks and 60 active cultures were obtained (12). The total number of cultures that are active against at least one test organism is given below:

<u>Test organisms</u>	<u>No. of cultures</u>
Gram positive bacteria (at least one)	51
Gram positive (3 of them)	17
Gram positive and gram negative	16
Yeast and filamentous fungi	23
Mycobacterium 607	28
Ehrlich ascites tumor cell	26

In these tests only 1 kind of tumor cell was used. It is advisable to test the active brew not only on one kind of tumor but on several experimental tumors such as sarcoma 180, carcinoma 755 and leukemia L-1210.

Only one, S-62-15, had strong activity against gram positive and gram negative bacteria besides having antitubercular activity.

The production of antibiotics against plant pathogens (14) *Xanthomonas oryzae* and *Pyricularia oryzae* was surveyed in solid (primary screening) and also in submerged culture (secondary screening). It was found that of 272 streptomycetes in solid medium, 160 showed inhibitory action of varying degrees against either of the two plant pathogens or both; 36 against *X. oryzae* only and 39 against *P. oryzae*, and 85 against both pathogens. Submerged culture of 52 isolates using 8 media combinations gave 29 strong antibiotic producers, 47 moderate and 11 weak ones. It was observed in the media studies that there seemed to be a medium really suitable for antibiotic production for any particular isolate.

Selective isolation of streptomycetes (15) by incorporation of antibiotics into the screening media and fermentation in submerged culture gave a total of 249 streptomycetes from 171 soil samples. Chlortetracycline, oxytetracycline and tetracycline 2

Table 3. Showing the Most Active Streptomyces Isolates, Their Sources and Activity

Isolate No.	Origin of Soil	Degree of inhibition of active streptomycetes against test bacteria							
		I	II	III	IV	V	VI	VII	VIII
5779	Batangas 2	++++	+++	+++	++	++	+++	++++	++++
5731	Batangas 3	++++	++++	—	—	—	+++	+	+
5751	Compost, SLH	+++	++++	—	++	+	—	++++	—
5579	Albang, Rizal	+++	+++	+++	++++	+++	++	+	+
5787	Batangas 4	++++	+++	—	—	—	+	++	+
5724	Batangas 4	++++	+++	++	++	—	—	—	—
5719	Quezon City	+++	+++	++	++	—	+++	++	++
5780	Sulu	+++	+++	—	—	—	+++	++	++
5618 A	Papaya, N.E.	+++	+++	+	—	—	+	+++	++
5614	Peñaranda, N.E.	+++	++++	—	—	—	+++	—	—
563	Diliman, Q.C.	++++	—	—	—	—	—	—	—
57108	Balete, Aklan	+++	+	++	—	—	—	—	—
5746	Balete, Aklan	+++	+	—	—	+	—	—	—

Legend:

I	—	<i>Micrococcus pyogenes aureus</i> 209P	Inhibition zones
II	—	<i>Bacillus subtilis</i>	
III	—	<i>Escherichia coli</i>	++++ — 30 mm and above
IV	—	<i>Salmonella gallinarum</i>	+++ — 15 — 29 mm
V	—	<i>Pseudomonas aeruginosa</i>	++ — 5 — 14 mm
VI	—	<i>Mycobacterium</i> 607	+ — 5 mm and below
VII	—	<i>Saccharomyces cerevisiae</i>	
VIII	—	<i>Candida albicans</i> .	

mg/ml (0.5 ml) per plate with 0.5 ml of statin were used as treatment for all plates. In solid medium, 64 produced vitamin B₁₂; in liquid medium, 143 produced 1 to 120 µg vitamin B₁₂ per 100 ml. fermentation brew. The antibioticly active isolate in solid and liquid media were 166 and 94 respectively. Of the former, 14 were active against all test microorganisms and of the latter only two were active.

Table 4 gives the summary of the screening of the streptomycetes included in this report.

In this survey of the antibiotic activities of streptomycetes from Philippine soil samples, several promising organisms were obtained and a few, namely, S-62-30, S-67-3, S-A-15, S-27-C were studied in detail (6a, 13, 15a). Actinomycins were isolated from the culture of the first three of these and oxytetracycline produced by the last one. Chemical analysis of the complex S-62-30 did not show any threonine which was present in S-67-3. *In vitro* studies showed significant activity against ascitic tumors *Mycobacterium* 607 and gram positive bacteria (11). *In vivo* studies in Swiss mice

Table 4. Showing Number of Antagonistic Streptomycetes

No. of Soil Source	Culture Method	No. of Strepto- mycetes Tested	Total Active Cul- ture	Number of cultures active against individual groups of test organisms					
				Bacteria	Yeast & Fungi	Plant Patho- gens	Tumor System		
				I	II	III	IV	V	VI
30	solid	294	80	55	24	33	56		
182	shaken	90	60	34	17	29	20		26
—	solid	272	160					39	
--	liquid	52						19	
171	solid	249	166	119	53	NT	NT		
171	liquid			68	9	NT	NT		

Legend:

- I — *M. pyogenes var. aureus* NT — not tested
 II — *E. coli*
 III — *Mycobacterium 607*
 IV — *S. cerevisiae*
 V — *P. oryzae*
 VI — *Ehrlich ascites tumor cells (EAT)*

showed inhibition of Ehrlich ascites carcinoma (EAT) but not sarcoma (S-180) nor Leukemia (L-1210) using Actinomycin D as standard (1).

S-A-15 was identified as *S. parvus* Philippine strain (13). When cultivated in a dextrose-peptone-meat extract medium by shake flasks and stirred aerated jars, actinomycin complex was obtained. The isolation procedure is given in Figure 4.

Part III. Basidiomycetes (Higher Fungi)

One of the most promising research projects which is believed to have a vital relation and significance to the problems of drug research, drug industry especially so in a country like ours which imports drugs, is an investigation into the possibilities of Philippine basidiomycetes (mushrooms and toadstools) as potential sources of medicinals, drugs and antibiotics.

The Basidiomycetes or commonly called higher fungi are those fungi in which the sexual spores are borne externally on special club-shaped cells called *basidia*, the edible ones being called mushrooms and the poisonous ones referred to as toadstools.

They are plants belonging to the lowest of all plant groups, the Thallophytes. Each grows tiny reproductive body called a spore which is formed in the mature plant. In some mushrooms, millions of spores are formed in gills beneath the cap; some in

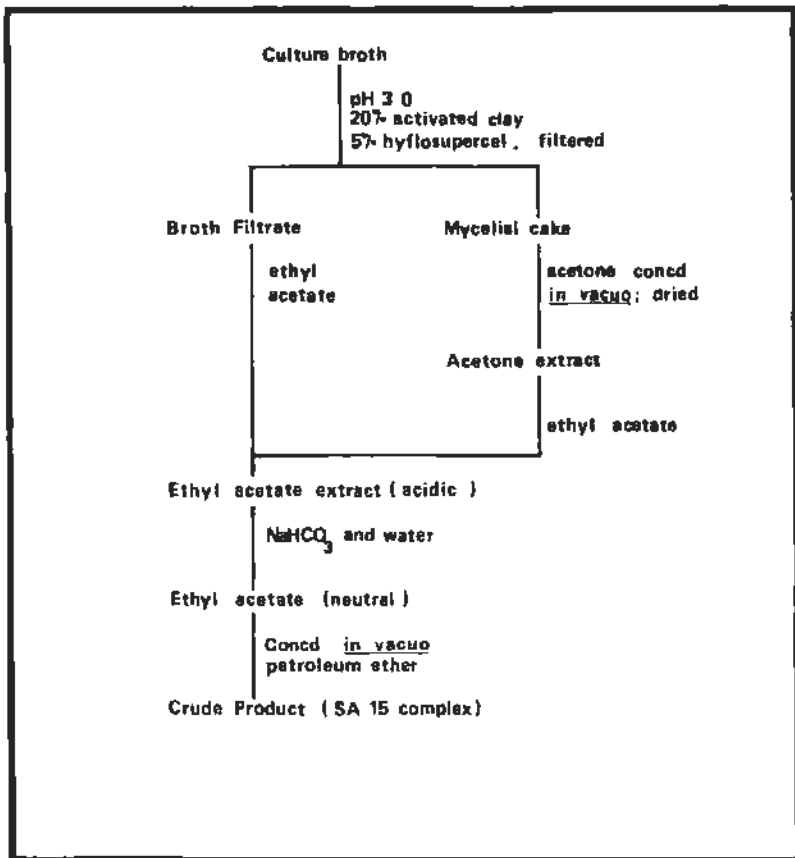


Figure 4. Schematic diagram of method of isolation of an antibiotic produced by streptomycete (SA-15 complex)

pores or tubes or in corrugated walls under the cap; some in the mass of white flesh comprising the whole fungus.

As food for man, mushrooms have an ancient history. However, mushrooms were not only used for food. Their medicinal uses either real or fancied, continued to exist for a long time. The old Greeks had used pieces of burning *Fomes* or *Polyporus* to cauterize wounds and ulcers. The latter became known as the magical Cure-all, a marvelous mushroom believed to have more power over the ills of mankind than anything else at that time. Its power covered various ailments such as broken bones, sores, colic, bruise, liver complaints, asthma, jaundice, dysentery, kidney trouble, hysteria, epilepsy, and snake bites. By the beginning of the 17th century the old beliefs continued. Dried puffballs were used to stop bleeding and fumes from a burning puffball were employed for their slightly anaesthetic property during operations. The Jew's ear mushroom was used for throat inflammations.

Even as late as 1884, *Lactarius* was eaten as a fancied cure of tuberculosis in England. The fly *Amanita* besides being effective in killing flies, was indicated for epilepsy, ringworm infection and used as a narcotic. In the Philippines the mature puffballs locally called "Tumbong" are reported to be used to stop bleeding. Table 5 gives a list of some mushrooms and the diseases for which they are indicated.

Table 5. Some Medicinal Mushrooms, and Uses (18)

<i>Name of mushroom</i>	<i>Indications</i>
Fomes (burning)	cauterize wounds and ulcers
Polyporus (burning) also for:	cauterize wounds and ulcers broken bones, sores, colic, bruise, liver complaint, asthma, jaundice, dysentery
Puffball (dried)	stops bleeding
Puffball fumes	anaesthetic during operations
Jew's ear	throat inflammations
Lactarius	tuberculosis (England)
Fly amanita	killing flies, epilepsy, ringworm narcotic
Puffballs	stop bleeding (Philippines)

The importance of basidiomycetes as source of antibiotics came into focus as early as 1944 when Wilkins and Harris (24) made an examination of Basidiomycetes for the presence of bacteriostatic substances. Among the studies made along this time in several parts of the world were those of Mathieson (9), Robbins *et al.* (13), Hervey (17) and Atkinson (2), Sevilla-Santos *et al.* (17, 20).

Out of the numerous antibiotic substances produced by the mushrooms and toadstools, only a few have been studied extensively and were proven valuable. Lofren *et al.* produced nebularin from *Agaricus nebularis* and found it active against human, bovine and avian mycobacteria. Psalliotin was extracted from *Psalliota xanthoderma* (1). Clytocybin was first described by Hollande. It was obtained from *Clitocybe gigantea* var. *candida* and found to inhibit *B. typhosus*, *E. coli*, *Brucella abortus* and *Myc. tuberculosis*. Pleurotin was extracted from *Pleurotus griseus* and was reported to inhibit *S. aureus*, *B. mycoides*, *B. subtilis*, *E. coli*, *Myc. phlei*, *Myc. smegmatis*, *Myc. tuberculosis* and *K. pneumoniae*.

From *Polystictus sanguineus* collected in India Bose (3) isolated an antibiotic polyporin which inhibits *S. aureus*, *Str.*

pyogenes, *Str. viridans*, *S. typhi*, *S. paratyphi A*, *S. paratyphi B*, *Bact. coli*, *V. cholera* and *Sh. flexneri* (4). The culture fluid was filtered aseptically, placed in ampoules and used successfully in the treatment of typhoid fever. Antibacterial substances have likewise been reported in other higher fungi of India. Meyer (11, 12) reported that extracts of *P. cinnabarinus* (Jacq.) Fries inhibited *Staphylococci*, *Streptococci* and *Pasteurella avicida*.

Other antibiotic compounds from mushrooms are given in Table 6.

Table 6. Antibiotic Compounds from Mushrooms

<i>Antibiotic compounds</i>	<i>Basidiomycete source</i>
Pleurotin C ₂₀ H ₂₂ O ₅	<i>Pleurotus griseus</i>
Biformin	<i>Polyporus biformis</i>
Biforminic acid	<i>Polyporus biformis</i>
5-methoxy-p-toluquinone	<i>Coprinus similis</i> and <i>Lentinus degener</i>
Marasmic acid	<i>Marasmius conigenus</i>
Nemotin	<i>Poriacorticola</i>
Nemotinic acid	<i>Poria tenuis</i>
Agrocybin	<i>Agrocybe dura</i>
Polyacetylenes	<i>Clithcybe distrata</i>
Illudin R	<i>Clitocybe illudens</i>
Illudin S	
Pleuromutilin C	<i>Pleurotus mutilus</i>
C ₂₂ H ₃₄ O ₅	<i>Pleurotus passeckerianus</i>
Antibacterial substances	<i>Drosophila substrata</i>
Fomecin A	<i>Fomes juniperinus</i>
Polyporin	<i>Polystictus sanguineus</i>
Cinnabarin	<i>Polyporus cinnabarinus</i>

Oncostatic principles were produced *in vivo* and *in vitro* by species of the genus *Calvatia* which later was called calvacin (8, 14). From *P. botulinus*, triterpenes were isolated and were found effective on malignant neoplasms. (22, 23).

An initial survey of 172 Basidiomycetes tested showed 169 with varying degrees of activity on the test organisms (17). It was found that the gram positive bacteria were more sensitive to the action of the mushroom extracts than were the gram negative test bacteria.

The next survey included 587 Basidiomycetes samples (20) which were tested for their activity against 3 gram positive and 4 gram negative bacteria (20). Out of 587 samples, 506 were found to inhibit at least one of the test organisms used. 60.48 per cent were observed to contain substances inhibitory to *M. pyogenes* and *aureus* 209 P; 59.11 per cent to penicillin resistant

M.P. aurens: 18.74 per cent to *S. gallinarum*; 27.43 per cent to *P. aeruginosa*; and 40.2 per cent to *A. faecalis*. The figures indicate that the gram positive bacteria are more sensitive to the inhibitory action of the basidiomycete extracts than to the four gram negative ones. A list of the outstanding species is given in Table 7.

It was observed that the inhibitory action of extracts from various samples occurs not only in different species but also in the same species collected from same places at different periods of the year.

Since it is definitely known that Basidiomycetes are potentially a good source of antibiotics, the problem that may arise in a possible commercial exploitation of the valuable substances is *where* and *how* to get a big and continuous supply of the fungus raw material. The natural supply is out of the question as it can not be expected to be consistently large and continuous. Cultivating the Basidiomycete under natural conditions or in green houses may entail much expense without any certainty that it would always produce sporophores containing the inhibitory substances. If a strongly active antimicrobial substance from Basidiomycetes could only be produced in the same way as penicillin is produced from *Penicillium chrysogenum* or streptomycin from *Streptomyces griseus*, then the problem of its commercial production would not be difficult to solve.

It was observed that a few species were found to produce the antibiotic substance both in the sporophore in nature, and also in the culture liquid of the fungus grown in the laboratory. Two wood rotting fungi *P. sanguineus* and *P. cinnabarinus* Phil. sp. which were cultivated in mineral salts solution with rice bran (darak, Tag.) extract produced very potent antibiotic with antibacterial and antitumor activities. A yellow substance very similar to that obtained by Bose in India was isolated from them by extraction and crystallization process (18).

Local species of *Calvatia*, *C. lilacina* (puffball) gave antitumor principles in the sporophore as well as when cultivated under laboratory conditions using a modified Czapek's medium with 40% coconut water. It produced a yellowish white substance when purified by freezing and thawing followed by lyophilization. The substance obtained shows an inhibitory action *in vitro* on Ehrlich ascites tumor cell, following Miyamura's method (15).

In the case of a mushroom, *Psathyra umbonata*, which was grown in an artificial culture medium containing mineral salts and an enricher, the antibiotic substance was detected not only in the mycelial growth but also in the metabolite secreted by a mycelium into the liquid medium. Other antibioticly active mushrooms which were successfully cultivated such as *P. cinnabarinus*, *Lentinus squarrosulus* and *C. lilacina* were found to pro-

Table 7. List of Outstanding Basidiomycete Species among the 587 Isolates (20)

Basidiomycete species	Degree of inhibition of the test bacteria						
	I	II	III	IV	V	VI	VIII
1. <i>Trametes</i> sp. 59157	+++	++	+	+	+	+	+++
2. <i>Psalliota argyrostica</i> Copeland 60225	++	+++	+++	+	++	+	++
3. <i>P. comtula</i> Fries 59137	+++	+++	+++	++	+++	—	++
4. <i>P. merilli</i> Copeland 59138	+++	++	+++	+	++	++	+
5. <i>P. subrufescens</i> 60232	+++	+++	+++	+	++	—	++
6. <i>Psathyra umbonata</i> 59141	+	+++	+++	+	—	—	—
7. <i>P. umbonata</i> 59142	+++	+	+++	+	+	+	+++
8. <i>Clithybe candicans</i> Fries 62005, 62006	+++	+++	+	+	+	—	+++
9. <i>Copeland papiionaceae</i> (Bull.) Bres. 62010	+++	+++	+++	++	—	—	—
10. <i>Cortinarius violaceous</i> Fries 59037	+++	+++	++	+	—	—	+++
11. <i>Cortinarius</i> sp. 59038	+++	+++	+++	+	+	+	+++
12. <i>Galera tenera</i> Fries 59053	+++	—	+	+	—	—	+++
13. <i>Lepiota americana</i> Peck. 60113	+++	+++	++	++	+	+	+++
14. <i>L. cepaestipes</i> Fries 59078	+++	+++	++	++	+	+	+++
15. <i>L. cepaestipes</i> Fries 59079	+++	+++	++	+	+	—	+++
16. <i>L. cepaestipes</i> Fries (3 strains)	+++	+++	+++	+	++	+	++
17. <i>L. cepaestipes</i> (2 strains)	+++	+++	+++	+	+	+	+++
18. <i>L. cepaestipes</i> 60129	++	+++	++	++	—	+	+++
19. <i>L. cepaestipes</i> 60130	+++	+++	++	+	—	—	—
20. <i>L. cepaestipes</i> 60125	—	+++	++	+	+	+	+++
21. <i>L. metulispora</i> Berk and Bres. 59086	+++	++	++	+	+	+++	++
22. <i>L. Lepiota</i> sp. 60143	++	+++	+++	—	++	+	++
23. <i>Pluteulus coprohilus</i> Peck. 59104	+++	+++	++	++	+	+	+++
24. <i>Polyporus cinnabarinus</i> (Lacq.) Fries 61053	+++	+++	++	+	+	+	+++
25. <i>P. sanguineus</i> Fries 61062	+++	+++	+	+	++	—	+++
26. <i>Polyporus</i> sp. 59111	+++	+++	+	+	+	—	+++
27. <i>Polyporus</i> sp. 59119, 52120	+++	++	++	++	+	+	++

Legend:

I — <i>M. p. aureus</i>	inhibition zone
II — <i>M. p. aureus</i> (penicillin resistant)	+++ — 25 mm and above
III — <i>B. subtilis</i>	++ — 27 — 24 mm
IV — <i>E. coli</i>	+ — 9 — 16 mm
V — <i>Salmonella gallinarum</i>	
VI — <i>Ps. aeruginosa</i>	
VII — <i>Alkaligenes faecalis</i>	

duce the active substance both in their mycelium and in the culture medium (15).

Table 8 shows the local species cultured in artificial media for production of antibiotics.

A survey into the tumor inhibitory activity of the Basidiomycete samples using Ehrlich ascites tumor cell system gave interesting results. Table 9 gives a list of the active ones with strong inhibition shown by intensity of color and big inhibition zones.

An outcome of the screening for antibiotically active Basidiomycetes, a list of some of the active ones with their local names is presented in Table 10.

Lower Fungi

A series of antifungal compounds is produced by a *Geotrichum* species (5) isolated as an air borne contaminant in copra. The antibiotics are produced in coconut water or defined medium and have been extracted from broth on an XAD-2 resin, eluted from resin with methanol, and chromatographed over a silica gel column, yielding two well separated antifungal components. Each of the two consists of a pair of antibiotics characterized by thin layer chromatography, mass spectrometry, and nuclear magnetic resonance, ultraviolet and infrared spectroscopy. Based on their characteristics and comparison with authentic samples. The present antifungal antibiotics are distinct from the azasteroidal antibiotics (A 25822) described earlier from *Geotrichum flavobrunneum* NRRL-3862 (*J. antib.* 28:95, 102, 112 (1975).

A polyene yellow antifungal antibiotic, novalichin (6) was isolated from a culture of *Paecilomyces fusisporus* ATCC 24148 grown in stationary culture on Czapek broth enriched with g/l — sucrose, 30.0, yeast extract — 2.0, sodium nitrate, 3.0, potassium chloride, 0.5, dipotassium phosphate 1.0, magnesium sulfate 0.5, ferrous sulfate 0.01, pH 4.5. From the mycelium, methanol extracted the compound with activity against *Candida albicans*. The antimicrobial spectrum (m.i.c.) in mcg/ml follows: *Ceratostomella paradoxa* 34, *Aspergillus oryzae* 68, *Saccharomyces cerevisiae* 68, *Candida abicans* 34. It was inactive against bacteria.

III. Algae

In their studies on the antimicrobial activity of 150 kinds of marine algae from Puerto Rico, Burkholder *et al.* (1) observed that 44 per cent were active against *S. aureus* and that the two species *Dictyopteris plagiogramma* and *Goniaulax tamarensis* which were usually found associated with the red tide water possessed both inhibitory and growth-promoting properties. Pratt

Table 8. Antibiotic Activity of Local Basidiomycetes Mycelium

<i>Source</i>	<i>Name of Basidiomycete</i>	<i>Culture media for propagation</i>	<i>Where activity was located</i>	<i>Antibiotic activity</i>	<i>Reference</i>
Quezon City Garden	<i>Psathyra umbonata</i>	mineral salts wood enricher (yeast extract)	mycelium and culture fluid	gram positive	16
Metro Manila	<i>Polyporus cinnabarinus</i>	mineral salts solution with rice bran	mycelium and culture fluid	gram positive	19
Metro Manila	<i>P. sanguineus</i>	mineral salts solution with rice bran	mycelium and culture fluid	gram positive	19
Quezon City	<i>Calvatia lilacina</i>	modified Czapek's solution with coconut water	mostly in mycelium	gram positive	16
Quezon City	<i>Lentinus squarussulus</i>	mineral salts with enricher (yeast extract)	mycelium and culture fluid	gram positive	16

Table 9. Antitumor Activity of Sporophore Extracts of Various Basidiomycetes on Ehrlich Ascites Tumor (cells (20)).

Basidiomycetes	No. of samples tested	Zone of Inhibition	
		Degree	Intensity
Auriculariaceae			
<i>Auricularia polytricha</i>	1	++	*
Hydnaceae			
<i>Hydnum adustum</i>	1	++	*
Polyporaceae			
<i>Boletinus</i> sp.	1	+	*
<i>Ganoderma mastoporum</i>	1	+	*
<i>Lenzites</i> sp.	2	+	*
<i>Polyporus gilvus</i>	1	+	*
<i>P. gramocephalus</i>	1	++	*
<i>P. cinnabarinus</i> (Jacq.) Fries	1	++	**
<i>P. sanguineus</i> Fr.	1	+	*
<i>Trametes corrugata</i> (Pers.) Bres.	1	+	*
<i>T. hirsuta</i> (Wulf. ex. Fr.) Lloyd	2	++	**
Agaricaceae			
<i>Clitocybe nebularis</i> Batsch	1	++	*
<i>Clitocybe</i> sp. (Las Piñas)	1	+	*
<i>Clitocybe</i> sp. (Batangas)	1	++	**
<i>Collybia confluens</i> Pers.	2	++	*
<i>C. deliciosa</i>	1	+	*
<i>C. dryophila</i> Fries	3	++	**
<i>Copelandia papilionacea</i> (Bull.) Bres.	1	+	*
<i>Coprinus cothurnatus</i> God.	1	+	*
<i>C. micaceus</i> Fr.	1	+	*
<i>Crepidotus mollis</i>	1	+	*
<i>Eccilia griseo-rubella</i> Lasch	1	++	*
<i>Entoloma</i> sp.	1	+	*
<i>Galera tenera</i> Fr.	1	+	*
<i>Galera</i> sp.	1	+	*
<i>Hebeloma crustuliniforme</i> Fr.	1	++	*
<i>Lepiota americana</i> Peck.	1	++	*
<i>L. cepaestipes</i>	5	+++	**
<i>Marasmius graminum</i> Berk.	1	++	*
<i>Naucoria pediades</i> Fr.	1	++	*
<i>N. platysperma</i>	1	+	*
<i>N. semiorbicularis</i> Fr.	4	++	**
<i>Omphalia reclines</i>	1	+++	**
<i>O. umbellifera</i>	1	+	**
<i>Omphalia</i> sp.	1	++	*
<i>Psathyra umbonata</i>	2	+	*
<i>Psalliota compestris</i> var. <i>umbrina</i> Fr.	1	+++	**
<i>P. perfuscus</i> Copeland	3	+	*
<i>P. comtula</i> Fr.	1	+++	**
<i>P. luzoniensis</i> Graff	1	+	*
<i>Schizophyllum alneum</i> Linn.	2	+	**

Lycoperdaceae

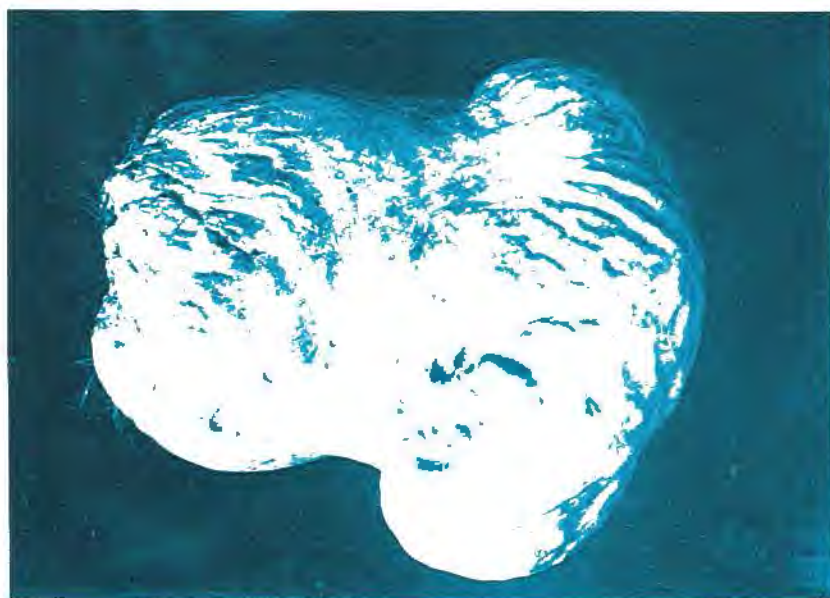
<i>Bovista pila</i> Berk and Curtis	1	+	*
<i>Calvatia lilacina</i> Fries	1	+++	**
<i>Lycoperdon gemmatum</i> Batsch	1	+	**
<i>L. pyriforme</i>	1	++	*

Legend:

Inhibition zone	Intensity
+++ - 21-25 mm	** - dark blue zone
++ - 16-20 mm	* - blue zone
+ - 11-15 mm	

Table 10. Local Names of some Antibiotically Active Mushrooms

<i>Scientific Name</i>	<i>Common Name</i> *	
<i>Auricularia affinis</i> (Leveille)	Taingang daga (Tag); dolongan sand kahoy (Panay)	Edible
<i>Auricularia auricula-judae</i> (Linnaeus)	Same as above	"
<i>Auricularia polytricha</i> (Montagne) Saccardo	Same as above	"
<i>Calvatia lilacina</i> (Fries)	Tombong (Tag.); parapara (Ilocano)	"
<i>Clautriavia merulina</i> (Phallus merulinus Berkeley)	Kabuteng may pandong (Tag.) oong ti uleg (Ilocano)	Poisonous
<i>Clavaria crispa</i> (Sulfen)	Oong nga repolio (Ilocano)	Edible
<i>Clavaria stricta</i> (Persoon)	Kabuteng bulaklak ng bato (Tag.)	"
<i>Collybia albuminosa</i> (Bresadola) Petch	Kabuteng punso or kabuteng pusngo (ag.) oong ti bunton (Ilocano); oong na pangol (Pangasinan); payung-palungan kulog (Pampanga)	"
<i>Colybia distorta</i> (Fries) Gillet	Kabuteng pilipit (Tag.)	"
<i>Copelandia paponacea</i> (Bulliard) Bresadola	Kabuteng taing kalabaw (Tag.)	Not tested
<i>Coprinus comatus</i> (Fries)	Kabuteng Kampanilla (Tag.)	Edible
<i>Cortinarius collisteus</i> (Fries)	Kabuteng Kalauangin (Tag.)	Suspicious
<i>Cyathus striatus</i> (Hoffmann)	Pugad ng ibon (Tag.)	Not Edible
<i>Daedalea flavida</i> (Leveille)	Kabuteng kapis (Tag.)	" "
<i>Daldinia concentrica</i> (Bolton) Cestadi and de Notaris	Kabuteng matigas at mabilog (Tag.)	Not specified
<i>Galera tenera</i> (Fries)	Kabuteng payat ang tangkay (Tag.)	Not tested



Calvatia lilacina, known as tumbong in Pilipino is a sample of mushroom. It has antibiotic and antitumor activity.

Table 10 (continued)

Scientific Name	Common Name*	
<i>Lentinus elmerianus</i> (Lloyd)	Kulatkulat bundoc (Tag.)	Edible
<i>Lentinus exilis</i> (Klotzsch)	Kulatkulat kawayan (Tag.)	“
<i>Lentinus squarrosulus</i> (Berkeley and Curtis)	Kulatkulat na may kaliskis (Tag.)	“
<i>Lepiota americana</i> (Peck)	Kabuteng mamulamula (Tag.)	“
<i>Lepiota cepaestipes</i> (Fries)	Kabuteng may singsing (Tag.)	Poisonous
<i>Lepiota chlorospora</i> (Copeland) (L. Morgani Peck)	Payong ahas (Tag.); oong ti takki noang (Ilocano); oong na tai	“
<i>Lepiota cristata</i> (Fries)	Kabuteng tigre (Tag.)	Suspicious
<i>Lepiota deundata</i> (Rabenhorst)	Kabuteng kolor azufre (Tag.)	Poisonous
<i>Lepiota lilacea</i> (Bresadola)	Kabuteng lila (Tag.)	Not tested
<i>Maramius haematocephalus</i> (Montagne)	Kabuteng mukang balat (Tag.)	Edible
<i>Naucoria semiorbicularis</i> (Fries)	Kabuteng kinalauang (Tag.)	Not specified
<i>Panaeolus campanulatus</i> (Linnaeus)	Kabuteng kampana (Tag.)	Not tested
<i>Panus rudis</i> (Fries)	Kulatkulat morado (Tag.)	Not specified

Table 10 (continued)

<i>Scientific Name</i>	<i>Common Name*</i>	
<i>Pleurotus canus</i> (Quelet)	Alitaptap (Tag.); anandap (Ilokano)	Edible
<i>Pleurotus porrigens</i> (Persoon)	Alitaptap (Tag.); anandap (Ilokano)	"
<i>Psalliota campestris</i> (Fries)	Kabuteng parang na puti (Tag.)	Edible
<i>Psalliota campestris</i> (Linnaeus) var. Umbrina (Fries)	Oong ya balit (Pangasinan)	"
<i>Psalliota cotula</i> (Fries)	Payung-payungan malagu (Pampangan)	"
<i>Psalliota merrilli</i> (Copeland)	Kabuteng parang na bulik (Tag.)	"
<i>Psalliota perfuscus</i> (Copeland)	Kabuteng parang na may sing- sing	"
<i>Schizophyllum alneum</i> (Linnaeus) (Schizophyllum commune) Schroet	Cudet (Ilokano); Kunas or sigdot (Tag.)	"
<i>Volvaria esculenta</i> (Bresadola)	Kabuteng ginikan or kabuteng saguing (Tag.); oong ti garami or oong ti saba (Ilokano); oong na puti or oong na dayami (Pangasinan)	

*The local names were taken from Mendoza "Philippine Mushrooms."

et al. (7) have shown that the unicellular green alga, belonging to genus *Chlorella*, is the source of an antibiotic known as chlorellin, and that extracts of several species of marine algae inhibited the growth in vitro of one or more of the following bacteria: *S. aureus*, (*M.p. var. aureus*), *E. coli* and *P. aeruginosa*.

Other reports on the antibiotic activity of aqueous or organic solvent extracts of seaweeds include those of Kamimoto (2, 3) on the effects of extracts from seaweeds against the growth of some pathogenic organisms, acid fast bacteria and of Mauntner (7) on the antibiotic activity of *Rhodomela larix*.

Since algae abounds in our coastal waters, a survey of their antibiotic activities would increase our knowledge in their medicinal potentials.

Several species of marine algae collected from various places in the Philippines were screened for their antibiotic activity against test organisms commonly used for testing (11). Samples were washed, drained and ground to fine pieces. They were extracted with organic solvents and the dried extracts tested. Identification

of the species was kindly done by Dr. Paciente Cordero. A list of the species and their origin is given below:

From San Esteban, Ilokos Sur

- 001 *Sargassum enerve*
- 0021 *S. hemiphyllum*
- S. fulvellum*
- 0051 *Turbinaria trialata*
- 007 *Hormophyra triquetra*

From Pangasinan

- 002P *S. hemiphyllum*
- 004P *S. duplicatum*

From Matabungkay, Batangas

- 002B *S. hemiphyllum*
- 004B *S. duplicatum*
- 005B *Turbinaria trialata*

From Dumaguete City

- 006 *S. yendoi*
- 007 *S. crispifolium*

It can be seen from Table 11 that the ether and ethyl acetate extracts of algae shows the most inhibitory power. The sargassum species failed to inhibit *M. pyogenes* var. *aureus* 209 P, but inhibits *B. subtilis* and *B. cereus*. *H. triquetra* had very strong inhibition of *Myc* 607. *T. trialata* (IS) has strong activity on *M.p. aureus* 209 P and weak on *B. subtilis* and *Myc* 607.

Ether extracts of samples showed inhibitory activity on the Gram positive test bacteria *B. subtilis*. Hexane, petroleum ether and aqueous extracts gave negative results. Methyl alcohol, ethyl alcohol, acetone extracts gave light inhibition while ethyl acetate extracts gave the strongest inhibition.

When tested on *Lymphocytic leukemia* P. 388, some samples such as *S. fulvellum* (I. Sur), *S. yendoi* (Dumaguete City), *S. crispifolium* (Dumaguete City) and *T. trialata* (I. Sur) showed positive indication of antitumor activity. However the results need confirmation.

Chlorella pyrenoidosa was cultivated in the presence of sunlight and CO₂ in a mineral salts solution. When sufficient growth has taken place. it was centrifuged to get the algal cells. Ether extracts of the cells produced slight inhibitory activity on the gram positive test bacteria.

IV. Lichens

Lichens are dual organisms composed of algae and fungi growing together, hence lichens cannot exist without algae and fungi (5). Lichens are not plants at all, but only associations of two plants (fungus and algae) growing together and botanists have always given them generic and specific names comparable to those of nonsymbiotic plants such as fungi, mosses or ferns. They held a

high place in the pharmacopoeia of medical doctors during the middle ages.

Foreign lichen species have been reported to be used as food and medicine as well as the dye and perfumery industries. As early as 1700 the lichens *Cetraria islandica*, *Lobaria pulmonaria*, and the *Usnea* species have been known to be used extensively as demulcents, tonics, febrifuges, purgatives and antitubercular drugs. In 1896 Chiba observed that tinctures prepared from several species of *Usnea* were beneficial in the treatment of *Lymphadenitis tuberculosa colli* (4a).

The antibiotic activities of foreign lichens have been reported by Stoll *et al.* (23), Burkholder and Evans, (3), Litvinov and Rassadina (10), Asahina and his associates, Kutami, Borkowski *et al.* (2), Liu *et al.* (9) and of Philippine lichens by Sevilla-Santos *et al.* (16). In general it was found that the gram positive bacteria and *Mycobacteria* were inhibited by the lichen extracts. Asahina and N. Kutami established the presence of lichen acids in native lichens in Japan. Seshadri (14) conducted a chemical investigation of Indian lichens and isolated compounds belonging to the fatty acid, depside, depsidone, pulvinic acid, anthraquinone, phenanthrene —



Sargassum duplicatum, is a sample of marine algae from Batangas. It has activity against some bacteria and Ehrlich's ascites tumor cells.

Table 11. Antibiotic Activity of Algal Extracts on Eight Test Organisms

Samples Samples	Acetone				Chloroform	Benzene	Ethanol			Ether			Ethyl acetate							
	Bs	Bc	Ec	Sc	Ec	Ec	Bc	Ps	Ca	Bs	Bc	Ps	Ma	Bs	Bc	Ec	Mt	Ca		
<i>Sargassum enerve</i> (IS)		—											—	+		+	+			
<i>S. hemiphyllum</i> (IS)		—											+	+	+	—	++	+	+	
<i>S. hemiphyllum</i> (B)		—											+							
<i>S. hemiphullum</i> (P)	—		+	—	++	+++	—									+				
<i>S. fulvellum</i> (IS)		—														++				
<i>S. duplicatum</i> (P)													+			—				
<i>S. duplicatum</i> (B)														+		+	+			
<i>Turbinaria tri-</i> <i>lata</i> (IS)																+++	+		+	
<i>T. trialata</i> (B)							+									+	+	+	+	
<i>S. yendoi</i> (D)																—	+			
<i>Hormophyra tri-</i> <i>quetra</i> (IS)																+	+		+++	+
<i>S. crispifolium</i> (D)																—	+	+		
Control							—		—	—	—					—	—		—	—

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Legend:

Source:

IS — Ilocos Sur
B — Batangas
P — Pangasinan

Test organism:

Ma: *M. p.* var. *aureus* 209 P
Bs: *B. subtilis*
Bc: *B. cereus* var. *mycoides*
Ec: *E. coli*

Ps: *P. aeruginosa*
Mt: *Myc. 607*
Sc: *S. cerevisiae*
Ca: *C. albicans*

Degree of inhibition:

+++: 21-25 mm
++: 16-20 mm
+: 12-15 mm
-: 11 below

quinone, xanthone and diphenylene oxide groups. Dahl and Hale (5) also isolated some of these types of compounds and utilized them in lichen systematics for distinguishing chemical strains.

The antibiotic property of the chemical components of lichens were studied by Stoll *et al.* (23), Burkholder and Evans (3), Borkowski *et al.* (2) and Liu *et al.* (9) and they found that the lichen substances salazinic acid, stictic acid, usnic acid, prototective bacteria and mycobacteria but were inactive against the gram negative forms.

Usnic acid derivatives were tried by Takai *et al.* (25) on cultured L1210 cells and *in vivo* against Lewis lung tumor and Murine P 388 leukemia. None of the derivatives was more potent than Usnic acid in the *in vitro* assay. It was active against Lewis lung tumor and had some activity on the P 388 leukemia test system. The study on polysaccharide from *Gyrophora esculenta* indicated antitumor activity (11).

Interest in Philippine lichens dated as early as 1836 when Charles Gaudichaud, a French botanist, visited Manila and collected five lichens. This was followed by a systematic study of these lower plants by Wainio (26-30) followed by Herre (6-8). Quisumbing (12) reported a medicinal lichen *Usnea philippina*.

A study of the antibiotic activity of lichens which abound in the Philippines may pave the way for the exploration of the untapped lichen flora as sources of medicines which may be of far reaching significance in our country's drug shortage.

Lichen samples were collected from barks of trees, from soils, rocks and stone walls in Quezon City, Baguio City, Cavite, Rizal, Batangas, Mt. Mayon, Albay Province. Their antibiotic activity against 12 test microorganisms composed of 3 gram positive bacteria, 4 gram negative, 1 acid fast, 2 yeasts and 2 filamentous fungi was determined. Results obtained show that 30 extracts from 33 lichens inhibited at least one of the test organisms (20).

Table 12 shows 14 very active ones with strong activities on the gram positive bacteria and acid fast bacteria and light activity on the test fungi. The most active lichen extract against the gram positive bacteria are: *Lecanora subfusca*, *L. varia*, *Lepraria chlorina*, *Ramalina farinacea* and *Usnea montagnei*, while against *Myco. 607* are *Crocynia membranacea*, *R. farinacea* and *U. montagnei*.

To determine the chemical constituents of the lichens, thin layer chromatography of these extracts was conducted (15). Lichen substances salazinic acid, stictic acid, Usnic acid, protocetraric acid, barbatic, zeorin, atranorin, lecanoric acid, homosekikaic acid, lecanoric acid were run with the compounds obtained from the lichens. Table 13 shows the chemical consti-

Table 12. Showing the degree of antibiotic activity of lichen extracts (19)

Name of Lichen	Degree of response to test bacteria			
	Number of Samples Tested	Gram positive bacteria (all)	Mycobacterium 607	Fungi
<i>Crocynia membranacea</i>	2	++	+++	+
<i>Lecanora subfusca</i>	3	+++	++	+
L. sp. ARL 69	1	++	++	+
L. varia (Ehrl.) ARL 97	1	+++	—	++
<i>Lepraria chlorina</i> ARL 34	1	+++	++	—
<i>Parmelia dactylifera</i> Vainio ARL 75	1	++	++	++
<i>P. zollingeri</i>	1	++	—	—
<i>Physcia albicans</i> (Pers.) Thoms.	2	+	—	+
<i>P. picta</i> (sw.) Nyl. ARL-60	1	++	—	++
<i>Physcia</i> sp.	2	++	—	—
<i>Ramalina farinacea</i> (L.) Ach.	1	+++	+++	+
<i>Ramalina</i> sp.	3	++	++	—
<i>Stereocaulon</i> sp.	2	++	++	—
<i>Usnea montagnei</i>	1	+++	+++	+

Legend: Inhibition zone
 +++ - 25 - 32 mm
 ++ - 17 - 24 mm
 + - 9 - 16 mm
 - - 9 below

tvents and it can be seen that most of the lichens tested especially the *Usnea* species contain usnic acid, a potent antitubercular substance.

Polysaccharides were isolated by hot aqueous extraction of two lichens (*R. farinacea* and *U. montagnei*) (22) and when tested on P 388 and Leukemia L1210 gave promising results.

Since some of our native lichens contain polysaccharides and usnic acid, it might be worthwhile to conduct further investigations so that these two potentials of antineoplastic action could be exploited.

An attempt to identify the active component and verify the antibiotic activity led to the chemical study of some active species namely: *Usnea intercalaris* (*U. montagnei*) *U. elmeri*, *Physcia albicans*, *P. picta*, *Crocynia membranacea* and *Ramalina farinacea* (16, 22, 30).

Table 13. Showing chemical constituents of Philippine lichens detected by thin layer chromatography (15)

Name of Lichen	Lichen substances								
	Usnic acid	Zeorin	atranorin	barbatic acid	lecanoric acid	salazinic acid	stictic acid	protocetraric acid	homosekikaic acid
<i>Usnea elmeri</i> Heree	*	*				*	*		
<i>U. flexilis</i> (Stirt)	*					*	*	*	
<i>U. hossie</i> Vain	*			*		*			
<i>U. intercalaris</i> Kremp	*					*		*	
<i>U. squarrosa</i> Vain	*			*		*	*	*	
<i>Physcia albicans</i> (Pers.) Thoms.		*	*						
<i>Parmelia cetrata</i> Ach.			*		*				
<i>P. zollengeri</i> Hepp.	*		*						
<i>Crocynia membranacea</i> (Dicks) Zahler	*	*							
<i>Ramalina farinacea</i> (L.)	*								*
<i>Stereocaulon</i> sp.			*						

*shows the presence of chemical constituents

Six lichens were studied in detail. This included the isolation and identification of the constituents and determination of the antibiotic activities.



Thallus of lichens, *Usnea montagnei* or *Ramalina farinacea*, is known as lumot niyog in Pilipino. They have antibacterial and antitubercular activities.

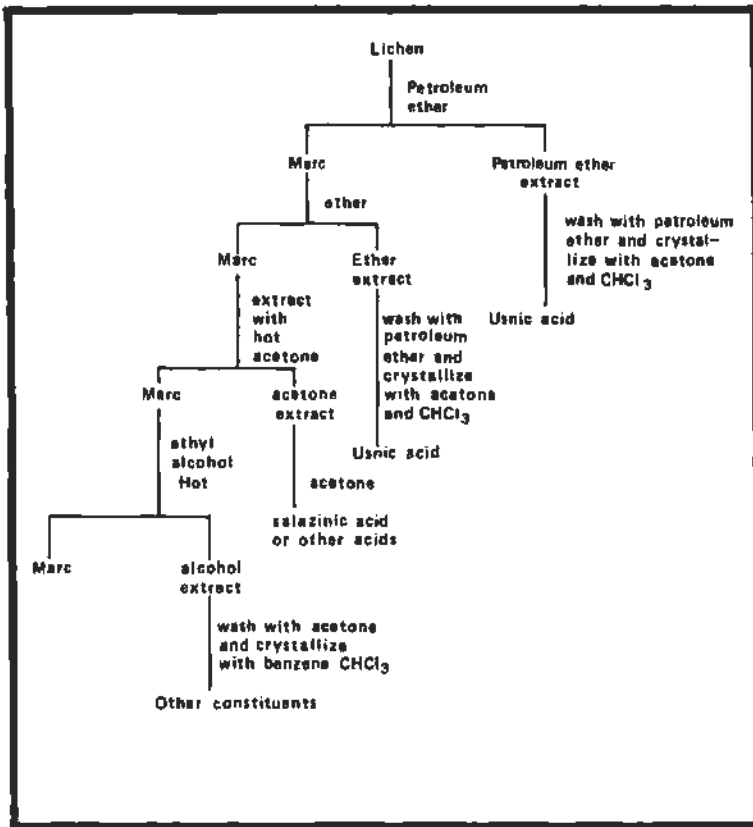


Figure 5. Schematic diagram showing isolation of chemical constituents of lichens.

A method for the isolation is given in the schematic diagram (Fig. 5).

Table 14 gives the chemical constituents which were obtained from the lichens studied with their physical and chemical properties as well as antibiotic activities.

Usnic acid, yellow, prismatic crystals melting at 198-210°C was obtained from *U. montagnei* (1.17%), *U. elmeri* (traces) and *C. membranacea* (0.57-0.96%).

The minimum inhibitory concentration for *M.p. var. aureus*, *M. aureus* (penicillin resistant), *B. subtilis* and *Myc. 607* in µg/ml was 2, 3, 2 and 3 respectively.

Salazinic acid a white, fluffy silk-like, shiny needles, m.p. 240-260°C was isolated from *U. montagnei* (4.08%) and was inhibitory only to *M. aureus* (penicillin resistant) at 1 mg./ml.

Atranorin, colorless, prismatic crystals m.p. 196-197°C was obtained from *P. albicans* (2.3%) and *P. picta* (0.1%). The mini-

mum inhibitory concentration in $\mu\text{g/ml}$ for *M.p. var aureus*, *M.p. aureus* (penicillin resistant) and *B. subtilis* was 0.133, 0.05 and 0.333 respectively.

Conclusion

I have endeavored to put before you some of what I consider to be important in my research efforts. I could of course have told you a great deal more and kept you here several hours while doing so, but there are more detailed documents setting out these matters for anyone interested.

In closing, I should like to point that antibiotic research is a very expensive endeavor. One should have sufficient and available funds, in order to keep experienced and efficient research workers and provide them with income, security and facilities. I find it rather difficult to find good jobs for admirable, young research workers in my own laboratory. They are the next generation of scientists and I feel that promising ones should be given all the encouragement and security.

This research on antibiotics started at the Bureau of Research and Laboratories, Department of Health under the sponsorship and guidance of Dr. Walfrido de Leon Sr. This was then transferred to the National Institute of Science and Technology, NSDB thru the leadership of Dr. Paulino Garcia (Chairman), Dr. C. Manuel and Dr. J. Velasco, Commissioners, where it stayed for some time. At present, I am continuing this research at the Research Center of the University of Santo Tomas with the encouragement of Rev. Fr. Ciriaco Pedrosa, O.P. Almost all the while the research has been largely and generously funded by the National Research Council of the Philippines. To them and to the NRCP, I am deeply grateful.

Perhaps, I might end on a personal note. I have been extraordinary well accorded by my scientific colleagues who sometimes over estimated my worth as a scientist. I am grateful to them for having done so, but I would like to place on record that my work could not have been accomplished without the joint effort of a number of people. To those who have worked with me in the laboratory and to those who collaborated with me in my research activities and who provided me with the inspiration and encouragement, I am also very grateful. If I have not mentioned them all by name it is because I have done so elsewhere and it would take up too much time.

Table 14. Chemical constituents of some Philippine lichens

Chemical	Lichen source	yield %	Physical and chemical properties				Minimum inhibitory concentration $\mu\text{g/ml}$
				Melting point $^{\circ}\text{C}$	optical rotation	λ max μ	
Usnic acid	<i>Usnea montagnie</i>	1.17	yellow	202-203	[α] ²⁹ D 494 $^{\circ}$	285,235	MA — 2.0
	<i>U. elmeri</i>	traces	prismatic	198-201			MAR — 3.0
	<i>Crocynia membranacea</i>	0.57—	crystals	208-210			BS — 2.0
	<i>Ramalina farinacea</i>	0.96					M 607 — 3.0
Salazinic	<i>U. montagnie</i>	4.08	white fluffy silk-like shiny needles	240 (brown)	250,312	MAR — 1000	
	<i>U. elmeri</i>	traces		260 (dec.)			
Stictic acid	<i>U. elmeri</i>	0.52	white needles	268-270	313,237	n.d.	
Zeorin	<i>C. membranacea</i>	0.39—	colorless hexagonal crystals	218-246	[α] ³¹ 0 + 64 $^{\circ}$ (C ₁ CHCl ₃)	absorp tion no bands	no activity
	<i>Physcia albicans</i>	6.64		230-232			
				245-247			
				225-227			
Atranorin	<i>P. albicans</i>	2.3	colorless prismatic rods	1976-197	optically inactive	252 log E 4.7	MA — 0.133
	<i>P. picta</i>	0.1					BS — 0.05
Atranorin— chloratranorin mixture	<i>P. picta</i>	1.6	crystalline		n.d.		

Legend:

MA — *Micrococcus pyogenes aureus* 209 F
 MAR — *Micrococcus pyogenes aureus* (penicillin resistant)
 BS — *Bacillus subtilis*
 M 607 — *Mycobacterium* 607

n.d. — not

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DISCUSSION ON THE ANTIBIOTIC AND ANTITUMOR ACTIVITIES OF SELECTED PHILIPPINE THALLOPHYTES

Flordeliz R. Uyenco, Ph.D., Discussant

The paper of Dr. Patrocinio Sevilla-Santos on the antibiotic and anti-tumor activities of selected Thallophtyes is to be commended for its comprehensive exploration into the potential of our lower plants for such activities. Nowhere in the annals of Philippine scientific investigations has a study like this been as thorough and encompassing. For these, Dr. Santos deserves to be congratulated.

The potential sources of antibacterial and anti-fungal drugs from Philippine seaweeds cannot be overemphasized. The archipelago teems with macroscopic green, brown and red algae which can be tapped for such purposes. *Digenea simplex*, a common red alga encountered in waters around Luzon, has been known to be an effective vermifuge. Its anti-viral property has been reported quite recently. Effective against the Influenza B and mumps viruses, this plant can be included among those in the list of economically important ones. The studies of a group of investigators headed by Prof. Leticia Angeles of the U.P. College of Medicine, have brought out the report that *Sargassum natans*, one of our common brown algae, possesses the anti-bacterial property against *Salmonella galinarum*, a parasite of poultry. *Phaeocystis pouchetii*, another brown alga, produces acrylic acid, an antibacterial compound.

The planktonic dinoflagellate, *Prymnesium parvum* has anti-cancer properties in a phospholipase-like toxin known as prymnesin. Macroscopic algae lend advantage in the production of drugs with such specific properties largely because of their abundance as natural resource in our waters. *Sargassum* can be farmed, thus assuring ample supply for extraction of drugs.

The Actinomycetes, or mold-like fungi, have long been known to produce antibiotic metabolites. *Streptomycin* is a household word. The biological implications of polyene macrolide-sterol interaction have contributed to our understanding of the mechanisms by which Actinomycetes affect sterol-steroid metabolism in animals. The polyene macrolide of Nystatin, for instance, is capable of acting on cell membranes of fungi and so can control systematic and topical fungal infections. The fungi

bind to this antibiotic in a sterol-containing site. Since bacteria do not contain sterols, they are insensitive to Nystatin.

Lichens have been shown by our speaker to effectively inhibit the TB organism and tumor cells. However, because of the very slow growth of lichens (about 1 cm. increase in diameter a year or 1 inch in length for fruticose forms) a massive program of mass production of antibacterial and anti-tumor substances from these plants, available at very low supply, becomes seemingly impossible and expensive.

Calvacin, an anti-tumor compound present in the basidiomycete, *Calvatia*, has been successfully isolated and tested by Dr. Santos from a local species. A similar compound has been extracted in the U.S. and tested on patients in a hospital in Texas. The results are encouraging. We should not lose time in putting up our own antibiotic plant because we have the resources right here.

Studies on the biochemistry and pharmacology of antibacterial agents would naturally follow the results of Dr. Santos' screening program. The biochemical basis of action, e.g., the action of these compounds at one particular site of metabolism and the mechanisms affected by antibiotics and anti-tumor substances should be investigated if only to determine the possible emergence of drug resistance. Such studies would be useful in dealing with the routes of administration of the compounds to man and animals, the ways in which the drugs are treated in the body, including absorption and distribution, metabolism and excretion, toxicity and interactions.

The mechanisms involved in antibiotics have been fully established although much remains to be done for our local isolates and screened microorganisms. Inhibitors of peptidoglycan, nucleic acid and protein syntheses are known but have these been determined for our own microflora?

Lydia M. Josen, Ph.D.

It is my great honor and pleasure that I have been asked to give comments on the life time work of Dr. Patrocinio Sevilla-Santos. I was once upon a time one of those youths she mentioned in her introduction whom she had inspired and to whom she had passed her knowledge of antibiotic research. It has been my good fortune that I had worked directly with two of the most-respected and prolific scientists of our time, Dr. Alfredo C. Santos and Dr. Patrocinio Sevilla-Santos. Both of them together with Mrs. Luz Baens-Arcega have influenced my scientific inclination and career. To them my deep appreciation and gratitude.

Dr. Santos' work on the antibiotic and anti-tumor activities of the thallophytic is quite embracing. She and her co-workers have done surveys of antimicrobial and antitumor activities of streptomycetes from soil, indigenous mushrooms, lichens and marine algae. Steptomycetes capable of producing actinomycins, tetracyclines and penicillins from fungi had been isolated. The potentially good ones were further studied for the production of the active principles using locally-available raw materials, followed by the isolation and characterization of the desired products. The antibiotic yields, however, have been rather low. To bring these yields to industrial scale, strain improvement programs must be instituted. And this is where R and D in antibiotic research in the Philippines should be emphasized as well as the search for new antifungal antibiotics.

The world-wide search for new antibiotics is still being actively pursued, for there are needs for new substances that are active against resistant organisms to known antibiotics; substances active against targets not covered by known antibiotics; also for new substances with better pharmacological features than known antibiotics.

It is hoped that an integrated approach to R and D in antibiotics would bring about the discovery of new antibiotics or the development of technology that will bring about the establishment of an antibiotic plant in the Philippines — a long cherished dream of Dr. Santos.

LINKING HOSPITALS WITH THE COMMUNITY AND MEDICAL REORIENTATION RELEVANT TO PRIMARY HEALTH CARE IN THE PHILIPPINES

By Fe del Mundo, National Scientist

Introduction

It is an observation that the spectacular achievements of medical science are not being delivered to the people who are most in need. There is now greater awareness that the need is for the health care system to be directed to underserved communities and to reorient physicians, specialists and paramedics in community care of the masses. Medical schools in the Philippines have not been indifferent to this need, much less have they turned a deaf ear to remarks of irrelevance of medical center, often called "disease palaces" and "ivory towers", for practice training.

A repeated suggestion is to improve health care delivery through reorientation and community exposure of medical and paramedical graduates and undergraduates. Furthermore there is always a concern that as primary health care relies mostly on the rural midwife and on local or indigenous health workers, the type of care may be second or third rate. To overcome such possibility, a referral system and linkages between hospitals and the community are highly recommended.

There is a need for a holistic approach to human growth and development by effective integration of medical and health services, specially in the remote rural areas of the country where the developments in medical science need to be delivered. This can only be achieved if there is a linkage of the hospitals with the community, if there is an accepted organized referral system and if the medical professions have been made aware of the relevance of their roles in the delivery of essential health service components of primary health care.

The ultimate goal is to improve the quality of life of the people through the primary health care approach which will bring about self-care and self-reliance. The communities are now aware of the responsibilities for their own health as shown by their acceptance and support for the project and utilization of community local or indigenous health workers. This paper presents a project that was undertaken in response to needs stated above and in compliance with recommendations from various sources for relevance in the delivery of primary health care, as accepted by the global health conference in 1978.

Objectives

General

1. To apply health care delivery procedures and measures suitable to communities.
2. To link hospitals of different levels to the community and thus allow the people to obtain affordable scientific health care.
3. To reorient and retrain medical graduates in community activities so as to inculcate in them attitudes and concepts, relevant to large and poor populations.

Specific

1. To determine cultural characteristics and traditions of communities concerned.
2. To bring about social preparation of the people.
3. To seek local resources and plan income-generating activities.
4. To give health education and information for self-reliance, resourcefulness and initiative among the population.
5. To give back-up support to the midwife and mother health workers in accepted aspects of primary health care through linkage with hospital of different levels.
6. To organize a referral system as a step in possible linkage with hospitals.
7. To meet periodically with the community leaders and local staff for better communication and dialogues.
8. To assist in evaluation methods of the project.
9. To encourage relevant field studies in communities.

Methodology

After at least a year of clinical training in a hospital, the participant is exposed to the social aspects of community and family health for a total of six months, each one on rotation basis, to different community health projects. A six-month schedule of medical and paramedical training participants in a community-based practice area is outlined as follows:

I. Preliminary Sessions

1. Briefing and field orientation at headquarters in Metro Manila
2. Didactic orientation and introduction to Community Organization at the Management Service of the University of Life, Pasig, Metro Manila.

II. First three (3) months — introduction into barangay activities by assignments two or three days a week. Each training participant goes with a mentor or field worker and researcher in any of these areas:

Barangays San Roque and Sto. Niño

Barangays Talang and Barit

Barangays Acli and Pandacaqui

Barangay Akle and Alagao

Assigned at first as observer, the trainee becomes involved in the following activities:

Participates in community organization, makes surveys

Gets involved in promotive, preventive, and curative activities

Participates in training mother health workers

Guides in a Botika sa Barangay and other income-generating activities

Learns possibilities of research studies

Reports

III. Three-month assignment residing in one community

A. Courtesy call in the capital of the province to

1) The Governor of the province

2) The Health Officials:

Regional Health Director

Provincial Health Officer

B. In the municipality, meet with:

— the Mayor of the Municipality

— the Municipal Health Officer and Staff

— the Director and Staff of the Emergency Hospital

C. Venue and Facilities

— Extension office at the Emergency Hospital

— Residents' and Nurses' Quarters in the Hospital

Sites of work — the Emergency Hospital and the Rural Health Center

The Barangay Health Center

Vehicles — 1 jeep, 1 tricycle, 1 motorcycle

D. Weekly Schedule

3 1/2 days assignment in the various barangays, two (2) residents working separately

1 1/2 days in the Emergency Hospital for rounds, OPD consultations

- 1 day at headquarters medical center for clinical conference, rounds, OPD (Saturday)
- 1 day off (Sunday)

E. Scope of work

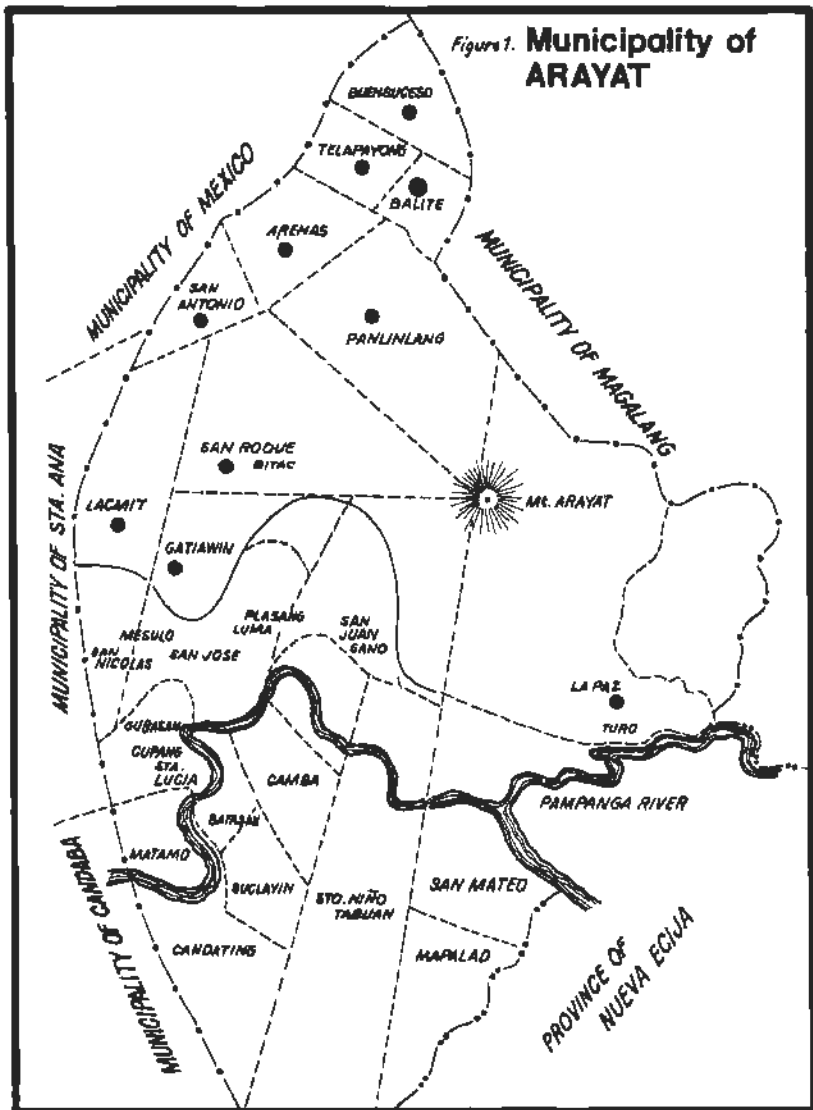
1. Meeting with the field staff of the central office.
2. Social preparation of the people
3. Dialogues with the Barangay Council and Health Council
 - on community health problems
 - on income-generating projects
 - on self-reliance
 - on health statistics
4. Back up support to the midwife and community health staff
5. Implementation of Primary Health Care components Health Education; Nutrition; MCH and Family Planning; Immunization; Minor curative procedures; Sanitation and Water Supply; Control of Communicable Diseases
6. Applied and field researches
7. Evaluation schemes
8. Reports/researches/statistics

The Practice Area

A municipality in Luzon about 65 km. northwest of Manila was chosen for community medical reorientation and training (Fig. 1). This has a total population of 52,737 and a land area of 12,972 hectares, 2/3 of which is agricultural while 1/3 consists of forested areas. The main occupations are farming (rice and sugar) and fishing. Most of the families are below average economic levels.

In the government health network, the municipality is divided into two health units, RHU I and II, each with a government municipal health officer (MHO), but RHU II has not had any physician for about 7 years now. Hence during the past 6 years, the health work has been taken over by the project staff. RHU II has a population of about 20,000 distributed in 10 barangays (Table I).

There are five (5) government rural health mid-wives (RHM) assigned to RHU II, each taking charge of two barangays. The mid-wives submit reports to the MHO of RHU I which is the main health office of the municipality. A simple primary health care delivery system in one of the barangays (villages) in this project is illustrated in Fig. 2.



Health Facilities

The Emergency Hospital. This is a 25-bed emergency government hospital, which has been in operation since 15 years ago. It is located on a hill at Bitas, in RHU II, overlooking a beautiful scenery. It is well located on a small hill but is not easily accessible as there is no regular public transportation to reach it.

The staff includes a medical director, 3 resident physicians, 6 staff nurses and 4 midwives. It renders pediatric, obstetric,

Table I. Ten Barangays (Villages) of Arayat Health Unit II
Population and Number of Mother Health Workers (MHWs)
1981

<i>Barangay</i>	<i>Population</i>	<i>Households</i>	<i>Health Center</i>	<i>Botika</i>	<i>MHWs</i>
Baliti	1012	153	+	+	18
Turo	339	141	—	+	16
Lacmit	2520	386	+	+	30
Gatiawin	2010	313	+	+	24
Bitas	1923	266	—	—	16
Panlinlang	1070	157	+	+	18
Arenas	1599	246	+	+	17
San Antonio	1450	221	—	+	21
Talapayong	1321	200	+	—	20
Buensoceso	431	63	—	—	14

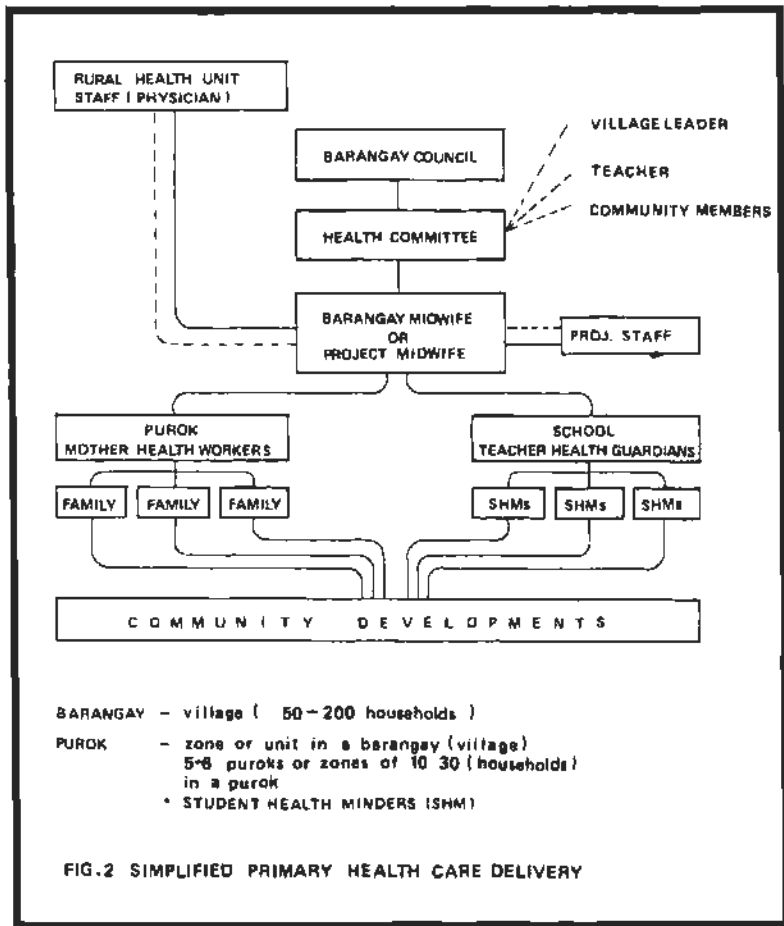
surgical, dental and family planning services. Laboratory facilities are for simple routine examinations, an x-ray and an electrocardiogram.

The Main Health Center RHU II

About 4 kilometers northwest of this hospital is the main Rural Health Center (RHU), a small recently inaugurated concrete center. As the position of the Municipal Health Officer II (MHO) has been vacant for almost 7 years, the officer in charge is the MHO of RHU I who covers administrative aspects of the vacant unit, but the medical problems, consultations and day to day health activities are handled by 2 medical residents and five (5) government midwives.

The other nine (9) health centers in this Health Unit have been upgraded or revived and are located either in school buildings or in Barangay Halls. There is one botika (drugstore) per barangay, organized and managed by the community through their Barangay Council and the mother health workers. Remarkable is the fact that whereas the people depended on dole-outs and on others for their medicines, they have succeeded to be self-reliant and generate income while obtaining their medicines more readily and conveniently than in the past.

A Barangay Health Committee is selected by the Barangay Council so that there is a responsible voluntary group directly involved and concerned with the health activities of the barangay, including the botika sa barangay and problems of logistics (Fig. 3). A referral system has been established as illustrated in Fig.4.



The hospital linkage in this project is from the health centers to the Emergency Hospital of 25 beds to the provincial hospital which is also a regional training hospital, and as needed to a tertiary hospital in Metro Manila (Fig. 5).

Evaluation

Evaluation of the training and experience in the practice area.

1. Built-in evaluation

a. Series of questionnaires

initial and exit (end of-course) tests
 oral during the period of assignment

b. Meetings with staff to discuss pertinent problems and

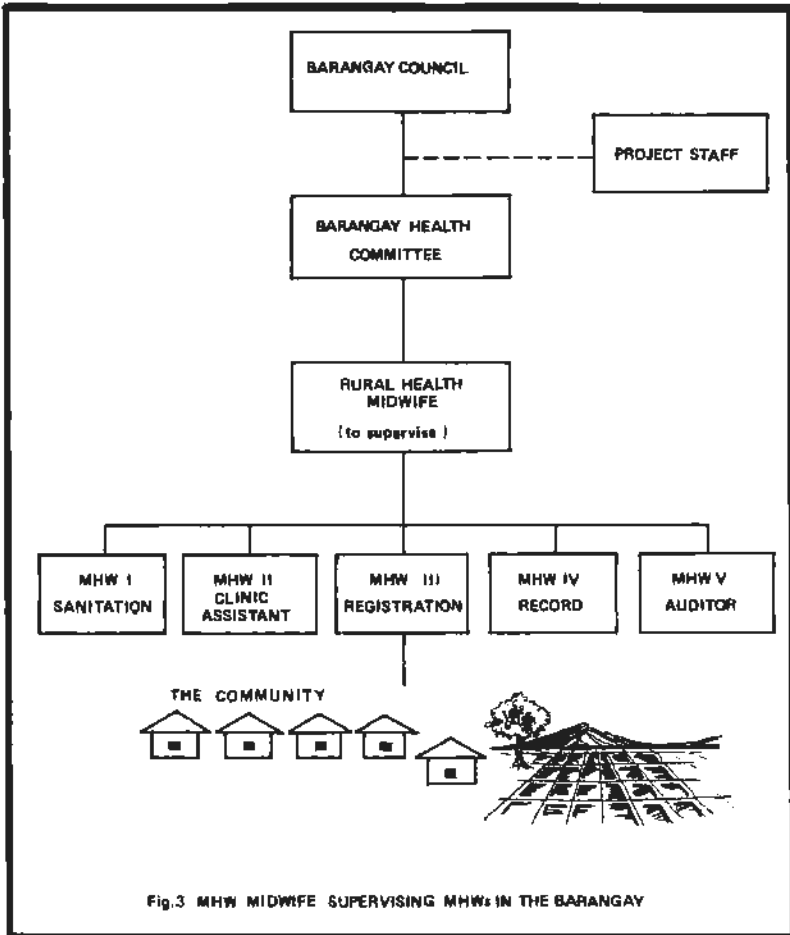
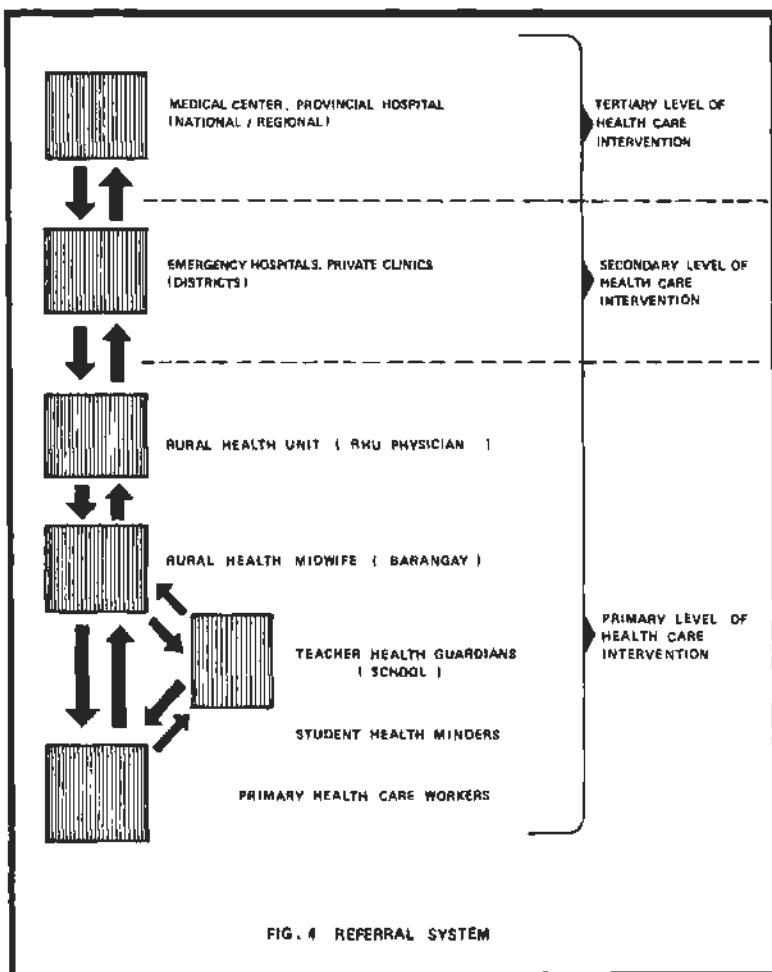


Fig.3 MHW MIDWIFE SUPERVISING MHWs IN THE BARANGAY

needs both of the trained staff and community or practice area

- c. Observations on developmental changes in the
- 1) Team approach in delivery of health care
 - 2) Relationship of trainee with MHWs as primary health care workers.
 - 3) The training participants as leader in community health development
 - 4) Reaction of community
 - 5) The effects of the program in the practice area

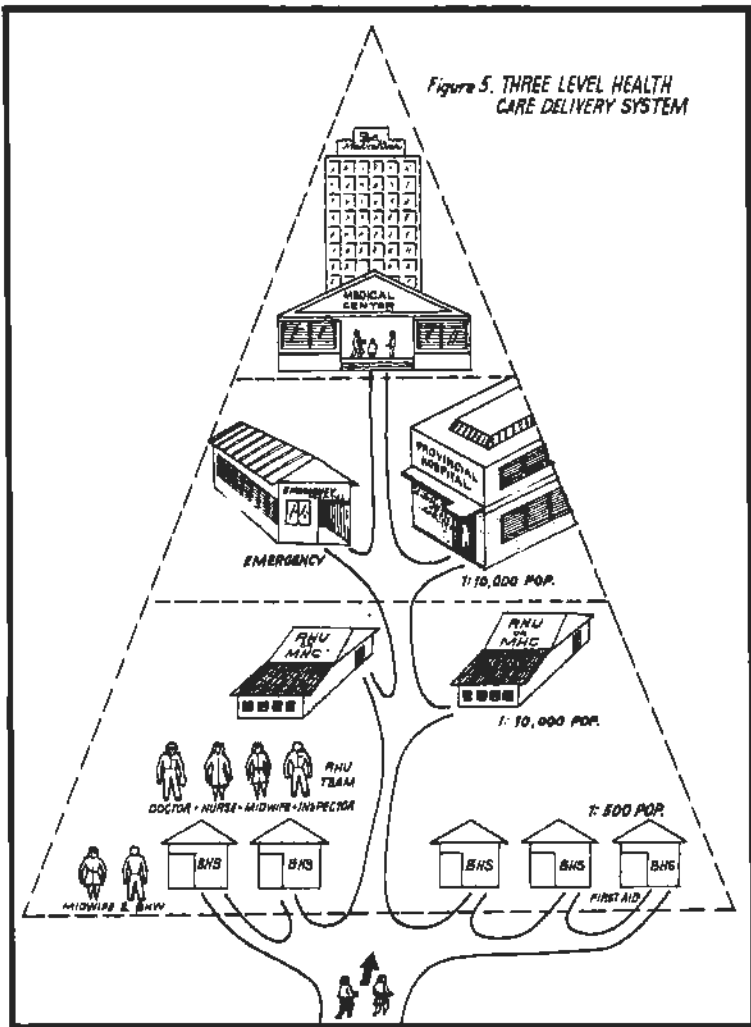
2. Reports/studies submitted



3. Follow-up of training participants upon completion of assignment.
4. Follow-up questionnaires concerning opinions of the course and innovations carried out by the participants on the return to their respective homes or areas of work.

Observations and Discussion

In this project a linkage was established between hospitals of three (3) levels and the community through the guidance and encouragement of the medical training participants. Implementation was eventually carried out from the most peripheral areas, the puroks, by mother health workers (MHWs) channeling through



the Health Committee and the Barangay Council to the rural health midwife (RHM) in the Health Center.

Initial care was given by trained health workers and when needed the patient was taken to the health center. In turn as the need was felt, the RHM with the MHW took the patient to the Emergency Hospital for consultation or in-patient care. About 10 kms. away is the provincial hospital which is also a regional training hospital and where secondary level care may be provided. For highly specialized tertiary care, patients were transferred to a Metro Manila hospital. This is the usual pattern of a hospital



Training of Mother Health Care Workers.

Mother Health Care workers have learned to take care of simple health care problems like taking blood pressure.





Breast-feeding, still the feeding of choice.

referral system. The patients then returned directly to their respective localities. It is presumed that each hospital is prepared for its expected roles: services, counselling, health education, including nutrition and family planning, and back-up report. Transportation and funding the transfer would be the usual problem.

On the other hand, linking the hospitals with the community as part of medical training has provided the medical trainees the opportunities to understand the health needs and problems of the communities, to relate the causes of illnesses/diseases to problems of community environment and to realize the need to develop an integrated curative, preventive, promotive and rehabilitative services to improve the quality of life of the people, particularly those in the remote underserved areas.

With this community exposure, the training participants have learned with very simple methods and minimum logistics to coordinate and work with the health workers in programs for the solution of common health proceedings, such as immunization, deworming, nutrition and environmental sanitation programs and in health education of the people. The teamwork concept in the delivery of essential health service components of primary health care was fully demonstrated with the medical trainees providing leadership and guidance.

Communities were reactivated to organize an infrastructure to manage and support community-managed basic health services



A bright-looking botika-their preference is still Western Medicine. They are for imported drugs, although we are encouraging Herbal Medicine. They run their own drug stores.

and income-generating activities such as botika sa baryo, tailoring and dressmaking, cosmetology and goat raising.

Local human resources, such as mothers, teachers, students and other types of community health workers were mobilized, trained and given continuing education and technical assistance through re-training and supervision. Direction and guidance were provided by the medical trainees. More than 200 mother health workers (MHWs) have been trained in this particular area and are still receiving continuing education. Efforts were made to improve the use of local technologies and indigenous practices such as the use of herbal medicine. However, the rural people prefer modern medicines noted in their stocks in the botika sa baryo.

The following are some accomplishments in the community after social preparation and dialogues with the people as well as linkages between hospitals and the community through a medical reorientation and training program.

Accomplishments in the Community with a Programmed Medical Reorientation and Training.

1. In each of 10 barangays, an infrastructure has been established to look after the health and well-being of the community.
2. A referral system has also been organized which emphasizes linkages between the community with primary and

secondary levels of health care in the municipal and provincial hospitals and even with tertiary medical centers in Manila.

3. Modern but simple, applicable and inexpensive technologies have been taken to the communities from medical institutions through the services of the medical participants in training.

4. A total of 200 mother health workers (2 to 3 per purok or about 20 per barangay) have been trained to do primary health care in the communities.

5. Each barangay has organized a drugstore (Botika sa Barangay) managed by local health workers.

6. The communities have been encouraged to undertake feasible income generating activities thus enhancing self-reliance among the people.

7. The components of primary health care have been implemented in simple, inexpensive, acceptable ways.

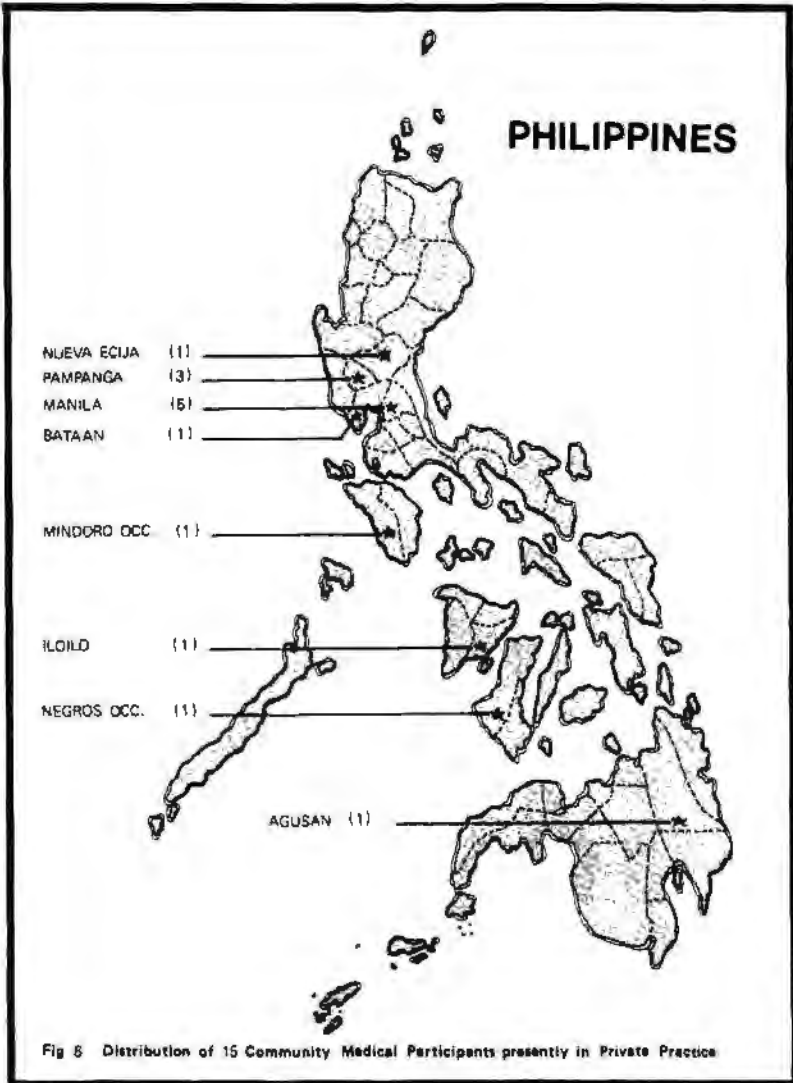
8. The medical training participants have gained experience, and provided leadership as they met challenges. A follow-up of 32 medical training participants in communities is shown in Table II and Fig. 2.

Table II. Whereabouts of 32 Medical Participants with Community Exposure and Training

A.	In the Philippines	25
	5 went abroad on grants but returned	
	Abroad	7
B.	Nature of work of 25 who stayed	
	Public Health	1
	Teaching	2
	Private Practice	15
	Subspecializing	7
C.	Location of 15 in private practice (Fig. 6)	
	Manila	6
	Provinces	9

Summary and Conclusions

This paper presents simple and feasible ways of upgrading primary health care (PHC) in peripheral communities unreached by advances in modern technology and medical progress. It is well-known that PHC has been accepted by all countries and all sectors as the key to achieving health for all in the next two decades.



Attention was focused on two aspects in the concept of PHC mainly to prevent it from becoming second or third rate; these are: 1) linkages between the community and hospitals of different levels; and 2) reorientation of medical graduates. Implementation of these two objectives are described. Simple built-in evaluation, a follow-up of the accomplishments in the communities, and the effects of exposure and experiences in these areas in the medical participants are most encouraging and noteworthy.

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DISCUSSION ON LINKING HOSPITALS WITH THE COMMUNITY AND MEDICAL REORIENTATION RELEVANT TO PRIMARY HEALTH CARE IN THE PHILIPPINES

Amanda V. Valenzuela, M.D., M.P.H., Discussant

I could not agree more with Dr. del Mundo than to reiterate the importance of establishing linkages between the community and hospitals and winning the support of medical professionals for primary health care to be successfully implemented. The project in Arayat, Pampanga amply demonstrates that the primary health care strategy can work. I wonder how long it would have taken these Pampango communities to adopt and operationalize a health care system without the leadership and initiative and commitment of Dr. del Mundo and her staff. Clearly, there are many pre-conditions to effectively mobilize the citizens to organize, manage and continuously support a community based health service.

1. Leadership and commitment — Behind successful community development projects are leaders with real concern for people. Identification of such leaders or potential leaders may be crucial.

2. Adequate funding and resources — Contrary to the common impression that primary health care is inexpensive; initial outlays needed may be heavy. Money will be necessary for preparing the community, training community health workers, re-orienting health personnel and health professionals; initiating livelihood activities to help ensure continued support of the health services.

3. As community members become more aware of their health needs and rights, there will be a demand for better back-up services from physicians and hospitals. The latter will have to be upgraded and physician skills sharpened to provide secondary and tertiary levels of medical care. The hospital can provide training for the municipal health officer who should acquire more diagnostic and therapeutic skills that go beyond ordinary day to day cases of upper respiratory infections and diarrheas.

4. The expanded role given to midwives in the management of illnesses may expose them to liabilities of medical malpractice or negligence. Legal and administrative measures should be adopted to extend adequate protection to the barangay midwives and health workers. It would be unfortunate if a worker is held

responsible for practicing medicine beyond what the law allows, but his new role and training dictates. This would discourage barangay midwives and health workers from rendering services expected of them in primary health care programs.

5. More opportunities for dialogue between the private sector (especially hospitals and groups serving community health needs) and the Ministry of Health need to be created to promote a true partnership in reaching the goal of health for all Filipinos.

Some suggestions:

1. The project of Dr. del Mundo is one model that can be utilized by other training hospitals and institutions; but unless government involvement is sought such projects will terminate prematurely. They deserve support for as long as they are effectively serving the people. Only government can provide this.

2. The compulsory rural service of underboard medical graduates could be programmed systematically as has been done in this project in Arayat. The graduates may then be able to appreciate better their roles in the delivery of the health and medical care services in primary health care. Hospitals can be prepared to take on the supervision of those in rural service.

3. Schools for health professionals should integrate into the curricula the concept of primary health care. Students can be imbued with the desired attitudes towards service to man through modelling by their mentors. Planned experiences in community health organization and diagnosis can be helpful as part of their course in preventive medicine. But more important than ever, is the education of the medical students to be competent, compassionate physicians, if they are to serve as back-up resource to primary health care workers.

Thelma N. Clemente, M.D., Discussant

Firstly, permit me to congratulate Dr. Fe del Mundo and her group for their interesting presentation of a simplified and a feasible means of upgrading Primary Health Care (or PHC) in the peripheral communities — before unreached by advances in modern technology and medical progress. Heretofore, 85% of the population in the developing countries are those living in far flung communities who receive, as Dr. del Mundo said, second, or third rate, substandard health care.

Furthermore, tertiary hospitals and medical centers are viewed as ivory towers or isolated medical islands, too sophisticated, and, beyond the reach of those who really need such

care. It had been known and accepted by all countries and all sectors that PHC is the basis or the key to achieve health care for all by the year 2000. That PHC is vitally important hence, it merited the time and attention of the prestigious National Academy of Science and Technology.

There is a need for the wholistic approach as emphasized and the two points are linkages between the communities and the hospitals. The orientation of medical graduates being practical and workable implementation at the municipality of Arayat, was shown by Dr. del Mundo. Participation of the community was productive, innovative and genuine. Here we have had the trisectoral referral system and the linkages of barangays to the Rural Health Units and to the secondary and tertiary levels of care even up to Metro Manila as needed. The catchment areas are defined and the community service is focused in helping the people grow up into mature persons, self-reliant, secure and responsible.

This paper shows how the general and specific objectives were all attained by the simple and relevant methodology.

In the primary health care system, hospitals must now divorce themselves from the traditional role of the therapeutic and diagnostic and occasionally rehabilitative work but must now assume more leadership in social roles by integrating with the community. Of course, private hospitals are always wary about such community involvement, primarily so because of the sad fact that most or 90% of them are financially-distressed and frowns upon this as a further financial burden.

The Philippine hospitals would like to reiterate this position and manifests this kind of support for PHC. The support of these hospitals are most important in about many ways — supportive help through the community health centers; trisectoral referral system, emanating from the barangay to the community health centers then to the hospitals; services like x-ray and the laboratories, physical medicine and therapy services at nominal or at very low-cost; later, admission to the truly deserving patients should be encouraged. Available referrals and appropriate expertise should be assured to them.

Technical support to hospitals should be considered as obligatory and not a mere rationality to provide technical support to the health units. There should be continued upgrading of knowledge and skills of the health professionals and workers in community health nursing at the periphery; medical internship and residency training should be given during their community assignment to help trainees adopt to the realities existing in other communities.

This type of health care may be needed specially by the accrediting society and they can be sent to the rural areas. Information and communication systems; hospital base workers learn about the disease profile prevailing in the rural areas, whether infectious or so forth and so on, and prepare for them in these specialized centers of heart, lungs, and kidney etc. Information is also disseminated through the use of the TV, the media, lectures on food values, nutritional requirements; home economics, maternal and child care can be learned even in evening classes. Radio stations can be utilized for these.

Family planning materials and methods can be distributed through the secondary and even tertiary hospitals. Mass screening for high blood pressure or self-examination for breast mass can be taught.

Simple research like what is prevailing as endemic parasitism and something of this sort like the urban areas are present only in the far flung areas. We have also in urban areas what we call the urban slums. Simplified management systems can be developed in this tertiary hospital level and then applied and utilized in the systematic planning, programming, monitoring, control and evaluation of all the resources, and manpower, money and materials.

Any economic and financial gains or efficiency can be re-applied to the community for better health care at lower cost. This may enhance the effectiveness of the national health policy. Then we have the inter-sectoral collaboration. With the full knowledge that health is not only the concern of the hospital nor of the individual alone, the hospital can tap other similar community groups, like engineering for artesian wells and sanitary toilets; the parish, the church foundations; women's auxiliaries, socio-civic groups or organizations, industrial and other segments of the community.

Last, but not least, would be attitudinal and value transfer. In the paper of Dr. Amparo Banzon, in-charge of PHC in the Ministry of Health, she made mention of this very important role as number one to be considered when it comes to the community.

There is always resistance to change and any move towards change is viewed upon with suspicion as there is an inertia of rest and complacency with old methods. In the light of present developments all those engaged in health development works are enjoined to reflect on their mission and philosophy of existence to identify discrepancies between the intended and the real, realign their operations to approximate the ideal goals and objectives.

This activity requires leadership — leadership of hospitals. The hospitals must lead to obtain community participation and

must have the ability to mobilize multi-sectoral involvements. There must be a just concern for the scores of people in want and hospitals are expected to provide the leadership and concern. Reorientation of manpower development and education is another part of rationalization in health care development.

The orientation depends upon the education, as mentioned by Dean Valenzuela. Nurses and midwives and other health professionals should be given more public health subjects—psychology, sociology and health concepts to produce practical, adaptable and versatile graduates, without thinking less of their scientific background and professions.

The PHC physicians functions as managers, advocates, educators and counselors for their patients serving as coordinators of other professionals involved in PHC. Primary health physician is the best title, other than general practitioners as suggested. He is a coordinator of the health care team.

Lastly, it is very essential to seek the willing cooperation of the medical and paramedical staff and their solid commitments to the program. They carry a heavy responsibility in terms of time and effort towards the fulfillment of their social commitment, an effective and enduring partnership of the private, the community and the government must be established.

In closing, I would like to repeat what I have often said before owners of private hospitals that while the viability of hospitals is mercilessly connected with the amount of money it can make and its success measured by profits and return to investments, development and growth, the personal satisfaction as you have something for those who really need them, is the highest and noblest measure of fulfillment and success.

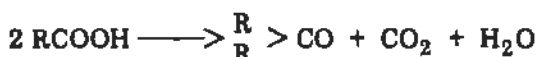
Again let me congratulate Dr. Del Mundo and her group for taking concrete steps towards the implementation of PHC, and for taking relevant steps to reorient the medical, paramedical and other segments of the community towards a very good health effort. Thank you for your kind attention.

DECARBOXYLATION OF THE FATTY ACIDS OF COCONUT OIL

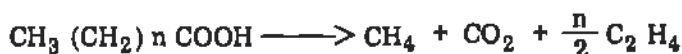
By Julian A. Banzon, Academician

Abstract

At ca 300°C, the fatty acids (FA) of coconut oil (CNO) undergo partial decarboxylation forming high molecular weight ketones in good yield:



At ca. 1000°C the FA of CNO yield by decarboxylation, ethylene, probably according to the equation:



At ambient temperature, ca. 30°C the FA of CNO undergo readily a microbiological decarboxylation yielding methane. For lauric acid, the main FA of CNO, the chemical reaction may be written:



A review of decarboxylation studies in the Philippines is presented.

Theoretically the decarboxylation of fatty acids should yield hydrocarbons of the type $\text{C}_n \text{H}_{2n+2}$. Thus from the acid $\text{C}_{11} \text{H}_{23} \text{COOH}$ (lauric acid, the principal acid in coconut oil), the hydrocarbon undecane would be formed by decarboxylation:



Since gasoline, kerosene and LPG are hydrocarbons, the importance of decarboxylation is obvious. The fatty acid composition of coconut oil is shown in Table I (reference 1). Because of this possibility of producing gasoline from vegetable oils, decarboxylation attracted quite some attention. (ref. 2, 3, 4, 20, 21, 22). During the last China-Japan war, "gasoline" was manufactured by

TABLE I
Fatty Acid Composition of Coconut Oil
(reference I)

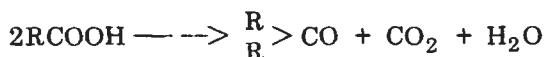
		Possible Hydrocarbon				
100 g CNO	8.34g H ₂ O	FA 94.13g	C ₆ .063 g	C ₅ H ₁₂		
			C ₈ 8.45 g	C ₇ H ₁₆		
			C ₁₀ 5.87 g	C ₉ H ₂₀		
			C ₁₂ 45.32 g	C ₁₁ H ₂₄		
			C ₁₄ 17.85 g	C ₁₃ H ₂₈		
			C ₁₆ 8.28 g	C ₁₅ H ₃₂		
			C ₁₈ 4.24 g	C ₁₇ H ₃₆		
			C _{18'} 2.89 g	—		
			C _{18"} 0.59 g	—		
			Glycerol 14.2 g			

the Chinese from tung oil (ref. 5). The process was further studied in India (ref. 6). In 1946, there was an attempt to make "gasoline" from coconut oil in the Philippines. (ref. 7 & 8). The general method involved in these endeavors is based on the chemistry textbook procedure summarized by the chemical equation:

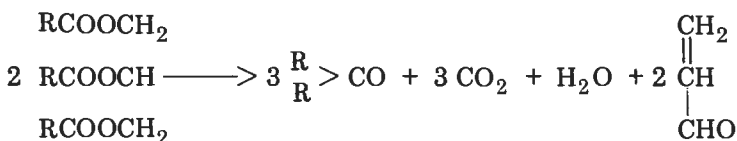


where M may be sodium. In effect the process consists of heating ordinary soap (RCOONa) with sodium hydroxide. To make the process cheaper, the calcium soap is used and heated with slaked lime. (ref. 7 & 8).

Decarboxylation yielding ketones. We tried catalytic decarboxylation using compounds of Al, Zn, Cd, Fe. Small amounts of non-saponifiable liquids were produced, except that Fe catalyst yielded a crystalline solid, melting point 55°C (ref. 9). It proved to be a high molecular weight ketone (ref. 10). We can explain its formation by the following equation:



We found that the formation of ketones proceeded easier with coconut oil itself rather than with the fatty acids probably because with coconut oil the temperature could be raised higher (above 300°C). For coconut oil the decarboxylation reaction can be represented thus:



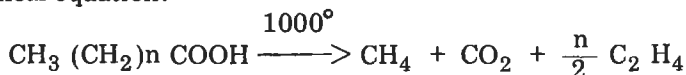
With the formulation of ketones in good yield (64%), we have achieved partial decarboxylation but fell short of getting the desired hydrocarbons. Nevertheless, the ketones present a new chemical derived from coconut oil and open a new area of coconut oil research.

Decarboxylation with transition metal complexes as catalysts.

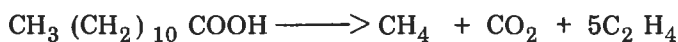
There were reports from the USA of a process for converting tallow (beef fat in large supply in the USA) into gasoline range hydrocarbons, using transition metal complexes as catalysts. It may be recalled that the transition metals proved to be the key to the successful polymerization of ethylene, propylene and styrene.

Anticipating that he can get hold of the tallow-to-gasoline process, a Vietnamese national offered to the NSTA to undertake a coconut oil-to-gasoline conversion. (ref. 11) Nothing further has been heard about this process and there were even denials that the process ever existed.

High temperature decarboxylation. Our studies on decarboxylation of coconut oil indicated the production of another type of hydrocarbon: ethylene. Also during the Occupation, at the U.P. College of Agriculture we generated gas for the laboratories by pyrolysis of coconut oil in lieu of the usual, but no longer available bunker oil. The temperature was estimated at 1000°C because of the dull red color of the heated iron retort. The gas formed was rich in unsaturated hydrocarbons, ethylene mainly. We can explain the formation of ethylene from a fatty acid by the following chemical equation:

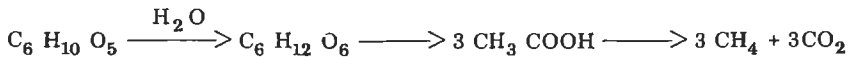


For lauric acid, and calculating for theoretical (and therefore maximum) yield, the conversion percentage would be 70 percent based on the equation:



The standard heat of formation for lauric acid is ca. - 33.6 K cal/mole; the heat of reaction for the above reaction would then be - 15.8 K cal/mole lauric acid.

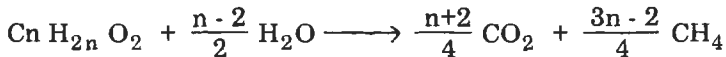
Microbiological decarboxylation. The formation of biogas from organic matter is kind of decarboxylation carried out by microorganisms. The series of biochemical events from organic matter to biogas, appears to be very complex, but may be summarized by the following sequence of reactions (ref. 12).



It is seen that the last step is a decarboxylation reaction of a fatty acid. If this reaction applies to lauric acid then the equation would be:



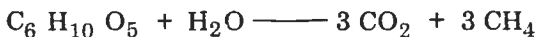
The formation of hydrocarbons other than methane is now ruled out in "anaerobic digestion" process. (ref. 12). However, simple fatty acids have been known to produce biogas. A general equation for fatty acids undergoing anaerobic decomposition has been proposed (13):



Under a grant from the National Research Council of the Philippines we undertook a study to test if coconut oil (which contains higher fatty acids), does decarboxylate microbiologically (ref. 14). We found the process to take place readily, the "fermentation" time is comparable to that of animal wastes, that is 15 to 20 days. The theoretical methane yield for lauric acid is calculated to be 68% based on the equation:



By comparison, the theoretical methane yield from cellulose is only 30% based on the equation:



Significance of ethylene production from coconut oil. Ethylene is the raw material for the manufacture of many and varied consumer items: polyethelene ware, sheets, pipes; textile fibers like Dacron and Terylene (the "polyesters") ; extremely durable plastic sheets (Mylar); it enters into manufacture of modern detergents. In the USA, ethanol is produced from ethylene on a commercial scale.

The present industrial source of ethylene is petroleum hence the need to locate renewable sources. In India, ethylene is produced from ethanol because of shortage of petroleum. The case of India emphasizes the need to find replacements of petroleum not only for fuel but as raw material for manufactured goods. The urgency of the situation is shown by the following world conferences:

- 1969 Symposium on non-food uses of coconut oil (ref. 15)
- 1976 Report of a study of renewable resources for industrial materials. National Research Council-Academy of Science (USA). (ref. 16).
- 1978 World conference on future sources of organic materials (ref. 17)
- 1979 New crop developments for industrial oils (ref. 18).
- 1979 Fats and oils as chemical intermediates. (ref. 19).

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DISCUSSION ON DECARBOXYLATION OF THE FATTY ACIDS OF COCONUT OIL

Florencio Medina, D. Sc., (*honoris causa*), Discussant

This paper of Dr. Banzon emerged out of scientific investigations of coconut oil which are safely deposited in no less than 22 reference materials. Sometime in the past, coconut was often referred to as the lazy man's crop, and reading 22 research papers, and being able to organize a good paper on the "Decarboxylation of the Fatty Acids of Coconut Oil" is not a lazy man's job. In his paper, Dr. Banzon has objectively pointed out that the fatty acids of coconut oil and therefore the coconut are available and renewable source of energy and an important and versatile source of industrial raw materials. The decarboxylation of fatty acids yields high molecular weight, ketones and saturated as well as unsaturated hydrocarbons.

Of course, it all depends on the nature and the temperature of the reaction and on the catalyst used. The temperature of the reaction can be under ordinary room temperature or can be as high as 1000°C. The catalyst could be compounds of aluminum, cadmium, iron as well as transition metal complexes.

The reaction can be an ordinary simple reaction or a microbiological one. This area of research to my mind is as important and as challenging especially here in the Philippines. I would like to venture and say the NAST can play an important role as a catalyst and have the Ministry of Energy react to the suggestion that it considers. The decarboxylation of fatty acids is one of the several possible sources of energy in the Philippines which is one of the leading countries considered high producers of coconut oil in the world.

The decarboxylation of fatty acids in coconut and other vegetable oils to form hydrocarbons that maybe fractioned into gasoline components should be seriously considered by the Ministry of Energy, by research agencies as well as by industrial organizations in this country.

Industrialists should likewise be interested in the decarboxylation reaction yielding unsaturated hydrocarbons such as ethylene which finds use in the manufacture of polyethelene wares, durable plastics, paper dacrone and terylene and even detergents. Maybe I should not miss to point that in some countries, ethylene is produced from ethanol while in others ethanol is produced from ethylene.

Microbiological decarboxylation has been discussed in the paper of Dr. Banzon. Lauric acid has been made an example in which undecane may be formed but Dr. Banzon points that the formation of hydrocarbons, other than methane is ruled out in anaerobic digestion process.

I would like to inform that alpha articles such as those emitted by plutonium are capable of the decarboxylation process in producing hydrocarbons and in producing methane. Here is another instance of the decarboxylation of fatty acids that has not yet been explored in the Philippines.

The Philippine Atomic Energy Commission, the agency dedicated to the application of nuclear science to agriculture, medicine and basic science and should be in the best position to undertake this kind of research. Funds coming from the Ministry of Energy should be invested in this process. We would like to ask in closing whether any pilot plant has been installed in utilizing any of the processes mentioned in Dr. Banzon's paper and if there is any, have they studied the economics of the processes? Have they also looked into the possible pollution aspects of the process?

Thank you.

Augusto Santos-Ocampo, Ph.D., Discussant

Dr. Banzon's paper has brought attention to the fact that the coconut has other possibilities aside from its use as coconut oil. We all know that these days, coconut oil is blended with diesel as fuel. And coconut oil can be esterified and be used as substitute for diesel fuel. Here, we have all the possibilities of using coconut oil as sources of hydrocarbons and perhaps take the place of gasoline in the future.

Now the only question we should keep in mind, is whether this hydrocarbon from coconut oil will give a favorable energy balance because what we are producing here is an energy product and whether it would be advantageous to produce hydrocarbons out of oil, instead of coconut oil as diesel extender or methyl ester as substitute.

The paper also discusses the possibility of coconut oil as source of ethylene which we know is an important raw material for the plastic industry. I am sure this work is an exploratory and a starting point for what we need is to carry on with this program — that developed this for our future requirements.

THE RESPONSE OF RICE TO LIGHT

By Jose R. Velasco, Ph.D.

Introduction

Let me start with a digression: Legend has it that Diogenes once went about Athens carrying a lantern in broad daylight looking for an honest man. The reporter went further in saying that Diogenes found none.

Diogenes has been cited as a prototype of a researcher because he searched, then searched again until he exhausted the possibilities. However, let us make a critical analysis of Diogenes' actuation to determine if he measures up to our concept of a researcher: First, we will note that he set his sights too high. He knew that he was not likely to find an honest man because all men were dishonest in various degrees. For example, if he were honest with himself, he would not cover his delicate parts with clothes. (Do you remember the anecdote concerning Sir Winston Churchill? At the height of a recrimination with a lady friend, he was said to have rushed out of the bathroom, and wearing only a weak smile, told her: "Honestly, I am not hiding anything from you.") Secondly, he used an irrelevant tool to attain his objective — i.e., a lantern in broad daylight to locate an honest man. Then his results were likely to be highly subjective because he did not specify his criteria of an honest man. And fourthly, he adopted a rigid frame of classification. Thus, a person can be nothing but honest or dishonest; he can not be non-honest. In this system, a singer for example is not judged by the beauty of his music but rather, by the honesty of his singing. Incidentally, Diogenes was fortunate in having somebody to report his deeds; otherwise, this account would not have come to us. To parody Gray's *Elegy*,
he could have been "born to blush unseen
and waste his queerness in his island lair."

Unhappily, in this critical analysis, we end up by being critical of Diogenes.

Now let me recount to you how much my colleagues and I are equally guilty of Diogenes' errors of commission and omission.

Setting sight in research

As a novice in research during my early days in Los Baños, I had an inordinate ambition to contribute to the science of rice

growing. My thought then was to es skew the biochemistry of the plant so that it would produce starch exclusive of cellulose. The job was apparently simple: we induce the plant to make only alpha-glucose linkages and inhibit the formation of beta-glucose, its stereoisomere. In this way, we can double the grain yield without having to correspondingly increase the biomass. The foolish thought led me to the study of hormones and enzymes. However, I have to confess that up to now, I have not yet seen "light at the end of the tunnel." Obviously, I set my sights rather high.

On the other extreme, I have been running experiments on the application of fertilizers to rice. The job did not give much of a challenge, and most of the time I caught myself delegating the work to the laborers. The results were not very exciting: a fertilizer may be better than two or three others when given to a particular variety, planted in a given soil, at a certain time. However, when the trial is repeated, a different (pecking) order among the fertilizers may be obtained. The study could be a never-ending busy work which could not get me anywhere.

I have since concluded that the essence of a self-rewarding research effort is to choose the area and level of study which one can handle with competence. And this will include the ability to circumscribe a problem within testable limits. However, despite this conclusion I still have to shuttle and fumble. Like the pointer in a balance, I swing from left to right oscillating past the rest point.

The use of relevant procedure

Common sense dictates that we should proceed to attain our objectives via the most relevant and direct way. Hence, we thought it queer that Diogenes would use a lantern in broad daylight in his search for an honest man. However, we may be reminded that there are various degrees of queerness. For example, Columbus was thought queer when he proposed to reach the East by sailing west. Again, when I was in the grade school, I could not comprehend how human voice could be sent around the world without any visible medium of transmission.

In our study on the effect of light, we started with the premise that light is essential in photosynthesis. Our immediate thought was to supplement sunlight with artificial light — that is, to use a lantern in broad daylight — and measure its effect on photosynthesis. This may be in terms of carbon dioxide consumed or amount of sugar (or starch) produced.

A friend suggested to use the idea of planting a crop of rice at different dates in order to expose them to different amounts of

sunlight. (The amount of sunlight varies with the seasons.) We initially rejected this idea, because the approach is indirect; furthermore, other factors such as rainfall, humidity and temperature vary with the seasons, as well. These latter factors might skew the results.

However, reviewing the literature, we found that Peralta (1919) had done just that: He planted a crop in the different months of the year. . . With some mental reservation — we tried to repeat Peralta's experiment with a slight modification. Besides the variety Inintiw which he used, we planted Elon-elon. Inintiw is early-maturing and grows in flooded soil.

This incident illustrates our diffidence. We tend not to entertain a strong feeling against a procedure, which (initially) we think irrelevant.

It is curious that intermittently, we have been debating to ourselves the merits of a direct approach in research. Adverting back to the quest for a route to the Orient, the early Europeans through — and very correctly — that to reach the East they had to go east. But then, they precluded the chance of discovering a new world.

Criteria of results

It is a rare occasion when researchers pause to cogitate on the criteria of results which they have been using. This is because most criteria come as a natural consequence of the objectives of the experiment. For example, if we are comparing the performance of different varieties, yield of grains comes naturally to our mind as a criterion of performance.

However, in a less positivistic field, such as the social sciences, concepts and entities are not easily measured; hence difficulties often arise. Such concepts as honesty, love and happiness may defy attempt to concretize them. When Diogenes set out to look for an honest man, he probably did not ask himself what characteristics identify a man as being honest. He perhaps should have asked himself: (1) Should an honest man always tell the truth? What is truth? (2) Should he take only the things which belong to him? For example, are we Filipinos honest in taking the Freedomland? are the Vietnamese? are the Chinese? (3) Is it honest to cover up something which exist, such as a murder? How about covering one's delicate parts?

Even in the more positive sciences of physics and biology, it may be hard to determine what criteria or properties are to be observed and recorded. This usually arises from the fact that several concatenated processes proceed before a measurable entity is produced. Thus, the photosynthetic chain starts (in rice,

as in other plant) with the splitting of water to form nascent hydrogen; the latter reduces in a few steps the carbon dioxide which has been "fixed" to a shuttle; then, three-carbon and six-carbon sugars are formed. The latter may be translocated to the grain, polymerized and deposited as starch. Since the intermediates are inconvenient to measure, grain yield is taken as a criterion of performance. But please note that grain is quite remote from the first step in photosynthesis. If perchance the sugar gets polymerized as cellulose and deposited in the stem, our criterion sustains a big margin of error.

During the preparation for the research undertaking, our mentors (i.e. yours and mine) have dinned on us the importance of sticking to our criterion of results. If we "change horses in mid-stream" we will obtain a blurred picture of what happened in the experiment. On the other hand, a single-minded use of criterion can blind us to certain important deviances. For example, in the experiment on planting rice in different months, we set to observe the different grain yields. When *Elon-elon* planted in February did not produce grains within 180 days, we thought that our culture got spoiled. Hence, we missed to note the effect of photoperiod on rice.

This brings to mind an incident which illustrates how a different criterion can lead to an entirely different conclusion — and conversely. I once showed a friend the beautiful water-soaked specks which we produced on the leaves of coconut seedlings by withholding magnesium from the culture solution. My friend, who happened to be a plant pathologist, did not get attracted to the water-soaked specks; instead, he noticed the few brown blotches in the other leaves. In the tone of a Eureka, he exclaimed: "I bet you, you have a beautiful case of infection by *Ceratosmella paradoxa*."

Results and their interpretation

The conceptual frame with which we view the results of our experiment often determines whether or not we would make a discovery. For example, Lord Rutherford and his colleagues adopted a nonstatistical frame of mind in making their far-reaching discovery of the nucleus of the atom. They bombarded a very thin gold leaf with alpha particles and most of the particles went through, implying that the atoms in the leaf were empty. Only one alpha particle out of 6.17 million got deflected by more than 90 degrees. Other scientists observed the same phenomenon earlier than Rutherford but they regarded the straying as fortuitous — i.e., it was not statistically significant. Rutherford, however, interpreted this in terms of an atom which is for the most part

inert to alpha particles but has a very small solid core — the nucleus.

In microbiology, a plant pathologist in Los Baños claimed that he used to be exasperated by contaminations in his bacterial cultures. Around a putative fungus colony he used to observe a clear halo where no bacteria would grow. If, instead of throwing away his contaminated cultures, he had interpreted the halo in the same way that Fleming did, he could have been a pioneer in the study of anti-biotics.

In medicine, a wrong diagnosis can lead a doctor to prescribe a cure which is irrelevant to the disease. The worst thing which could happen is that the patient could be killed by the prescription. Because medical doctors hold the life of their patients in their hands, medical schools admit only the best among the student applicants.

The results of our experiment with Inintiw essentially confirmed those of Peralta, and this made us jubilant. Much later, Yoshida and Parao (1967) obtained parallel results, using a different early maturing variety. Since our results were not published, we will not attempt to recall them here; instead, we will simply point out the salient points of these two published papers. Figure 1 shows that Peralta obtained high yields in his plantings of February, March, April, May and June. Likewise, Yoshida and Parao's best crops were planted in March, April, May and June. Peralta's February planting was harvested in June, or it took 134 days to mature; his June planting was harvested in September, taking 141 days to mature. The best grain-to-straw ratio of 0.63 was obtained in the May planting, followed by 0.59 in the June planting. The vegetative period of these two crops occurred in May to August, a period of high possible sunshine hours (figure 2). (However, the actual sunshine hours in this period was rather low and erratic, and its solar radiation was not very high either; (figure 3). In addition, its rainfall was high, especially during July and August (figure 4); however, high rainfall is also noted in other periods, especially September to November. Perhaps, the high yields and favorable grain-straw-straw of these two plantings were favored by a combination of high possible sunshine hours (long days), and high rainfall — with a consequent high relative humidity. The latter condition results in lower evapotranspiration.

On the other hand, Elon-elon, a late-maturing variety, presented a different picture. It flowered so erratically that it simply did not fit in with our hypothesis. For example, on the basis of sunshine hours received, the crop planted in February would be expected to give the highest grain yield because its growth period was longest. In fact it was among the lowest

tons per hectare

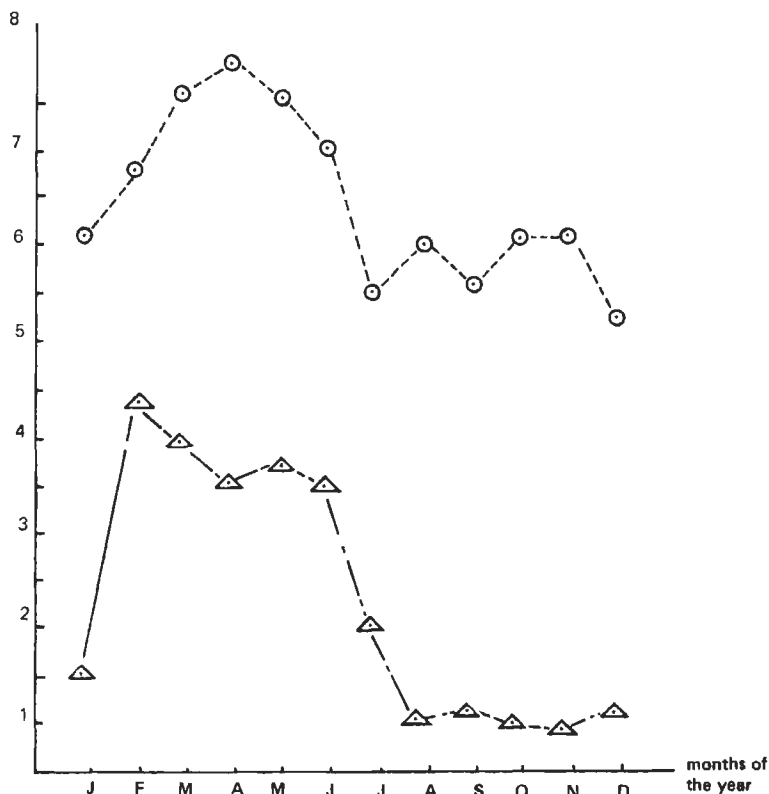


Fig. 1. Yield of Inintiw (lower curve) and IR 747 B2-6 (upper curve) planted at different months of the year.

yielders. Figure 5 shows that *Elon-elon* flowered in 75 days when planted in January and in 281 days when planted in February. This was quite baffling to us at the time.

In our course in plant physiology, we had been told in passing that Garner and Allard (1920) reported that short days could induce flowering in tobacco, soybeans and other crops. However, we missed to relate this with our observation on rice because it is a tropical crop and day-length does not fluctuate very much in the tropics. Hence, in our state of quandary, we left our data idle in our file.

This experience of ours illustrates again the dictum that "discovery starts in the mind." If we had not tacitly limited our frame of mind to the working hypothesis, we would not have had the blinders as it were, which made us miss the implications of the erratic flowering in rice. According to Medawar (1979), to make a

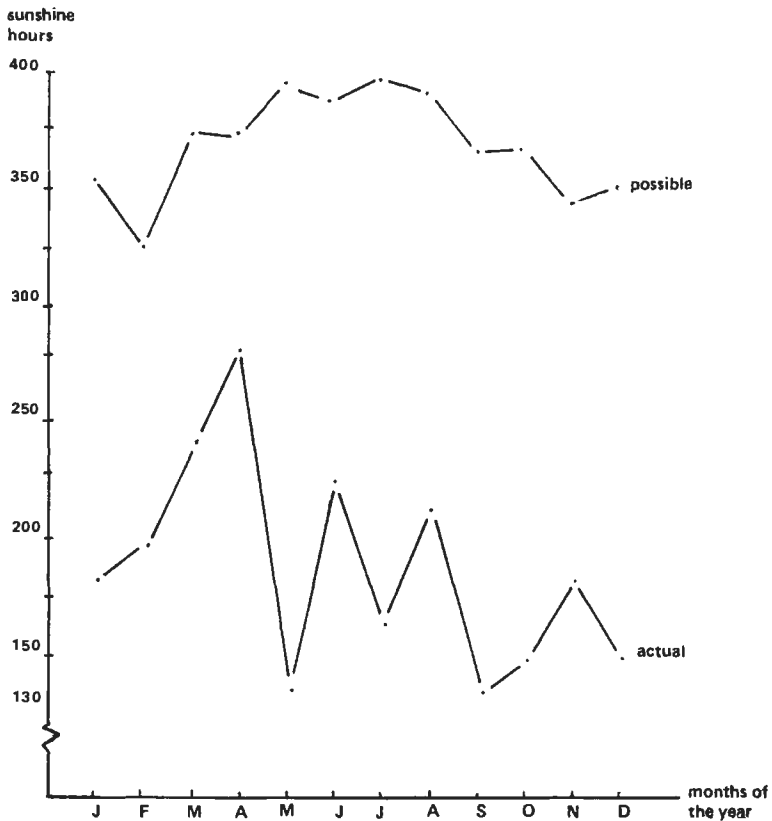


Fig. 2. Number of sunshine hours per month in Los Baños.

discovery “the mind must already be on the right wave-length, another way of saying that all such discoveries begin as covert hypothesis — that is, as imaginative preconceptions or expectations about the nature of the world, and never merely by passive assimilation of the evidence of the senses.” He went on to say that discoveries may be grouped in two categories: synthetic and analytic. “A synthetic discovery is always a first recognition of an event, phenomenon, process or state of affairs not previously recognized or known.” On the other hand, an analytic discovery is “the result of sustained dialogue between conjecture and refutation.”

Our state of quandary remained for about a decade; then in 1951 (and after a visit in Borthwick’s laboratory), we decided to re-study the effects of daylength on the flowering of rice. This was

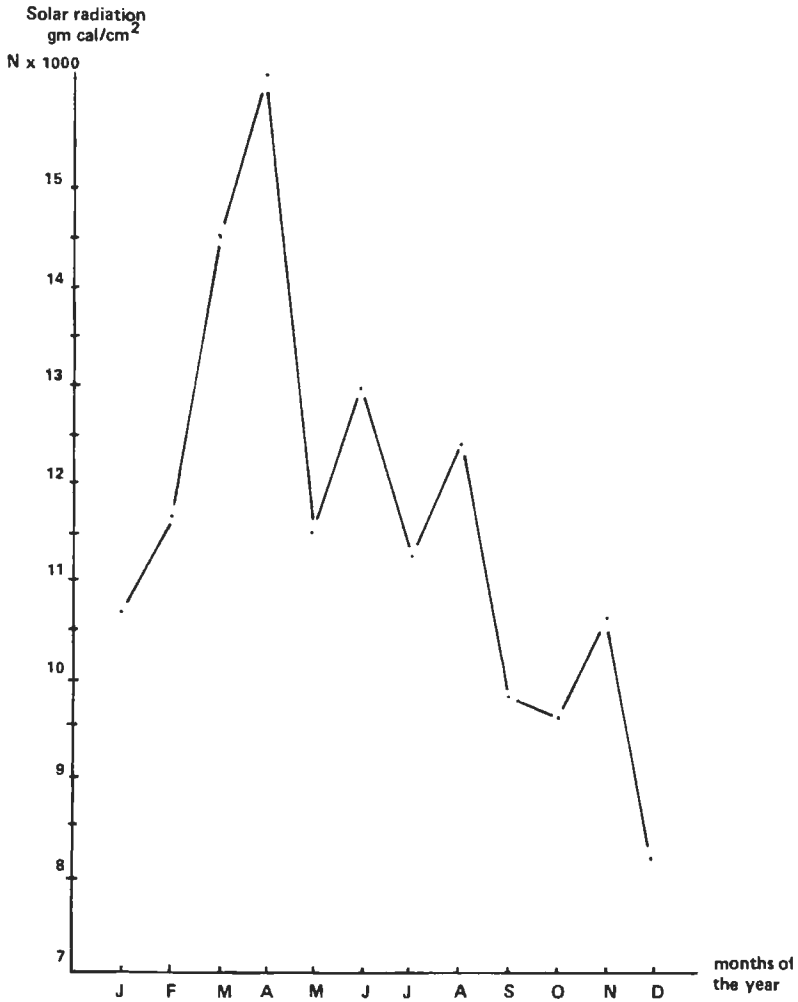


Fig. 3. Amount of solar radiation in gram-calories per square centimeter per month (Los Baños).

the start of the series of studies which is the basis of the present review. Our interest in photoperiodism in plants reached its peak in 1965, when I transferred from Los Baños to Diliman.

Publication of results

As mentioned earlier, our data on the erratic flowering of the variety *Elon-elon* were kept idle in our file. In the chaos of 1944-1945, they became a casualty of the war. If we had taken the trouble of publishing our results in 1943, we would have called

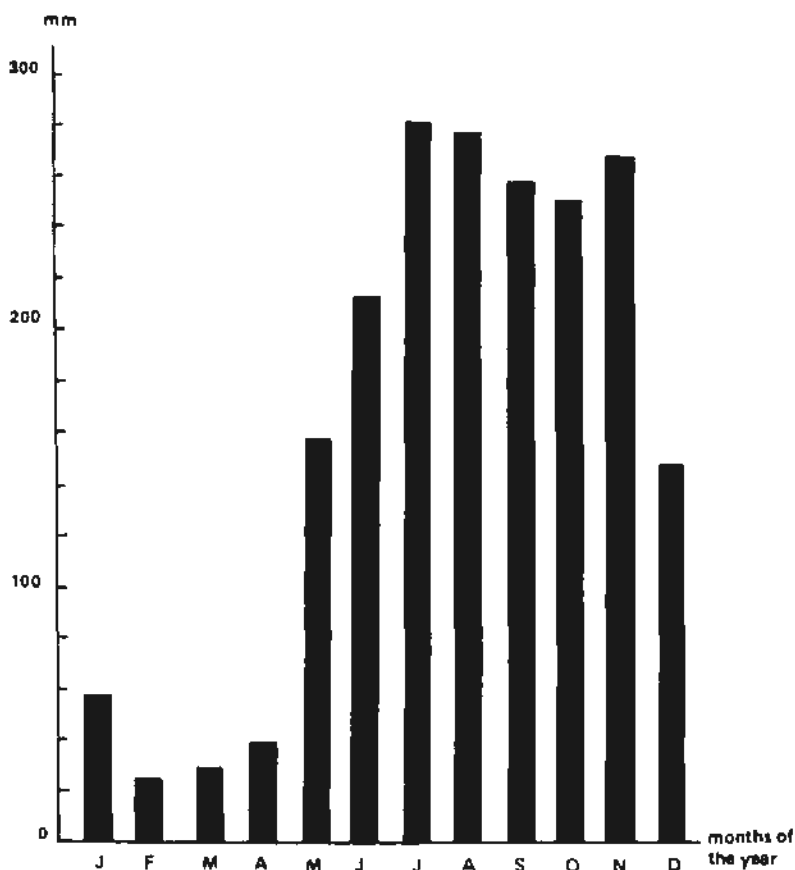


Fig. 4. Rainfall in mm in various months (Los Baños)

attention for the first time to photoperiodism in rice. It was only in 1945 that Sircar and Parija published their results on the subject, and they designated the phenomenon as vernalization. Two factors contributed to our failure to publish: (1) because of the war turmoil, the scientific journals ceased to publish; and (2) we missed the implications of our data. We should have published our results even if we could not, as yet, see any immediate or apparent explanation for them. Then we would have attracted curiosity to the peculiar effect of time of planting on the flowering of rice.

Quite apart from consideration of priority and the perpetuation and/or propagation of information, publication of results has certain inherent benefits. For instance, in the process of preparing results for publication, we incidentally study, review and interpret our data. This affords an opportunity to note the weak points

No. of days

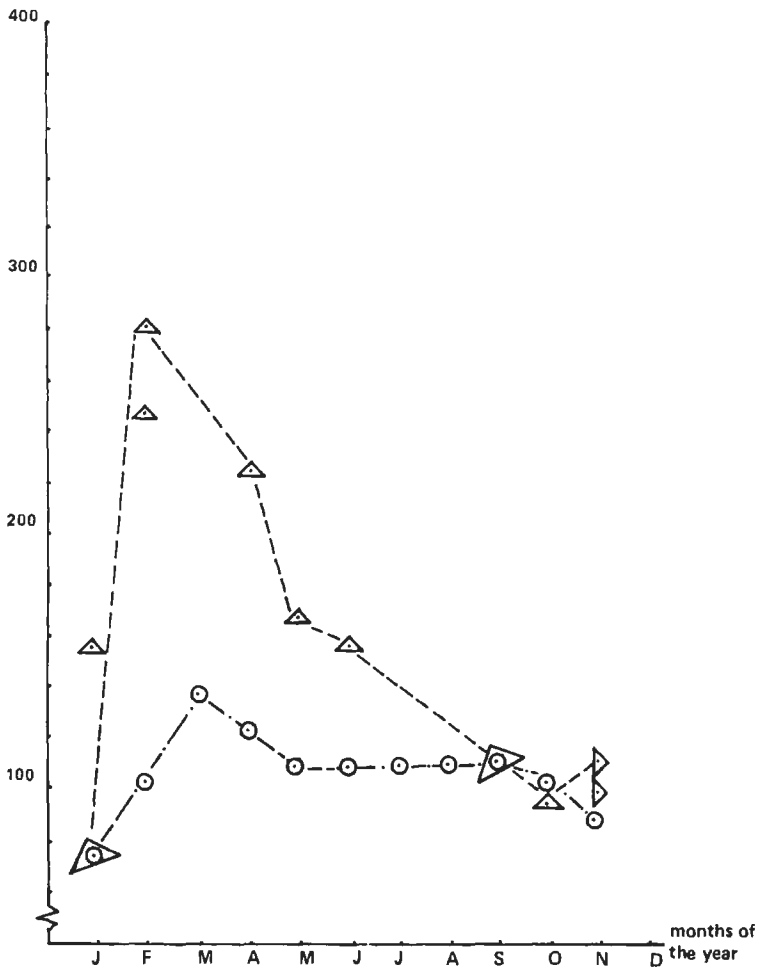


Fig. 5. Number of days from planting to flowering of Inintiw (lower curve) and Elon-elon (upper curve) planted in different months.

which need verification. Furthermore, the implication of the data may lead us to form a new hypothesis or modify a current one.

Again, to relate our results to the body of extant information, we may feel the need to study the literature on the subject. Hence, we broaden our outlook and, perhaps, find opportunity to improve on what we (and others) have done before. It is a truism that in science we stand on the shoulder of those who came before us.

An incidental benefit from a research paper is that it serves as a vehicle for the propagation and promotion of local research and researchers. This is least appreciated in the local scientific circle. Filipino researchers have a penchant to cite in their articles the studies made by Europeans and Americans, hardly, if at all, citing those made by Filipinos. This is perhaps an attempt to put on a mask of erudition — others call it colonial mentality. One good example of narrow nationalistic patronage in citation is to be noted in the paper of Yoshida and Parao (1976). They cited 50 (out of 69) of Japanese origin; 17 of the remainder were published by the International Rice Research Institute — many of which were co-authored by visiting Japanese scientists. They did not cite any study on rice from the U.P. College of Agriculture — not even the pioneering study of Peralta. Perhaps they felt that it was not worthwhile.

This matter of setting standards for worthy research and research papers is rather moot. Most present-day scientists ignore papers published in so-called developing countries because the data were secured with outdated equipment. Furthermore, the experimental conditions were not well controlled. Unhappily, to come up to their standard, we have to establish and run our laboratories through a pipeline, as it were, from the developed countries. (I facetiously call this, “economic colonialism through science.”)

Lest I leave the impression that I am a modern Luddite, let me hasten to add that if we decide to establish an advanced laboratory we should attempt to supply at least part of its requirement. By moving to dispense with the “pipeline” we may yet succeed in upgrading local technology.

Well, so much for the rambling thought.

If we come to think of it, the primary objective in research is to advance the frontiers of knowledge. It is desirable to attain this objective with precision equipment; but the latter is not always essential. Thus, if Peralta’s “haphazardly” obtained information is confirmed by Yoshida and Parao with the use of sophisticated equipment, why should we not credit Peralta for gaining the insight despite “non-standard” equipment and conditions? Let us recall that Einstein formulated his famous energy-mass equation without any experimental evidence. The supporting precise experiments came very much later. And yet people credit Einstein for his contributions.

Further studies on photoperiodism

Our realization that photoperiodism was involved in the erratic flowering of rice planted in different months may perhaps be considered as — i.e., can pass for — a synthetic discovery (in

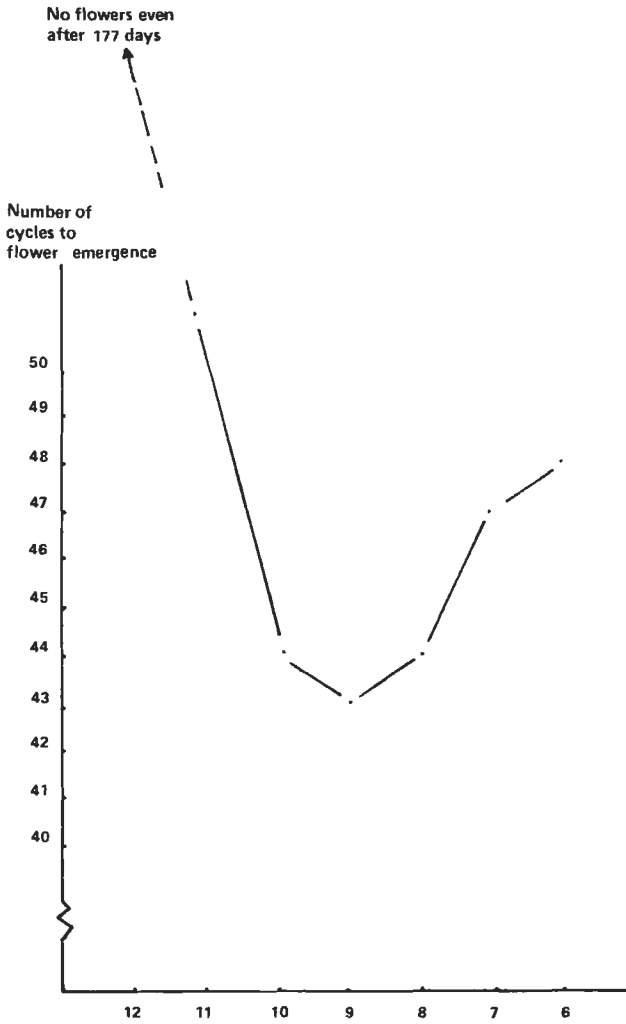


Fig. 6. Number of cycles needed to effect flowering in Elon-elon variety of rice.

line with Medawar's classification). If this were so, our subsequent studies on the effect of daylength on rice was a continuous dialogue between conjecture and refutation/confirmation hence, analytic.

First, we conjectured that rice might have a limit in daylight hours beyond which it would not flower — a so-called critical daylength. To find this limit, we subjected 45-day old plants to daylight cycles ranging from 6 hours to approximately 12 hours (natural day-length). Figure 6 shows that under normal day, no

flower emerged even after 177 days. (The normal day in March, when the experiment was started, has about 12 hours of light; it gradually lengthened towards April, May and June.) At 11 hours of light, flowers emerged after 51 cycles. The number of cycles decreased as the daylength was decreased reaching a minimum of 9 hours of light. When the daylength was further decreased towards 6 hours, the number of cycles for flowering became inversely increased. Unhappily, the critical daylength was not established in this experiment; perhaps it lies between 11 and 12 hours of light. Although we missed on the critical daylength, we were able to speculate from the results that light could have two complementary roles in flower formation: (1) it mediates in the elaboration of a substance (hormone) which triggers flowering, and (2) it helps form the plastic material (carbohydrates) which is the building block of the flower. In other words, light influences the form and substance of the shoot apex — the architecture and structure which underline all nature. The minimum number of cycles to flower-emergence obtained with the 9-hour daylight cycle indicates that, the optimum combination of the complementary roles of light occurs here.

This travel-log into the by-ways of thought and experience can be interestingly amusing. As Robert Frost said,

The woods are lovely, dark and deep,
But I have promises to keep,
And miles to go. . .

In order that my talk would not deteriorate into a second-childhood tale, let me summarize by saying that through the process of conjecture and refutation/confirmation, we seemed to have established the following facts:

1. The stage of ripeness to flower is attained at the age of 15 days. However, the number a short-day cycle for flower induction decreases as the plant grows older. The optimum age for short-day treatment is 45-60 days.
2. If we schematize the process of flowering into (a) flower induction (b) flower and initiation and (c) flower development, shortdays seem to affect all the three stages. On the other hand, mild temperature (21°C) during the dark period seems to affect markedly only flower development. It can not replace short-days in flower induction.
3. Synthetic growth accelerators (NAA) and growth inhibitor (MH) seem to have supplementary effects on short days.
4. The youngest, fully exserted leaf seems to be most responsive to short-day treatment. And,

5. The flowering stimulus does not seem to migrate to other non-induced tillers.

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DISCUSSION ON THE RESPONSE OF RICE TO LIGHT

Benito S. Vergara, Ph.D., Discussant

I would like to comment on a point Dr. Velasco made regarding the non-use of Philippine scientific articles in many technical papers he has read. We should analyze this problem and make the necessary campaign, and exert effort to rectify the problem. We certainly would like to hear the solutions to this problem from Dr. Velasco who has thought about it for many years. (I remember his concern about this problem more than 10 years ago when he attended the Pacific Science Congress).

A simple analysis of the problem may give the following reasons for infrequent citation of Philippine publications:

1. Philippine journals are not widely circulated. Even if they are, many students, scholars and scientists are not aware of their existence. What can be done about this? Are Philippine scientific journals abstracted by abstracting services? A study of IRRI publications, a relatively young institution, showed that a great majority of papers on rice published in the last 10 years cited IRRI publications.

2. In writing reports and scientific papers, scientists tend to go through the literature of the last 10 years only. This is so because literature dating earlier than 10 years back are either difficult to retrieve or expensive to retrieve. For example, most of the computer systems in Europe and USA will give you citations on a topic only up to the last 20 years. Depending on the research topic, most scientists will not spend more than a month going through the literature. We are all guilty of this. But is it always necessary to make a very exhaustive search? In many cases it is almost impossible.

3. Filipino scientists do not exert effort to cite Filipino publications in their papers. A paper published in 1919, like that of Dr. Peralta's, can be brought to the attention of young scientists only if it was cited in a recent paper or review. On the other hand, a look at a Russian paper will show that 99% of their citations are Russian. Similarly, the Japanese, Indians and Chinese have the same tendency. . . . but this is not so with the Philippine scientific papers.

4. The problem may also be the result of non-confidence in the data obtained by local scientists, as pointed out by Dr.

Velasco. I am not sure how serious this problem is. But, I do have full confidence in the scientific papers coming out of Los Baños. And my confidence is shared by many foreign scientists. I have not heard of any one questioning the reliability of their data.

There are varied reasons for the problems pointed out by Dr. Velasco — let us think of how we can contribute to its solution. And I hope the Academy can plan a program to help in getting our scientific papers better known not only locally but by the outside world as well.

Reynaldo A. Tabbada, Ph.D., Discussant

I will limit my discussion to photoperiodism itself which I think is the thrust of Dr. Velasco's paper. Since the 1920's when the phenomenon was discovered, all attempts so far to trap the product(s) of the photoperiodic stimulus have failed for one reason or another. From the 1920's to the 1950's, most studies have substantially described the gross morphological responses of different plants and classified these into different response groups — as short-day plants, long-day plants and so on. From the 1950's up to the present, plant physiologists have intensely pursued work on possible internal mechanisms and processes that may explain the photoperiodic behavior of flowering plants. Now, evidences, for example, have been established linking the photoperiodic behavior with the phytochrome system, a plant pigment. Other studies also have invoked the participation of hormones as a possible intermediaries in the flowering behavior of photoperiodic plants. The involvement of protein as well as nucleic acid metabolism in the photoperiodic response is also well documented.

But beyond these concepts, we really do not know the basic mechanism involved in the photoperiodic responses of flowering plants. In the case of the rice plant, Dr. Vergara's review of practically all available literature on the subject matter strongly indicates that most studies are basically descriptive in emphasizing the morphological responses when rice cultivars are subjected to varying degrees of photoperiodic treatment, number of photo-inductive cycles and so on. It is quite obvious then that such remains to be worked out. For one, we have not looked into what is happening inside the recipient of the stimulus, like the tillers. What events are taking place there? What are the structural changes that follow the perception of an inductive stimulus that would describe the photoperiodic nature of a specific cultivar. As pointed out in Dr. Vergara's review, such studies in the rice plant apparently have not been pursued for reasons I really don't know.

Geminiano de Ocampo, M.D., Discussant

I do not know why Dr. Velasco chose a physician to discuss his paper on rice culture. It might be because of my book on a System of Medical Research which is applicable to all life sciences. Biological research should start with the proper questions based on previous observations — clinical, laboratory or field, Theoretical and basic research should also start with a question even without any previous observation. In a research proposal, objectives are not sufficient. Specific questions on the objectives are necessary. The formulation of the proper question is one of the most difficult phases of any biological or other forms of investigation. If the proper research question is the starter of any worthwhile research, comparison and measurement are the crux of the expedition. Serendipity and discovery are in a different category of investigative endeavors. A discoverer need not be a good researcher. The results of an investigation are valid and valuable if they have answered the starter question or questions.

I recall that in 1946 soon after World War II, Dr. Velasco and I were among those sent to the U.S.A. for further studies. Dr. Velasco has a regard for a physician in healing a patient. In truth we just help the patient to recover from an illness. It is really the Almighty that heals.

The history of the proper questions on a research problem is very important. If photoperiodism is a concept in plant science, the proper questions on it should be framed before embarking on any investigation on it.

The application and implication of the results and conclusions of any investigation should be pursued further separately. Sometimes a researcher stops at its application but fails to grasp and pursue its implication. Sometimes the application of a concept is prematurely investigated without clarifying its basic aspects. Here is where applied basic research is needed. The research on laser and its application is a good example of this.

Literature research on a research question is very important. The research organization in the Philippines must confront this problem. Nationalism in biological and other areas of Philippine research should be promoted. Setting Philippine standards in all areas of our research is a challenge. Another problem of research in our country is acquisition of the proper instruments and the training of man to handle them.

Einstein and most Nobel Prize winners had concentrated on theoretical research. Basic research encompass theoretical research. We should engage more in directed applied and directed basic research. I am glad that the new science community leadership has set 15% of our research support towards basic research.

I know little about plant research but as in medical research there should be some classification of the meaning of "growth". In our research training more emphasis should be placed on semantics and framing of research questions.

I have formulated two basic concepts in ophthalmology and medicine, that of "self-renewal" in life and death and the postulation of five biological pathways, viability, development, differentiation, protection and proliferation. The phenomena of growth, flowering and fruit bearing are different activities in these different biological pathways. I hope these concepts on the subdivision of the genome will attract the attention of plant and animal biologists. I invite the biological groups of the Academy to scrutinize this concept. I would be very glad to expound on them in any appropriate place and time.

THE QUEST FOR THE CONTROL OF PHILIPPINE CORN DOWNY MILDEW

By Ofelio R. Exconde, Ph. D.

Abstract

Until about 1980, the annual Philippine loss in yield due to Philippine corn downy mildew caused by *Peronosclerospora philippinensis* (Weston) Shaw was estimated at 205,470 metric tons of corn valued currently at ₱267,111,000. After 16 years of research on the etiology of the disease and field testing of foliar spraying, seed-dressing and soil treating of nearly 800 chemical toxicants, Apron 35 SD (formerly Ridomil) has finally been found effective as seed-dressing. This fungicide can absolutely control corn downy mildew from seedling emergence until harvest.

Introduction

The causes of low yields in farmers field have been identified and discussed in several symposia/congresses sponsored by various government agencies and professional societies. The low yields are mainly due to a number of interrelated causes, viz. a) minimal usage of fertilizers, b) damage by diseases, particularly downy mildew, c) high losses due to weeds, d) damage by insect pests like corn borer, armyworm and corn maggots, e) insufficient control/lack of water, f) low usage of high yielding corn varieties, g) use of marginal and very unproductive land for corn production, h) lack of locally adaptable machineries and equipment for land preparation, planting and cultivation for small scale farming, and i) low adoption of recommended agronomic cultural practices (Mercado, 1976).

Of these interrelated causes of low yields of corn in farmer's field, I shall discuss only the role of downy mildew caused by *Peronosclerospora philippinensis* (Weston) Shaw. In the 1974-1975 crop year, our estimated national yield loss due to this disease was 8% with corresponding yield reduction of 205,470 metric tons valued at ₱178,759,000.

One of the adjuncts in the control of corn downy mildew is the use of downy-mildew resistant (DMR) varieties which have been developed from 1970 to date. Among the DMR's which have gained a fairly wide acceptance among farmers are Phil. DMR-2, Phil. DMR Composite 1, Phil. DMR Composite 2 and lately Ginintuan, an improved version of Thailand's Suwan 1. These varieties have an appreciable degree of resistance to downy mildew compared to UPCA Var. 1 and 3.

It can be noted from the above discussion that even though DMR varieties have been developed, some of these do not possess high level of resistance particularly under severe epiphytotic conditions. In view of this problem on some DMR varieties, a complementary control strategy, possibly the use of seed-dressing, should be considered in the overall management of corn downy mildew.

History of chemical control. Among the several methods of chemical application to control Philippine corn downy mildew, foliar sprays, soil treatments, and seed treatments either with protectant or eradicants had been looked into. Weston (1923) suggested the soaking of the seeds in 70% alcohol from 30 sec to 1 min; afterwards the seeds have to be washed in running water for 1 hr. and finally dried. Orillo and Gibe (1956) reported that out of the 8 fungicides sprayed in the field for the control of downy mildew, Phygon XL (50% 2, 3-dichloro-1, 4-naphthoquinone) and Fermate (76% ferric dimethyldithiocarbamate) were effective.

From 1962-1965, extensive seedbed and field tests of fungicides and antibiotics showed that under severe epiphytotic outbreaks, no fungicides could give adequate protection against the pathogen (Orillo et al. 1964; Exconde et al. 1965; and Exconde et al. 1966). The study made by Dalmacio and Exconde (1969) showed that the invasion of the shoot apex is a pre-requisite for systemic infection or complete chlorosis of all the leaves of infected plants. Also, they proved that the vulnerability of corn to infection by *P. philippinensis* decreases with plant age. With these findings, the use of protectant and systemic fungicides has been re-studied to gain more information on the use of chemicals for the control of this malady.

Extensive studies conducted by Dalmacio and Exconde (1971) and Exconde and Dalmacio (1971) on the use of protectant fungicides showed that 3 spray applications for Duter (10% triphenyl tin hydroxide) at 0.83 lb/100 gal at 2, 6 and 10 days after emergence and alternate 5 sprayings with Dithane M-45 (85% zinc manganese ethylene bisdithiocarbamate) at 2 lb/100 gal at 4, 8, 12, 14 and 16 days after emergence effectively controlled downy mildew. Schultz and Manimtim (1970) and Manimtim (1971) evaluated some systemic fungicides for seed treatment, foliar application and combination of the two. They found that neither dip nor dust applications of Bonlate (50% butylcarbamoyl 2 benzimidazole carbamate), Thiabendazole (40% 2-4 thiazalyl benzimidazole) and Polyoxin (10% polyoxin B) controlled downy mildew. Furthermore, combination of seed treatment plus foliar application of concentrated suspension of Uniroyal F 427 (75% 2, 3-dihydro-5 orthophenyl carboxynilido-6-methyl, 1, 4-oxathiin),

Thiabendazole, and Benlate to newly emerged seedlings did not control the disease.

Schultz (1971) found that corn seeds treated with Demosan (60%chloneb) by both slurry and dip applications reduced disease incidence up to 2-1/2 weeks after planting even when exposed to high inoculum density. Thereafter, he noted that the fungistatic proportion of the compound were either inadequate or its systemic movement was too limited to effect control.

Because of the need for new effective chemicals to control downy mildew, Exconde and Raymundo (1972) evaluated in seedflats and in seedbeds 9 experimental systemic fungicides. Results in seedflat experiments showed that CP 11-647-1 and EL-273 sprayed 4 times at 3-day interval gave 20.1% and 37.4% infection, respectively, compared to the untreated check which had 100% infection. Although CP 11-647 was promising at 5 m/l, it was phytotoxic.

Further study on foliar spray with 5 systemic fungicides starting 2 days after emergence at various frequencies and different intervals of spray application showed that at daily spray for 14 days, Cela (experimental) and Dexon (70% dimethylaminophenyl-diazonium sulfonate) gave 89 and 92% control, respectively. At every 3-day spray application also for 14 days, Dexon gave 80% control while Cela gave 58%.

It could be noted from the above that the most promising chemical method of controlling downy mildew is by spraying with Duter-Dithane M-45 combination. The economic feasibility of using Duter-Dithane M-45 to control downy mildew was studied by Raymundo, Exconde and Soriano (1973). We found that returns above added costs with 8 sprayings of Duter-Dithane M-45, 4 sprayings with Duter-Dithane M-45, on UPCA Var. 3 and Ph 801, amounted to ₱1,238.03, ₱1,202.02, ₱1,913.19 and ₱1,482.40, respectively.

Raymundo and Exconde (1976) evaluated the economic feasibility of resistant varieties, and fungicide application for the control of corn downy mildew. We found significant increases in yield in all treatments, except on 4 and 8 spray applications of Duter/Dithane M-45 during the dry season of 1973. We found further that the use of resistant varieties gave the highest additional income and spray application of Duter-Dithane M-45 gave generally lower income than with the use of resistant varieties. Eight applications resulted in highest increased income compared with 4 spray applications during the dry season but not during the wet season.

Field test of the oil's protective value either alone or in combination with Dithane M-45 on UPCA Var. 3 for 2 seasons was conducted by Estrada and Exconde (1976). Significantly, we

found low level of infections in both seasons from the oil- and oil-fungicide-treated plants compared with the control. F-1243 was slightly more effective than F-1805 when applied singly or in combination with Dithane M-45. Yield loss was consistently reduced among plants sprayed with F-1243+Dithane M-45 compared to other treatments. Furthermore, we found that the low incidence of downy mildew as a consequence of spraying with F-1243+Dithane M-45 resulted in an increased yield and consequently in economic returns. In all cases, F-1243 + Dithane M-45 gave the highest added returns.

Ridomil: — A newly discovered fungicide for corn downy mildew control. — It will be seen from the foregoing discussions that none of nearly 800 fungicides tested from 1962 to late 1977 has offered substantial solution to the downy mildew problem. Perhaps, it is worth looking back on the few random thoughts on the future outlook of the downy mildew problem in East Asia and Southeast Asia which I have stated in a special lecture I delivered in the first International Downy Mildew Conference held in Nanintal, India in 1969 and in other meetings and symposia (Exconde, 1970; 1973; 1974). In all of these meetings/symposia I sounded off a call to the chemical companies around the world to include the Oomycetes in the group of pathogens being used to evaluate the biological spectrum of their candidate chemicals. In all of these occasions I also conceptualized the kind of chemical that could be adapted by farmers in combating the downy mildew problem in the region. I opined that a seed dressing fungicide that can be taken into the system of the corn plants and protect the corn plant from the downy mildew pathogens for at least 6 weeks is wanting. It seems that Ridomil has provided the answer to some of the thoughts that I have conceptualized regarding corn downy mildew control by chemicals.

The experiments on Ridomil. — In July 1977 Ridomil WP 10 and WP 25 were made available to us by Mr. Wolf R. Dinnendahl, Agro-chemical Division, Ciba-Geigy, Philippines, for evaluation as foliar spray for downy mildew control. As what I have contended before that the most realistic method of controlling corn downy mildew is by means of seed dressing, it has always occurred to me that new fungicides should be evaluated first by seed dressing, then foliar spraying and if necessary by soil application.

On 8 August 1977, preliminary study on seed dressing of Ridomil WP 10 was made with rates of 2, 4, 6 and 8 g a.i./kg seed plus untreated seeds. Treated and untreated seeds were planted in plastic trays and then the seeded trays were exposed underneath the mildewed corn plants in the field for 30 days. Our results showed that at all rates tested, no infections of downy mildew

were observed compared to 45% infection in the untreated seeds which occurred as early as 3 weeks after planting.

In November 1977, field experiments on foliar spraying as recommended by the company were undertaken. Two frequencies of spraying, 4 and 8, both on protectant and eradicant tests were made. Results showed that in both frequencies of spraying, Ridomil used either as protectant or eradicant did not effectively control corn downy mildew.

In view of the failure of Ridomil to control Philippine corn downy mildew by foliar spray applications as originally conceived by Ciba-Geigy and because of the very encouraging results on seed dressing we have obtained in our preliminary experiments, 4 field trials on seed dressing in replicated plots were made from November 1977 to February 1978. Two trials were conducted under moderate low inoculum density. In all trials seed dressing was by "slurry". Infection percentage was taken at 16, 23, 30, 42 and 63 days after seedling emergence by taking the ratio of the total infected plants and the total population multiplied by 100. In 2 trials, the crop was harvested as green corn, 63 days after emergence, while the other 2 trials, the crop was harvested at 110-120 days after planting as unshelled corn.

Results of all trials conducted under moderately low and high inoculum densities showed that all rates tested, (2, 4, 6 and 8g a.i./kg seed) no infection of downy mildew was observed from seedling emergence until harvest, either as green corn or unshelled corn (Exconde and Molina, 1978). The lowest rate of 0.5 g a.i./kg seed on moderately resistant variety performed as good as 1 g a.i./kg seed on a susceptible variety. We believe that the present finding is considered as a significant "breakthrough" in the long (16 years) elusive search for the chemical control of corn downy mildew, the most destructive disease of corn in the Philippines. Furthermore, the ease by which the chemical can be applied to the seed and the small amount of chemical needed to sustain 100% control of corn mildew from seedling emergence until harvest makes Ridomil a "wonder" chemical for corn downy mildew control.

Regional trials of Apron 35 SD on varieties and hybrids. — In 1978-79 wet and dry seasons, trials were made at Tumauni, Isabela; Musuan, Bukidnon; Kabacan, North Cotabato and UPLB. Results showed that on untreated seeds of UPCA Var. 1 infection in the wet season ranged from 52 to 100%, while in the dry season, infection ranged from 11 to 80%, compared to the treated seed which had zero infection in both seasons. On DMR Comp. 2, untreated seeds in the wet season had infection ranging from 10 to 48%, while no infection occurred from the treated seed. In the dry season, on DMR Comp. 2, untreated seed had infection ranging

from 4 to 25%. On the other hand, treated seed had zero infection.

Trials made on hybrids at Pili, Camarines Sur showed that infection on untreated seeds at 30 and 60 days after planting ranged from 1.6 to 40.3% compared to the treated seeds which had no infection. Significant differences in yields between treated and untreated seeds and among hybrids were obtained. Yields of more than 5 tons/ha were obtained from some hybrids.

At General Santos, South Cotabato infection from untreated seeds ranged from 34 to 100% at 32 and 38 days after planting, compared to no infection from treated seeds. Yield obtained from treated seeds ranged 3.88 to 5.50 tons/ha.

Some Factors Affecting the Efficacy of Apron 35 SD as Seed-Dressing Fungicide

A number of factors that may affect the efficacy of Apron 35 SD as a seed-dressing fungicide to control Philippine corn downy mildew has been studied (Molina and Exconde, 1981 a & b). This includes methods of seed dressing and frequency of rainfall and amount of water used in the preparation of slurry, storage duration and temperature. Germination of treated seeds and subsequent downy mildew infection in the field under high inoculum pressure (spreader rows had 40 to 50% mildewed plants) and moderate inoculum pressure (spreader rows had 5 to 15% mildewed plants) were considered in evaluating the efficacy of each treatment combination.

Methods of seed-dressing. — Apron 35 SD was evaluated when applied as dust or slurry through some crude but seemingly practical ways. Under condition of high inoculum density, the slurry treatment was more efficient than dusting. Infection ranged from 6.2 to 18.2% and 0 to 5.7% for dusting and slurry, respectively. Among the several methods tested in applying the slurry, the wide mouth gallon jar and cement mixer appeared to be more efficient than shoveling, plastic bag and plastic pail.

Under moderate inoculum density, however, slurry and dusting were equally effective, except when the fungicide was applied as dust by shoveling wherein an infection of 4.3% was obtained. On the other hand, all plants in the other treatment combination were completely free from downy mildew infection as compared to the untreated check which had 67.8% infection.

Duration of rainfall. — Effects of frequency and duration of rainfall on the effectiveness of Apron 35 SD showed that the frequency of heavy rainfall did not affect the effectiveness of Apron 35 SD. The efficacy of seed treatment subjected to daily rainfall of 20 mm/day for 3 weeks starting immediately after

seeding was not different from that of lesser frequency. Plants grown from treated seeds were completely free from mildew under different rainfall conditions compared to the untreated check which had 97.6% infection.

Storage duration and amount of water. — Results showed that seed germination ranged from 96 to 100% among seeds treated with Apron 35 SD either as dust or as a slurry with the use of either 5 ml or 10 ml water/kg seed. When the amount of water was increased to 20 ml, 30 ml and 40 ml/kg seed, seed germination was 86, 33, and 16%, respectively after storage of 150 days. However, the depressive effect on seed germination was not noticeable regardless of the amount of water used in the preparation of slurry, when treated seeds were not stored.

The depressive effect of high amount of water added to the seeds in relation to duration of storage showed that even without treating the seeds with Apron 35 SD, seed germination was adversely affected by the addition of 20, 30, and 40 ml water/kg seed.

The germination of seeds treated with Apron applied as dust or slurry with either 5 or 10 ml water/kg seed was comparable to the untreated regardless of the storage duration.

Rate, storage temperature and duration. — Results on seed germination as affected by rate of Apron 35 SD, storage temperature, and duration showed that seed germination was not affected by any of the treatments. Seed germination ranged from 93 to 100%.

Efficacy of each treatment combination against downy mildew under field condition showed that untreated seeds sustained as high as 97.8% infection. On seeds treated with Apron 35 SD at the rate of 0.5 g a.i./kg seed and stored at two temperature levels and duration of storage periods, infection ranged from 7.8 to 23.8%. Infection at this rate started as early as 14 days after emergence and increased thereafter until about 35 days after emergence when no increment in infection occurred. On the other hand, treatment combinations with 2.0 g a.i./kg seed were completely free from downy mildew from seedling emergence until harvest, regardless of storage duration and temperature.

Apparently, storage duration as well as temperature at storage did not influence the infection percentage. The differences on mildew infection were more of a function of the rate of Apron 35 SD, rather than duration and temperature at storage.

Corn Downy Mildew Control. Now a History

The recent breakthrough in the chemical control of Philippine corn downy mildew caused by *Peronosclerospora philippinen-*

sis with the use of Apron 35 SD has answered the long sought solution to this most destructive disease of corn in the country. As a seed-dressing fungicide, the use of Apron 35 SD apparently agrees with the common belief that the more practical way of controlling diseases of cereals, such as corn, by chemical means is by seed-treatment. Its effectiveness in controlling corn downy mildew, the ease by which this chemical is applied, and the small amount needed to sustain 100% control will surely make its application acceptable and adaptable by farmers.

Hand-in-hand with the use of Apron 35 SD is the development and release of resistant varieties/hybrid to downy mildew plus the wide-scale planting of these resistant varieties/hybrid is another key factor that would ultimately provide solution to the once dreaded downy mildew of corn. With the use of the above control strategies, we can truly say now that we cannot afford to lose millions of pesos worth of potential production every year due to downy mildew alone.

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DISCUSSION ON THE QUEST FOR THE CONTROL OF PHILIPPINE CORN DOWNY MILDEW

Manuel M. Lantin, Discussant

The downy mildew disease caused by *Perenosclerospora philippinensis* (Weston) has been one of the major constraints to corn production in the country. The estimated loss in yield, as pointed out by Dr. Exconde, is indeed staggering. The amount (over 200,000 metric tons) is only slightly less than our current yellow corn importation. An effective and inexpensive means of control of this disease will definitely improve productivity and income in our corn growing areas.

The importance of Philippine corn downy mildew disease has been fully recognized in the agricultural research community. For many years corn research was concentrated on the development of effective means of controlling the disease. Solution to the problem was approached basically from two distinct directions. The first was through genetically endowed resistance to the disease and the other was through chemical control.

Varietal improvement efforts at U.P. at Los Baños have been primarily aimed at the development of downy mildew resistant cultivars. For a long time, this has been the single most important objective of the breeding program. Through the concerted efforts of the maize breeder and pathologist several varieties/populations with relatively high degree of resistance to the disease have been produced and released for commercial production.

On the other hand, efforts to control the disease through chemical means consisted of screening/testing of a large number of chemical toxicants. The long years of search met very little success until four years ago when the fungicide Ridomil (now Apron 35 SD) was found to provide effective control when used as seeddressing. The discovery of Ridomil is indeed a "break-through" in chemical control research and may be considered one of the most significant outputs of agricultural research in the Philippines during the late 1970's.

The availability of a fungicide that provides practical and effective control of downy mildew disease has some important implications on other control strategies particularly on the use of varietal resistance. Breeding for downy mildew resistance has been and will remain a major objective of maize varietal improve-

ment program in the Philippines. However, with the breakthrough in chemical control, some efforts can now be focused on other breeding problems. The use of chemical could compensate for the low to moderate resistance usually possessed by the higher yielding or elite maize genotypes/populations. Normally, such genotypes are excluded and forever lost in a selection program where downy mildew resistance is given a high priority.

An almost immediate consequence of the discovery of Apron 35 SD is the advent of "new" technology concerning the varietal component of the production package for corn. The chemical has made possible the use of downy mildew-susceptible but high yielding corn hybrids. Four of such hybrids are currently being used in the Maisagana Program.

After all is said about the now available technologies for the control of downy mildew, could we claim that the downy mildew pathogen has finally been licked? During the past 2 or 3 years little incidence of downy mildew disease in the corn fields was reported. The findings are very encouraging and could lead one to believe that the downy mildew problem has indeed been solved. I believe that we would be grossly naive and appear uninitiated to think along this line. We know that we are dealing with a dynamic living organism (pathogen) with a capacity to adapt to changes in conditions surrounding it. We have heard stories about resistant crop varieties succumbing to the same species of pathogen (presumably of different race). In much the same way, pathogens could evolve races or strains to which a certain chemical would prove ineffective. Development of resistance of pathogens to certain chemicals has been reported. This is a distinct possibility that we in corn research should consider.

Fernando Sanchez, Ph.D., Discussant

The long search for an answer to the corn downy mildew problem has all the way been an uphill battle. For many years there was little progress, then came the downy mildew-resistant varieties that helped the corn farmers in this country to increase their production. However, the degree of resistance to the disease was only low, to at most moderate, so losses persisted despite the availability of these downy mildew resistant varieties.

The discovery and development of Apron (metalaxyl) after many years of work by Dr. Exconde and his group was indeed a great contribution. Used at the recommended rate, it provided 100% protection against the disease. Be that as it may, it is a discovery that has really not been fully exploited. It means it has not really filtered down to most of the corn farmers. Why is this?

There are many problems related to the adoption of this important discovery. First, there is distribution problem. It is not available to most because it is not readily available in the market. And if it is available there is the problem of lack of purchasing power on the part of the farmer. Or otherwise the farmer is not able to exploit this development. To some extent, the Maisagana Program has solved some of these restraints to the full utilization of this important discovery.

Like most chemical control methods, there is a distinct possibility of development of resistance as Dr. Lantin has earlier alluded to. We cannot really stop at this point with the discovery of this important fungicide. We can say that we have won a battle but the war is still on.

There is need for new chemicals to replace APRON. That is definite. If and when resistance comes we should be ready. But the prospects for new chemicals is not that good. About a decade ago, to produce a chemical from the synthetic laboratory to commercialization cost about 2-3 million dollars. Nowadays it may cost from 40-45 million dollars. So, who's willing to invest capital money of that magnitude? The prospects for new developments is really not too good.

In the crop protection field there is no such thing as a permanent solution. Resistance to pest/disease in resistant varieties break down and pests and pathogens develop pesticide resistance that confer to them immunity from previously effective pesticides. It is a never ending battle between pests and man. We can only hope to be a few steps ahead of the pests.

ACCIDENTAL HUMAN PHILOPHALMIASIS IN THE PHILIPPINES

By Carmen C. Velasquez, Academician

Referred to me for diagnosis were 3 flukes out of 6 removed from the eye of a woman from Ilocos Norte admitted for treatment in the North General Hospital in Manila. The patient complained of lachrimation and purulent exudate for three years. The specimen were stained in borax carmine and mounted in permount. Although the specimens were damaged due to improper method of removal, diagnosis was possible. The trematodes belong to the genus *Philophthalmus* Looss, 1899. This finding constitutes the first case of human philophthalmiasis in the Philippines and the third in the world.

Microphotographs and camera lucida drawings were made. Measurements are in mm unless otherwise stated. Averages are in parentheses.

Philophthalmus III

Diagnosis (based on 3 specimens); Body elongate 5.03 to 9.48 (7.2) long by 1.55 to 2.7 (2.26) wide. Tegument aspinose. Oral sucker subterminal 0.45 to 0.825 (0.62) long by 0.5 to 0.6 (0.566) wide. Pharynx 0.35 to 0.70 (0.53) long by 0.625 (0.57) wide. Acetabulum 0.73 to 0.78 (0.755) long by 0.70 to 0.95 (0.825) wide. Ratio of oral sucker width to acetabular width 1:1.3 to 1.46. Esophagus 0.38 to 0.55 (0.436) long. Ceca extending to near posterior end.

Testes intercecal, 0.38 to 0.725 (0.576) from posterior tip of body; tandem to obliquely tandem, slightly lobed. Anterior testis 0.25 to 0.375 (0.30) long by 0.40 to 0.625 (0.523) wide; posterior testis 0.275 to 0.375 (0.358) long by 0.45 to 0.55 (0.358) wide. Cirrus sac on left side of acetabulum, extending to about the posterior level of the acetabulum 0.55 to 0.925 (0.90) long by 0.175 to 0.375 (0.308) wide at its dilated end, containing the internal seminal vesicle and reversible cirrus.

Ovary pretesticular, spherical, clearly seen in one specimen, 0.225 to 0.325 (0.266) long by 0.30 to 0.35 (0.316) wide. Mehli's gland immediately postovarian; Laurer's canal? Uterus partly extracecal occupying available space between acetabulum and anterior testis. At level of the posterior border of acetabulum lying close to the left side, the terminal portion of the uterus runs

parallel to the cirrus pouch to open at the common genital pore, which in two specimens protrude to the right, posterior to the intestinal bifurcation. Vagina 0.50 to 1.125 (0.833) long. Vitellaria extracecal, tubular with irregularly spaced tubules; extending from the midbody to the level of the anterior testis, at which level, the glands on both sides meet medially posterior to ovary. Eggs in utero with eyespots 100 to 125 (115) long by 38 to 75 (58) wide microns. Excretory pore posteroterminal; excretory bladder opening to the exterior by the median excretory pore.

Host: Man

Location: Conjunctiva

Locality: Ilocos Norte, Philippines

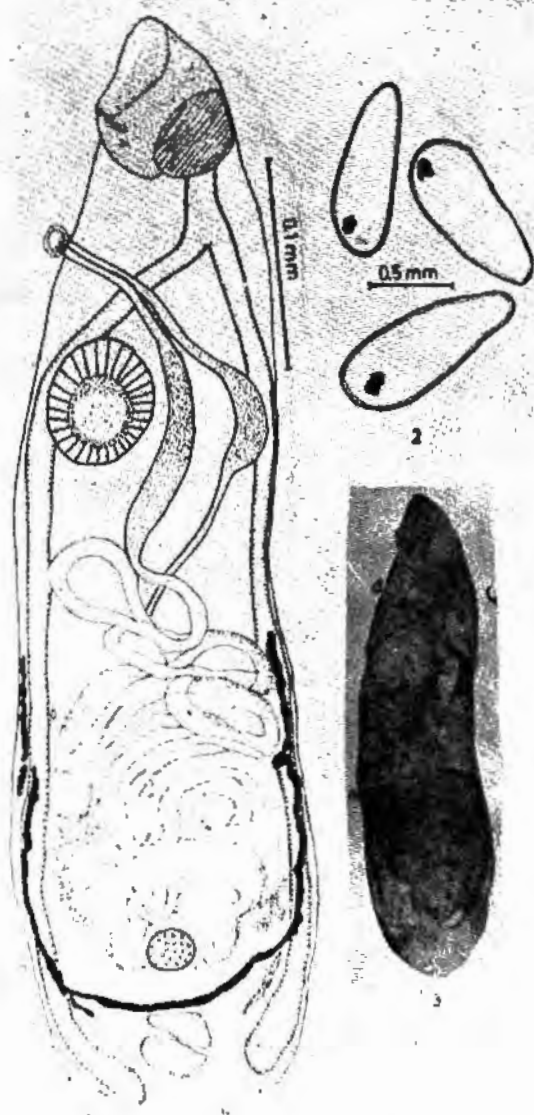
Deposited in the C.C.V. Helminthological Collection

Discussion

The genus *Philopthalmus* Looss, 1899 was created for flukes infesting the eyes of birds. Several species have been recorded from the eyes of avian hosts in different parts of the world. Table 1 shows those reported in Asia and Southeast Asia. Tubangui's check list (1947) includes *Philopthalmus problematicus* Tubangui, 1932 from a domestic chicken in Manila and *Philopthalmus rizalensis* Tubangui, 1932 in a domestic duck from Pateros, Rizal. Both species were recovered from the conjunctival sac of the birds.

Philopthalmus III is bigger than the single specimen of *P. problematicus* in Manila from a Rhode Island Red hen imported from the United States and from *P. rizalensis* in the domestic duck from Pateros, Rizal. It is closer to *P. problematicus* in length and position of the cirrus sac but differs in shape and size of the testes; the eggs are bigger about the same size as those from the domestic duck *P. rizalensis* from Pateros, Rizal and *P. anatinus* from Formosa. It falls within the size range of *P. gralli* in the domestic chicken from Tonkin (Mathis and Leger, 1910) and Formosa (Sugimoto, 1928), *P. anatinus* Sugimoto, 1928 from the domestic duck, in Formosa, *P. mirzai* Jaiswal and Singh, 1954 from the common Kite, *Milvus govinda* and *P. indicus* Jaiswal and Singh, 1954 from the Smaller White Scavenger Vulture, *Neophron porenopterus gingianus* in India. The most distinguishing features of *Philopthalmus* III from the human eye are the length and position of the cirrus sac, the shape and position of the testes and size of eggs which is smaller than *P. gralli* from Tonkin and bigger than *P. gralli* from Formosa and *P. mirzai* and *P. indicus* from India.

Included in Table 1 are two philopthalmids reported from the human conjunctiva, that of *P. lacrymosus* (Braun, 1897) by Markovic (1939) in Belgrade and *Philopthalmus* sp. in Ceylon (Dis-



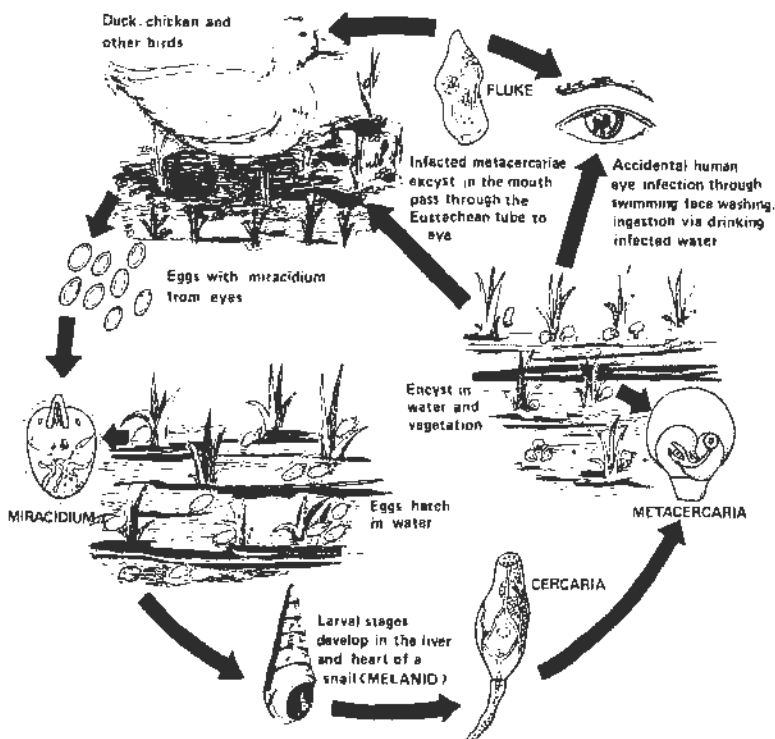
Figures 1,2,3.

sanaïke, 1958). *P. lacrymosus* was found earlier in a gull (*Larus maculipennis*) in Brazil and later found by Markovic and Garzicic (1939) in a gull in Belgrade. They believed the infection to be direct to the conjunctiva while the patient bathed in the Sava River. The philopthalmid from a patient in Ceylon was from an Indian resident. He had a history of visiting his home country and bathed in a stream frequented by ducks and crows in Tinnevely, South India (Dissanaïke, 1958). The Belgrade infection caused follicular conjunctivitis whereas the Ceylon fluke caused irritation and tenderness of the eyes. In both cases the lesions disappeared after the removal of the worms. At the time, the developmental cycle of any philopthalmid was unknown, hence there was no definite conclusion regarding the mode of entry of the parasite. Dissanaïke (1958) conjectured that an "already adult fluke may have fallen off the eye of a bird and invaded the eye of the patient while he was bathing or more probably, the infection took place through the cercaria stage either directly or via the bloodstream". However, he was of the opinion that the cercaria has directly entered the conjunctiva and developed to maturity there.

Philopthalmus III from the human eye in the Philippines can be distinguished from those previously described in human from Belgrade and Ceylon by its bigger size, position of the gonads and genital aperture, shorter cirrus than *P. lacrymosus* and longer than *P. sp.* from Ceylon. The eggs with eyespots are bigger than the two philopthalmids from the human eye.

Philopthalmus III cannot be identified with any of the philopthalmids in Table I. The writer is not inclined in erecting a new taxon until more specimens from avian hosts are available for study.

The family Philopthalmidae Travassos, 1921 are digenetic trematodes and require a snail as intermediate host. They are ovoviviparous since the eggs contain a well formed miracidium. The developmental pattern of *P. gralli* as elucidated by West (1961) in Indiana in the United States and later Cable and Hayes (1963) designated it to be *P. megalurus* (Cert, 1914) and that of *P. gralli* by Alicata (1962) in Hawaii, the eggs hatch in the water and the miracidia actively bore into the tissues of a suitable snail where the larval stages develop. The cercaria are released in the water and encyst as metacercariae on the surface of vegetation or other objects. The encysted flukes are infective to the final host. In Hawaii, the flukes utilized melanid snails, *Stenomelania newcombi* and *Thiara granifera* as intermediate hosts. Experimentally *P. gralli* has been found to develop in the eyes of rats and rabbits (Alicata and Ching, 1960).



Life Cycle of a Philophthalmid
Figure 4.

From the above, the philophthalmid infection from the human eye in the Philippines might have taken place through the cercarial or metacercarial stage directly by washing the face with contaminated water or bathing in contaminated waters frequented by birds (Fig. 4).

Acknowledgement

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ACCIDENTAL HUMAN PHILOPTHALMIASIS IN THE PHILIPPINES

Geminiano de Ocampo, National Scientist

Ocular parasitic infestation has been reported here and elsewhere. It is quite rare in comparison with ocular infection by bacteria, virus, and fungus, Schistosomiasis is quite frequent and it is a public health problem in the Philippines. In the case reported the route of infestation seems to be direct from the outside. The ocular manifestations of the case seems to be a combination of bacterial infection superimposed on fluke infestation. Could there be some toxin secreted and or excreted by the flukes? Mechanical factors must have played in the pathogenesis of the ocular lesion.

Ophthalmomiasis has been reported many times. What is of fundamental interest in its manifestation is the feeding by the worms on the necrotic tissue but not on the live tissues. In any infected-infested corneal ulcer there are areas which are necrotic, infected, toxin affected and normal tissue. What is of fundamental interest here is how the maggots can recognize the dead and the necrotic tissue upon which they fold. As a matter of fact the problem of determining whether a cell or intercellular tissue (fibers and membranes) is dead or alive is a basic question which we have investigated for many years by numerous experiments. These form the background of our concept that the most essential property of living cells and non-cellular membranes and fibers is biological self renewal or in simple terms, biological "turn over". This is the most significant property of living things. Dead structures cease to undergo self-renewal. How the maggots can differentiate the necrotic from the living tissue challenges imagination and investigation.

Dr. Edito G. Garcia, M.D., Discussant

The data presented and reviewed by Dr. Velasquez indicate that trematodes of the Family Philophthalmidae and particularly of the Genus *Philophthalmus* are enzootic in portions of the Philippines like areas around Laguna de Bay Lake. These flukes are commonly called "eye flukes" of birds although some species also inhabit avian intestines.

Although the case presented is only the 3rd reported in humans, it is possible that more cases actually occur. The potential for exposure or contact with philophthalmid cercariae or metacercariae may actually be significant among duck raisers, fishermen and children at leisure in endemic areas. Consequently it is suggested that further studies be done. These should include:

1. identification of endemic areas
2. determination of prevalence in ducks and possible economic loss resulting from infections
3. determination of frequency of philophthalmiasis among duck raisers, fishermen and other potentially exposed segment of the human population in endemic areas.

This will lead to indicators for determining if this group of trematodes is a problem of health needing more attention.

PESTICIDE –INDUCED CHROMOSOMAL ABERRATIONS AND INHERITANCE OF VIABLE SEEDLING MUTATIONS IN SORGHUM

By Joventino D. Soriano, Academician

Abstract

Seeds of sorghum were treated with "Folidol" at concentrations ranging from 0.20%-0.80% for five hours at 30°C. The pesticide appears to be a more effective treatment for inducing numerical than structural changes in chromosomes. Both sub-lethal and lethal concentrations induced chlorophyll-deficiency seedling mutations. While the *striata* seedling mutation was inherited as a monogenic recessive character, a *virescent* seedling mutation was found to be a digenic character presumably due to the induction of two independent gene mutations acting as duplicate factors. One of the gene mutations probably occurred in a chromosome of the genome while the other took place in a segment of an extra chromosome which had probably become attached to one of the four chromosomes that ordinarily forms a rod bivalent at MI thereby causing the increase in chiasma frequency to 17.0-18.0 per meiocyte. The study shows the need for determining the genetic nature of induced mutant characters in experimental mutagenesis to unravel new knowledge for human advancement.

Introduction

Hundreds of mutagenic substances are now known existing in the human environment ranging from common food additives to highly reactive biocides. Many studies during the last 30 or so years have successfully demonstrated the mutagenicity of pesticides on seeds, seedlings and plants at different stages of growth and more work will likely be done on the problem as new pesticidal preparations are made available. It is quite ironical that the pesticides used in the modern technology of crop production have been found by some investigators to be sources of potentially-hazardous substances to man. This situation could be very serious in some tropical regions where cropping is year round requiring more or less continuous pesticide applications.

Many investigators working on the mutagenic effects of pesticides on plants agree that both numerical and structural changes are induced by these chemical compounds. Pesticides have been reported to alter the chromosome number in cells by acting as spindle poisons, causing stickiness of chromosomes, delaying chromosomal disjunction or inhibiting cross-wall formation^{5, 12} and cause breakage of chromosomes by inhibiting protein or nucleic

acid synthesis or acting as plain radiomimetic substances^{11, 14}. While a few workers have reported that pesticide-induced mutations are easily inherited by the offspring^{3, 21} others found that some induced morphological malformations were not transmitted to the progeny⁶. There is no doubt that a preponderance of the reports show that pesticides possess sufficient mutagenic properties to be effective treatment for inducing genetic variability in plants.

More studies need to be done on the genetic effects of pesticides not only to increase our understanding of these problems and to test the mutagenicity of new pesticidal solutions but also to advance the work in experimental mutagenesis toward determining the nature of the mutant gene. While the types of pesticide-induced chromosomal configurations have been closely observed, very little interest appear to have been given to the genetic nature of mutant characters. Mutagen-induced genetic characters inherited like those of spontaneous origin enable us to gain some understanding of the problems related to the origin and nature of organic variability. Spontaneous heritable variations, however, have undoubtedly passed the test of adaptation where viability and fertility are the major criteria for survival.

The main objectives of this work were to determine the types and frequencies of chromosomal aberrations and chlorophyll mutations induced by "Folidol" pesticide and to study the inheritance of the viable types of mutant seedling characters.

Materials and Methods

Dormant seeds of sorghum (*Sorghum vulgare* Per.) were treated with aqueous solutions of "Folidol" at concentrations ranging from 0.20%-0.80% for a period of 5 hours at a temperature of 30°C in a constant temperature waterbath and washed in running water for 3 hours to remove the excess chemical. Previous trial treatments with more than a dozen other pesticidal preparations showed that only "Folidol" had the mutagenic potential as evidenced by reductions in seed embryo growth and occurrence of aberrant root-tip chromosomes. "Folidol" contains as active ingredients 50% of 0,0-dimethyl-O-p-nitrophenyl phosphorothioate.

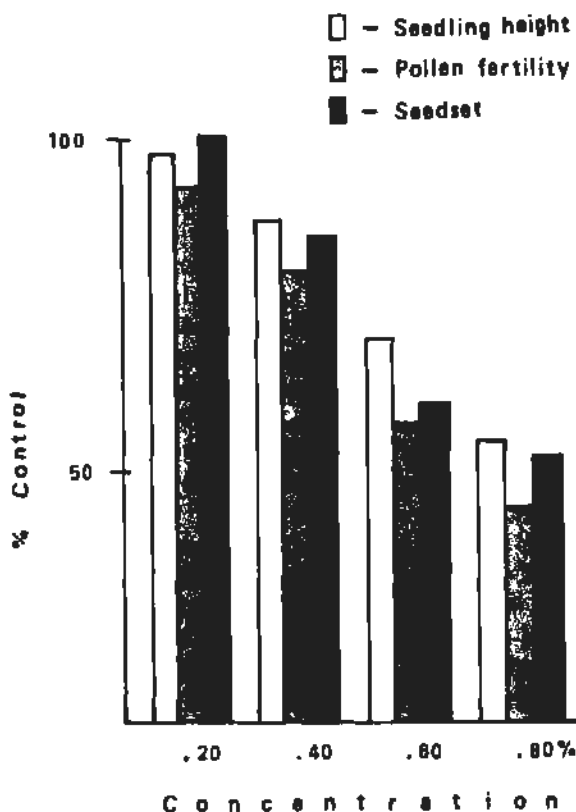
Some of the seeds were grown in "blotter sandwich" in growth room with a temperature range of 28°C-30°C, about 98% humidity and uniform and constant fluorescent illumination of about 120 footcandles for measurement of seedling height 7 days after germination. Most of the seeds were sprouted on moist blotting paper in petri dishes and then planted directly in field rows at the Botany Experimental Garden and the Biosaline Experiment Station in a randomized concentration-to-row plan with three replications.

Flower buds were preserved in freshly prepared Farmer's fluid and stored at low temperature. The anthers were prepared for microscopic examination employing the smear technique using aceto-carmin stain. The M_2 seeds were sown spike-to-row for types and frequencies of chlorophyll-deficiency seedling mutations.

In the second year of the work, reciprocal crosses were made involving plants of the wildtype green seedling lines and the viable types of chlorophyll-deficient seedling lines. Most of the F_1 hybrids were selfed while the rest were back-crossed to the wildtype to determine the segregation ratios in the F_2 and BC progenies.

Results and Discussion

M₁ plant responses. The effects of "Folidol" on seedling height, pollen fertility and seedset as compared with the control are shown in the following diagram:



In the control lines, the mean seedling height was approximately 16.34 ± 0.467 cms.; pollen fertility, $94.02 \pm 0.97\%$ seedset $92.28 \pm 0.718\%$. LC50 for seedling height was found at a concentration of approximately 0.62%; pollen fertility, 0.44%; and seedset, 0.57%; indicating that a less concentrated pesticide solution produces a similar degree of response fertility than on embryo growth and seedset. In general, the data indicates that reductions in seedling height, pollen fertility and seedset increased with increasing concentrations of the pesticide.

Based on the degree of M_1 plant responses, the pesticidal solutions can be grouped into sub-lethal and lethal treatments, the latter causing marked reductions in seedling height, pollen fertility and seedset. Thus, 0.20% and 0.40% were sub-lethal solutions while 0.60% and 0.80% were both effective phytotoxic and gametotoxic treatments reducing seedling height by as much as 32% - 47%; pollen fertility, 52% - 78%; and seedset, 41% - 59%.

Similar M_1 plant responses to high concentrations of other pesticides have been reported such as 2, 4-D, Thiodan, Folithion, Labaycid, Kitacin, Alanap, Atrazine, Lotran, Banwel, Cystrol, Endrin, Lorox, Sevin, Simazine and others^{8, 16}. Reductions in seedling height are reportedly due to inhibition of cell division at the meristematic regions while fertility reductions are caused by death of gametophytes from chromosomal fragmentation and other cytological abnormalities^{6, 8, 21}.

Chromosomal aberrations. The types and frequencies of chromosomal abnormalities induced by "Folidol" observed at metaphase I and anaphase I of meiosis are as follows:

At Metaphase I

Concentration %	Total plants examined	Numerical No.	Changes %	Interchanges	
				No.	%
0	58	0	—	0	—
.20	65	1	1.54	0	—
.40	51	4	7.84	2	3.92
.60	47	5	18.64	2	4.25
.80	52	10	19.23	7	21.54

At Anaphase I

Concentration %	Total plants examined	Bridges/Fragments		Laggards	
		No.	%	No.	%
0	58	0	—	0	—
.20	65	0	—	0	—
.40	51	1	5.88	2	3.92
.60	47	2	4.25	4	8.51
.80	52	2	7.69	9	17.31

Out of a total of 215 M_1 plants which were sources of young florets for cytological study, 51 plants or about 23.72% gave meiocytes with aberrant chromosome number or structure. None of the control plants showed any sign or evidence of abnormal meiosis. Based on pesticide concentration, treatments with 0.20% gave only one M_1 plant or 1.54% with an aberrant meiosis; 0.40%, 9 plants or 17.65%; 0.60%, 13 plants or 27.66% and 0.80% 28 plants or 53.85%. The frequency of chromosomally-aberrant plants increased more or less linearly with concentration.

The cytological data show that "Folidol" causes both numerical and structural changes in chromosomes. However, the pesticide proved to be a more effective agent for numerical aberrations than structural changes, i.e., it is a less effective treatment for chromosomal breakage than for altering the chromosomal number in the cell. Of 51 M_1 plants with aberrant meiosis, 35 plants or about 68.63% gave numerical aberrations while 16 plants or about 31.37% yielded structural changes. Although similar data were reported by other workers using various kinds of pesticides^{3, 4, 5} the difference in these two types of cytological effects due to treatment have not been recognized. This is quite important in experimental mutagenesis work because some of the treatments that have been previously reported to be exclusively mitotic poisons for several decades are now turning out to cause chromosomal breakage as well.

The numerical changes in chromosomes observed at metaphase I were aneuploidy or extra individual chromosomes of up to two or three chromosomes and euploidy or multigenomic chromosome numbers. At anaphase I, laggard chromosomes were mostly found in plants from the higher concentrations. The structural aberrations found at anaphase I were interchange configurations consisting of both rings and chains of four chromosomes. It was noted that only one or two such configuration per meiocyte was observed. At the anaphase I stage, chromosomal bridges with or without acentric fragments were found. Only one to three such anaphase configurations were observed per cell. It is of interest to note that plants with numerical aberrations showed a significant number of prophase I meiocytes with densely or loosely clumped chromosomes.

Some workers^{5, 12, 16} attribute the numerical changes in chromosomes as being due to some pesticides acting as spindle poisons, delay or inhibition of chromosomal disjunction, modification of the chromosomal surface or inhibition of crosswall formation. On the other hand, a number of investigators^{3, 4, 11, 14} reported that the mechanism of chromosomal breakage by pesticide treatment is similar to that by X-rays and various known chemical mutagens, i.e., through interference or inhibition of pro-

tein and nucleic acid synthesis or through radiomimetic action^{5, 8, 11, 14}. The clumping of chromosomes at the early stage of meiosis has likewise been previously reported^{3, 7}.

Seedling mutations. The data on mutation rates after seed treatment with "Folidol" are shown below:

Concentration (%)	Total M ¹ spikes	Mutation per 100 spikes	Average seedlings per spike	Mutation per 1000 M ₂ seedlings
0	278	—	122.67	—
.20	215	0.93	116.14	12.93
.40	182	2.75	122.47	11.44
.60	153	5.88	108.81	18.39
.80	127	9.45	92.55	20.06

In general, the mutation rated based on 100 M₁ spikes increased more or less linearly with increasing concentration of the pesticide. However, the mutation rate based on 1000 M₂ seedlings was non-linear and appeared to be independent of concentration. It is interesting to note that the mutation rate on the 100 M₁ spike basis is related to the phytotoxicity of the treatment solutions. The non-lethal concentrations accounted for only about 25% of the mutant spikes and about 12.98% of the seedling mutations while the phytotoxic solutions yielded 75% of the mutated M₁ spikes and approximately 87.02% of the seedling mutations. This is taken as an indication that "Folidol" is more mutagenic at the lethal concentrations than at the non-lethal solutions.

The types of chlorophyll-deficiency mutations found in the M₂ generation were *albina*, a lethal white seedling which dies about 10-16 days after germination; *xantha*, a lethal bright-yellow seedling which withers within 15-20 days after germination; *chlorina*, a lethal pale-yellowish seedling which dies within a period of 14-20 days after germination under ordinary field conditions; *striata*, a viable type of seedling mutation with characteristic longitudinal yellowish lines on leaves at the juvenile stage growing into a green plant about 30 days after germination; and *virescent*, a viable type of seedling with light green leaves turning into a green plant 20-30 days after germination.

Out of a total of 77 mutant seedlings in the M₂ generation, 38 seedlings or about 49.35% were *albina*, 21 or 27.27% *xantha*; 11 or 14.29%; *chlorina*; 3 or 3.90%, *striata*; and 4 or 5.19%, *virescent* seedlings. Thus, only 7 seedlings or 9.09% of all the M₂ mutant seedlings were viable. In a previous report using various pesticides¹⁵ *albina* was found as the most frequent type of mutant seedling while in another study⁸ *tigrina* was the predominant type of seedling mutation. The viable mutant seedlings of sorghum were grown individually in pots to maturity for multiplication.

All the three striata mutant seedlings set normal seeds giving rise to mutant lines, ML-78022, ML-78028 and ML-78051 while the four viridis seedlings originated ML-78025, ML-78026, ML-78034 and ML-78035.

Similar mutation rates appear to have been induced by "Folidol" as those produced by other pesticides^{8, 10, 12, 21}. Based on the highest mutation frequency obtained from treatments with other mutagenic agents like X-rays, EMS and other chemical mutagens, pesticides are reported to be less mutagenic^{1, 20}.

Inheritance of striata seedling. The inheritance of the striata seedling character is shown below:

Parentage	Generation	Green seedling	Striata seedling	X ²	P
Green x Striata	F ¹	1114	—		
Green x Striata	F ²	986	319	0.214	.75-.50
F ₁ Green x Striata	BC	209	184	1.560	.25-.10

Only plants from ML-78028 were used in this part of the study. The homozygous genotype of the wildtype green seedling line is indicated by the selfed progeny consisting only of some 1,427 green seedlings. Similarly, the homozygous genotype of the mutant plants from ML-78028 is shown by the selfed progeny which consisted only of 818 striata seedlings. The germination of all the F₁ seeds into green seedlings establishes the allelic relationship between the two characters as well as the recessive nature of the mutant seedling character. As the data indicates, the F₂ and backcross progenies segregated in proportions very close to the ratios of 3:1 and 1:1, respectively, showing that the striata mutation is a monogenic recessive character. It is presumed that a one-gene mutation was induced by the pesticide treatment.

In a study of the inheritance of a radiation-induced chlorophyll-deficient mottled seedling in the eggplant (*Solanum melongena* L.)¹⁷, it was found the mutation is a monogenic recessive character which is lethal under direct sunlight but can reproduce in the partial shade.

Inheritance of virescent seedling. The mode of inheritance of the virescent seedling mutation is shown in the following data:

Cross	Generation	Green seedling	Virescent seedling	χ^2	P
$V_1V_1 V_2V_2 \times$	F ₁	1472	—		
$v_1v_1 v_2v_2$	F ₁	209	—		
$V_1V_1 V_2V_2 \times$	F ₂	1028	61	0.769	.50-.25
$v_1v_1 v_2v_2$	F ₂	1409	102	0.508	.50-.25

Selfing plants from the wildtype green-seedling parental line gave in the progeny only green seedlings indicating the homozygous genotype of the plants. Similarly, the selfed progeny of plants from ML-78034 consisted only of virescent or light-green seedlings. The reciprocal crosses between plants from the wildtype green-seedling line and ML-78034 gave 1,472 F₁ seeds that all germinated into green seedlings. When the F₁ hybrids were selfed, the F₂ progeny consisted of a total of 1,089 seedlings which segregated into 1,028 green seedlings and 61 virescent seedlings. Based on the mono-hybrid ratio, there was a large excess of the green seedlings and a large deficiency of the recessive character.

The genetic ratio that best fitted the observed F₂ numbers was 15:1, which indicates inheritance of characters governed by duplicate factors.

Following Gustaffson's factor designations⁹, the dominant duplicate factors are gene V_1 and gene V_2 and their respective recessive alleles, gene v_1 and gene v_2 . Presence of one of the dominant genes produces a green seedling while absence of both gives a virescent seedling.

Thus, the genotypes V_1-V_2- , $V-v_2 v_2$ and $v_1v_1 V_2-$ are green seedlings while $v_1v_1 v_2v_2$, virescent seedlings.

These data were verified by a second set of reciprocal crosses which gave 209 F₁ plants, which when selfed, gave a total of 1,511 F₂ seedlings similarly segregating into a proportion that best fitted the 15:1 ratio ($P = 0.50-0.25$).

The attempt to understand the origin of the duplicate factors governing a mutant character that is widely known as a monogenic character, proposes a new direction in experimental mutagenesis work, particularly the need for determining the genetic nature of each induced mutant character. Heretofore, most, if not all induced mutation work ends coterminus with the duration of the funded project which is usually planned to be finished upon determining the mutation frequency. In the present work, understanding the possible origin of the duplicate factors would have been insurmountable were it not for some previous cytological data on chiasma frequency in the four mutant lines obtained the year before as a form of chromosomal change due to the pesticide summarized as follows:

Mutant line	No. of MI cells	No. of ring bivalents	No. of rod bivalents	Total chiasmata	Mean Chiasma frequency
PS- 77006	1256	7536	5024	20096	16.0
ML-78025	841	6728	1683	15138	18.0
ML-78026	716	4296	2864	11456	16.0
ML-78034	807	5649	2421	13719	17.0
ML-78038	628	3768	2512	10048	16.0

The mean chiasma frequency in the wildtype green-seedling line of sorghum is 16.0 chiasmata per metaphase I meiocyte. At this stage, the normal chromosome complement consists of six ring bivalents each with two terminal chiasmata and four rod bivalents, each with one chiasma. A count of ring and rod bivalents in 1,256 meiocytes from 30 M₁ plants gave 7,536 ring bivalents and 5,024 rod bivalents with a total of 20,096 chiasmata and mean chiasma frequency of 16.0 chiasmata per cell.

In ML-78034, which was the sole source of plants for the inheritance studies by chance selection, 807 MI cells from 30 plants gave 5,649 ring bivalents, 2,421 rod bivalents and a total of 13,719 chiasmata, giving a means chiasma frequency of 17.0 chiasmata per meiocyte. Compared with the bivalent configurations of the wildtype line, there was an increase of one ring bivalent and a reduction of one rod bivalent in ML-78034 over the wildtype. Possibly, one of the four rod bivalents was transformed into a ring bivalent presumably through a lengthening of one of its arms resulting in an additional terminal chiasma and enabling it to form a ring bivalent configuration at metaphase I. The increased length of the rod bivalent possibly resulted from the attachment of a segment from an extra chromosome which had been eliminated at later gametophytic stages.

The attached segment carried gene *v* which mutated from gene *V* before chromosomal breakage and its attachment to one of the chromosomes of the genome that ordinarily forms a rod bivalent configuration at metaphase I. One of the predominant types of numerical changes in sorghum chromosomes due to treatment with "Folidol" was extra individual chromosomes. The mutation in the *V*-locus of the extra chromosomes and a similar but independent gene change in a chromosome of the regular genome bearing the *V*-locus are believed to have given rise to the two mutant genes acting as duplicate inheritance factors.

Apparently, the attachment of an additional segment on a chromosome does not at all affect the process of chiasma formation, terminalization and crossing-over. In an analysis of the effects of a translocated segment from the grass *Tripsacum* on chiasma formation in a maize bivalent¹³, the presence of a "for-

eign" segment in a chromosome did not affect pairing or terminalization in the composite chromosome. Other studies^{2, 18} show that ionizing radiations and chemical mutagens could increase chiasma frequency while treatments with mitomycin C at low concentrations could increase the chiasma frequency¹⁹.

Conclusions

From the foregoing results and discussions, the following conclusions are drawn:

1. In general, the mean M_1 seedling height, pollen fertility and seedset decreased with increasing concentration of "Folidol" and was an effective phytotoxic and gametotoxic agent at the higher concentrations.

2. Both numerical and structural aberrations of chromosomes were induced by the pesticide. The higher frequency of plants bearing numerical than structural changes indicates the mode of action of "Folidol" in the cell nucleus.

3. Regardless of M_1 plant response, all the solutions induced M_2 chlorophyll-deficiency seedling mutations with *albina* seedlings as the predominant type. The mutation rate at the 1000 M_2 seedling basis was non-linear and independent of chemical concentration.

4. While *striata* seedling was monogenic recessive character, *virrescent* seedling was inherited as a digenic character presumably through the action of duplicate factors based on the consistent F_2 ratio of 15:1.

5. The possible origin of the duplicate inheritance factors is briefly discussed.

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PESTICIDE-INDUCED CHROMOSOMAL ABERRATIONS AND INHERITANCE OF VIABLE SEEDLING MUTATIONS IN SORGHUM

Adoracion T. Arañez, Ph. D., Discussant

Folidol seems to produce both chromosomal aberrations and point mutations. Chromosomal aberrations in the form of change in number could probably be due to the observed clumping of chromosomes which somehow prevent their normal separation into two daughter cells, or as mentioned by the lecturer, it could be due to inhibition of cross-wall formation, or the agent may have some effects on the spindle fibers.

The active ingredient of Folidol O, O-dimethyl-O-p-nitrophenyl phosphorothioate probably acted as an alkylating, specifically methylating, agent and reacted with N-7 of guanine. Alkylation of guanine weakens the hydrogen bonds and the N-C glycosidic bonds and thus apurinic sites are produced. The depurination of guanine produces an unstable deoxyribose residue which undergoes rapid hydrolysis resulting in cleavage of the polynucleotide chain. The cleaved ends of two different polynucleotide chains may unite forming interchanges. The formation of rings and chains of four chromosomes and chromosomal bridges are indications of interchanges. The broken ends may remain unjoined resulting to deletions.

Chlorophyll-deficiency mutations such as *albina*, *xantha*, *chlorina*, *striata*, and *tigrina* could be produced through point mutations. When apurinic sites are not repaired and cleavage of the polynucleotide chain does not occur, a gap in the DNA is produced. During replication this is either ignored producing a frameshift, or a base selected at random is inserted into the new strand opposite the deletion resulting to transition or transversion. However, methylated guanine may remain attached to the DNA and behave as a base analogue of adenine. Preferential pairing of the methylated guanine with thymine rather than cytosine during replication will produce transition. Chlorophyll-deficiency mutations could also be due to small deletions. Thus O, O-dimethyl-O-p-nitrophenyl phosphorothioate may change the genetic material in various ways.

Florencio-Isagani S. Medina III, Ph. D., Discussant

I would like to congratulate Dr. Soriano for his very informative paper.

The paper brought in the open the environmental hazards of the pesticide which maybe categorized into: 1) occupational hazards to farmers; 2) mutation in plants and weeds; and 3) possibly mutations in plants pests and diseases causing organisms.

Dr. Soriano was able to show the possibility of induction of chromosome aberrations by pesticide. If we equate this to agricultural workers, then, there is a possibility of induced chromosomal damage to somatic and genetic cells.

A damage to the somatic cells, though it is not necessarily heritable, may cause some amount of debility, hence low productivity whereas, damage to genetic cell will mean the possibility of mutant offspring. Supernumerary chromosomes in human beings could result in offsprings exhibiting such abnormalities as Patau, Klinefelter, or Down's syndrome.

It appears that at present, viral and other bacterial organisms mutate as fast or even faster than production by man of antibiotics and/or control measures. The results of this paper point to a possible mutagen in "Folidol" that may even dampen present efforts in plant pests and diseases control.

The effects on plants as a whole may be more harmful than beneficial because mutation induced in this case is not controlled compared to experimental mutation and may consequently lead to low production.

I would like to add that there are now a number of tests to determine the mutagenicity, terratogenicity of environmental pollutants, chemicals, etc., such as the Ames test, Cytogenic tests Dominant Lethal test and translocation test, etc.

To say that a chemical or compound is mutagenic, carcinogenic and/or terratogenic a tier system of testing should be done which uses especially a mammalian test system where extrapolation to human experience is more reliable.

A survey should also be done on agricultural workers to determine the present extent of damage done on our most important resources.

Thank you.

INDUCED ANDROGENIC SEX REVERSAL AS A POPULATION CONTROL METHOD FOR TILAPIAS

By Rafael D. Guerrero III, Ph.D.

Abstract

Tilapias are important foodfishes with vast potentials as a source of animal protein for human nutrition in developing countries. The major drawback of tilapias is their prolific breeding habit that often results in overpopulation and stunted growth in ponds. One method that has promise for controlling populations of the species in commercial culture is induced androgenic sex reversal.

Application of the sex reversal method for production of all-male progenies in three species of tilapia is reviewed. The method is considered effective, easy to apply and economical for aquaculture application in developing countries. Androgen-treated fish are safe for human consumption.

Introduction

Tilapias are important foodfishes commercially raised as a source of animal protein for human nutrition in many developing countries including the Philippines. The advantages of tilapias as cultured species include their fast growth, ease of breeding and resistance to disease.

The major drawback of tilapias is their tendency to breed excessively and overpopulate ponds. With crowding, growth is hampered and yields of harvestable-size fish are low.

To control tilapia populations, various methods have been tried. Hybridization, manual sexing, use of predaceous fishes and induced sex reversal are among the population control methods applied for commercial production of tilapias.

This paper reviews the hormone theory of sex reversal and the application of induced androgenic sex reversal for population control of tilapias. It will also discuss the significance of the method to aquaculture.

Hormone Theory of Sex Reversal

The theory that differentiation of the genital structures of the embryo is controlled by hormone or hormones produced by the embryonic gonads is currently accepted (Burns, 1961). This hormone theory of sex differentiation in vertebrates was first proposed by Bouin and Ancel (1903, cited by Burns, 1961) and later formulated by Lillie (1916, 1917).

Development of the gonad in the vertebrate embryo takes place in the dorsolateral lining of the peritoneal cavity. Unlike most vertebrates, however, the gonads of cyclostomes and teleosts arise from the cortical portion of the peritoneal wall (Hoar, 1969). The cortex develops into the indifferent protogonia and later differentiates into either the male or female gonad depending on the genotype of the embryo.

Hormones or hormone-like substances (sex inductors) are believed to be produced by the embryonic gonad of fishes. This assumption is supported by mounting evidence that administration of androgens and estrogens to sexually undifferentiated fry can modify the direction of sex in either direction by overriding genetic regulation of sex differentiation (Yamamoto, 1969). The mechanism of action of sex hormones on the undifferentiated gonad, however, is not well understood. Furthermore, the nature and site of production of sex inductors (androterme for the male and gnoterme for the female) have not been established.

Induced Androgenic Sex Reversal of Tilapias

Yamamoto (1958) was the first to achieve functional sex reversal in a female fish (*Oryzias latipes*) using methyltestosterone at dosage levels of 1 and 2 I.U./g (25 and 50 mg/kg) of diet. Yamamoto (1969) stated that two conditions should be fulfilled for achieving sex reversal in differentiated gonochorists: (1) the heterologous sex hormone should be administered starting with the age of indifferent gonad and continued throughout the stage of sex differentiation and (2) adequate dosage levels of hormones should be used.

The males of tilapias grow faster than the females. Hickling (1960) indicated that growth rate of female tilapias is greatly reduced upon attaining sexual maturity. Van Someren and Whitehead (1960) compared the growth rates of all-male and all female *Tilapia nigra* populations and found that separation of sexes did not affect the faster growth of the males. Moreover, growth rate was significantly lower and mortality was higher in the all female population than in the all-male population. Fryer and Iles (1972) concluded that although male growth superiority in tilapias may be modified by environmental factors, it has a genetic basis and is not associated with the reproductive process.

Culture of all-male tilapia is preferred to the all-female population. With no females in the population, reproduction is not possible and overpopulation is averted.

Phenotypic sex reversal of genotypic females of three tilapia species, using methyltestosterone and ethynyltestosterone, has been achieved (Table 1).

Table 1. Tilapia Species Treated with Androgens for Sex Reversal

<i>Species</i>	<i>Androgen</i>	<i>Dosage (mg/kg diet)</i>	<i>Duration (days)</i>	<i>% Males</i>	<i>Reference</i>
<i>T. mossambica</i>	M	10-30	60	95-100	Clemens & Inslee (1968)
	E	50	40	100	Guerrero (1976a)
	M	30	21-28	93-98	Guerrero (1976b)
<i>T. nilotica</i>	M	30	60	100	Jalabert <i>et al.</i> (1974)
	M	15-50	42	96-98	Guerrero & Abella (1976)
	M	30-60	25-59	99-100	Tayamen & Shelton (1978)
	E	30-60	25-59	98-100	Tayamen & Shelton (1978)
<i>T. aurea</i>	M	15-60	18	84-98	Guerrero (1975)
	E	15-60	18	85-100	Guerrero (1975)
	E	30	22	90-100	Sanico (1975)

M = methyltestosterone

E = ethynyltestosterone

According to Yamamoto (1969), effectiveness of the sex reversal treatment depends on the kind and dosage of steroid used, the method of administration, time and duration of treatment, and on the species to be treated.

For the three tilapia species in Table I, methyltestosterone and ethynyltestosterone were found effective for inducing sex reversal at dosages of 15-60 mg/kg diet. Guerrero (1975) found ethynyltestosterone more potent than methyltestosterone for sex inversion of *T. aurea*, particularly at the dosage level of 60 mg/kg diet. Clemens and Inslee (1968) found 40 mg/kg and 50 mg/kg diet of methyltestosterone less effective than 30 mg/kg diet for inducing sex reversal in *T. mossambica*. The refractoriness of methyltestosterone at high concentrations was also reported by Yamamoto (1958).

The route of administration affects the activity of androgens (Dorfman, 1969). Synthetic androgens such as ethynyltestosterone and methyltestosterone are orally active while naturally occurring androgens like testosterone, androsterone and androstenedione are more potent when injected.

Clemens and Inslee (1968) suggested that androgen treatment of *Tilapia mossambica* fry when 30-50 days of age (an interval of about 3 weeks) which includes the indifferent gonad stage and period of differentiation is sufficient to influence sex direction. Ekstein and Spira (1965) indicated that gonadal differentiation in *T. aurea* takes place when the fry are 18-22 mm in total length or about 7-8 weeks of age.

Induced sex reversal of other tilapia species has not succeeded. Using oral administration of methyltestosterone at 50-200 mg/kg diet for 10-30 days after hatching, Yoshikawa and Oguri (1978) did not achieve sex reversal in fry of *Tilapia zillii*. Similarly, Jalabert *et al.* (1974) obtained negative results with *T. macrochir*.

Culture conditions during hormone treatment may also affect effectiveness of sex reversal. Yamamoto and Kajishima (1968) indicated that variations in feeding, water temperature and degree of crowding greatly affect the growth of goldfish under treatment for sex reversal.

In the androgen treatment of *T. aurea*, Shelton *et al.* (1981) reported that temperature, stocking density and feed regime appeared to have no influence on the effectiveness of the sex reversal treatment. For standard application, oral treatment of 9.11 mm *T. aurea* fry at a density of 2,600/m² or less with ethynyltestosterone dosage of 60 mg/kg diet for six weeks at 25-29°C is recommended for production of all-male populations (Shelton *et al.*, 1978).

Sex reversal in the species is ascertained by comparing the sex ratio of androgen-treated fish with that of the controls

(untreated fish) and/or by progeny-testing. Treated fish with a percentage of males significantly higher than that of the controls are considered to have been masculinized. Sexing of fish can be done by gonadal examination in juveniles and by examination of the genital papilla in adults.

Sex reversal is further verified by mating suspect genotypic females with male phenotype with untreated females and sexing the offspring. A homogametic sex reversed female will produce all-female progenies when mated with a normal female.

Significance of the Sex Reversal Method of Aquaculture

For any method of population control for tilapias to be practical for fish culture, it must be effective, easy to apply and economical.

Results of various studies have shown that 100% males can be achieved with treatment of ethynyltestosterone and methyltestosterone at 60 mg/kg and 30 mg/kg diet, respectively.

The administration of oral androgens for sex reversal of tilapias is relatively easy. The method involves three essential steps:

1. Collection of newly-released fry measuring 9-11 mm total length from the brood pond,
2. Rearing of fry in suitable indoor tanks where they can be fed adequate amounts of the androgen treated feed throughout the necessary treatment period, and
3. Stocking of androgen treated fry in production ponds devoid of females.

It has been estimated that the cost of the hormone and feed for treating 1,000 fry with methyltestosterone at 30 mg/kg diet for 4 weeks is approximately ₱7 (Guerrero, 1976b). On a commercial basis, the production of 1 million fry annually can be done by one operator working halftime (Hida et al., 1960). Thus, the application of induced androgenic sex reversal is economical even in developing countries.

The use of synthetic androgens for the production of all-male tilapia has the following advantages:

1. Reproduction of tilapia in ponds is minimized or eliminated.
2. Females are not wasted as in the manual sexing method.
3. Higher yield of fish is obtained due to the faster growth of males.
4. High stocking densities of treated fish can be used.
5. The technique is not too laborious or expensive.

Like the other population control methods, sex reversal has its disadvantages. Hatchery facilities and skilled workers are re-

quired for effective treatment of fry.

The question of whether the androgen treated fish are safe for human consumption has often been raised for obvious reasons.

As far as the present knowledge on the action of androgens is concerned, androgens are not carcinogenic in humans. Synthetic androgens are widely used in human medicine for therapy of certain tumors. Ethynyltestosterone, for instance, has antifibromatogenic activity. Likewise, methyltestosterone is used for long-term therapy of disorders such as hypogonadism and pituitary dwarfism in humans (Dorfman and Shipley, 1956).

Rongone and Segaloff (1962) isolated urinary metabolites of methyltestosterone catabolyzed in the human body. Ralph Dorman of Syntex Research, Palo Alto, California (letter dated 17 December 1973) believes that the metabolites of ethynyltestosterone and methyltestosterone are safe for human consumption.

More recently, experiments on metabolic clearance of methyltestosterone from tilapia conducted by Donald Macintosh to the University of Stirling, Scotland have provided interesting findings (letter dated 15 January 1982). I quote: ". . . the levels of hormone fed to juvenile tilapia (rate 40 ppm for 40 days) fall to undetectable levels within 133 hours after the termination of hormone feeding. Thus, eating fish five days or more after treatment involves no significant intake of hormone.

With the low dosage levels used and an interval of about 90 to 120 days between treatment and consumption, it can be categorically stated that fish treated with synthetic androgens for sex reversal are not hazardous to human health.

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DISCUSSION ON INDUCED ANDROGENIC SEX REVERSAL AS A POPULATION CONTROL METHOD FOR TILAPIAS

Jose A. Carreon, Ph. D., Discussant

The focus of Dr. Guerrero's paper centers on the significance of population control for more productive culture of the tilapias.

Tilapias, the world's most studied group of fish for aquaculture, are well noted for their rapid multiplication under normal conditions with males and females together. And over population is totally undesirable in grow-out ponds where large individual fish is desired rather than large total harvest of undersized fish.

The working objective of tilapia sex-reversal is to produce /attain one-sex-stock in a culture system. Is the method of using androgenic hormone the only way to attain monosex stock of fish? Certainly not. Is one-sex-stock of fish best easily attained by the use of sex hormone through oral administration? May be yes, may be not. In any case, hormone-induced-sex-reversal technique is the handier approach in producing "all-male" brood compared to the hybridization method, e.g., *Tilapia nilotica* vs *Tilapia aurea*, since the latter has a very tough requirement of keeping pure genes in the parent fish stocks.

Yes, indeed, hormone-induced-sex-reversal technique is the most promising for an effective control of tilapia populations in culture ponds. I for one do agree; however, there are a few things that must be given a second look about this approach to tilapia aquaculture as well as those interests that are incidentally related to it, as follows:

1. Culture period for larger fish, as is presently the trend, vary from 5 to 8 months or longer within which sex-reversed tilapia broods that are lot-stocked in ponds may likely produce substantial number of spawns which will, in effect, result into overcrowding--hence small fish sizes at harvest -- since sex-reversal technique is not guaranteed 100% to attain monosex broods. In the species *Tilapia nilotica* for example, even the best results of sex-reversal, as shown in Table 1 of the paper in review, indicate a percentage range of uncertainty from 4% to 1% or an average uncertainty of 2.33%. For every lot of, say, 300 hormone-treated broods per parent female, therefore, we may expect about 7 females. Even if this is reduced to 50% by mortality upon stocking in ponds, there would still be about 3 or 4 female fish larvae per

brood lot per parent female. Since tilapias generally attain sexual maturity at very early age, the inherent error of missing to sex-reverse a few post-larvae per parent female would give significant amounts of spawn during the length of culture period of 5 to 8 months.

2. While it is true that in general, male tilapias grow faster than females, however, the belief that the "all-male" broods produced by sex-reversal will all grow faster and bigger than an "all-female" broods may not be entirely true. Pruginin (1975)¹ observed that *not* all of his "all-male" hybrid tilapia populations that were obtained by crossing *Tilapia nilotica* vs *Tilapia aurea* have grown well as may be expected, and I quote: "All-male hybrid populations in this study segregated into one class of larger sexually well developed males and a second class of smaller sexually underdeveloped males; this second class may hint at the possibility that it is composed of 'genetic females' that sex-reversed to phenotypic males." The mean weight of the first class males referred to here was 323 g, and that of the second class males was 182 g. The same suspicion will prevail even if the broods were sex-directed to be all females!

3. If all "all-female" broods are produced by sex-reversal, will it be possible that some degree of growth heterosis may be observed? Have we really tried sex-reversed "all-female" broods? Under Philippine conditions there has been no credible research yet conducted to prove that an "all-female" tilapia sex-reversed would perform inferior to an "all-male" stocks regardless of lengths of culture period, type of nutrition and other controllable factors.

4. The method of sex-directing the developing fish larvae is not really that simple, particularly to fishfarmers in general who do not have the basic knowledge on the rudiments of this technique. Not all farmers can easily apply this method of sex-reversing the tilapia broods. Only the well-informed and better educated fishfarmers may feel at ease in using this technique. For industrial practice, this would probably need the establishment of specialized centers for the dispersal of sex-reversed tilapia seedlings.

5. The stigma of the prejudice against consuming androgenic-hormone-treated-fish is something that must be overcome by medical research. Although there are scientific researches in biology and aquaculture that tend to assure no harm in eating hormone-treated fish, the concern will always be there for as long as there is no study on humans that would guarantee otherwise.

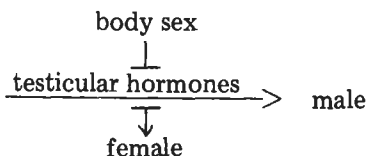
¹Pruginin et. al. (1975) all male broods of *tilapia nilotica* x *tilapia aurea* hybrids. Aquaculture (6) 11-21.

Notwithstanding all the concerns above enumerated, I believe, and I support, all the good intentions of Raffy Guerrero's paper. Indeed, the tilapias are the most promising group of fishes for culture in freshwater production systems for as long as we are able to effectively manipulate their populations, improve their stocks, develop their appropriate feeds, improve their market and find more and better ways of consuming them.

E. M. Rigor, Ph. D., Discussant

From this paper two important aspects are mentioned; 1) The prolific breeding habits of tilapias resulting in overpopulation, competition for nutrients and subsequently stunted growth; 2) Because of the latter, induced androgenic sex reversal has been attempted resulting in all male populations and hence the maintenance of a constant or reduced population in a given volume of environment.

It is almost tempting to extrapolate from mammals to fishes although this is not the intention of this discussion. Certainly, similarities are obvious. In mammals the masculine characteristics of the body have to be imposed in males by fetal testicular hormones against a basic feminine trend of the mammalian body. Female organogenesis results from the mere absence of the testes; the presence or absence of the ovaries being unimportant. Hence, the fetal testis is a remarkably important endocrine organ and there is no symmetry in male or female development. Femaleness corresponds to an intrinsic program of the primordia, it is obtained *in vitro* in the absence of male hormones. Masculine differentiation is actively imposed on the system at an early stage, no possibility being left for further feminine differentiation. This can be summarized in a simple scheme showing that every structure would become feminine if not prevented from doing so by testicular hormones.



The developmental history of the sex glands also shows a striking chronological asymmetry in both sexes. Testes differentiate early when the primordial germ cells become encompassed in seminiferous cords and when testicular interstitial cells are formed. For a prolonged period of time presumptive ovaries are characterized mainly by the fact that they do not become testes. They

actually remain undifferentiated. During testicular differentiation the germ cells are rapidly enclosed in seminiferous tubules and do not enter meiosis; during ovarian development the germ cells start the meiotic process before being tightly surrounded by follicular cells. It is even more likely that when follicles develop, the follicular cells stop the meiotic process. The reason why meiosis begins in oocytes prior to true ovarian organogenesis is not understood.

The evidence of the freemartin suggests that presumptive ovaries, if submitted to an appropriate influence, probably the two kinds of fetal testicular hormones still may develop testis-like structures in place of ovarian follicles. The concept then, is introduced that the fetal testis produces at least two or two kinds of morphogenetic secretions, one (or more masculinizing hormone(s) whose action is duplicated by androgens and a Mullerian inhibitor (anti mullerian hormone, AMH) the action of which is not duplicated by steroidal androgens. AMH is synthesized by fetal Sertoli cells very early in life, as soon as seminiferous tubules are recognizable under the light microscope and before the appearance of fetal Leydig cells. AMH production ceases in the perinatal period and is not resumed at puberty. AMH is probably a glycoprotein.

Since androgen induced sex reversal in tilapias is economical, wherein only minute or physiological amounts (as against pharmacological) of androgen are required, one wonders if this practice has found widespread application. Since hatchery facilities and skilled workers are required for the effective treatment of fry, has something been done about the problem?

While the paper is a review, it would have been more meaningful if experiments were presented comparing sex reversal as against a control tilapia population in regard to yields of harvestable fish (percent?), weights of each harvestable fish, feed efficiency as well as the most desirable stocking rate per unit of volume.

Hermínio R. Rapanal, Ph. D., Discussant

1. I would like to commend Dr. Rafael Guerrero for taking up this research work on tilapia which can have great scientific as well as economic significance. It is a problem based on sound and logical scientific principle and the results thus far obtained are very encouraging.

2. If I recall correctly, Dr. Guerrero's first paper enunciating this technique of sex reversal in tilapia prominently mentioned as one of the significant contributions to the FAO World Conference on Aquaculture held in Kyoto, Japan in 1975. Of course, the actual research work must have antedated this named date by a

number of years. Subsequently, Dr. Guerrero has been invited and contributed papers related to this subject to meetings and during travel that brought him to Italy, Africa, and Latin America. Between 1975 to this year (1982), a period of seven years, it would be of interest to assess to what extent the method or research results been put forward or adopted by tilapia culturists on the aquaculture industry.

3. A cursory look at the table of results of this work by different researchers (Table 1 of paper) including Dr. Guerrero and associates, and other workers, reveal that there are only two cases out of ten where 100% sex reversal was attained (Jalabert, *et al.*, 1974 for *T. nilotica* and Guerrero 1976a for *T. mossambica*). The other eight cited results give varied percentages ranging from as low as 84% to 98%, even 100%, for experiments on *T. mossambica*, *T. nilotica* and *T. aurea*. I believe that in this regard, the attainment of 100% sex reversal is highly important. The presence of even a very small percentage of unreversed females in a treated population could wreck havoc in that particular population considering the very high fecundity or reproductive capacity of this species. What could happen is that an extremely high reproduction of the unreversed females may occur to fill up what seems to be a vacuum.

4. Corollary to the problem presented in paragraph 3 above is the inherent difficulty of screening out or eradicating tilapia in their natural environment. Tilapia eggs have been suspected of passing through the finest gate screens and tilapia eggs or fry are likewise suspected or perhaps even observed to be able to survive the smallest pools left by the footprints of the fish farmers. Again surviving females from this undetected sources can destroy management plans for a productive monosex culture of tilapia.

5. Dr. Guerrero's paper appears to be very convincing on the economic feasibility of carrying out sex reversal management in tilapia culture. This is borne out by the fact that the operational cost for feed and androgen is about 0.7 centavos per fry or about ₱7,000 per million fry. The paper however did not state the investment or capital costs for the construction and setting up of tanks and other container facilities, the feed making facilities, cost of the site, depreciation of facilities, etc. The amount of skilled as well as unskilled labour man-hours has to be estimated also to evaluate manpower costs. All such costs should be accounted for if a farmer envisions to establish a set-up in this work. Likewise, the sources of the chemicals to be used, their availability and costs of such substances and other ingredients needed, and the methodology of their preparations are inadequately explained in the present paper. If these have not been explained in previous public-

ations, perhaps a further enlightenment on these aspects will be required.

6. The paper does not mention if there are any post-treatment re-reversal in sex of the treated tilapia after a period of time. But the paper stated that if the sex reversed females that have not become males are mated with other females, the progenies would all be females. Considering that females are much smaller than the males would such an occurrence then result in the possibility of culturing a relatively dwarf population of tilapia.

7. We have great faith and confidence in the reliability of the experiments on sex reversal in tilapia by androgenic treatment. Since this idea has been enunciated for over seven years now, and considering that practise of these scientific results can have valuable economic and food production significance, I believe the time is now appropriate for the setting up of practical demonstrations or pilot projects to propagate the techniques for the benefit of the industry. Training programmes with extension workers and fishfarmers as the recipients should be put up. The practical demonstration or pilot projects should clearly illustrate farm and facilities design and the kinds and quantities of supplies and equipment required. With the encouraging prices now being paid for tilapia in the market, we look forward to the time when this research result is adopted as a general practice by fishfarmers.

TAXONOMIC VALUE OF TEGUMENTAL STRUCTURE IN SEPARATING SOME CLOSELY RELATED SPECIES OF PARAMPHISTOMES OCCURRING IN RUMINANTS

By Salcedo L. Eduardo, Ph.D.

Abstract

Many closely related species of the family Paramphistomidae Fiscoeder, 1901 are separable from each other by the histological details of certain organs particularly the acetabulum, pharynx and terminal genitalium.

Examination with the scanning electron microscope of the surface tegument of the following closely related species, *Paramphistomum cervi* and *P. leydeni*; *Calicophoron* and *C. raja*; *Calicophoron microbothrium*, *C. microbothrioides* and *C. clavula* and *Gigantocotyle gigantocotyle* and *G. symmeri* revealed that some differences exist on the surface of these species. On this basis, it is possible to separate them from one another.

Paramphistomum leydeni differs from *P. cervi* by the presence of surface papillae which are concentrated anteriorly around the oral opening and ventrally around the genital pore. These papillae are entirely lacking on the surface of *P. cervi*.

Calicophoron calicophorum and *C. raja* have papillae around the oral opening. The latter differs from the former by the presence of smaller papillae densely arranged on the surface of the genital pillar. These are absent on the genital pillar of *C. calicophorum*.

Calicophoron microbothrium and *C. microbothrioides* have papillae around both the oral opening and genital pore. The former has papillae of the same structure and almost of the same size on the two areas while the latter has papillae around the genital pore than around the oral opening. *C. microbothrium* has also smaller papillae around the acetabular opening which are absent on *C. microbothrioides*. *C. clavula* differs from both species by the presence of papillae only around the oral opening.

Gigantocotyle symmeri differs from *G. gigantocotyle* by the presence of papillae around the anterior end. These are lacking on *G. gigantocotyle*.

Introduction

The family Paramphistomidae is a large assemblage of species affecting almost all kinds of vertebrates. Those in mammals particularly ruminants have been the cause of fatal outbreaks in various parts of the world and the disease caused by them has been reviewed in details by Horak (1971).

In any parasitic infection, accurate identification of the species involved is the first vital step before any sound control could be instituted. It is also a prerequisite to studies in epidemiology, physiology and immunology of the parasite. Members of the family Paramphistomidae are no exception. From the systematic point of view, the family is very difficult because specific diagnosis

still depends largely on histological details of the various organs like the pharynx, acetabulum and terminal genitalium. This means, preparation of specimens for examination requires a lot of time and effort and is indeed a tedious process. This difficulty has led to many inaccurate record of species due to misidentifications, hence a picture of the geographical distribution of the species based on literature is far from accurate (Eduardo, 1980e). There is a need therefore to find out what other stable characters that could be employed in separating species of the group.

Eduardo (1979, 1980a, b, c, d, e; 1982a, b, c) in a series of papers on the family Paramphistomidae included in his description of species the character of their tegumental surfaces as revealed by scanning electron microscopy. Several types of anterior papillae found on the anterior region of many species were described and the value in separating species of the group was discussed, presenting a new aspect in the taxonomy of the group.

This paper will deal only on the importance of tegumental structures in separating some closely related species within the family Paramphistomidae. For information on the taxonomic revision of the various genera and detailed description of species occurring in ruminants, the reader is referred to the papers mentioned above.

Materials and Method

Specimens examined in this study were obtained from various hosts and localities and these are given below. Since specimens received were already fixed, only those in good condition after careful examination under the stereomicroscope were used. Specific identification was first established by examination of sectioned materials and only those lots which proved to consist only of a single species were processed. For scanning electron microscopy, at least 10 individuals from each lot were processed and the rest were sectioned for histological examination under light microscopy.

The technique of preparing and processing paramphistomes for light and scanning electron microscopy are already detailed in a separate paper (Eduardo, 1982c) and the reader is referred to this for detailed information.

Materials examined, hosts and localities.

Genus *Paramphistomum* Fiscoeder, 1901

1. *Paramphistomum cervi* (Zeder, 1790) Fiscoeder, 1901
Cattle — Denmark, England, Netherlands
Cervus elaphus Austria

2. *Paramphistomum leydeni* Nasmark, 1937
Cattle — Netherlands, Turkey
Cervus elaphus. — Austria

Genus *Calicophoron* Näsmark, 1937

1. *Calicophoron calicophorum* (Fischoeder, 1901)
Näsmark, 1937
Cattle — Australia, India, New Zealand, Philippines,
Vietnam
2. *Calicophoron raja* Näsmark, 1937
Cattle — Cuba, Kenya, Zambia
Aepycerus melampus (impala) — Botswana
Connochaetes taurinus (blue wildebeest or
brindled gnu) — Tanzania
Damaliscus korrigum (topi) — Tanzania
Syncerus caffer (African buffalo) — Namibia
3. *Calicophoron microbothrium* (Fischoeder, 1901)
Eduardo, 1980
Cattle — Egypt, Chad, Kenya
Aepycerus melampus (impala) — Zimbabwe
Capra hircus — Angola
Hippotragus equinus (roan antelope) — Republic
of South Africa
Taurotragus oryx (eland) — Kenya
4. *Calicophoron microbothrioides* (Price & McIntosh,
1944) Eduardo, 1980
Cattle — Cuba, Puerto Rico, U.S.A.
5. *Calicophoron clavula* (Näsmark, 1937) Eduardo, 1980
Aepycerus melampus (impala) — Tanzania
Alcelaphus buselaphus (hartebeest or kongoni)
Tanzania
Kobus defassa harnieri (waterbuck) — Zaire
Syncerus caffer (African buffalo) — Uganda

Genus — *Gigantocotyle* Näsmark, 1937 *sensu stricto*

1. *Gigantocotyle gigantocotyle* (Brandes in Otto, 1896)
Näsmark, 1937
Hippopotamus amphibius — Sudan, Zaire, Zambia
2. *Gigantocotyle symmeri* Näsmark, 1937
Cattle — Cameroon, Sudan
Kobus leche (red lechwe) — Botswana, Zambia

The species mentioned above under each genus were selected because they are closely related to each other.

Result

Scanning electron microscopy revealed the following characteristics of the tegumental surfaces of the species examined. The surface of *P. cervi* is smooth and entirely devoid of papillae (Figs. 1 & 11). That of *P. leydeni* has papillae which are concentrated around the oral opening and ventrally around the genital pore (Fig. 2). Smaller papillae are also found sparsely distributed around the acetabular opening (Fig. 12). These papillae are dome-shaped and non-ciliated.

Papillae were observed on all the five species of *Calicophoron* herein examined. They differ however in size and distribution among the five species. In *Calicophoron calicophorum*, papillae are concentrated on the anterior half of the body especially around the oral opening (Fig. 13). Smaller papillae are also found sparsely distributed around the acetabular opening. The area immediately around the genital pore region and the surface of the genital pillar are devoid of papillae (Fig. 3 & 13). In addition to papillae present around the oral opening of *Calicophoron raja*, much smaller ones are densely arranged around the genital pore region and on the genital pillar (Figs. 4 & 14). In *Calicophoron microbothrium*, papillae are present around the oral opening and ventrally around the genital pore region (Fig. 7). Smaller papillae but few in number are also present around the acetabular opening (Fig. 15). *Calicophoron microbothrioides* has papillae both on the area around the oral opening and the genital pore, but those on the latter are much larger than those on the former (Figs. 5, 6 & 16). In *C. clavula*, papillae are present only around the oral opening (Figs. 7 & 17). Papillae observed on these species are also dome-shaped and non-ciliated.

Of the two species of *Gigantocotyle*, *G. symmeri* revealed the presence of dome-shaped non-ciliated papillae which are concentrated around the anterior end (Figs. 10 & 19). Papillae are lacking on the tegumental surface of *G. gigantocotyle* (Figs. 9 & 18).

Discussion

It is apparent from the result that tegumental papillae have some value in the identification of paramphistomes. Although they are not of value at the generic level as species belonging to different genera may have similar tegumental papillar pattern, they are of value at the specific level as differences exist among different species as to their occurrence, distribution and size and they are consistent in the same species even from different hosts and localities. Eduardo (1982a) have shown that these papillae are also consistent in the same species even of different ages. Two lots of *Calicophoron microbothrium* of different ages (184 days and

3 years) recovered after experimental feeding were examined and both showed similar pattern of surface papillae.

It is therefore possible to separate the closely related species examined in this work based on the occurrence, distribution and size of tegumental papillae. *Paramphistomum leydeni* is easily distinguished from *P. cervi* by the presence of surface papillae which are entirely absent on the latter species. Odening, Bockhardt and Gräfner (1978) have expressed the view that both are one and the same species but as they have not studied and compared their surfaces they were not aware of this difference. Furthermore, the terminal genitalium of *P. cervi* is the gracile type while that of *P. leydeni* is of the leydeni type (Eduardo, 1982a, b).

Calicophoron raja is separable from the closely related species *C. calicophorum* by the presence of densely arranged small papillae on the surface of the genital pillar which are absent on the latter species. *C. clavula* differs from the two related species, *C. microbothrium* and *C. microbothrioides* by the restricted distribution of papillae which are present only around the oral opening. The latter two species have papillae both around the oral opening and the genital pore. *C. microbothrium* and *C. microbothrioides* are separable by the size of papillae on the two areas. On the former, papillae are of the same size and structure in both areas while on the latter, papillae around the genital pore are larger than those around the oral opening.

Gigantocotyle symmeri is distinguished from *G. gigantocotyle* by the presence of papillae around the oral opening. Papillae are entirely absent on the latter species.

The papillae observed in the present study correspond to type A of anterior papillae described and illustrated by Eduardo (1980e, 1982a) which is characterized by the dome to conical shape and absence of cilia. This type has also been observed on other species of trematodes namely, anterior surface of *Diclidophora merlangi* (Morris, 1973), ventral haptor of *Entobdella solea* (Lyons, 1973), posterior sucker of *Megalodiscus temperatus* (Nollen & Nadavukaren, 1974), oral and ventral suckers of encysted juvenile of *Fasciola hepatica* (Bennett, 1975), whole body with aggregation on oral sucker and genital atrium of *Leucochloridium* sp. (Bakke, 1976) and around oral sucker and lateral regions of *Philophthalmus megalurus* (Eduards, Nollen & Nadavukaren, 1977).

The function of dome of conical non-ciliated papillae is not yet clear. Lyons (1973), Bennett (1975) and Bakke, (1976) however have suggested mechano-reception. They act as contact receptors signalling direct contact, recording pressure of stretching of tegument and signalling tension developed in the sucker wall during adhesion. Aggregation of this type of papillae around the

genital atrium may communicate contact with sexual partners (Bakke, 1976). The occurrence and concentration of papillae particularly around the oral opening of most paramphistome species as shown by Eduardo, (1980a, 1982a) and in this work suggest that they may be sensory in nature. Transmission electron microscopy of this type of papillae would reveal the exact nature of its internal surface and give some indication of its function. So far, only those on the ventral haptor of *Entobdella solea* have been studied by this method and these were found to be packed with folded nerves indicating a sensory function (Lyons, 1973). Whether this is also true to the other species with the same type of papillae is not certain until a similar study is undertaken.

Acknowledgement

Thanks are due to Dr. Sheila Willmott, then Director of the Commonwealth Institute of Parasitology, England for the use of the Institute's facilities and Dr. L.F. Khalil for supervising this work.

This work was supported by a scholarship grant under the 4th Education Project of the Philippines with the World Bank.

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Explanation to Figures

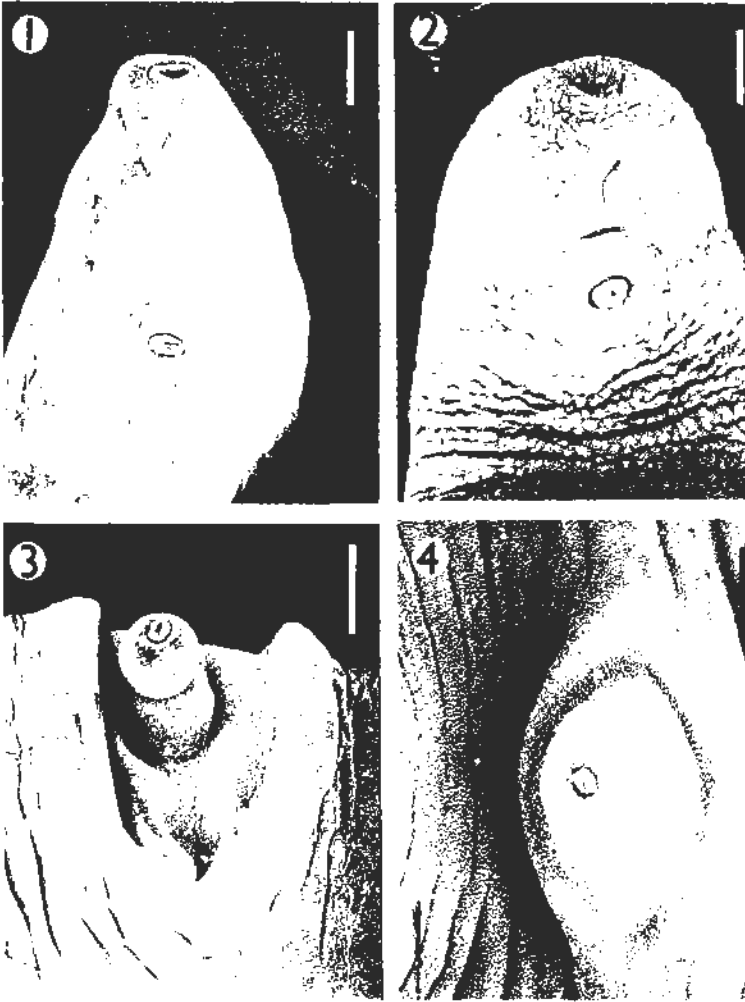


Fig. 1. *Paramphistomum cervi*, anterior half, SEM
(scale bar = 500 , um).

Fig. 2. *Paramphistomum leydeni*, anterior half, SEM
(scale bar = 500 , um).

Fig. 3 *Calicophoron calicophorum*, genital pillar, SEM
(scale bar = 200 , um).

Fig. 4. *Calicophoron raja*, genital pillar, SEM
(scale bar = 200 , um).

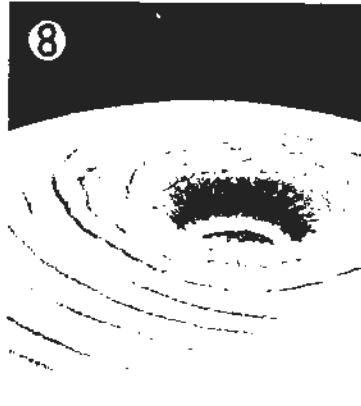
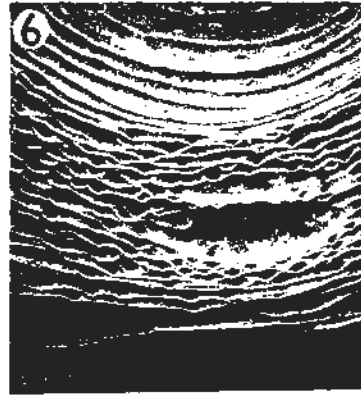
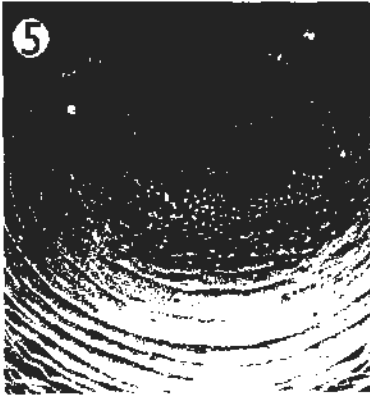


Fig. 5. *Calicophoron microbothrioides*, oral end, SEM (scale bar = 200 , um).

Fig. 6. *Calicophoron microbothrioides*, genital pore region, SEM (scale bar = , um).

Fig. 7. *Calicophoron microbothrium*, anterior region, SEM (scale bar = 500 , um).

Fig. 8. *Calicophoron clavula*, oral end, SEM (scale bar = 200 , um).

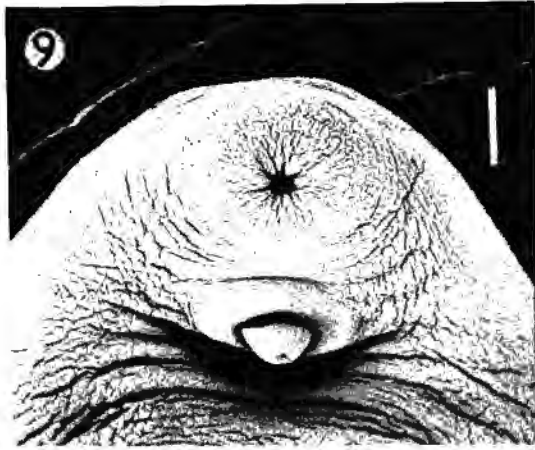
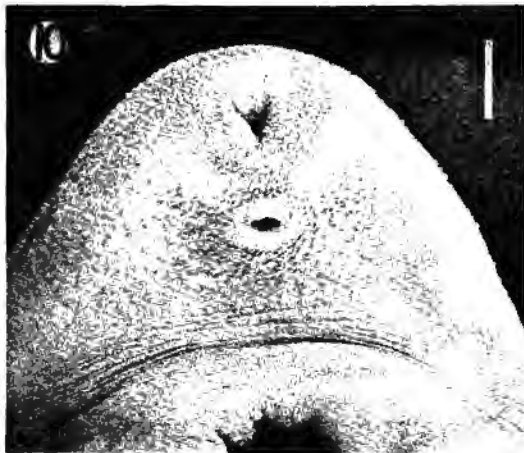


Fig. 9. *Gigantocotyle gigantocotyle*, anterior region, SEM (scale bar = 500 , um).

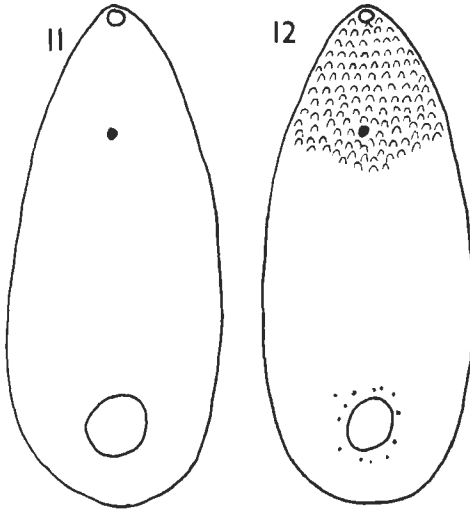
Fig. 10. *Gigantocotyle symmeri*, anterior region, SEM (scale bar = 800 , um).



Schematic representation showing occurrence and distribution of papillae on the tegumental service.

Fig. 11. *Paramphistomum cervi*

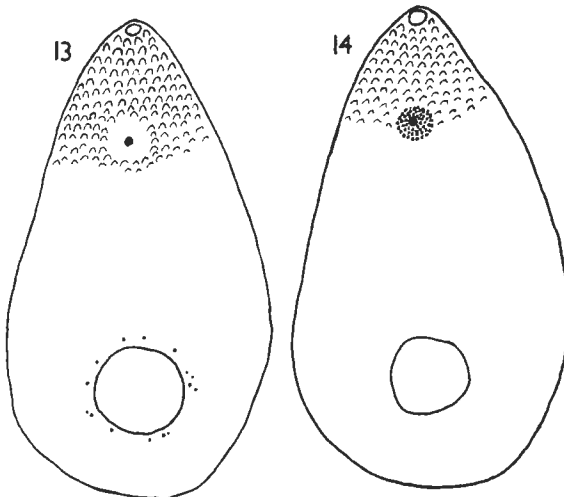
Fig. 12. *Paramphistomum leydeni*.



Schematic representation showing occurrence and distribution of papillae on the tegumental surface.

Fig. 13. *Calicophoron calicophorum*

Fig. 14. *Calicophoron raja*.



Schematic representation showing occurrence and distribution of papillae on the tegumental surface.

Fig. 15. *Calicophoron microbothrium*

Fig. 16. *Calicophoron microbothrioides*

Fig. 17. *Calicophoron clavula*.

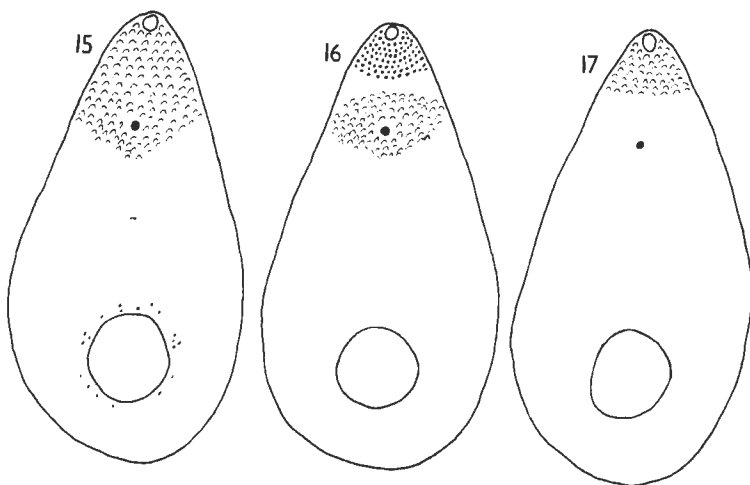
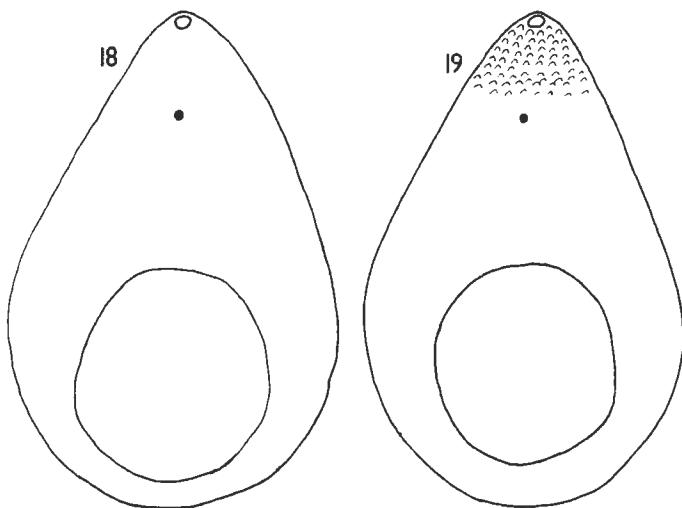


Fig. 18. *Gigantocotyle gigantocotyle*

Fig. 19. *Gigantocotyle symmeri*.



**DISCUSSION ON
TAXONOMIC VALUE OF TEGUMENTAL STRUCTURE
IN SEPARATING SOME CLOSELY RELATED SPECIES OF
PARAMPHISTOMES OCCURRING IN RUMINANTS**

Carmen C. Velasquez, Academician, Discussant

I am glad that Dr. Eduardo has pursued this very difficult problem on the family Paramphistomidae Fiscoeder. It was quite a long time, before I could find one who could work on a family like this. It brought him all the way down to England after his masteral thesis under my direction and his Ph. D. in the University of London.

Those people were also interested in the family, because it is in chaos. He started at the beginning in his masteral thesis using the histological method and finally, he got into a new technique which of course belongs to the developed countries — a SEM, a scanning microscope will not be here for a long time. We will still be using the histological method unless, our government will be able to provide such instrument.

We do hope that someday, we will be able to have the SEM and other needed sophisticated instruments. According to him, we will only need a little part which can be attached to the scanning electron microscope that is now found in the College of Engineering. We still have hopes that someday, we can be provided with this little instrument that can be attached to that one for their use. Perhaps other groups can also make use of the SEM in the near future.

Using the SEM enhances even more the status of species based on the present histological methods.

How many species did you scan? I think you already answered this. I understand this is a part of your doctoral thesis in the University of London. I could not believe that Dr. Eduardo could finish all the amphistomes the world over in so short a time.

Are variations in this group infra-specific? Are they intra-specific?

Nonette L. Jueco, M.S. Discussant

What Dr. Eduardo here has just shown to us reveal that minute animals hitherto looked upon as something abhorrent, are also beautiful in their own way when seen in high magnification

such as seen in this scanning electron-microscope. There is no doubt that the use of the SEM will greatly facilitate taxonomic identification of parasites, especially when these parasites are closely similar in morphological characteristics when viewed only under the ordinary light microscope. But what I would like to emphasize here is that the use of the SEM for taxonomic purposes is not the end, but only the beginning in the study of parasites. It is just a tool, as Dr. Eduardo himself said and I quote:

“Accurate identification of the species is the first vital step before any sound control method could be instituted. It is a pre-requisite to the study in immunology and physiology of parasites.”

Most of the slides shown this afternoon, show the papillae of Paramphistomes in different shapes, sizes and numbers, also in different locations in different species. Papillae are sensory organs and may function as chemo receptors, others as tango receptors.

Further studies on the papillae may help elucidate the pathogenesis caused by certain species, their predilection for certain organs in the body and many other nagging questions in the biology of this parasite which is yet unknown at present.

I would like to add further to the discussion, the other uses of SEM which is being applied now in medical parasitology. One is the study on the effect of treatment on the fine tegumental structures of parasites like trematodes. It is now being used to study the effect of different dosages of drugs and also the effect of these drugs and to the different species of the parasites. They usually result in alteration of the tegumental surface of the parasites and used by the drugs.

SEM is also being used in the study on immunology of parasitic infections. For example in multi-cellular parasites, there is a reorganization of their surface component, as a defense mechanism against the host immunity. It is also used in the study of the physiological changes that take place in the development of parasites from the immature stage to sexual maturity by looking at their teguments, also in differences between males and females. It has made possible more extensive research on the mechanisms of miracidial attachment and penetration into the snail intermediate host.

Thus, a scanning electron-microscope can be utilized to understand more clearly, many parasite host and will provide information essential to biochemists, malacologists, physiologists and behaviorists.

But to echo the comment of Dr. C. Velasquez how can local taxonomists avail of such kind of technology in the Philippines at the present time? Thank you.

INTRASPECIFIC HYBRIDIZATION IN VOLVARIELLA VOLVACEA BY PROTOPLAST FUSION TECHNIQUE

By Claro M. Santiago, Jr., Ph.D.

Abstract

Methods for the isolation of protoplasts from *Volvariella volvacea* using *Trichoderma harzianum* liquid culture was evaluated. Addition of chitin, laminaria meal and hyphal walls from the fungus stimulate synthesis of both chitinase and B-glucanase activities which resulted in high protoplasts yield. A comparison of protoplasts yields in different stabilizer system was described. Reversion frequency was shown to be influenced by nutrient composition especially carbon and nitrogen source in the regeneration medium. Investigation of the factors affecting fusion frequency indicate that polyethylene glycol concentration (PEG), pH and temperature were important. Proof of heterokaryosis in fused protoplasts was evident by the recovery of recombinant progenies after meiotic segregation from two nutritionally complementary auxotrophic markers.

Introduction

Studies on the mass cultivation of the edible mushroom *Volvariella volvacea* have been actively carried by workers in tropical and subtropical regions (1-3). However, interest in the genetics and breeding of this economically important fungus has not been developed despite the pioneering work of Chang and Yau (4) on its life history.

In recent years several studies have shown the possibility of obtaining successful complementation between nuclear genes, especially among fungal strains having incompatible mating factors by using the protoplast fusion technique (5). Successful crosses have been achieved with many species, including some of industrial importance, e.g. *Saccharomyces cerevisiae*, *Schyzosacchromes pombe*, *penicillium species* and *Candida tropicales* (6). The significant development of fusion technology made at intraspecific level may enhance the possibility of improving different commercial mushroom strain.

A comprehensive investigation was therefore undertaken to demonstrate heterokaryon formation following induced intraspecific fusion between protoplast of nutritionally complementary auxotrophs of *V. volvacea*, using solutions containing polyethylene glycol. Additional information derived from this work may be of great value to potential mushroom investors and may lay the foundation for future breeding experiments which would undoubtedly lead to the discovery of high yielding strain.

Materials and Methods

Culture media

A range of regeneration media osmotically stabilized with either MgSO_4 or KCl was prepared. Tests for different carbon sources were conducted using sugar concentration of: glucose, sucrose, dextrose, D-galactose, L-xylose, lactose and mannose. Sugars were autoclaved separately prior to incorporation in mushroom minimal medium (7). Source materials for nitrogen were as follows: yeast, peptone, asparagine, urea, potassium nitrate and monobasic ammonium phosphate. The amount of different nitrogenous substances added to the agar media was based on computed nitrogen contents of the sample to give 1g^{-1} . All media were sterilized for 15 min. at 15 psi and the pH value was adjusted as required.

Organism

Auxotrophic mutants of *V. volvacea* were maintained on a mushroom minimal medium supplemented with the growth requirements of the organism. *Trichoderma harzianum* was maintained routinely in TLE medium as described by Peberdy and Isaac (8).

Treatment with mutagen

Protoplast suspensions were exposed to U.V. lamp (with emission of $39\text{ erg sec}^{-1}\text{cm}^{-2}$) with constant agitation using a magnetic stirrer, and a distance of 30 cm from the lamp. Exposure was terminated at varying time and the suspensions were suitably diluted before plating on to complete mushroom medium (7). A non-irradiated sample was used as a control.

Protoplast Isolation

Lytic enzyme from *T. harzianum* was prepared according to the procedure of Santiago (9). Mycelium for protoplast isolation was grown in submerged culture in minimal medium at 28°C . After 3 days incubation it was harvested by filtration, washed three times in buffer/stabilizer solution and dried by vacuum. It was re-suspended in a digestion mixture of equal volumes of buffer-stabilizer solution and *Trichoderma* liquid enzymes, at a final concentration of $20\text{ mg fresh weight ml}^{-1}$. Digestion mixtures were incubated at 28°C on a reciprocal shaker for 3-4 h.

Protoplast reversion

The frequency of protoplast reversion was determined as colony counts from diluted protoplast preparations. Comparison

was made using minimal mushroom medium containing different carbon and nitrogen sources in an attempt to optimize reversion.

Fusion Treatment and Selection of Heterokaryons

Protoplasts of two nutritionally complementary strain were mixed after washing and centrifuged for 10 min. The protoplast pellets were resuspended in 1 ml 30% (w/v) polyethylene glycol, mol. wt. 6000 (PEG) (Koch-Light), in 0.01 M CaCl_2 and 0.05 M glycine, adjusted to pH with 0.01 M NaOH. After incubation for 10 min. in a water bath at 30°C, the suspension was diluted with 4 ml stabilizer solution and centrifuged at 700 g for 5 min. The protoplasts were washed twice with 0.6 M MgSO_4 and finally resuspended in 5 ml of the same stabilizer system. Serial dilutions of treated protoplasts were plated on hypertonic minimal medium and complete medium to select heterokaryons and to count the total number of viable protoplasts, respectively.

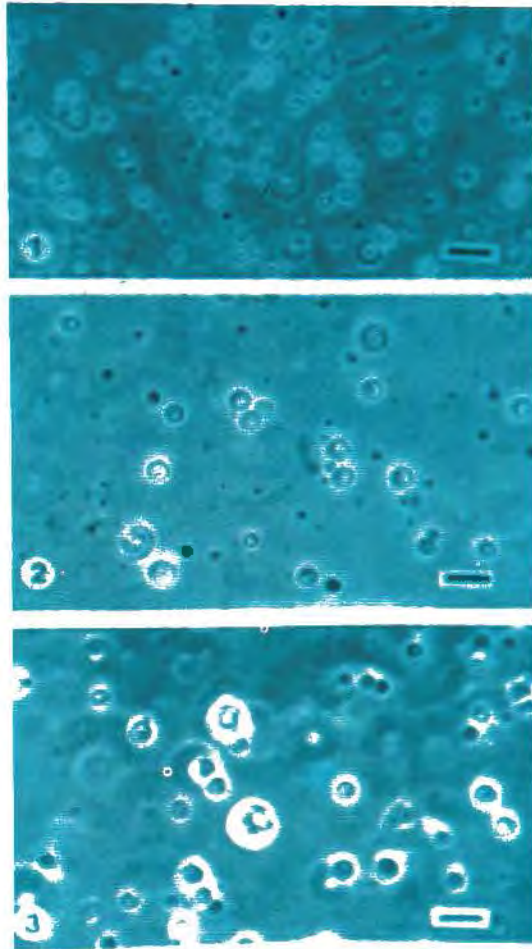
Fruit-body production

Heterokaryons produced following protoplast fusion were used in fruiting experiments. Rye gain spawn was prepared as earlier reported (9) and after sterilization was inoculated with agar plug taken the margin of a growing colony. The fruiting ability of the heterokaryons was tested by culture on wheat straw.

Results and Discussions

Variations in protoplast yield with different inducer substrate supplements used in TLE production.

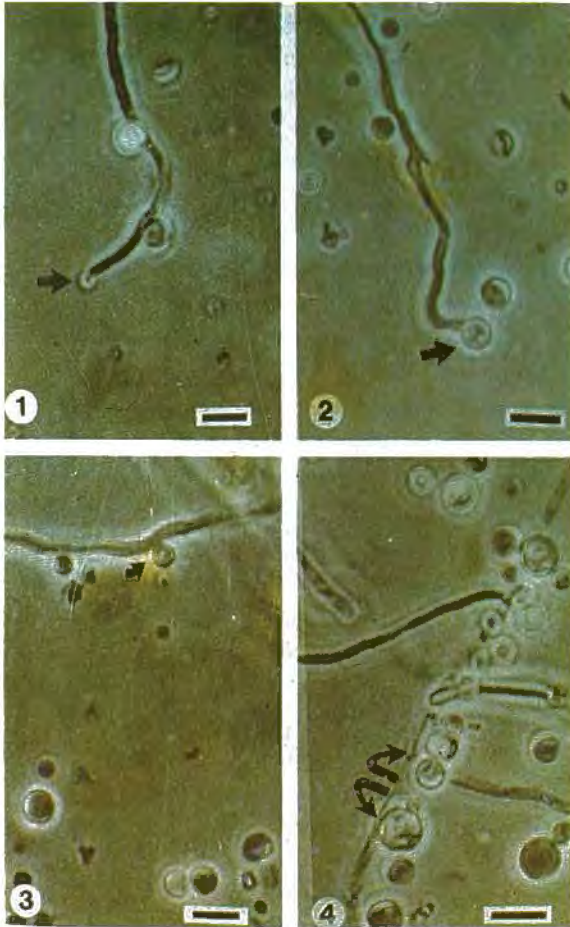
Various growth substrates were incorporated in the basic TLE liquid culture and tested for effectiveness in producing protoplasts from *V. volvacea* (Fig. 1). Compared with media containing chitin and laminaria meal, the addition of *V. volvacea* hyphal walls had a significant effect on enzyme production and in turn on the protoplast yield. The maximum level of enzymatic digestion with this supplement was reached after 4 h incubation, the peak occurring in MgSO_4 stabilizer. With both laminaria meal and chitin supplemented separately to the hyphal walls there is an increase in protoplast production. Addition of hyphal walls to the culture medium show higher chitinase activity, but lower α and β -glucanase activity than the enzyme produced on the other substrate (Table 1). Enzymes produced using a total mixture of inducer substrates, i.e. hyphal walls, laminaria meal and chitin was active in mycelial lysis resulting in total fragmentation and disintegration of the hyphal. This preparation stimulated synthesis of both chitinase and β -glucanase activities producing high protoplast released from this fungus.



Morphology of protoplasts released during incubation of *V. volvacea* mycelium in 0.6 M MgSO_4 stabilized lytic mixture at 28°C .

Protoplast photographed in the lytic mixture, phase contrast microscope

- (1) Protoplasts liberated after 1 hr digestion, small and dense
- (2) Protoplast after 2 hr have uni- and multi-vacuolate types
- (3) After 3 hr the protoplasts were large and highly vacuolate. Bar markers represent 5μ .



Morphology of protoplasts emerging and liberated from *V. voluacea* mycelium during incubation in 0.6 M. $MgSO_4$ and 0.6 M KCl stabilized lytic mixtures at 28°C.

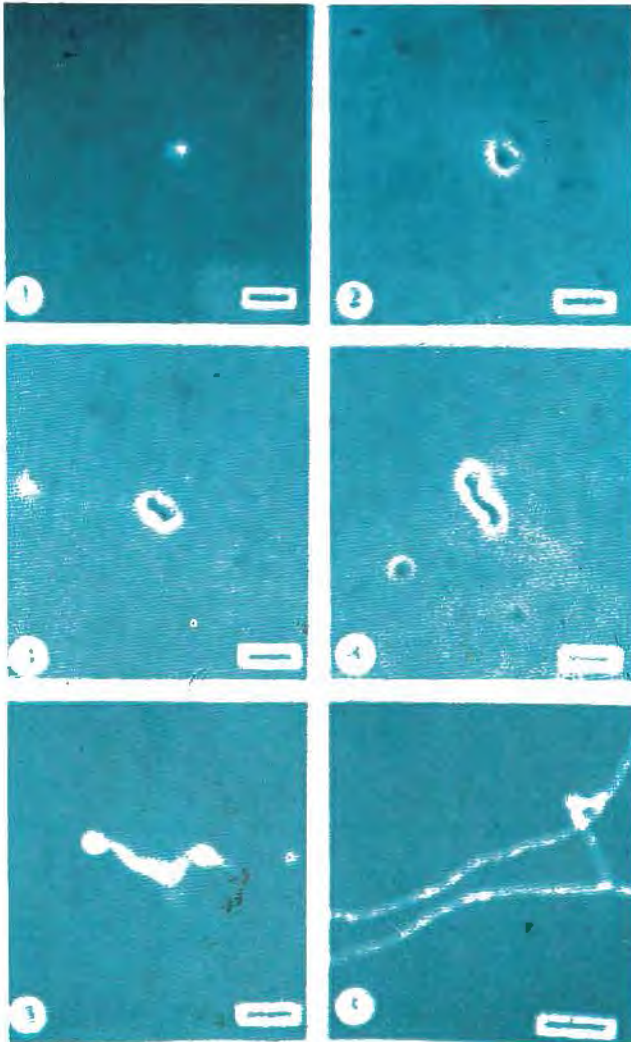
(1) Emergence of protoplast at the swollen hyphal tip in 0.6 M KCl after 30 min. digestion.

(2) Protoplasts liberated from the hyphal tip in 0.6 M $MgSO_4$ after 2 h digestion.

(3) Protoplasts emerging from subapical hyphal in 0.6 M KCl after 1 h digestion. The protoplasts are small and non-vacuolate.

(4) Highly vacuolate protoplasts liberated from the subapical zone in 0.6 M $MgSO_4$ after 3 h digestion.

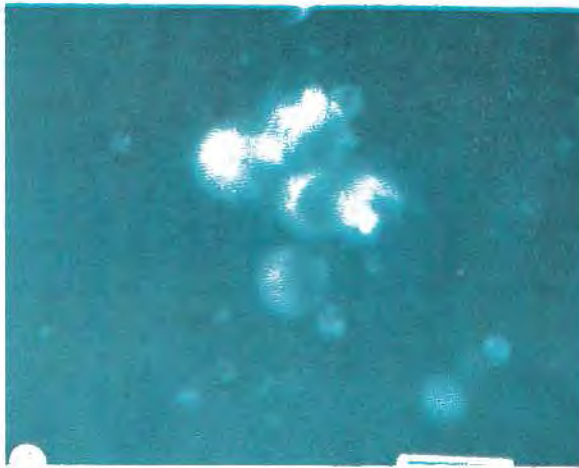
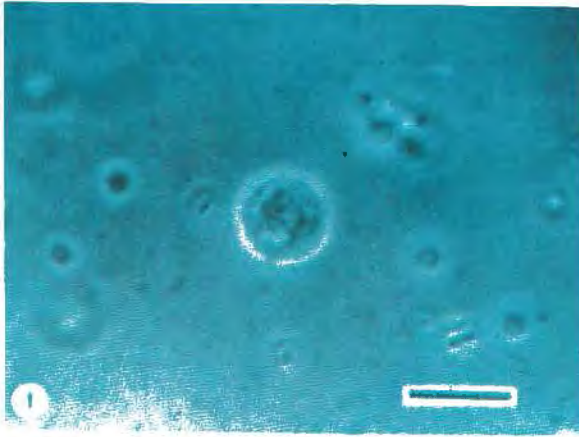
Bar markers represent 5 μ .



Morphology of protoplast reversion during incubation in liquid culture at 30°C

- (1) Uninucleate protoplast from 3 h digestion in kcl osmotic stabilizer
- (2) Protoplast showing constricted appearance after 4 h digestion
- (3) Budlike structure begin to appear after 5 h reversion
- (4) Budlike structure elongate to form a normal hyphol after 6 h reversion
- (5) A multinucleate hyphol originating directly from reverted protoplast after 8 h
- (6) Normal hyphol develop and elongate to a multinucleate structure

Bar markers represent 5 μ



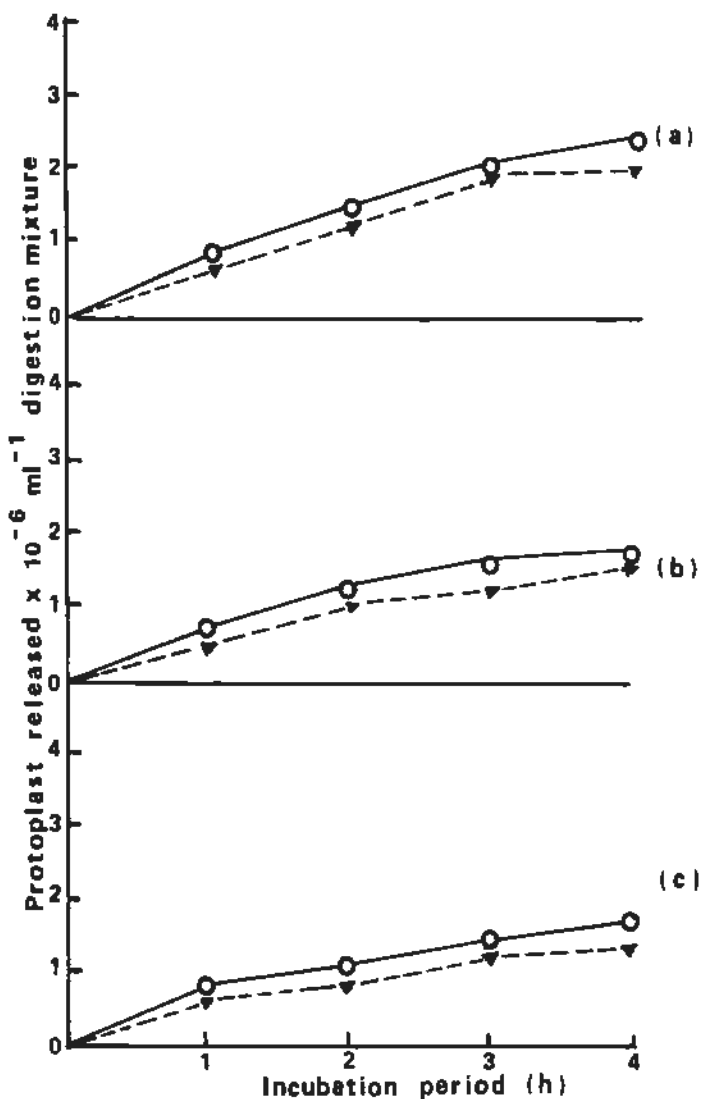
Morphology of large protoplasts after 24 h incubation in $MgSO_4$ stabilizer

Phase contrast microscope

- (1) Highly vacuolate giant protoplasts. Unstained
- (2) Highly vacuolate giant protoplasts
Fluorescent staining with chromomycin A_3 .
- (3) Fixed overnight with 4% glutaraldehyde

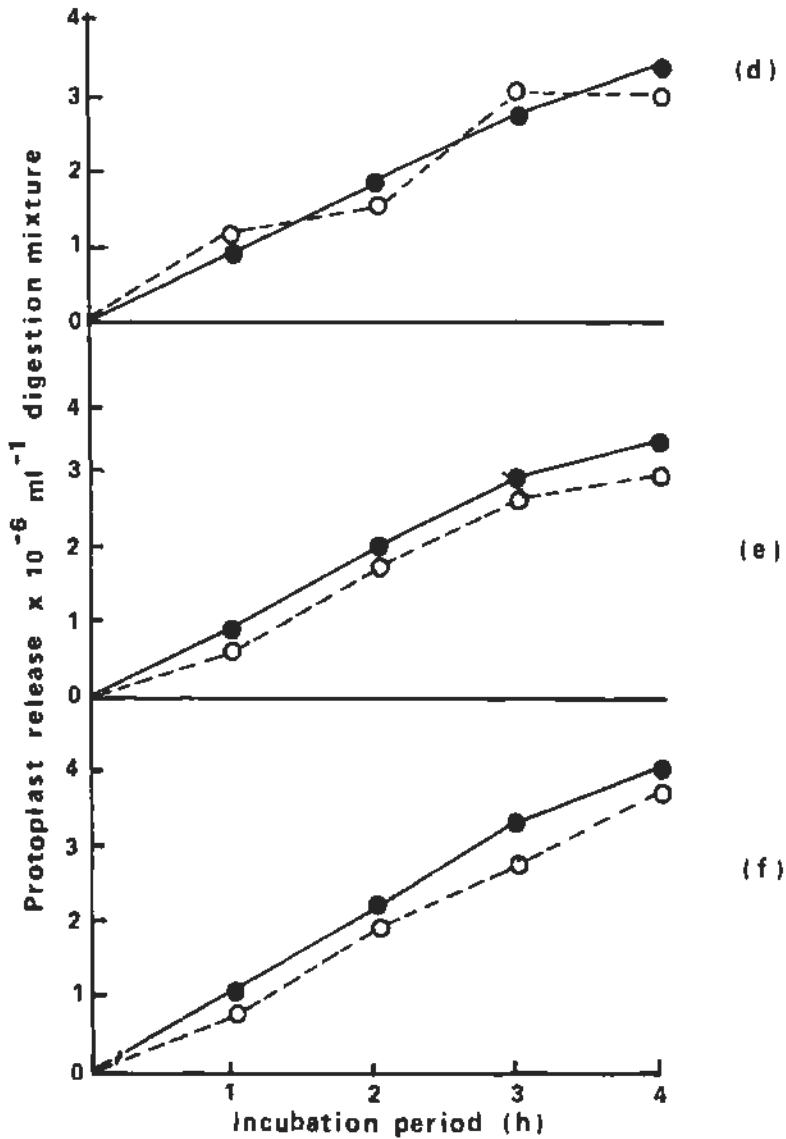
Bar markers represent 5μ .

Figure 1. Effect of medium supplement in *Trichoderma narzanianum* liquid culture (ten-fold concentrates) with 0.6 M MgSO_4 (●—) or with 0.6 M KCl (○—) stabilizers on protoplast release.



- (a) TLE + hyphal walls (5g.l⁻¹ dry weight)
 (b) TLE + laminaria meal (5g.l⁻¹)
 (c) TLE + chitin (5g.l⁻¹)

Figure 1. Effect of medium supplement in *Trichoderma nazariarium* liquid culture (ten-fold concentrates) with 0.6 M MgSO_4 (●—) as with 0.6 M KCl (○—) stabilizers on protoplast yield.



- (d) TLE + hyphal walls (5 g.l^{-1} dry weight) + laminaria meal (5 g.l^{-1})
 (e) TLE + hyphal walls (5 g.l^{-1} dry wt.) + chitin (5 g.l^{-1})
 (f) TLE + hyphal walls (5 g.l^{-1} dry wt.) + laminaria meal (5 g.l^{-1}) + chitin (5 g.l^{-1})

Table 1. Activities of chitinase and α - and β -glucanase in tenfold concentrate of 4 day culture filtrates from *trichoderma harzanum*.

Culture	Chitinase	α -Glucanase	β -Glucanase
	μ moles G/C Nac* $\text{min}^{-1} \cdot \text{mg protein}^{-1}$	μ moles glucose $\text{min}^{-1} \cdot \text{mg protein}^{-1}$	μ moles glucose $\text{min}^{-1} \cdot \text{mg protein}^{-1}$
TLE + Homogenized mycelium (100g. 1^{-1} fresh weight)	$4.59 \pm 0.05^{**}$	0.03 ± 0.02	2.17 ± 0.03
TLE + Laminaria meal (10g. 1^{-1}) + Chitin (5g. 1^{-1})	39.96 ± 0.10	0.07 ± 0.015	2.15 ± 0.081

* N - acetylglucosamine

** Standard deviation

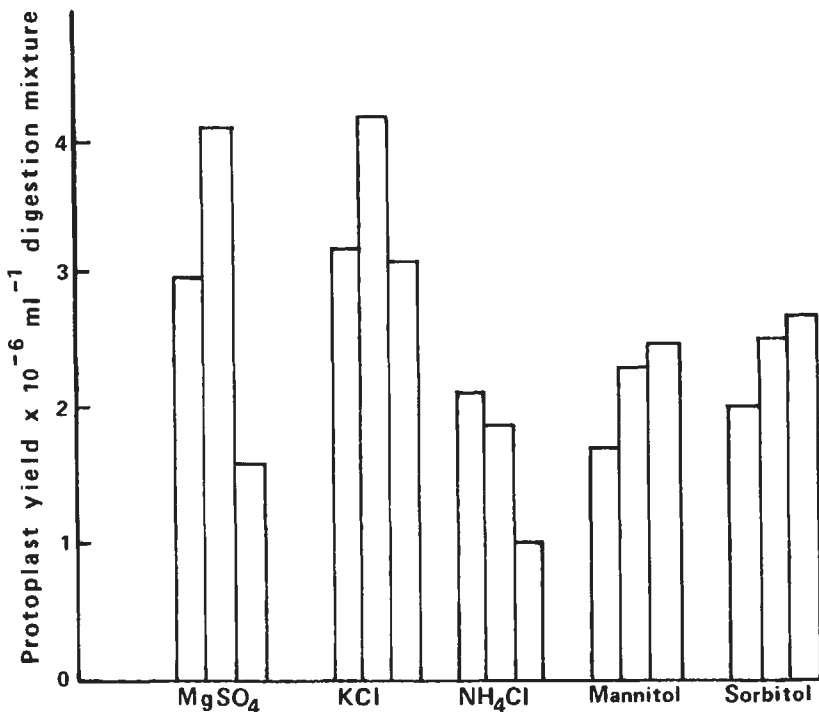


Figure 2. Comparison of protoplast yields using different osmotic stabilizers. The concentrations of stabilizer are 0.4 M, 0.6 M and 0.8 M from left to right. The digestions were carried out for 4 hr. at 27°C .

Effect of various stabilizers and their molarity.

Various compounds were tested for their effectiveness in supporting protoplast release and stability (Fig. 2). The relative density of the protoplasts varies, depending on the osmotic stabilizers used. Incubation with MgSO_4 or KCl gave more than 40% increase in yield compared to other stabilizers. In NH_4Cl , mannitol, and sorbitol small non-vacuolate protoplasts were released in the early phases of digestion, but later several vacuolated protoplast appeared similar to the pattern of release in the KCl -stabilizer system.

MgSO_4 and KCl proved more effective than the sugar alcohols for this fungus. The use of these organic salts instead of organic compounds also prevented bacterial growth during incubation (10). MgSO_4 is preferred because most of the liberated protoplast developed large vacuoles and floated. This affords a convenient method for the recovery of these protoplasts from the residual hyphal fragments by slowspeed centrifugation. Protoplasts isolated with this stabilizer system were found to have a high reversion capability.

Effect of carbon source on reversion of protoplasts

The ability of protoplasts to regenerate a new cell wall and undergo reversion to the hyphal state was investigated by plating appropriate dilutions, after haemocytometer count, into hypertonic agar media. The presence of a carbon source is required for the reversion of protoplasts (Fig. 3). With asparagine as nitrogen source glucose, lactose, sucrose, fructose, maltose, arabinose and ribose generally increased the reversion rate of protoplasts. Stimulation of reversion by the polyols was lower compared to monosaccharides, disaccharides and pentoses. The efficient stimulation of reversion by the disaccharide could be caused by the greater permeability of the protoplast or a greater rate of utilization and assimilation. The germination promoting action in some fungal spores has been suggested to be due to the presence of phosphorylase, B-fructofuramosidase and invertase activities (11, 12, 13) but no effort was made in the present study to identify these enzymes.

Effect of nitrogen source

A similar trend indicating an increase in the reversion frequencies of protoplasts was obtained when various nitrogenous compounds were added to the hypertonic agar medium. The results presented in Fig. 4 show that reversion is much better with the organic substrates. KNO_3 and $\text{NH}_4 \text{Cl}$ promote less than 2% reversion. Without a nitrogen supplement in the medium, protoplasts do not revert. The reversion frequency obtained in *Aspergillus nidulans* (14) was lower at 10-30% than that reported for *Neurospora crassa* (15) and *Schizophyllum commune* (16). However, in *V. voluacea* the reversion frequency was exceedingly low and never greater than 4%. The inability of most protoplasts to revert may be due to the absence of nuclei (17) or the absence of other organelles in the cytoplasm (18).

Influence of different parameters on the fusion frequency

To determine the effectiveness of PEG as a fusogenic agent for *V. voluacea* protoplasts, sterile auxotrophic mutants which failed to produce sporophores in several conventional crossing experiments were fused. The criterion used to identify fused protoplasts was the formation of heterokaryons between nutritionally complementary auxotrophs growing on minimal medium. The fusion frequency (Ff) was expressed as the number of colonies on minimal medium (mmm) to the number of colonies developed on complete medium (mcm) after 2 days incubation at 37°C.

Carbon Sources		Reversion Frequency (%)			
		1	2	3	4
Disaccharides	Lactose				
	Maltose				
	Sucrose				
Monosaccharides	Glucose				
	Fructose				
	Manose				
Pentoses	Xylose				
	Arabinose				
	Ribose				
Polyols	Sorbitol				
	Mannitol				
	Inositol				
Control (w/o carbon)					

Figure 3. Effect of various carbon sources on the reversion of protoplasts. Protoplasts were isolated after 4 hr lytic digestion and incubated at 37°C for 2 days on 0.6 M MgSO₄ (|||) or 0.6 M KCl (: ::) stabilized media.

$$Ff = \frac{\text{number of colonies on mmm}}{\text{number of colonies on mcm}} \times 100$$

Effect of PEG concentration

A solution containing 30% (w/v) PEG was found optimal in fusion and stability of protoplasts (Fig. 5). Most protoplasts were observed to burst at concentration lower than 20% especially

NITROGEN SOURCES		REVERSION FREQUENCY (%)			
		1	2	3	4
Complex organic Nitrogen sources	Peptone		┌─┐		┌─┐
	Yeast extract	┌─┐		┌─┐	
	Casitone		┌─┐		┌─┐
Simple organic Nitrogen sources	L Asparagine		┌─┐		┌─┐
	L Arginine	┌─┐		┌─┐	
	Urea			┌─┐	┌─┐
Inorganic Nitrogen sources	NH NO	┌─┐	┌─┐		
	NH Cl	┌─┐	┌─┐		
	KNO	┌─┐	┌─┐		
Control (w/o Nitrogen)		┌─┐			┌─┐

Figure 4. Effect of various nitrogenous sources on the reversion of protoplasts. Protoplasts were isolated after 4 hr lytic digestion and incubated at 37°C for 2 days on 0.6 M MgSO₄ (||||) or 0.6 M KCl (: ::) stabilized media.

when the amount of stabilizer was reduced. Above 40% PEG solution the protoplasts showed shrinkage probably due to the hypertonic conditions, but they normally regained their size after dilutions of PEG.

Effect of pH

There was an increased frequency with increasing pH and the highest yield of fusion was obtained at pH 8.0 (Fig. 6). Above this value heterokaryon formation was noticeably decreased. The effect of pH on fusion frequency was probably influenced by the presence of calcium ions from the fusion mixture containing CaCl₂.

Effect of temperature

Fusion of protoplasts initially took place at 10°C and there was a considerable increase with increasing temperature. The

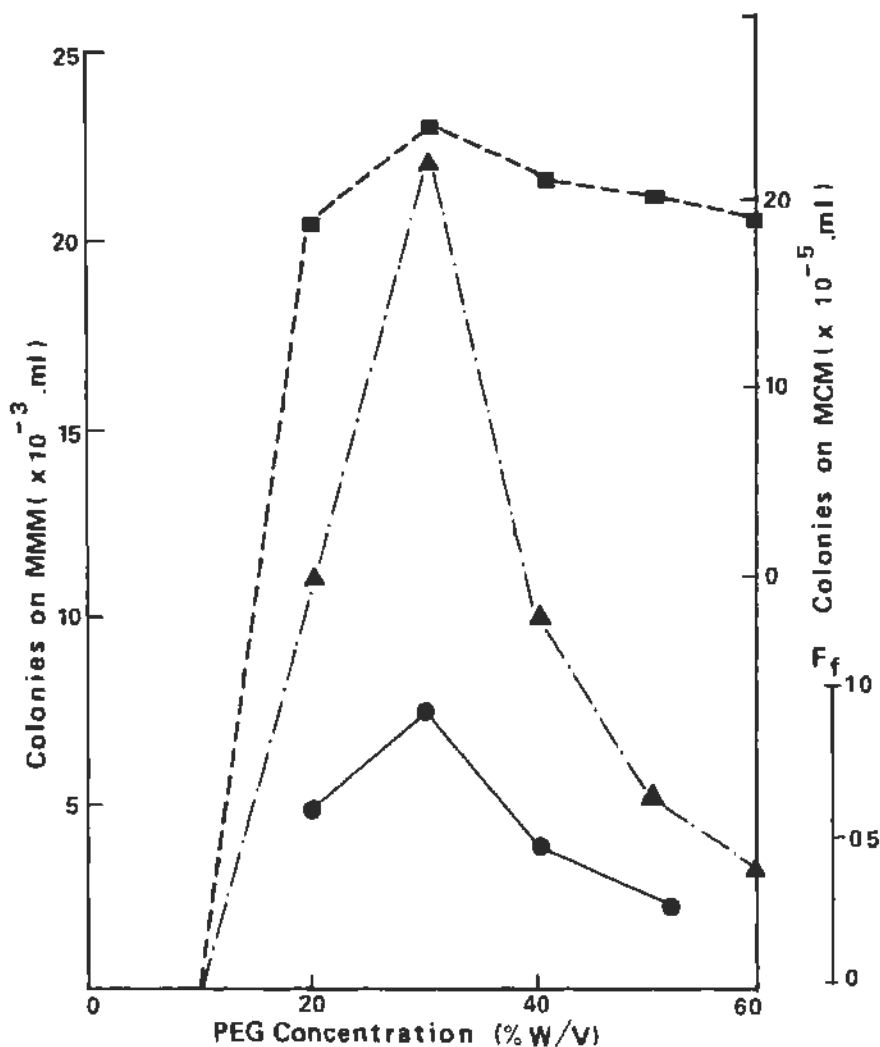


Figure 5. Effect of concentration of PEG on the fusion frequency (●—) of protoplast between Ade (R-type) x Leu (T-type) cross. Protoplasts were treated with different concentrations of PEG in 0.01 M CaCl_2 and 0.05 M glycine, pH 8 (30°C , 10 min). Heterokaryons and total number of viable protoplasts were counted in MMM (▲—) and MCM (■—) after 2 days at 30°C .

optimum temperature was found at 30°C (Fig. 7). The number of regenerating protoplasts decreased sharply above 40°C . This is probably due to reduction in viscosity of PEG solution at high temperature.

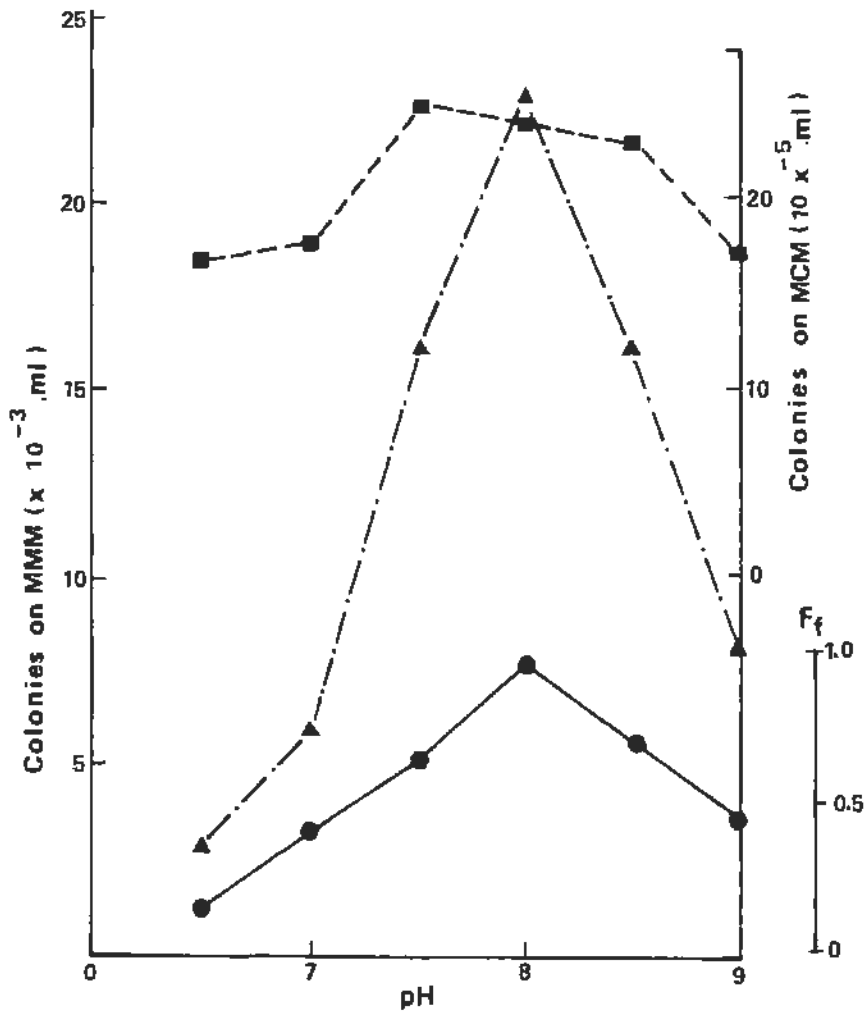


Figure 6. Effect of pH on the fusion frequency (●—) of protoplasts between Ade (R-type) x Leu (T-type) cross. Protoplasts were treated with 30% (W/V) PEG solution containing 0.01 M CaCl_2 and 0.05 M glycine. pH was adjusted with 0.01 M NaOH. Heterokaryons and total number of viable protoplasts were counted in MMM (▲—) and MCM (■—) after 2 days at 30°C .

Heterokaryon formation and fruiting between auxotrophic mutants using protoplasts fusion

No back mutation was found in any of the auxotrophs so the colonies recovered on mmm, following PEG treatment, were deemed to be heterokaryons. The frequency of heterokaryon

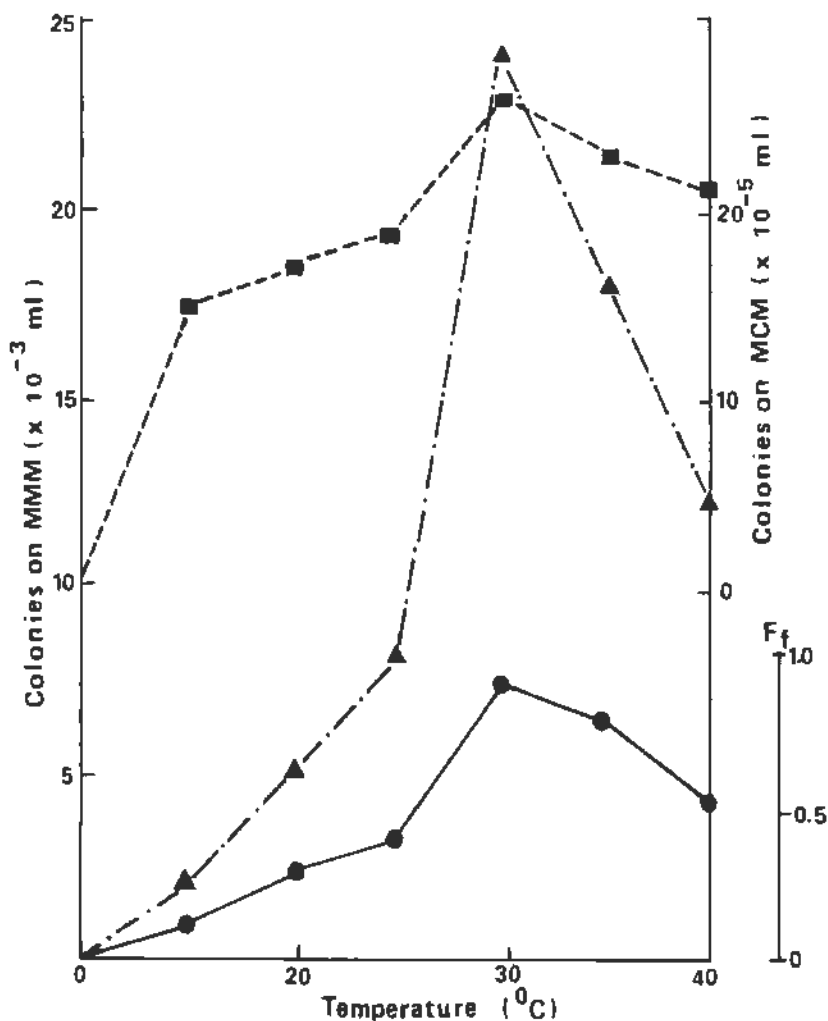


Figure 7. Effect of temperature on the fusion frequency (●—) of protoplasts between Ade (R-type) x Leu (T-type) cross. Protoplasts were washed with 0.6 M MgSO₄ and incubated at different temperatures. Heterokaryons and total number of viable protoplasts were counted in MMM (▲—) and MCM (■—) after 2 days.

formation was generally low (< 0.7%) and variable (Table 2). The heterokaryons were isolated and maintained on mmm. The colonies were irregular and morphologically different from the parental strains. Further evidence for heterokaryons was obtained when the fusion product was successfully fruited. Analysis of the single spore isolates from crosses 1 and 2 showed the presence of both recombinant classes, i.e. prototrophs and double auxotrophs.

Table 2. Frequencies of heterokaryon formation following protoplast fusion between antagonistic strains

Cross	Protoplast mixtures	Heterokaryons ($\times 10^{-3} \text{ml}^{-1}$) on MMM	Colonies ($\times 10 \text{ml}^{-6} \cdot \text{ml}^{-1}$) on MCM		Fusion Frequency
		After PEG treatment	Before PEG	After PEG	
1	<i>Ade</i> (R-type) x <i>Leu</i> (T-type)	22	18.4	3.5	0.63
2	<i>Nia</i> (L-type) x <i>Met</i> (Q-type)	25.2	24.0	7.3	0.35
3	<i>Nia</i> (L-type) x <i>Arg</i> (D-type)	10.9	13.6	2.30	0.47
4	<i>Nia</i> (D-type) x <i>Ade</i> (R-type)	9.5	10.8	5.8	0.16

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NEW TECHNIQUE FOR GENETIC MANIPULATION OF INDUSTRIAL MICROORGANISMS

John F. Peberdy, Ph.D.

Natural mechanisms for recombination in micro-organisms have long been understood. These include sexual and parasexual processes in fungi and more specialized mechanisms in prokaryotes. However, strain improvement programmes for industrially important micro-organisms have rarely involved these approaches, relying extensively on mutagenesis and selection.

In the past decade microbial genetics has been revolutionized with the discovery and development of other mechanisms for genetic recombination. The most dramatic involve recombinant DNA technology which allows the manipulation of single genes and the possibility of expression of foreign genes in prokaryotes. Increasingly, these techniques are being developed and exploited in eukaryotes with undoubted advantages for industrial processes in the future.

The second major aspect of this revolution is the utilization of protoplast fusion as a tool for polygenic recombination. This technique is becoming increasingly useful in the development of recombination systems in several prokaryotic and eukaryotic species as well as opening up prospects for interspecies hybridizations.

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EMIL Q. JAVIER Academician. A young and energetic young scientist, he was named Director General of the NSTA, he is currently chancellor of the UP at Los Baños. Minister Javier is a holder of Ph.D. in plant breeding and genetics from Cornell University in 1969, obtaining his MS. in Agronomy from the Illinois U. and his B.S. in Agriculture from the UP College of Agriculture.

He started out as research assistant at the UPCA and the University of Illinois and later as graduate assistant at Cornell U. He went back to the UP Academic halls at Los Baños in 1966, after 10 years he became a professor — up to this day. He is responsible for the creation of the Institute of Plant Breeding in 1975 at UPLB.

In his earlier years, he came up with 48 research works and he is still working on many more. Because he believes that the man-in-the-street will have an increasing amount to say about some issues raised by applied science, he came up with more than fifteen popular articles.

A TOYM awardee, it is not surprising to see behind him a very rich scientific and technological accomplishment.

ALFREDO V. LAGMAY, Academician, Ph.D. in Experimental Psychology, 1955, Harvard University. He is presently a professor of Psychology, College of Arts and Sciences, University of the Philippines.

His awards include: Professorial Chair, UPAA Research Professor of Psychology, 1974-75; Fellow of the University of the Philippines to Harvard University, 1950-55, 1962; Postdoctoral fellow at Harvard under a Rockefeller Foundation scholarship, 1967-68. Research fellow at University of California, Berkeley, under Fulbright Hays program administered by the Philippine-American Educational Foundation and the International Exchange of Scholars, New York; cum laude, Bachelor of Philosophy, U.P.; recipient of UP President's pin for graduating with honors, 1947.

ENCARNACION ALZONA, Academician. Ph.D. Columbia University. She has become specialized in Philippine History. Dr. Alzona has received several national awards in recognition of her dedication to historical writings that brought about Philippine history in a nationalistic perspective. Among the awards are: Republic Cultural Heritage Award for Historical Writing in 1966, Rizal Pro-Patria Award and Apolinario Mabini Memorial Award. The Philippine Women's University had conferred on her a degree of Doctor of Laws, *honoris causa*. She is engrossed on researches involving important people and events in Philippine past, one of these is about T.H. Pardo de Tavera. With these series of works, she initiated the translation of several works of our national heroes from Spanish to English. She sees a fair chance of getting these published in the future.

ROMEO N. BAUTISTA, Ph.D. An economics professor at the University of the Philippines, he obtained his Ph.D. from Yale University in 1970. He is likewise on special detail as deputy director general at the National Economic Development Authority. Prior to this, he was consultant since October, 1980 of the National Economic Council, 1970-72; Economic Commission for the Asia and the Far East, World Bank, 1975 and 1979-80.

He was named one of the Most Outstanding Young Scientists in 1982 by the National Academy of Science and Technology. A visiting fellow, Department of Economics, Research School of Pacific Studies, Australian National University, 1977; Research fellow, National Bureau of Economics Research, Inc. (New York), 1975-76; fellow, Technology and Development Institution at the East West Center in Honolulu from 1972-73 are some of his awards. Having attended several conferences and seminars here and abroad, he has close to 50 published works. In 1980-81, he was head of the Philippine Society for International Development.

ERNESTO M. PERNIA, Ph.D. As director for research at the Institute of Economic Development and Research, UP School of Economics, he is also associate professor. He is currently a consultant to Population Council, Regional Office, East and South Asia, among others. Likewise, he has served as consultant at the United Nations University in Tokyo, Japan 1978-79 and the World Bank (IBRD) in 1975.

In 1971-75, he was named to the Ford Foundation Fellowship at the University of California in Berkeley, Dr. Pernia was likewise a research grantee, Interdisciplinary Communications Program at the Smithsonian Institute in Washington, D. C., from 1974-75.

Centering on urbanization, population growth and statistics, his voluminous works dealt on economic development and its allied fields. He is a member of the International Union for the Scientific Study of Population based in Leige, Belgium.

ELY ANTHONY R. OUANO, Ph.D. He is a holder of doctor of engineering (Environmental) in 1972 from the Asian Institute of Technology, Bangkok, Thailand, he is a balik-scientist awardee of the NSDB (now NSTA) in 1978, his stint abroad includes: Environmental Background Level Assessment for the Proposed Thai Petrochemical Site in Chron Buri, Thailand from '74 to March '75.

Air pollution levels monitoring; Development of Air Pollution Management Structure and Consultant in many endeavors at the same time, including: at present, a consultant to MPW's REWARDS project on the availability, demand and quality needs of water resources throughout the Philippines; Environmental Impact Assessment of San Roque Dam; To Ayala Corporation on Water Supply, Sewerage and Sewage treatment and solid waste management for the New Alabang Subdivision and rehabilitation of water supply system for Makati; Black Mountain, Inc. in its water pollution problems; Secretary to the Board of Directors Consultancy Services Construction Management Firm involved in the construction of La Tondeña Canlubang, Intel (Phils.) and Ciba Geigy, since May 1979.

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in Pharmacy in 1931, also from the same University.

A grantee of the PHILCUSA-MSA Fellowship in Antibiotics Technology and Microbiology Special Training, she made exclusive antibiotics research, also in microbiology, mycology, industrial fermentation and pilot plant operations at the University of Illinois, USA. Most of her researches focused on antibiotics and microbiology. From 1967-68, she took studies on Laboratory Administration at the Polytechnic School of Management Studies in London England as a Colombo Plan scholar.

The Philippine Medical Association gave her two Abott Research Awards in 1973. These are in Basic Science in 1973 as First Prize on "Antitumor Activity of Locally-isolated Actinomycins (co-author, 1978 and Third Prize on Toxicity Studies on Locally-isolated Actinomycins (co-author), 1971.

FE VILLANUEVA DEL MUNDO, National Scientist, Doctor of Medicine, University of the Philippines, 1933. Ramon Magsaysay Awardee for Public Service by a Private Citizen, 1977 and Professor Emeritus of FEU, 1977. She was conferred three Doctor honoris causa degrees by the Philippine Women's University, 1968; Medical Women's College of Pennsylvania, 1970; and Smith College, Northampton, Massachusetts. At present, Dr. del Mundo's various positions are: Director and Founder, the Children's Medical Center Foundation of the Philippines; Director, Institute of Community Health; and many others. A leading Pediatrician and medical stateswoman, Dr. del Mundo has been the moving spirit behind the establishment of various medical institutions in the country. She is an outstanding woman in the Philippine, Asian and world medicine. A proficient scholar, distinguished educator, medical researcher, exemplary citizen, she is a humanitarian dedicated to help promote better living conditions through better health.

JULIAN A. BANZON, Academician, Ph.D. in Biophysical Chemistry, Iowa State University, 1940, Emeritus Professor of Food Science and Technology, University of the Philippines at Los Baños and Scientific Consultant, Maya Farms, Philippine Coconut Authority and Philippine Coconut Research and Development Foundation. His most important recognitions include, Professor Emeritus at UPLB, Chemist of the Year Award by the Professional Regulation Commission, 1978, PHILSUGIN award for Research, Crop Science Society of the Philippines, 1976 and the Distinguished Service Award conferred by the Integrated Chemists of the Philippines, Inc. in 1980.

His primary research interests are on the chemical aspects of food and energy. Ten publications on coconut as a renewable source of energy, two on the fermentive utilization of cassava and three on photochlorination of coconut oil are only a few of such researches geared towards energy and the utilization of local plant materials.

JOSE R. VELASCO, Ph.D. obtaining it from the University of California in 1949, he was a commissioner of NIST for ten years.

In the academe, he started out as assistant instructor for five years, an instructor (4 years); assistant professor (6 years); chairman of the Department of Agricultural Botany, College of Agriculture and a Botany professor for a year at the Graduate School of Arts and Sciences, UP. This is prior to his being named NIST head. His

research touched various areas of plant physiology like mineral nutrition, photoperiodism, chemical weed control and plant growth in general. These works have laid out the foundation of some important crop production management practices and paved way for research directions for the UP College of Agriculture.

Among his honors and awards are: fellowship from SEATO, in 1963; the Guggenheim Foundation, also in 1963; the UP Alumni Award in 1967; Colombo Plan Special visitor to Australia in 1979 and Distinguished Alumnus Award by the UPAA in 1971.

OFELIO R. EXCONDE, Ph. D. A doctor of philosophy (Plant Pathology) from Kansas State University, U.S.A. He is a professor at the Department of Plant Pathology and senior scientist at the Institute of Plant Breeding, College of Agriculture, University of the Philippines, at Los Baños.

Plant pathology is Dr. Exconde's field of specialization. He started out as instructor at the Department of Botany and Plant Pathology, Kansas State U., where he also obtained his Ph. D. in 1961. On his return to UPLB, he was appointed assistant professor at its Plant Pathology Department and rose to associate professor after seven years. He has over 80 published works.

To his credit, he is a recipient of the Rizal Pro Patria Awards from President Marcos in October, 1976 as well as the Presidential Plaque of Merit in August 1967 as Outstanding Plant Pathologist among others.

CARMEN C. VELASQUEZ, Academician, An Emeritus Professor of Zoology at the UP in Diliman, Q.C.

Appointed twice as member of the Executive Council of the National Academy of Science and Technology. She worked her way up before she became Full Professor VIII at UP's Zoology Department from 1975-78. Dr. Velasquez started out as student assistant in 1934 and rising to assistant professor in 1954. Four years after, she left for abroad and had a stint as a visiting investigator at the US Dept. of Agriculture, Beltsville in Maryland, USA and as a professional lecturer at the University of Maryland.

In 1961, she was back at UP and this time as associate professor and stayed here for six years. She returned to Maryland as a visiting professor and investigator at the Smithsonian Institute in Washington, D.C. The same year she was named full Professor I at the Zoology Department and from there made a phenomenal rise.

Behind her is over 50 research papers and most of them hit print in reputable international journals. Her brilliant works made it easy for her to garner several awards, among them: the Presidential Distinguished Service Medal and Diploma of Honor, Republic of the Philippines, 1965, "In recognition of valuable service to science and people" and the Phi Sigma Award" in recognition of meritorious graduate school achievement in the field of Biological Science in 1953 and Outstanding Woman in Science in the Philippines by UNESCO during its biennial conference in 1975.

JOVENTINO D. SORIANO, Academician, Ph.D. in Cytogenetics and Mutations Research, University of Chicago, 1957 and currently professor of Botany, Department of Botany, College of Arts and

Sciences, University of the Philippines.

He has held various positions like member, Fulbright Hays/East-West Center Grants Committee, 1975 to 1980; Director, U.P. Office of Research Coordination, 1971-1979; Chairman, U.P. Natural Science Research Committee, 1970 to 1974; Chairman, Committee on Evaluation of B.S. Biology Curricula, Higher Education Council, Senate of the Philippines, 1971; Director, U.P. Arboretum, 1970-1973; Chairman, Committee on Biological and Health Sciences, U.P. Graduate School, 1969 to 1980; Chairman, Department of Botany, 1969 to 1973; Professor of Botany, 1970 to date; Associate Professor of Botany, 1986-1970; Assistant Professor of Botany, 1957-1964; Instructor in Botany, U.P., 1949-1957; Instructor in Biology, 1944.

RAFAEL D. GUERRERO III, A Ph. D. holder is Fisheries Management from Auburn University, he is dean of the College of Inland Fisheries of Central Luzon State U, where he is also associate and assistant project director and research coordinator of the university's Freshwater Aquaculture Center. In 1960, while a consultant on tilapia cage culture project, of San Miguel Corporation and also that of LLDA-ADB, he was also elected to head the Fisheries Research Society of the Philippines. In 1978 up to the present, he is consultant for Aquaculture at NSDB (now NSTA) and the SEAFDEC Aquaculture Department.

The National Academy of Science and Technology elected him one of the Most Outstanding Young Scientists in 1981, Dr. Guerrero is also recipient of the 1978 TOYM Awardee for Fisheries — Aquaculture and the Rizal Pro Patria Award for Fisheries in 1975, among others.

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JOHN F. PEBERDY, A Ph.D. holder in Fungal Biochemistry from the University of Nottingham in England, he is currently a lecturer there and a reader in Microbiology. Likewise, he serves as a Microbiologist on the Water Pollution Program in England.

An active member of the Council of the British Mycological Society, he is very much involved in Biotechnology program in Hungary and Brazil. For the present, he is busy in the preparation of a major volume on Fungal Protoplasts, although he has edited several books and has published a textbook on microbiology. This is in addition to the other 50 research papers on fungal protoplasts, which he has already published.

Dr. Peberdy has been invited speaker at several international symposia, for example, he was guest lecturer in UNESCO Course on Fungal Protoplasts in Hungary in 1981. Recently, he was named member of the International Advisory Board for "Genetics of Industrial Microorganism" GIM '82.

