



# TRANSACTIONS of the NATIONAL ACADEMY of SCIENCE and TECHNOLOGY

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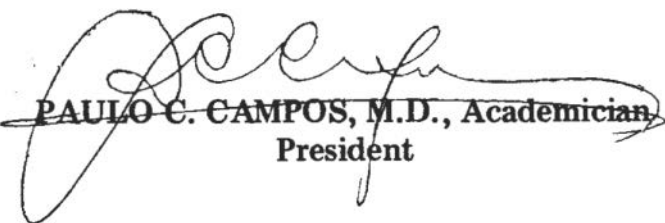
# Foreword

*As in the previous editions, the publication of the Transactions is predicated on the objectives of the creation of the National Academy of Science and Technology. These are to a) Implement the constitutional mandate that “the state shall promote scientific research and invention” and that “the advancement of science shall have priority in national development”; b) Provide meaningful incentives to those engaged in scientific and technological research; c) Recommend to the President outstanding achievements in technology and sciences for due recognition; and d) to help professionalize government scientific and technological research services”.*

*During the 3rd Annual Scientific Meeting of the Academy, our scientists pooled and shared expertise and resources. If we look close enough at the kinds of researches that were carried out, we find a variety of activities. And, if we are to push a step beyond the researchers themselves, we find a variety of purposes inspiring their efforts. Nevertheless, the scientists while trying to serve other ends as well are concerned about what their works may contribute to science literature.*

*Through the pages of the Transactions, the Academy hopes to share those resources and hard-won experience to fellow scientists of the country and that of the world.*

*With my good wishes and those of the rest of the officers and members of the Executive Council of the Academy.*



**PAULO C. CAMPOS, M.D., Academician**  
**President**

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# The Utter Need for More Scientists

**Address delivered at the National Academy of Science and Technology's Investiture of New Academicians at the PICC July 9, 1981 by President Edgardo Angara of the University of the Philippines.**

\* \* \*

The Filipino scientific community is our country's foothold on the 21st century. It is also the foundation of our efforts just to catch up with the present age. It is quite evident that in this technological era, our country's economic progress and national stability must rely on technological advance. That simply means of trained scientists available for the industrial and other needs of the Philippines.

Figures shown to me indicate that there are less than a hundred active research scientists with doctoral degrees who are involved in the Natural Sciences and Mathematics. That means less than 2 Ph.D's for every million Filipinos in the country today. If we multiply that figure 4—to take in scientists and technologists in other fields—that gives us only 8 Ph.D's for every million Filipinos.

The UNESCO, I understand has recommended that for viable and self-sustaining scientific undertakings for countries like the Philippines, we need about 400 research scientists and technologists for every million of the population.

That we do not have that number of scientific manpower at present and that there seems to be no central direction and unified program to attain that desired pool of scientists and technologists, poses a clear and present danger to the New Republic.

I need not remind you how essential the support of science is. And how overriding is our need for technology. For in a technological society, it is essential to have an adequate supply of scientific manpower capable of applying science and its methods to practical problems.

The development of science and its practical application in technology are the first and foremost concern of government everywhere. To a developing country like the Philippines, scientific development and technological advance are even urgent. They are crucial, not only to national growth, but to our capacity to grow. Technology has demonstrated its ability to telescope economic progress and leap-frog over certain painful stages in economic development.

The Report of the Independent Commission on International Development Issues concludes that a country can benefit from additional technology only if it can absorb and adapt what it has already received. More, it is also necessary that it provides "the 'welcoming' structure which can connect up new technology to old societies".

But when we speak of the ability to absorb and adapt new technology or of establishing a "welcoming structure", we are really referring to the scientific manpower that is trained to understand the theoretical basis of the latest technology and capable of adapting the latest technology and capable of adapting that technology to our needs and resources, and for the solution of our problems.

When we refer to science in relation to national development, we are referring to people and not just to disembodied theories. We are stressing the need for a quantity and type of scientific manpower sufficient for scientists to take root in our society. If we want to join the ranks of the developing countries, the training of the required number of scientists and technologists is the first goal we must achieve, resolutely and at once. To attain that objective, however, requires a singular force and central direction which science in our country presently lacks. There is also no concerted effort to glamorize public opinion behind the need for sciences so that government and private industry can be influenced to allocate adequate funds for a rational science policy. There is therefore a need to educate the public on the importance of science.

A public indifference that borders on ignorance has made science, as a career, one of the least attractive in our country today. It suffers from a meager material incentives and lack of laboratories. It is plagued by an obdurate bureaucracy and requires scientists to take a vow of poverty without Christian promise of heavenly reward.

Our apathy to science is not induced by an inherent inability to learn and apply it to practical uses.

The membership of this Academy is the best proof that we, as a people, are not incapable of mastering the sciences. Academies of science are regarded with the highest respect. Politicians and rulers, who usually listen to no one, invariably need their advice on scientific matters, particularly on the scale and distri-

bution of resources for research and science education. The Royal Society of London is an example. It is the highest adviser of the British government on science matters.

The same role could be played by our own National Academy for some of our most eminent scientists compose its membership. Even now, the National Academy can become a potent force in forging a national will to draw Filipino talent into advanced science and technology.

The Academy is in a singular position to provide independent and disinterested advice to our people and government. As the New Republic embarks in a new economic program, I urge you to field your prestige and influence to bring about a fundamental change in popular attitudes regarding scientific research. This country must realize its true values as the indispensable basis for our progress into the 21st century.

We are fortunate to be present at this time and era in our history. With the proclamation of a New Republic comes a clear call for a fresh start in our effort to achieve, through science and technology, a better life for our people. It is my hope, as it is your aim, that the National Academy of Science and Technology will be at the forefront of this renewal of effort and resolution.

● *The 3rd Annual Scientific Meeting of the National Academy of Science and Technology*





# The Coconut as a Renewable Energy Source

*By Julian A. Banzon, Ph.D., Academician*

## ABSTRACT-SUMMARY

The hopes that plants will be the renewable energy source of the future is dimmed by the possibility that such energy plantations may have to take over the lands needed for food crops. An energy inventory of the Coconut Tree shows a uniqueness in being able to provide both Food and Fuel without need for periodic replanting or re-growing for well over 50 years. The Philippine annual harvest of 12 billion nuts from plantings of 377 million coconut trees, furnish an annual harvestable biomass of 18.9 million metric tons with an energy equivalent of  $85.9 \times 10^{12}$  kilocalories. The food calories (oil and oil-meal) constitute 17.5% of the total calories. The major portion (32.5%) of the calories is then useable for fuel. Thus the coconut is to be looked upon more as an Energy tree. The magnitude of this energy reservoir (equal to ca 35 million barrels of petro oil) should spur concentrated research directed at utilization.

Discussed in the paper, is the energy value in terms of LPG, of a coconut, a coconut tree and a hectare of such trees. The information helps answer such questions as: how can coconut trees make the family kitchen self-sufficient in fuel?

Our predicament re-energy, is too well-known to be further discussed. Several steps have been taken to help alleviate the situation. Let me summarize:

1. sugar cane to produce ethanol
2. starchy material, e.g. cassava, by a more lengthy process, to produce also ethanol
3. animal wastes convert to biogas
4. return to wood (energy plantations) to fire steam boilers, generate electricity.
5. return to charcoal  
with air to generate "producer gas"  
with steam to produce "hydro" gas (water gas)
6. coconut oil as diesel fuel replacement

In other countries, other oils are being tried: sunflower, palm, even eucalyptus and peppermint.

7. "petroleum plants".

Practically all these materials are plant-derived and hence are renewable. Plants also provide the simplest method of solar energy collection and storage. Hence, the great hopes placed on plantations of ipil-ipil, petroleum (hanga) plants, cassava, etc.

World-wide, there has grown, however, an apprehension that energy-tree plantations may have to take over lands devoted to food crops; the dilemma is Food or Fuel.

This paper I am presenting is a study of the coconut tree vis-a-vis this Food-Energy problem. The coconut, under Philippine setting, possesses certain desirable characteristics which appear to have been unnoticed:

1. occurs in astronomical numbers (PCA Report 1979).  
     12 billion nuts harvested in 1979.  
     377 million trees, already existing
2. poses no threat to dislodge food crops.
3. possesses leaves that are unique in being massive and woody, suitable for fuel use.
4. only the fruits and the leaves are harvested unlike wood of trees which require cutting down the whole tree, resulting in several years of waiting for re-growth.
5. it is long-lived; it produces fruits and leaves month after month, very regularly throughout the year for 70 years or more.
6. offers both Fuel and Food. The magnitude of this production is the subject of the present paper.

*The harvestable biomass and energy-rich parts of the coconut* are the fruit (nut) and the leaf. The coconut has one of the largest and most woody leaves in the plant world. Thirteen to fifteen leaves are produced in a year, each leaf weighing well over 2 kg dry (1,2). The biomass and corresponding energy values are shown in Fig. 1.

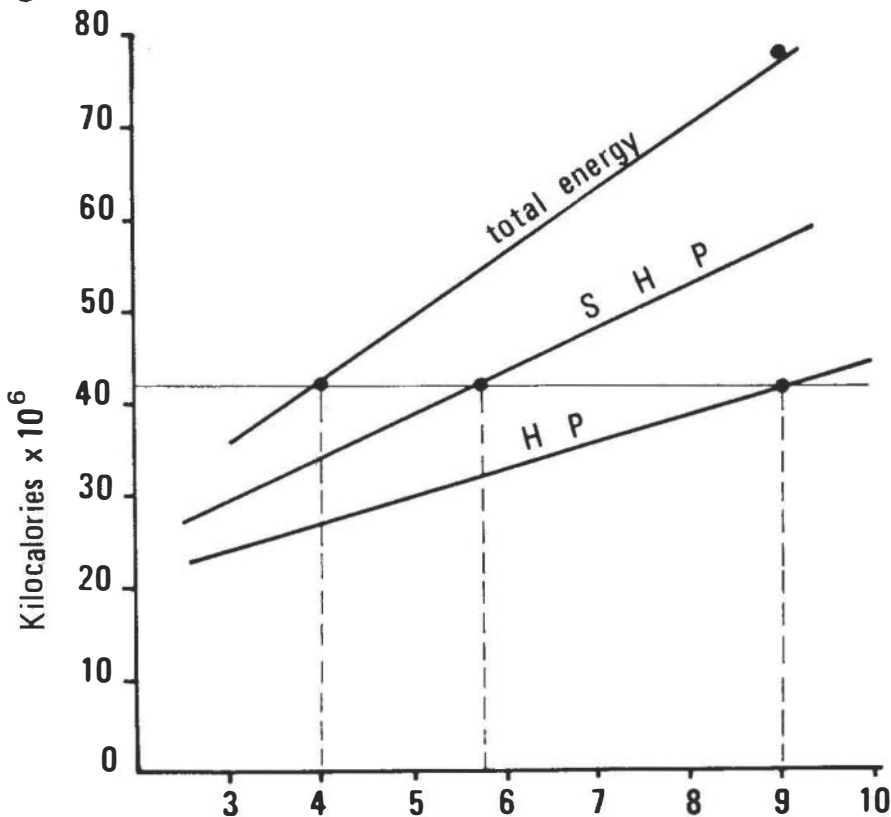


Figure 1. Energy at varying monthly yield of nuts.  
 One hectare of 150 trees.

The harvestable biomass and energy from Philippine coconut plantings. According to the Phil. Coconut Authority, the nut harvest in 1979 was 12 billion nuts. At 3895 Kcal/nut, this crop has an energy of  $46.7 \times 10^{12}$  KCal. Existing in the country are 377 million trees. At a production of 13 leaves/tree/year, each 2 kg in weight and at 4000 KCal/kg, the energy value of the leaves amount to  $39.2 \times 10^{12}$  Kcal. Table 2 summarizes the harvestable biomass and energy equivalent of the Philippine coconut plantings.

Table 1. Harvestable Biomass and Energy from a Coconut Tree

		Oil .12 kg	1080 KCal	} 1305 KCal
		Meal .06 kg	225 KCal	
Fruit 1.2 kg	}	Meat .18 kg		
		Husk .40	1600 KCal	} 2590 KCal
		Shell .18 "water"	990 KCal	
Tree	}	Petiole 2.0 kg	8000 KCal	
		Leaf Blade .18		
		Midrib .05		
		Trunk		
		Others		

Table 2. Harvestable Biomass and Energy from Philippine Coconut Plantings

	Biomass MT x 10 <sup>6</sup>	ENERGY KCal x 10 <sup>12</sup>	
Coconut oil	1.44	12.96	} 15.66 KCal 18%
Coconut meal	.72	2.70	
Husk	4.80	19.20	} 70.28 KCal 82%
Shell	2.16	11.88	
Petiole	9.80	39.20	
<b>Total</b>	<b>18.92</b>	<b>85.94</b>	

At 2 million KCal/barrel of petro oil, and 118000 KCal per LPG tank (10 kg), the energy from our coconut plantations are equivalent to 43 million barrels of petro oil and 728 million LPG tanks (10 kg). If, as at present, coconut oil and meal (copra-meal) are used for food/feed, then what is left for fuel is the Husk (H), Shell (S) and leaf Petiole (P). This fuel amounts to  $60 \times 10^{12}$  KCal

(35 million bbl of petro oil) and constitutes ca 82% of total energy output of the coconut. The coconut therefore is more of an Energy tree than a Food tree.

*A comparison of coconut and cassava.* Abroad, so much has been said in praise of ipil-ipil, sugar cane and cassava as producers of renewable energy. We have forgotten that these mentioned plants have yet to be planted (ipil-ipil and cassava) extensively, or have to be replanted periodically (sugar cane, cassava) while our coconut already exist in large number and is a permanent crop. Even then a comparison of the coconut with these other plants with regards energy production would be important. Comparison with cassava is here discussed. Consider the energy-rich part of the cassava (dry matter) to constitute 33% of the plant (root, stem); the starch content is only 25-28%. Consider a yield of 30 metric tons (MT) per hectare, thus giving 10 MT of useful biomass equivalent to 42 million KCal. This energy should be matched by a hectare of coconuts. To determine the energy productivity (nuts/month plus petiole) to equal 42 million KCal, consider 150 coconut trees/hectare. Table 4 gives pertinent information on Kilocalorie yields for H + P or H + P + S or H+ P + S + oil.

Table 3. Energy Equivalents of Philippine Coconuts

	KCal x 10 <sup>12</sup>	bbl oil x 10 <sup>6</sup>	10 kg-LPG x 10 <sup>6</sup>
Petiole	39.21	19.6	332
Shell	11.88	5.9	100
Husk	19.20	9.6	163
Total	70.3	35.1	595
Oil	12.96	6.5	110
Meal	2.70	1.3	23
Overall	85.95	42.9	728

Table 4. Energy from Husk, Shell, Petiole, Fruit in a Hectare of 150 Coconut Trees, Varying Nut Yield Per Year

Nuts/tree		Energy, KCal x 10 <sup>6</sup>		
per mo.	per Ha. yr.	H + P	H + P + S	All
3	5400	24	29	36
4	7200	27	34	43
5	9000	30	39	50
6	10800	33	44	57
9	16200	42	57	78

LPG equivalent of energy produced by one tree/year. The value of a coconut tree as a fuel producer is better appreciated when Kilocalories are translated into LPG-tanks. A 10-kg LPG tank has an energy value of 11800 KCal. Table 6 gives the desired information.

*Conversion to charcoal.* Coconut shell, husk and petiole may be carbonized to produce charcoal. Charcoal is a "cleaner" fuel; it is practically sootless when burned. There are other advantages over the uncharcoaled material. The disadvantage of charcoaling is the loss of heating value and decrease in weight. From the meager data available, the usual losses of both energy and weight are given in Table 7.

The decomposition of cellulose by heat may be represented by the chemical equation

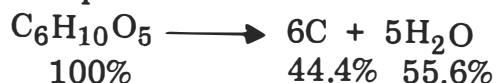


Table 7. Mass and Energy Losses in Charcoaling

	Mass loss Percent	Energy loss Percent
Shell	72	63
Husk	78	65
Petiole	(78)	(65)

Table 8. Products formed During Charcoaling (Wells, 1917)

Coconut Shell 100	Charcoal	32.5
	Liquids	51.3
	tar	
	water	
	methanol	
	acetic acid	
	Gases	16.2
	CO <sub>2</sub> CO	
	CH <sub>4</sub> H <sub>2</sub>	
Theory: $\text{C}_6\text{H}_{10}\text{O}_5 \xrightarrow{\text{heat}} 6\text{C} + 5\text{H}_2\text{O}$		
	100	44.4    55.6

Actual carbonization trials give a different result as shown by Table 8 (Wells, 1917). Although the heat value of shell charcoal (7200 KCal/kg) is much higher than that of the uncarbonized shell (5500 KCal/kg), the weight of the charcoal is only about 30% of the original weight of the shell, hence a loss of energy

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(accounted for by the gases and the liquids accompanying the formation of charcoal). Since uncarbonized Husk, Shell and Petiole are the economical fuel (compared to their char), research on improvement of stoves is indicated.

The difference between charcoal and uncarbonized material for use as fuel is demonstrated by the following example, where H + S + P of the coconut is used as fuel (10 nuts/tree/month). For uncarbonized material, E = 33,900 P (H + S + P). The number of trees to give fuel equal to one LPG tank is:

$$118000 \text{ KCal} = 33,900 P \quad P = 3.5 \text{ trees.}$$

For carbonized material, 11,970 P = 118000 and P = 9.8 trees.

*Magnitude of food obtainable from the coconut.* The Philippine coconut crop of 1979 is 12 billion nuts. The food component resides in coconut meat. The situation is shown in Table 9. The valuable portion is the protein, amounting to  $.15 \times 10^9$  kg and the coconut flour (the non-oil portion of coconut meat) amounting to  $.69 \times 10^9$  kg which consist of protein, carbohydrates and minerals.

Table 9. Food from Philippine Coconut Crop (1979)

Coconut meat	{	Dry matter	{	Oil	$1.44 \times 10^9$ kg	{	Protein	.15
$4.32 \times 10^9$ kg		$2.16 \times 10^9$ kg		Non-oil	$.72 \times 10^9$		Carbo	.47
	Moisture	$2.16 \times 10^9$ kg			Ash		.10	

At 70 gms protein/person/day, (25.25 kg/person/year) the number of persons that can be provided with adequate protein is

$$\frac{.15 \times 10^9 \text{ kg}}{25.25 \text{ kg/person/year}} = 5.87 \times 10^6 \text{ persons}$$

or 13% of the population of 45 million.

The coconut flour potential is corrected to  $.46 \times 10^9$  kg, by excluding fiber and converts to  $1840 \times 10^9$  KCal. Our estimate of calorie needs of a person is  $9 \times 10^5$  KCal/person/year. The number of persons that can be provided with 1840 billion KCal is

$$\frac{1840 \times 10^9 \text{ KCal}}{9 \times 10^5 \text{ KCal/person/year}} = 2 \times 10^6 \text{ persons.}$$



*Is the coconut a food or an energy tree?* A summarization of the contribution of the present Philippine coconut plantings to Food and to Energy is given in Table 10. According to this tabulation, only 17.5% of total calories are useable for food or feed. The coconut plantations at present are more of an energy source than otherwise. It appears that we are not taking advantage of the energy potential offered by the coconut.

Table 10. Food and Fuel from Philippine Coconut Crop (1979)

	Weight MT x 10 <sup>6</sup>	Energy KCal x 10 <sup>12</sup>
Food	2.16 (11.4%)	15.6 (17.5%)
Oil	1.44	12.9
Meal	.72	2.7
Fuel		70.3 (82.5%)
Shell	2.16	11.9
Husk	4.80	19.2
Petiole	9.80	39.2
Total	<u>18.92</u>	<u>85.9</u>

Table 10 gives the information for the entire coconut plantings in the Philippines. What would the picture be in a hectare of coconuts? Since the number of coconut trees in a hectare varies, 3 planting spacing are hypothetically set up, 100, 156 and 277 trees to the hectare corresponding to spacing of 10 x 10 meters, 8 x 8 and 6 x 6. The assigned nut yields are arbitrary but are likely to be conservative and close to reality. The calculated energy yield and other pertinent information are given in Table 11. It appears from this table that the fuel potential of the coconut is always much greater than the food potential. There is a need therefore to strive, by research and technology development, to exploit this fuel potential of the coconut.

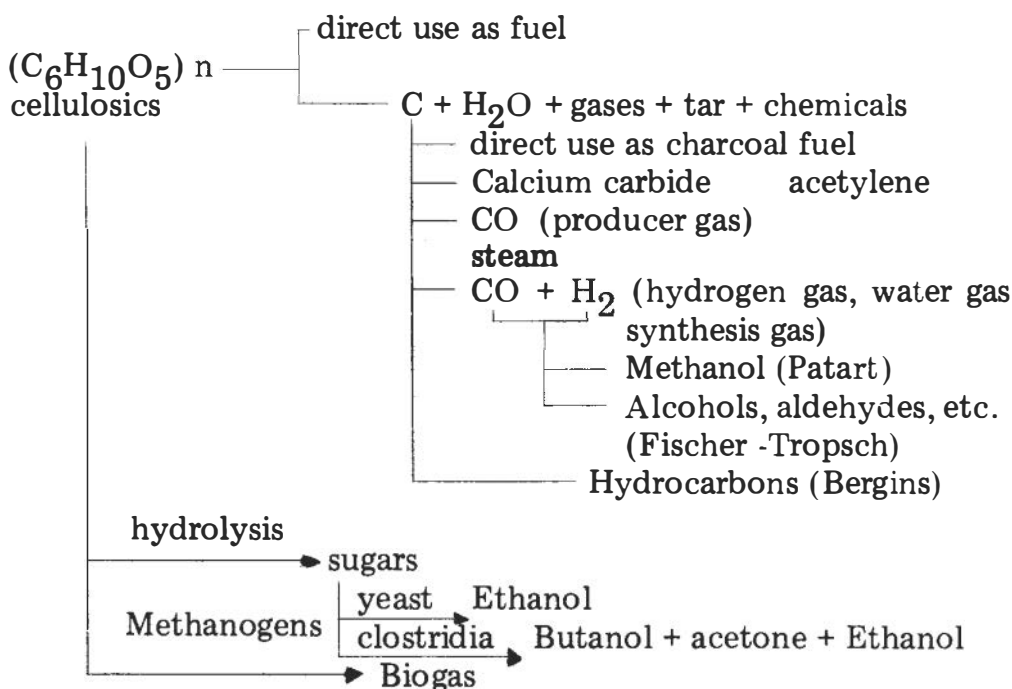
*The problem of utilization of Husk, Shell and Petiole in industry.* Solid fuels have been less convenient to use than liquid and gaseous fuels. For this reason, means have been invented to gasify solids if they cannot be converted to liquid-fuels, which are even more desirable. It may be informative to summarize the presently known methods as in Table 12.

*Conversion losses.* The conversion of material into desired fuels, e.g. sugar to ethanol, generally results in some loss of energy. Thus sucrose at 1349 KCal can generate 1307 KCal of ethanol or a loss of 42.2 KCal/mole sucrose.

Table 11. Energy Yield from one Hectare of Coconut at 3 Different Tree Spacing

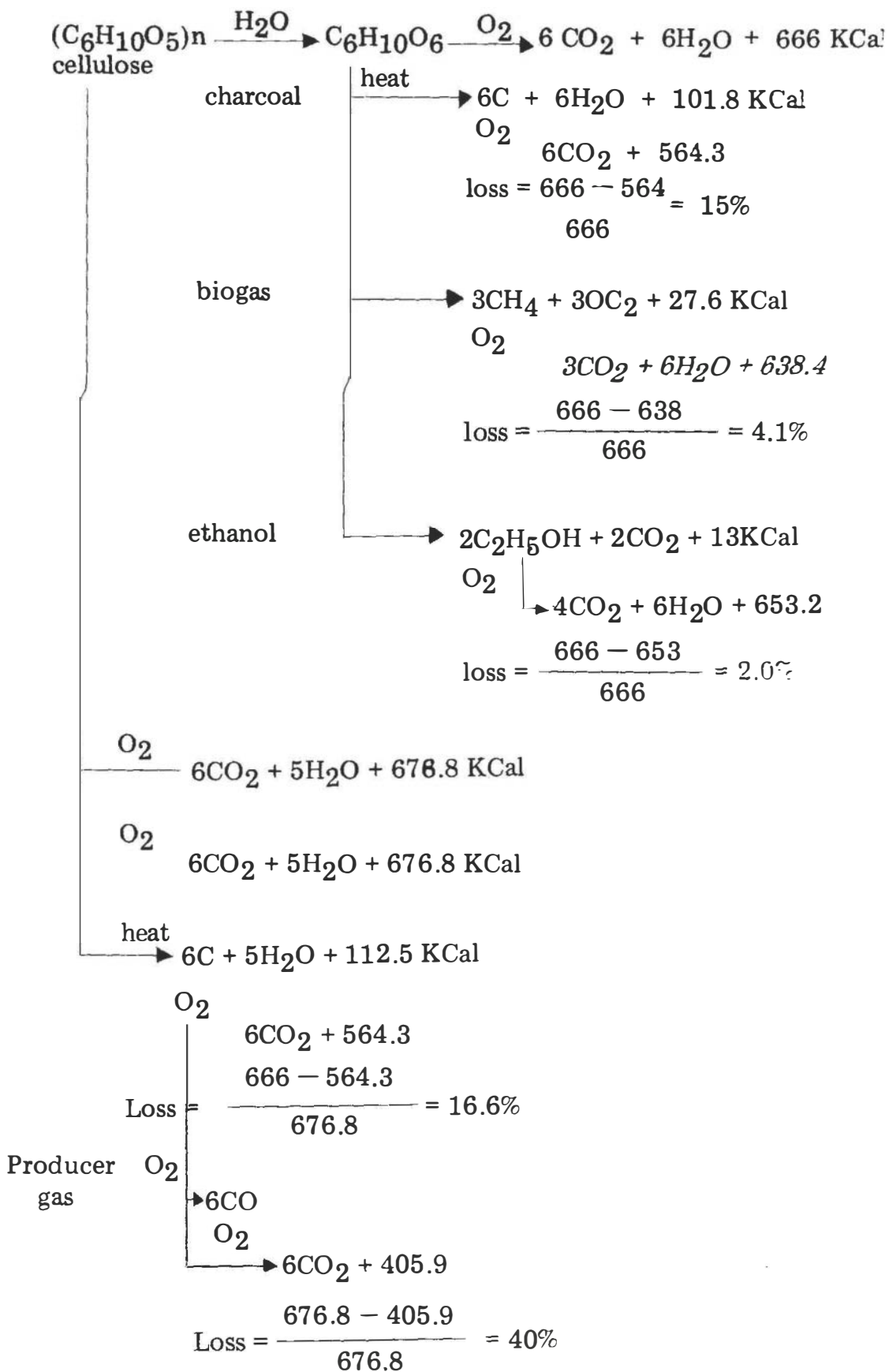
Plantation	A	B	C
Tree spacing, m.	10 x 10	8 x 8	6 x 6
Trees/hectare	100	156	277
Nuts/bunch tree (assumed)	12	4	1
Nuts/hectare. yr.	14400	7888	3324
Energy/year, KCal x 10 <sup>6</sup>			
food (oil + meal)	18.80	9.80	4.34
Fuel (H + S + P)	<u>47.65</u>	<u>35.59</u>	<u>37.42</u>
Total	66.45	45.39	41.76
Percentages:			
food calories	28.3	21.6	10.4
fuel calories	71.7	78.4	89.6

Table 12. Fuels from Cellulosic Materials



I have calculated the losses in selected transformations of this kind and the results are tabulated in Table 13.

Table 13. Energy losses in some fuel conversion processes



## THE COCONUT AS A RENEWABLE ENERGY SOURCE

Gen. Florencio A. Medina (ret)  
Discussant

At the outset, allow me to thank you for inviting me to participate in this symposium. I congratulate Dr. Julian Banzon on his very exhaustive study of the coconut and on his excellent delivery of his paper, "The Coconut as a Renewable Energy Source".

There are, of course, many sources of energy that man has learned to use. First, we have water: water in motion including steam, geothermal sites, tides, currents, and waves. We also have coal, mineral oils, and radioactive or nuclear materials. We have wind, we have plants, like what has been discussed by Dr. Banzon, and we have the sun, which is, of course, the primary source of all energy sources that we find here on earth.

But how renewable are these energy sources? Probably, we can say that a river may dry up or change its course. A source of geothermal steam may get exhausted. Tides and currents may not be reliable. Waves disappear on calm days. Deposits such as coal, mineral oils and nuclear materials, such as uranium and thorium are finite deposits. Wind is as changeable as the weather. It is changeable both in speed and direction. The sun, although always in the heavens, gives us its energy only during bright sunny days. Solar energy is a product of thermonuclear reactions that take place in the sun. That we get solar energy only during the sunny days, makes solar energy intermittent. Solar energy, in addition, poses the problem of storage. But, of course, as Dr. Banzon has correctly pointed out, solar energy is stored in the plants. Nature has provided us with solar energy storage facilities, the plants. But technologically up to now, storage of solar energy is still a problem. Of all these energy sources only the plants are renewable and this means that all parts of the plants including the resins and the vegetable oils that we get from them can be considered renewable. As Dr. Banzon has correctly pointed out, while the plants are renewable sources of energy, the continuous use of the land and the expansion of energy plantations can jeopardize the use of the land for food production. I know somebody who made a study of land use optimization in coconut plantations. In addition to the land being utilized for coconuts, the land between the trees can still be used for something else. Whether the

use of that part of the coconut plantation for other plants that will provide energy or food can be left to the better judgement of the farmer. He should know better the economics of his agricultural operations.

Dr. Banzon pointed out and, I agree, that the coconut can be used for fuel as well as for food. I join Dr. Banzon in asking the question: Should it be fuel or should it be food and feed? The coconut can be used not only as food for man but also as feed for the animals. Unlike other plants, the coconut provides us food and fuel and feed which is its biggest advantage over other plants that are also renewable.

Dr. Banzon mentioned other energy sources. Sugarcane produces ethanol and acetone when fermented with *Bacillus mace-rans* as well as butanol and acetone when *Chlostridium acetobu-tilicum*, a spore-forming bacteria, is used. Of course, there are now other methods of manufacturing ethanol and butanol. Water-gas and producer-gas from wood and charcoal including coconut charcoal, should be mentioned as sources of energy.

Let us not forget the coconut "tuba". I think this was not mentioned by Dr. Banzon in his study of the coconut. The coco-nut tuba, as you very well know, gives alcohol when fermented short of becoming vinegar. How efficient can this process be in the production of "lambanog"? I believe that science should be able to study and improve this fermentation and help the "lamba-nog"—producers in our coconut-producing provinces increase our alcohol production. Thousands of our coconut producers engaged in alcohol production can develop into "mass alcohol production by the masses", not only factory production of alcohol by the rich.

I was in Bangkok in 1969 when the International Atomic Energy Agency (IAEA) sent a Hungarian technical assistance scientist to Cambodia to look into the possibility of increasing the flow of latex from the rubber tree. That problem was solved very successfully by injecting plant hormones into the rubber tree. Now, can the same technique be used to induce increased flow of tuba from the coconut tree? I ask the question as a chal-lenge to our scientists.

My friends, I think we have done enough work on alcohol as motor fuel. The Research and Development Division, AFP, worked on 95% denatured ethyl alcohol. Scientists in the College of Agriculture, University of the Philippines at Los Baños, under the leadership of Dr. Anastacio Teodoro used alcohol-gasoline mixtures in stationary engines. Dr. Gregorio Y. Zara constructed his airplane, the "Tag-ak", and had it flown over Manila for several hours using 95% denatured ethyl alcohol as fuel. Passenger

buses plying between North Luzon and Manila were fueled with “gastarla”, a mixture of gasoline and alcohol produced by refineries in Tarlac. Those from South Luzon used “gasanol”. All these took place before the Second World War. It is too early to forget these. But now, we have been looking through the telescope and we see Brazil using alcohol-gasoline mixtures as motor fuel. And we say, “Let us follow the example of Brazil”, unmindful of what we were doing before the war and what Filipino scientists have been doing after the war. “Kawawa naman ang mga Pilipino scientists; lagi tayong sumisilip sa teleskopyo at ang nakikita natin at minabuti ay ang banyaga.” (I pity the Filipino scientists. We often use the telescope, and all that we see and value are only those of the foreigners.) Our society has not yet learned to appreciate the work of our scientists.

My time is already up. Thank you very much.

## COCONUT AS A RENEWABLE ENERGY SOURCE

ELIAS C. CANAPI, M.S.

Discussant

I'm glad Gen. Medina covered a lot of ground as this saves me from having to talk too long.

There is a very nice Spanish song, a Cuban song entitled "Pintor". It was probably written by a colored man. A painter whom the song-writer describes, painted angels in churches and he painted them white. He never painted them black, his color. And the song goes: "Por que desprecias tu color? Tu sabes que en el cielo tambien nos quiere Dios." (Why do you despise your color? . . . . .) I wrote this line because it has a message to us Filipinos. We have little faith in our own technical men. We sometimes unknowingly work against our domestic products. Take the coconut, for instance. The "synthetic" detergents are displacing coconut based soaps at an alarming rate. "Synthetic" detergents are derived from petroleum fractions. Their ever-growing popularity among housewives and laundry-women is partly due to heavy advertising with *premio* offers. Are we not abetting a situation clearly prejudicial to our coconut industry?

Because of the continuously escalating price of liquefied petroleum gas (LPG), there is more reason for us to hasten our search for indigenous substitutes. Dr. Banzon's paper compares the heat energies derivable from coconut petioles and LPG. Coconut petioles are indigenous and plentiful - LPG is neither indigenous nor plentiful.

We use decolorizing agents which are imported, although we have an abundance of coconut charcoal which could be processed into excellent decolorizing agents.

We hardly use copra meal. We choose to export most of it as cattle feed ingredient. The cows overseas produce milk which is spray-dried into powder. We import the milk powder, costing us more dollars than what we earned exporting copra meal.

And I recall the lyrics: "Por que desprecias tu color? . . . ." In a way, don't we scorn our native products? Or, aren't we just a bit blind?

Dr. Banzon's equation on petiole energy versus fossil fuel energy sounds almost like Einstein's  $E = mc^2$ . That energy from mass however can be harnessed for a useful purpose only through

technology and engineering. I hope that this symposium may trigger a series of giant leaps in coconut technology.

Gen. Medina, a former Chairman of the NSDB, has given support to numerous coconut studies. On the other hand, I cannot escape a strange feeling that non-coconut producing countries, in contrast to ours, seem more interested and seem to have accomplished more in coconut product research. I have some basis for this “strange feeling”. In reverse, the situation is like having the Philippines knowing more and doing more on apple-pie baking than the United States.

We cannot fully rely on others doing work for us and expect some benevolent handout of technology transfer. Technology transfers were never intended to be given for free — we pray for them in one way or another. We are reminded by the President that we are our own saviors. We must be self-reliant.

Let us encourage our scientists to do some homework on a very Filipino product — the coconut. It may help motivate them by creating an atmosphere approaching the level we provide expatriates. “. . . . tu sabes que en el cielo tambien nos quiere Dios.”



## COCONUT AS A RENEWABLE SOURCE OF ENERGY

IBARRA CRUZ, Ph.D.  
Discussant

First of all, I'd like to commend, Dr. Banzon, for a very informative and very useful presentation on the coconut tree as a source not only of food, but also of energy.

It is an eye-opener for me because it partly resolves my problem when working on coconut as a source of energy in answering the dilemma of whether using coconut oil, for example as power fuel, would compete adversely against its use as food. And it is very heartening to realize that from the coconut tree, you could actually get as much as 80% available for energy use and 20% could be allocated as food use. This suggests the direction of future research. What is obvious of course, is that, the fruit is most useful for food purposes. What is less obvious is that, from coconut oil you could also derive energy. Work on this has been going on, use of coconut oil as substitute for diesel fuel, for diesel engines. The justification may not be very strong because you are competing if you use coconut oil as fuel, you are competing against its use as food. The saving-grace maybe for this is that in so doing, you find an alternative use for coconut oil and when the foreign market for coconut oil is weak, then you have an alternative use for it as fuel. You use what you cannot sell as fuel, and that would also may be, force the price of oil in the foreign market to rise. And I think this is what is actually happening. Recently the price of copra has been very low, less than P1.00 per kilo and when the order to use coconut oil as a blend for diesel fuel was enforced, then the immediate result of this was to increase the price of copra from below P1.00 to about P2.00, which is of course a direct benefit to the copra farmers. A similar trend could occur to the export market.

There is also more to coconut usefulness as source of energy than "meets-the-eye". Dr. Banzon has pointed out that 80% of the tree which is in biomass form— from coconut shell, husk and petioles— can be a source of energy. This of course, at first glance seems to be a low grade form of energy which could be useful for household fuel, for cooking or maybe for burning to provide heat for drying crops, but what is less evident is that these wastes can be converted to produce high-grade energy like electricity and mechanical power. And this is being done through the gas-producer route where you gasify the solid wastes to produce a gas to power diesel engines. In this way, you displace use of diesel fuel by as

much as 80%. So, I think what the paper of Dr. Banzon has implied is that, in the future, more efforts should be directed towards upgrading this lowgrade type of energy which is in the form of husks, shells and petioles. Thank you very much.

# The Diary of Olivia Salamanca, M.D., 1889-1913

*By Encarnacion Alzona, Ph.D., Academician*

It is a distinct honor and a real privilege to me to present this short paper entitled *The Diary of Olivia Salamanca, M.D.* to the National Academy of Science and Technology. Its preparation was a delightful adventure.

Olivia Salamanca was one of the 37 Filipino students who were appointed scholars by the Philippine Government to study in the United States in 1905.<sup>1</sup> There were two other girls beside her. There should have been four of them, but the fourth, who obtained the highest rating in the examination, turned out to be only 12 years old, and 16 was the minimum age required by law. Her name was Felisberta Asturias. The feminists at that time must have rejoiced over her memorable feat.

Luckily the parents of Olivia Salamanca, unlike many Filipino parents at that time, were willing to permit their daughter to study in that faraway country, then little known to the Filipinos.

Arriving in the United States in 1905, she was sent to St. Paul, Minn. to finish the secondary course. Then, she went to Philadelphia to enroll in the Women's Medical College there, the medical course being her personal choice. Her academic record at the medical college was admirable. In her second year she won a prize in anatomy and physiology. She graduated on 1 June 1910 with an average of "A". She was then 20 years and 11 months old. She also took the civil service examination in March 1910 and passed it easily. She was one of the editors of *The Filipino*, the organ of the Filipino students in America. She visited Ithaca, New York; Lakehurst, New Jersey; Washington, D.C.; Baltimore, Md.; New York City; Providence, R.I.; Prudence Island; and Boston. Then she returned to the Philippines, arriving at Manila on 24 July 1910. She wrote in her diary:

Was up at five; got dressed in Filipino dress and went on deck. First thing I saw was a collection of white-looking

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<sup>1</sup>On 26 August 1903 the Philippine Commission passed Act No. 853 "providing for the education of Filipino students in the United States and appropriating for such purpose the sum of Seventy-Two Thousand dollars in money of the United States." It was introduced by Governor W.H. Taft, first civil governor of the Philippines under the American regime, who followed the policy of "beneficent assimilation" to win the goodwill of the Filipinos and stop their opposition to the American rule. See W.A. Sutherland, *Not by Might*, 1953, Las Cruces, New Mexico. Mr. Sutherland, Spanish secretary of Governor Taft, was the first superintendent of Filipino students in America.

buildings, at a distance apparently a city; and lo and behold I was looking at my own dear Cavite, while the boat was sailing into Manila Bay. Soon we neared Manila and launches already began to come near the S.S. *Siberia*. One of those coming from the direction of Cavite had apparently a party of people with music. Little did I at first think that this was the launch from Cavite to welcome me . . . .

The *Caviteños* had a right to be proud of her: the first *Caviteña*, to the best of my knowledge, to obtain the degree of doctor of medicine and the second Filipino woman to hold that high distinction.<sup>2</sup>

Since childhood Olivia had demonstrated exceptional intellectual qualities. Her own father, Jose Salamanca, a cultured man, founder of a private school in San Roque, Cavite, Colegio Ligaya, and a pharmacist by profession, regarded her as his smartest daughter. When she was a student in the Cavite High School, she was admired for her recitation of poems in both Spanish and English. Also she demonstrated exceptional histrionic talent when she took part in dramatic performances. Without any guidance from a teacher, she learned to play the piano. How pleasantly surprised was Maestro Manuel Ruiz y Javier, her elder sister's teacher, when he came to their house one day and found her playing with remarkable neatness the piano exercises of her sister. He offered to teach her and was greatly pleased to find out that Olivia was a perfectionist, never abandoning a piece until she could play it without a mistake. Inspired by his young pupil, he composed a mazurka which he titled *Olivia*. Indeed she was a prodigy.

While many of her contemporaries delighted in reading romantic novels such as those written by Carlota Braeme and the like, she chose to read Plato's *Republic*; and *Recollections of Socrates*; Herbert Spencer's *Data of Ethics*; Dante's *Divina Commedia*; Homer's *Iliad and Odyssey*; Vergil's *Aeneid*; Goethe's *Wilhelm Meister*; Lombroso's *The Criminal*; Klopstock's *Messiah*; G. de Grey's *Las leyes sociologicas*; J.J. Rousseau's *El contrato social*; Gustavo la Iglesia's *Tolstoismo y anarquismo*; Esteban de la Boetie's *La esclavitud voluntaria*; Ernest Renan's *El Porvenir de la ciencia*; J. Kropotkine's *La conquista del pan*; Ernesto Haeckel's *Los enigmas del universo*; Harriet Beecher Stowe's *Uncle Tom's Cabin*; Charles Lamb's *Chimney Sweep, Decay of Beggars, Roast Pig, Essays of Elia*; Hawthorne's *Scarlet Letter*; George Eliot's *Romola*; Milton's *Paradise Lost*; Victor Hugo's *Los miserables*; Emerson's *Essays*; Boswell's *Samuel Johnson*; Richter's *Titan*; Leigh Hunt's *Imagination and Fancy, Wit and Humor, Men, Women and Books, Jar of Honey from Mt. Hybla*; Bulwer Lytton's *The Caxtons, My Novel*; Hazlitt's *Round Table, Table Talk,*

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<sup>2</sup>The first one was Dr. Honoria Acosta of Pangasinan who graduated from the same medical school on 26 May 1909 with honor.



Olivia Salamanca, M.D. In cap and gown.



A mi mamá  
cuando se fue con un re-  
galo en las Pascuas, de tu  
hija.  
Olivia  
1905

Olivia Salamanca at the age of 16.



*Plain Speaker, Sketches and Essays; Carlyle's Cromwell's Letters; Sienkiewicz's Life and Death; Eucken's The Problem of Human Life; Shakespeare's dramas, etcetera.*

With such ponderous intellectual pabulum, she developed into a profound thinker, as a perusal of her diary, letters, and autobiography (though unfinished) clearly reveals.

She devoted her spare time to reading books, even when she was not feeling well. In her diary during her sojourn in Baguio, we find her commentaries on striking passages that she had read. Intellectuals sought her company, because the breadth of her knowledge made conversation with her most rewarding. An entry in her diary on 9 November 1912 reads: “. . . Had an interesting talk with Fr. Luis Lopez . . . was surprised at my wide grasp of things . . . .” She was fond of writing down her thoughts and impressions of people. Her sensitivity was remarkable. Had she been granted a longer life, she would undoubtedly become one of the Philippines' great writers.

In general, Filipinos honor and admire intellectuals, such as, Doctor Olivia Salamanca. As already stated, they gave her a splendid welcome when she returned from America with a doctor of medicine degree which she fully deserved; for in America with her brilliant academic record she demonstrated the intellectual capacity of her countrymen, which at that time was doubted by many Americans. They banqueted her and invited her to speak at important public celebrations. In the musical-literary program to commemorate the 14th anniversary of the execution of the Thirteen Martyrs of Cavite, held in the Teatro Caviteño on the night of 12 September 1910, she was one of the principal speakers. Her speech was in Spanish, then the current language of educated Filipinos and her home language. It was a patriotic speech, paying tribute to the Thirteen Martyrs and pointing out the significance of their sacrifice. May I quote here a portion of it which seems to have a certain relevance to the present situation in our country.

¿Y qué nos enseña la muerte heroica de estos ilustres hijos de Cavite?

Los Trece Mártires pertenecieron a diversas profesiones, lo cual demuestra que para servir a la patria, no se necesita ser expresamente un abogado, un político, ó, un soldado.

Para poder servirla, se necesita abnegacion y mucho sacrificio, como asi no han escatimado hasta su vida aquellos cuya memoria conmemoramos hoy.

Para amar y servir a la Patria no cabe distinción de religión, de estado social y profesional; no cabe distinción de language, de sexo y de filiación, y por esto mismo para poder levantarla al nivel de otras naciones es preciso que nosotros los hombres, las mujeres, y los niños, los obreros, los estudiantes y los profesionales; ricos y pobres; catolicos, protestantes y aglipayanos nos unamos los unos a los otros en masa compacta y única, ya que en la unión esta la fuerza.

Con gran dolor he notado que aquí entre nosotros existe una division social muy evidente que no debiera existir, porque todos nosotros como buenos filipinos abrigamos una misma aspiración, sostenemos un mismo pensamiento y circula en nuestras venas la misma sangre — La Sangre de Rizal. ¿Porqué no sacrificar sentimientos y ambiciones personales, cuando se trata de una labor que requiere union y fraternidad?

She was one of the charter members and the first secretary of the Philippine Antituberculosis Society which was founded on 29 July 1910. Towards the end of the same year she was found to be suffering from tuberculosis. She was at her office on the Escolta (No. 105) to attend a meeting of the Philippine Antituberculosis Society. While getting things ready for it, she wrote in her diary, "long spells of cough seized me, which left me, for a time, weak and breathless. Often enough I have had before this time similar coughing spells, but as I felt strong enough to work, I did not pay any attention to it. Today, however, because of the cough and the general weakness which was beginning to get hold of me, I was very much disinclined to work and exertion. I was feverish, nervous and dyspneic. . . ."

When Mrs. Martin F. Egan, the president of the Society, and Dr. W.E. Musgrave, member of the board of directors, entered the office, she wrote, "they noticed how I coughed, how ill I looked; so Dr. Musgrave suggested that I go out to San Juan del Monte and promised to have a house built there for me, even though at his own expense, about which Mrs. Egan suggested to have the Society pay for it. Dr. Musgrave made a slight examination and was rather rough to me. This same time I remember Mrs. Egan treated me very impolitely by giving me her back as an answer to a just question. I asked her whether she could come to the office the following Thursday, as I had to go to San Isidro to fulfill an engagement she herself advised me to make. Soon afterward I left the office extremely depressed and downhearted, because of my hard luck and unfair treatment I had received." She continued:

As soon as I got home, I told the people in the house of the advice of Dr. Musgrave and of the seriousness of my condition; also that I intended to go to San Isidro that day and sleep there that night. After lunch, they very kindly advised me to rest awhile . . . .

At 4 o'clock we left Plaza de Goiti in a *calesa* for San Juan. When we got there, Dr. Garcia, the resident physician, was very glad to see me, and was all attention and kindness. We were shown the hospital, grounds, and cottages. We were introduced to his mother and his only sister . . . We lingered here for 1-1/2 hours and then left with the understanding that I was to return to stay there that night and that Dr. Garcia was to go to the house to get me. Dr. Musgrave had telephoned him that same day about my condition and my



Articles of Incorporation  
of  
The Philippine Antituberculosis Society  
now all men by these presents  
that we, a majority of whom are  
the Philippine Islands have this day volun-  
tarily associated ourselves together for the purpose of  
forming a corporation under the laws of the Philippine  
Islands

And we hereby certify:

Corporate Name

First - That the name of said corporation  
is The Philippine Antituberculosis Society

General Purposes

Second - That the purposes for which such cor-  
poration is formed are:  
To advance the knowledge of tuberculosis  
encouraging original research in the part  
members and others;  
To collect and record facts concerning  
as ascertained through original research  
otherwise and to disseminate information  
in discussion among its members and by  
publication of papers

First page of the Articles of Incorporation of the Philippine Antituberculosis Society in her handwriting.

admittance. My first insight into a sanatorium, for, when I first went there with Dr. V.G. Heiser and others, it was being fixed and altered only.

At 6:30 Tio Pablo took me to San Juan, seeing that it was getting dark and Dr. Garcia had not arrived. As soon as I got there, I went immediately to Dr. Garcia's house and was there for a long time talking with the doctor's mother who told me about Dr. Garcia's studies, his illness and finally his marriage to which she was very much opposed . . . . After waiting for a long time, Dr. Garcia arrived and we had supper with fun and jokes now and then to whet our appetite. After supper Dr. Garcia took me to the hospital dining hall to see the patients' meal and to the hospital itself to see the patients. Then we sat down on the piazza adjoining his rooms until ten o'clock, when I retired to my tent. The tent was pitched on top of the stone wall surrounding the hospital grounds, the floor being of wood and the rest of canvas. There were two army cots in it, one for me and one for the nurse, one wash stand, one pitcher and one basin and a clean towel. There was no soap and . . . .<sup>3</sup>

In the following year, 1911, she was assigned to the hospital in Baguio in the hope that the mountain air of that summer resort would help her recover her health. There she led an active life, remaining in her cottage only when she was not feeling well. Nearly every day she had callers, Filipinos and Americans. She went out for strolls with friends. She studied French and read books. Sometimes she embroidered, crocheted, and sewed. Now and then she played the phonograph that an admirer had brought to her cottage. She continued her diary. Here is one entry:

Aug. 18, 1911:

I am sorry to be as cynical as I appear, but I cannot help it. It seems to me I have not had the sympathy and the cooperation I ought to have. Since the beginning, you all seem to be ready to condemn, to blame and to provoke me, rather than to encourage and give me hope. I have been alone — as far as my family is concerned — in my battle for life. He alone has sympathized, has encouraged and helped me in my misfortune. Do they think for a moment, I wonder, that I am satisfied to be thus deprived of my chances for success, accomplishment and work? Little do they know and realize my heartache, my despair at being handicapped. A nature, such as mine is, ambitious to an extreme, cannot, will not accept unwarranted and unjustifiable limitations. Physically disabled as I am, I do not allow my ailments to interfere with

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<sup>3</sup>From a typewritten copy, incomplete and damaged. Her diary for 1910 and 1913 in my possession is incomplete.

my intellectual activities. My life was meant to be a busy life and my mind a busy mind, so regardless of place or circumstances, there shall be something for me to do.

Her self-analysis:

August 26, 1911

Embarrassing as is the thought I cannot help entering it into this book of my life, for the truth of it seems to me more and more convincing. I am not by any means pretty, rather of the common, ordinary type of face; my conversation possesses nothing of the charm, vivacity and brilliance of most entertaining conversationalists; my manners, if anything, are awkward, lacking that polished and refined self-possession of a refined and educated girl — and yet I know, I must confess blushing, I must have some magnetic charm hidden somewhere that makes all people enjoy even a minute of companionship with me. Whatever it is, You put it there, oh Lord, and may it serve the purpose You intended it for. It is the one source of happiness to me, for thru this magnetic charm I am able to go near and help others.

Concerning the treatment she was given in Baguio, she wrote:

September 4, 1911

Rejoice at the fact that I shall be the first one in the P.I. to be subjected to the use of tuberculin in tuberculosis. I am glad, because I afford the best chances for its actions to be carefully noted. If tuberculin proves effective in the care of T.B. by the experiment made on me, I would feel as if I have rendered a public service to humanity. Should it fail (there is no occasion for such thought, for I would know in time whether it is doing me good or not) then I shall be glad also for it would save many from its dangers. Help me, Jesus dear! And may the experiment be carried out successfully, so that thousands of useless lives may be made useful by it.

During her time, there were many Americans in the Philippines: in the government service, in business, and in the professions. She worked with some of them and met many more, giving her ample opportunities to observe their attitude and behavior. Here are her impressions:

Feb. 27 Tuesday (Baguio, 1912)

Miss Dick cursed the P.I., which hurt me deeply. Such ingratitude!! Bah!

Feb. 28, 1912

Was very indignant at the ingratitude of Americans; no wonder Filipinos don't like them here, when they despise us and everything Filipino, and yet they make their livelihood in the P.I. They say everything here is bad, etc., etc.; but why remain? If Filipinos are lazy, it is not their fault. The climate demands that they be less energetic.

13. 1912 Tuesday

Inspection; heard Worcester spoke to  
of me. Dr. Reed went to Post Office  
another impression of Mr. Trull's who  
went to Gov. Centre. Then the disagree-  
woman - an agnostic, superstitious.  
- afternoon; walk after supper  
spoke to Worcester. Boys came - be-  
from. I was very much disappo-  
stop to Olive. Dear, stop it; don't  
a slave of your physical self.

14. Wednesday -

St. Valentine's Day. Went to Summer  
house. Sewed + wrote to Dr. Was bed in  
afternoon. Walk. Laundry.

15. Thursday

Got up. waited for Dr. or gave her  
Went to Summer house. to read  
to Papa + sister. In afternoon





They are all alike — wake up, Olivia; they do not deserve the consideration you show them. They have tried my patience so much by their continuous fault-finding and criticism that I feel like running into the woods and not see any American for the rest of my life. I have tried to meet them more than halfway, do all I can for them to promote good understanding between them and my people, but they are not worthy of the trouble.

Her patriotism was stirred by those tactless Americans.

Doctor Salamanca was an articulate feminist. She wrote to a correspondent on 30 June 1911:

Do not take one woman or two as a type of all women. Besides, if some of them — the majority, if you wish it — seem to be so regardless of men's feelings — it is not their fault. The seeming inevitable passive attitude within which society (the men) has limited woman's sphere of action is to be blamed for it. She is not permitted to take the initiative in most matters, not even in matters pertaining to her heart. Society seems to have placed her so high and she is condemned unmercifully when she falls. Society has placed so much personal responsibility upon her, but provided her with very little justice.

In another letter written by her we find this passage:

Well, I am a harmless and inexperienced little suffragette, with rather immature ideas yet as to what an ideal and useful life should be. It is a problem that confronts me now.

She was one of the early feminists in the Philippines. There were very few in her time.

On 21 May she left Baguio for Manila. Apparently her health had not improved, for she was confined in the Philippine General Hospital early in June.

She entered in her diary:

June 7-12 at Philippine General Hospital. Met Miss Williams and Mrs. Smith, very kind and good nurses. Miss Tirona, very kind to me. Met Miss Lopez who called with Mrs. de Veyra and Miss Zamora. Flowers daily from G.P. Dr. Musgrave and Mrs. Egan very kind to me; also Flores and Garcia. Dr. Ubaldo sent flowers. Dr. Reyes sent card and magazines. Mrs. Taulbu came to see me every morning. Dr. Acosta peeps in once in a while. Maria José, Juabita, Dr. Nicolas, and relatives came to see me.

She reported to duty on 17 June. She took part in the celebration of Rizal's birthday, 19 June. There was a party at her house on her birthday, first of July. Everybody was kind to her, she wrote in her diary.

Despite her poor health, she led a remarkably active life. She sailed for Hong Kong on 6 August, returning to Manila on the 15th. Then she was off to the southern islands on the 17th. She stopped at Mangarin, Mindoro, which she noted in her diary had

a beautiful beach; and then proceeded to Iloilo, Molo, Jaro, and Cebu. She was back in Manila on the 27th and on the same day embarked for Hong Kong, her second trip to the Crown Colony. She returned to Manila on 7 September. A week later she went to Naic by train, which she found uncomfortable, but she was pleased with the hospitality of the people. On 23 September she made a trip to Laguna Province and she was impressed by its "rich vegetation, fine sceneries, and imposing Mt. Makiling." She visited Sta. Cruz, its capital, and Pagsanjan. She returned to Cavite on 28 September.

She attended the meetings of the Philippine Medical Society held in Pasay from 4 to 7 November 1912. There she met Dr. M. Paz Mendoza and her impression of her is noted in her diary: "very kind and gentle." Vice Governor Gilbert addressed the Society and congratulated the Filipino women doctors on their attendance.

On 27 February 1913 she wrote in her diary:

Seriously ill. Medical consultation. Arrival of priest. Three hypo-injections. People seriously alarmed. Kindness of Dr. Leon. Offer of all Cavite physicians and *practicantes* to do anything they can for me.

Surprise presents in form of money, candy, etc. from people.

Surprise check from Burgos said to have come from "Relief Fund".

Her last entry, dated 13 April, expressed her gratitude to a friend who sent her a cheque. Written with pencil, it is now faded and almost illegible.

On the 11th of July 1913 she passed away. She was 24 years and 10 days old. Those whom the gods love die early is a Greek saying.

I conclude with a romantic confession of Doctor Salamanca:

I remember of two occasions only on which I truly cried, I mean the true genuine cry that comes from a wounded and suffering heart — not the cry of wounded pride and humiliated self-respect. One was when my father embraced me for the last time as I was leaving for the States; this was six years ago; and the other was when, through some heavenly warning or premonition, perhaps intuition, I came suddenly into the realization, without any tangible proof, at the time, that the one I loved was unfaithful to me. This was more than a year ago. I have a capacity for bearing sorrow, disappointment, pain, physical and moral, deprivations of any kind and troubles of all sorts often without showing any indication of the struggle in my facial expression or my mood. I think this is the reason why I have won the reputation here<sup>3</sup> and at San Juan del Monte of being always happy and cheerful no matter how terrible the struggle within. Some people think that it is due to a cold and indifferent temperament, but I feel it all just as keenly and as

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<sup>4</sup>Baguio



Olivia Salamanca in Filipino dress.



deeply, only self-mastery and self-restraint come to my rescue. The importance and the essential utility of these two forces are some of the good things I have learned during my five years exile in the United States.

Doctor of medicine, thinker, patriot, humanitarian, and feminist, Olivia Salamanca deserves eternal remembrance.

## THE DIARY OF OLIVIA SALAMANCA, M.D., (1889-1913)

### Fe del Mundo, M.D. Discussant

Dr. Alzona, you have always been an inspiration, a dear and ever helpful friend; hence I may not be the right person to comment because I am truly biased in favor of Dr. Alzona. I'm very grateful for having been chosen as one of her discussants.

Two persons deeply inspired me in this paper. First, the subject, Dr. Olivia Salamanca and more than this, I confess that I'm more inspired by the author. Well, I have heard of Dr. Olivia Salamanca and read about her but nothing half as detailed nor as full of compassion, understanding and inspiration as the one that was presented to us today.

The biography I have read about Dr. Salamanca is a very brief one and mostly about her medical activities and I must say that her professional life was so short that one may not be truly impressed with her activities.

I am sorry that at that time she was suffering from tuberculosis, we did not have the marvelous drugs we now possess; otherwise I am sure that in one or two months she would have recovered; who knows may be she would be sitting on this stage. I am also sorry that at that time she only spoke about tuberculin which is not even used now. Therefore, it was very unfortunate that she had this disease far ahead of the advances in medicine, particularly in tuberculosis.

We did not realize in her biography that she was so cultured and even from her diary, if Dr. Alzona ably quoted the words. Dr. Salamanca commanded English very well, very fluently, the right choice of words and I must say that it's far beyond our expectations. I presume that she studied English of course, in high school and five years in the United States.

Her use of Spanish language also was excellent. I was thinking that she would talk in Caviteño Spanish. But surprisingly how beautifully she expressed her thoughts and her emotions; in Spanish. It is really wonderful and I am not suprised now, having received the information of the books she read in her time, how far advanced she was for her age. How highly cultured she was from the proper choice of the best books she could get hold of. It is evident she was not limited to medicine, as is our usual tendency.

I know she went to Medical School at the Philadelphia Medical Women's College, at that time and even until recently, the only Medical College for women. Unfortunately, that has been

changed now. It is no longer a college for women only after having celebrated its 100th anniversary. I understand that it has to be co-educational to enable it to receive grants. I know that the first women from here who studied in the United States chose the Medical Women's College and they were very outstanding. These are Dr. Acosta, the first one, and Dr. Salamanca.

From what we heard of Dr. Salamanca, we had appreciated and honored her and so, the Philippine Medical Women's Association has a plaza, this Olivia Salamanca Plaza in her honor located at the corner of General Luna and T. Kalaw, with a memorial marker for her. We got the permission of the Historical Association and perhaps Dr. Alzona was one of those who granted us that permit. I am not probably updated but I know that so far, it is the only marker for a Filipino woman physician, and so, we have honored Dr. Salamanca and just as Dr. Alzona said in her last sentence, she deserves to be eternally remembered. We have also obtained a brief biography of Dr. Salamanca of which we have published in our Philippine Medical Women's Journal and it is in our library in the Medical Women Association Building. I am full of admirations of Dr. Salamanca but I will say that this was enhanced by what we heard from Dr. Alzona. With your permission, Dr. Alzona, I would like to present to our medical women a copy of your paper and I would ask them to read it because as I said what little we know is not even one tenth of what you have written about her in this paper.

I am truly surprised how a diary can become a veritable paper full of admiration for the one who wrote it but of course that depends on the writer. I wondered how a diary could be presented in such an interesting and inspiring way, but I have a feeling only Dr. Alzona can do that. I've written a diary only when I am abroad, but here, I don't really find time to write a diary. I am afraid I have lost an opportunity to be written about someday. I don't know whether I should start writing a diary now. I usually write when I am abroad more or less first to make an account of my expenses, my problems, and also the people I met so that when I forget the person I just look up my diary and I can get their names there. But I receive no less than 5 or 6 diaries on Christmas and I must tell you most of them are empty.

The contents of Dr. Salamanca's diary amaze me; how one could write so much and so vividly as Dr. Salamanca did. In a way perhaps it is better not to write a diary especially when you have disappointments. And I thought that when I heard that this was going to be about Dr. Salamanca I said, I wonder whether there will be some romance in it because she died so early and I'm glad that Dr. Alzona included the romantic part because it is also a little bit more impressive, and more touching.

I express again my admiration for the author but because of her patience in trying to decipher the faded handwriting of Dr. Salamanca. I am sure that if I were the one perhaps after one paragraph I would have ended there. Then the thoroughness with which Dr. Alzona took note of all the details which Dr. Salamanca expressed is remarkable. As I said, I don't know if anybody else really could have written with such patience, understanding, and full of meaning, as Dr. Alzona did. I just can't help it. I just said that both have inspired me and I also admire the fact that even now, Dr. Alzona is so eloquent. You must have noticed how she read her paper.

Dr. Alzona, may I reiterate our expression of thanks for putting one of our colleagues, Dr. Salamanca, in the limelight. I think more of us would like to read about Dr. Salamanca and emulate her patriotism, devotion, understanding, her ability to take her disappointments and sorrows even with humor. Thank you Dr. Alzona, for continuing the inspiring work you are doing; even at this stage we see how very useful Dr. Alzona is. I know she can never retire. Thank you.

## THE DIARY OF OLIVIA SALAMANCA, M.D. (1889-1913)

Anacleta Villacorta-Agoncillo, M.D.  
Discussant

I am glad that Dr. del Mundo mentioned already what I wanted to say. Even so, I would like to add that Dr. Salamanca's death at an early age was really an irony because she died of the very disease in which she specialized. She must have felt extreme sadness when she found out that she had herself contracted the dreaded disease, knowing quite well that there was, at the time, no specific treatment to the infection. If I am not mistaken, the antibiotics were not yet discovered, and the patients were confined only at a hospital known as Santolan. Later, the Quezon Institute was built specifically for tubercular patients. Here, they were given the classical treatment, which mainly consisted of good food, sunlight, and fresh air. Then pneumothorax was practised in the hospital, the procedure being to collapse the lungs to give them complete rest. In the 1920's when a person was found to be suffering from T.B., he/she was considered already doomed. He/she was usually shunned by society and the family was looked down upon, the common belief among the laity being that all the members of the patient's family were tuberculous. People called this *lahi, lahi-lahi* or inherited. Although this could be possible if the family did not observe the necessary precautions, it does not follow that all the members of the family would be infected. Nowadays, with the discovery of the antibiotics, tuberculosis is curable. It is interesting to note that tuberculin was used to treat Dr. Salamanca. What we know of tuberculin is that it is used only to test the presence of t.b. in the body, not as a treatment.

Well, I have a few questions to ask, Dr. Alzona, could it not be possible that Dr. Salamanca's condition was aggravated by her disillusionment with her boyfriend which ultimately led to her death?

Dr. Alzona:

In general, she had many admirers and not only one invited her. In fact, that physician in Baguio told her to stop receiving callers who came every day and who sent her flowers, fruits, and phonograph records. She did not lack admirers, so one love affair would not affect her health at all. Her younger sister, Socorro (Coring), is still alive but could not come here because she is suffering from arthritis and is deaf.

Dr. Agoncillo:

How would you place Dr. Salamanca in the history of Filipino women?

Dr. Alzona:

I think she was one of the most inspiring Filipino women. She was very much advanced for her age, being of a thinking kind, and having read much literary and philosophical works - Socrates, Aristotle, Plato, and others. I think she was only twenty years old when she received her medical degree. So I believe she occupies a very high place among the women of the world and not only of our country. She was truly a very remarkable person.

Dr. T. Agoncillo:

Regarding the culture of Dr. Salamanca, she reminds me of Dr. Acosta Sison, because when I was taking philosophy at the University of the Philippines she was my classmate; she also used to take courses in literature and higher courses in philosophy, and even discussed with our philosophy professor, Dr. Dharendra Nath Roy. She was, however, already matured at the time, compared with Dr. Salamanca who was very young. I think that the life of Dr. Salamanca should serve as an inspiration especially to the narrow specialists of today who know more and more about less and less and, more especially, to the young medical students of today. During our time, we read philosophy because we were told by our professor to do so; in the case of Dr. Salamanca, she read books outside her discipline because she wanted to widen her horizon.

Dr. Alzona:

I think she was really an intelligent young student.

Dr. Fe del Mundo:

I would like to add that in memory of Dr. Salamanca, a hospital, a government hospital in Cavite, was established and named after her.

# Relative Contributions of Mixed Variables to the Variation of a Regressand

*By José Encarnación, Ph. D., Academician*

Consider a regression equation whose regressors include classificatory as well as ordinary scalar variables. A classificatory variable is essentially a vector that has as many components as there are different (mutually exclusive and exhaustive) categories in the classification. For example, one might estimate a regression equation that explains employees' salaries in terms of length of service ( a scalar), occupation (a classificatory variable), etc. One might then want to estimate the relative contributions of the explanatory variables to the variation of the dependent variable. Handling this problem by beta coefficients is well known when the explanatory variables are all of one kind, either all scalar or all classificatory. There seems, however, to be no convenient reference that discusses this matter when the explanatory variables are mixed, i.e. when they include both kinds. This expository note might therefore be of some use.

I

Let  $x = (x_0, x_1, \dots, x_k)$  where  $x_k = 1$  for an individual (or observation) if it belongs to category  $k (k = 0, 1, \dots, K)$  of classification,  $x_k = 0$  otherwise, and  $\sum_{k=0}^K x_k = 1$ . More precisely, for any given individual  $i$ ,  $x_{ki} = 1$  if  $i$  is in category  $k$ , 0 otherwise, and  $\sum_{k=0}^K x_{ki} = 1$ . To each  $i$  thus corresponds  $x_i = (x_{0i}, x_{1i}, \dots, x_{Ki})$ .

Suppose it is appropriate to explain  $y$  in terms of  $x, z, u$  and  $v$  by means of a regression equation, where  $z$  is another classificatory variable  $(z_0, z_1, \dots, z_j)$  while  $u$  and  $v$  are real variables. (Discussion of more than two variables of either kind would be straightforward.) We calculate

$$(1) \quad y' = c + \sum_1^K a_k^* x_k + \sum_1^J b_j^* z_j + p(\mu - \bar{\mu}) + q(v - \bar{v})$$

where the  $a_k^*, b_j^*, p$  and  $q$  are the regression coefficients and  $y'$  is the predicted  $y$ . As usual, overbars denote means. Note that  $x_0$

and  $z_0$  are omitted in (1) in order to have determinate coefficients (Suits 1957).

We want to express (1) in the form

$$(2) \quad y' = \bar{y} + \sum_0^K a_k x_k + \sum_0^J b_j z_j + p(\mu - \bar{\mu}) + q(v - \bar{v})$$

where  $x_0$  and  $z_0$  are included, and the  $a_k$  and  $b_j$  measure the effects on an individual's  $y$  resulting from its belonging to  $k$  of  $x$  and to  $j$  of  $z$ , respectively. It is to be noted that the  $a_k$  and  $b_j$ , which might be called category effects (Encarnación 1975), are measured from  $\bar{y}$ . For suppose that for an individual  $i$ ,  $x_{ki} = 1$  for a particular  $k$  and  $z_{ji} = 1$  for a particular  $j$ . Then

$$y'_i = \bar{y} + a_k + b_j + p(\mu_i - \bar{\mu}) + q(v_i - \bar{v}).$$

so that  $a_k$  and  $b_j$  are simply added on to  $\bar{y}$ .

From least squares properties, using (1),

$$(3) \quad c = \bar{y} - \sum_1^K a_k^* \bar{x}_k - \sum_1^J b_j^* \bar{z}_j - p(\bar{\mu} - \bar{\mu}) - q(\bar{v} - \bar{v})$$

$$= \bar{y} - \sum_1^K a_k^* \bar{x}_k - \sum_1^J b_j^* \bar{z}_j.$$

But  $c$  is also the predicted  $y$  for an individual satisfying  $x_0 = 1$ ,  $z_0 = 1$ ,  $\mu = \bar{\mu}$  and  $v = \bar{v}$ . Therefore

$$(4) \quad a_0 = - \sum_1^K a_k^* \bar{x}_k$$

$$(5) \quad b_0 = - \sum_1^J b_j^* \bar{z}_j.$$



Further, if an individual satisfies  $x_k = 1 (k \neq 0)$ ,  $z_0 = 1$ ,  $\mu = \bar{\mu}$ ,  $v = \bar{v}$ , the predicted  $y$  is  $c + a_k^*$ . Since we already know from (3) – (5) that

$$(6) \quad c = \bar{y} + a_0 + b_0$$

we have  $c + a_k^* = \bar{y} + (a_0 + a_k^*) + b_0$  so that

$$(7) \quad a_k = a_0 + a_k^* \quad k = 1, \dots, K.$$

The  $b_j$  are similarly determined.

Substituting (6) in (1),

$$(8) \quad \begin{aligned} y' &= \bar{y} + a_0 + b_0 + \sum_1^K a_k^* x_k + \sum_1^J b_j^* z_j + p(\mu - \bar{\mu}) + q(v - \bar{v}) \\ &= \bar{y} + a_0 + b_0 + \sum_1^K (a_k - a_0) x_k + \sum_1^J (b_j - b_0) z_j + p(\mu - \bar{\mu}) \\ &\quad + q(v - \bar{v}) \\ &= \bar{y} + a_0 (1 - \sum_1^K x_k) + \sum_1^K a_k x_k + b_0 (1 - \sum_1^J z_j) + \sum_1^J b_j z_j \\ &\quad + p(\mu - \bar{\mu}) + q(v - \bar{v}) \end{aligned}$$

But  $1 - \sum_1^K x_k = x_0$  and  $1 - \sum_1^J z_j = z_0$ ; hence (2)

We note for later reference that  $\bar{x}_k = n_k/n$ , where  $n_k$  is the number of individuals for which  $x_{ki} = 1$  and  $n$  is the total number of individuals. Also, as one might expect,

$$(9) \quad \sum_{h=1}^n \sum_{K=0}^K a_k x_{kh} / n = \sum_0^K a_k n_k / n = \sum_0^K a_k \bar{x}_k = 0.$$

i.e. the mean  $\sum_0^K a_k \bar{x}_k = 0$ . (in the same way that the mean  $p(\mu - \bar{\mu})$ , say, is zero). For multiplying (7) by  $n_k$ , summing both sides and then adding  $n_0 \cdot a_0$  to the results,

$$\sum_0^K n_k a_k = n a_0 + \sum_1^K n_k a_k^*$$

which, in view of (4), gives (9).

## II

The motivation for calculating the partial beta coefficients of standard multiple regression is to be able to compare the relative contributions of the explanatory (scalar) variables to the variation of the dependent variable (see, e.g., Ezekiel and Fox 1959, p. 196). Accordingly, the variables are standardized to zero means and unit variances, so that their beta coefficients become directly comparable. Similarly, the beta coefficients discussed by Morgan *et al* (1962) perform the same function in the case of classificatory variables. Our problem is to see whether all the beta coefficients in a regression with mixed variables are directly comparable.

Write

$$(10) \quad \frac{y' - \bar{y}}{s_y} = \beta_x f(x) + \beta_z g(z) + \beta_u \frac{\mu - \bar{\mu}}{s_u} + \beta_v \frac{v - \bar{v}}{s_v}$$

which is to be equivalent to (cf. (2))

$$(11) \quad \frac{y' - \bar{y}}{s_y} = \frac{\sum_0^K a_k x_k}{s_y} + \frac{\sum_0^J b_j z_j}{s_y} + \frac{p(\mu - \bar{\mu})}{s_y} + \frac{q(v - \bar{v})}{s_y}$$

where  $s_y$  is the standard direction of  $y$ , etc.,

$$(12) \quad \beta_u = p s_u/s_y$$

which is the textbook definition of a partial beta coefficient, similarly for  $\beta_v$ ,

$$(13) \quad \beta_x = \frac{(\sum_0^K a_k^2 n_k / (n-1))^{1/2}}{s_y}$$

from Morgan *et al.* (1962), and the functions  $f(x)$  and  $g(z)$  are implicitly defined by the equivalence of (10) and (11) and the

definitions of the  $\beta$ 's. It is clear that if  $\beta_u^2 > \beta_v^2$ ,  $u$  contributes more than does  $v$  to the explanation of  $y$  variation. Our object is to show that  $f(x)$ , say, standardizes  $x$  essentially in the same way that  $(\mu - \bar{\mu})/s_\mu$  standardizes  $u$ , so that all the beta coefficients are then directly comparable.

From (10), (11) and (13), for individual  $i$ ,

$$(14) \quad f(x_i) = \frac{\sum_{k=0}^K a_k x_{ki}}{(\sum_{k=0}^K a_k^2 n_{k.}/(n-1))^{1/2}}$$

from which

$$(15) \quad f(x_i)^2 = \frac{\sum_{k=0}^K a_k^2 x_{ki}^2}{\sum_{h=1}^n \sum_{k=0}^K a_k^2 x_{kh}^2 / (n-1)}$$

since cross-product terms vanish and  $x_{ki} = x_{ki}^2$  (because  $x_{ki} = 0$  or 1 and  $\sum_{k=0}^K x_{ki} = 1$ ). But

$$(16) \quad \frac{(\mu_i - \bar{\mu})^2}{s_u^2} = \frac{p^2 (\mu_i - \bar{\mu})^2}{\sum_{h=1}^n p^2 (\mu_n - \bar{\mu})^2 / (n-1)}$$

corresponds precisely to (15), the only difference being that while one can factor out  $p^2$  in (16), which of course does not affect the ratio, it is not possible to factor out  $\sum_0^K a_k^2$  in (15), which pertains to a vector. The key observation is that  $x$  being a classificatory variable,  $\sum_{k=0}^K a_k x_{ki}$  is the analogue of  $p(\mu_i - \bar{\mu})$  and both have zero means.

This completes our task, and all the beta squares may then be ranked to indicate the relative contributions of their corresponding variable to the explanation of  $y$  variation.

## References

- Encarnación, J (1975), "Income Distribution in the Philippines: The Employed and the Self-Employed," in *Income Distribution, Employment and Economic Development in South-east and East Asia*, Tokyo: Japan Economic Research Center, 742-776
- Ezekiel, M. and Fox, K. A. (1959), *Methods of Correlation and Regression Analysis*, 3rd ed., New York: Wiley.
- Morgan, J. N. et al. (1962), *Income and Welfare in the United States*, New York: McGraw-Hill. Appendix E.
- Suits, D.B. (1957), "Use of Dummy Variables in Regression Equations," *Journal of the American Statistical Association*, 52, 548 - 551.

# RELATIVE CONTRIBUTIONS OF MIXED VARIABLE TO THE VARIATION OF A REGRESSAND

Cristina A. Parel, Ph.D.

## Discussant

1. The use of dummy variables in regression equations has not always been regarded favorably by some statisticians. But in application, "dummy" variables are getting to be indispensable because of the nature of some factors. These factors may have only two or more mutually exclusive levels in which case one cannot set up a continuous scale for the variables. However, the inclusion of dummy variables renders the resulting normal equations "unsolvable" in view of the singularity of the matrix of coefficients. To remedy the situation; that is, to be able to estimate the regression coefficients, some additional linear constraints involving the coefficients of the "dummy" variables need to be introduced. For example, if there are  $r$  sets of "dummy" variables (or, classifications) used in the regression equation, there would be  $r$  constraints needed to have the regression coefficients estimable. Two alternative methods are commonly used: (1) the sum of the coefficients of the "dummy" variables is equated to zero; and (2) one specified coefficient of each set of "dummy" variables is equated to zero. Dr. Encarnación used the second method. Using either of these methods, however, the resulting normal equations (obtained by the least squares method) can be solved directly with the use of an electronic computer because after using the constraints, the matrix of coefficients of the reduced normal equations will no longer be singular.

2. To determine the relative importance of the independent variables on the dependent (or, response) variable, any of the following three measures may be used.

i) the *partial correlation coefficient*,  $r_{yj \cdot kl \dots}$ , given by:

$$r_{yj \cdot kl \dots} = b_j \frac{S_j}{S_y} \frac{\sqrt{1 - R_{jj}^2}}{\sqrt{1 - R_{y\hat{y}}^2}}$$

where  $b_j$  = the regression coefficient corresponding to the independent variable  $x_j$  ;

$$R_{jj}^2 = 1 - \frac{\sum (X_j - \hat{X}_j)^2}{\sum (X_j - \bar{X})^2} ;$$

where

$\hat{X}_j$  = the regressed value of the independent variable  $X_j$  on the remaining independent variables;

and  $\bar{X}$  = the mean of the  $X_j$  values;

and  $S_j$  = the standard deviation of the  $X_j$  values

$S_y$  = the standard deviation of the  $Y$ -values.

ii.) the *beta coefficient* given by:

$$b_j^* = b_j \frac{S_j}{S_y}$$

iii) the coefficient of “part” correlation, given by:

$$r_{yj(kl\dots)} = \frac{b_j S_j \sqrt{1 - R_{jj}^2}}{S_y}$$

where  $b_j$ ,  $S_j$  and  $S_y$  are as defined above. It is to be noted that the beta coefficient is the easiest measure, among the three, to compute. However, the beta coefficient involves the unadjusted standard deviations of the variables involved. Obviously, the three measures have different values. However, usually, the ranking in terms of importance of the independent variables on the dependent variable will be the same, although this will not always be the case.

3. Some general remarks may be pertinent at this point. The beta coefficients can be highly influenced by purposeful selection of sample values of one or more of the independent variables. That is, if the values of one or more of the independent variables are specified by the researcher, as in this case of “dummy” variables, the beta coefficients will have “sampling significance only with respect to a special universe in which the standard deviation of each of the independent variables is held constant for all possible samples.” (Ezekiel & Fox, 1959). Thus, one should be judicious in using beta coefficients unless correlation models involving random sampling from a normally distributed “natural” universe are used.

# REMARKS ON RELATIVE CONTRIBUTIONS OF MIXED EXPLANATORY VARIABLES TO THE VARIATION OF A REGRESSAND

*By Tito A. Mijares, Ph.D., Academician*

(The following prepared remarks were distributed to participants at the conference. Dr. Mijares restated the problem of "mixed" explanatory variables - discrete and continuous - in a general linear model, then proceeded to derive some tests on the regression coefficients to effect some comparison among them. By examining the correlation matrix of the "mixed" set of explanatory variables, Dr. Mijares arrived at an interesting result which offers a direct interpretation of coefficients of discrete independent variables in regression problems. The correlation coefficient between continuous and discrete variables measures the degree of inequality of a particular characteristic among the different attributes in the population; e.g. "income inequality").

We have a general linear model in matrix form

$$(1) \quad Y = X \beta + \mu$$

where  $Y' = (Y_1, \dots, Y_n)$ ;  $X = (X_{ij})$ ,  $i = 1, \dots, n$ ,  $j = 0, \dots, k$  with the first column of  $X$ 's each equal to unity:  $\beta' = (\beta_0, \beta_1, \dots, \beta_k)$  and  $\mu' = (\mu_1, \dots, \mu_n)$ .  $\beta$  is a column vector of unknown parameters and  $\mu$  is a column vector of random values. The usual assumptions are: (a) the expected value  $E(\mu) = 0$ , (b)  $E(\mu \mu') = \sigma_\mu^2 I_n$ , where  $I_n$  is a unit matrix of order  $n$  and  $\sigma_\mu^2 < \infty$  is the common variance of the  $\mu$ 's, (c)  $x+1$  is a set of fixed real numbers with  $\text{rank } k+1 < n$ . The vector of parameters  $\beta$  is to be estimated, usually by least squares.

Without loss of generality the model may be restated by expressing the dependent vector  $Y$  and the explanatory variables  $X_{ij}$  as deviates from their respective means and eliminating  $\beta_0$ . Thus equation (1) may be written

$$(2) \quad y = x \beta + \epsilon$$

where  $y' = (y_1, \dots, y_n)$ ,  $y_i = Y_i - \bar{Y}$ ,  $\bar{Y} = \sum_{i=1}^n Y_i / n$

$x = (x_{ij})$ ,  $i = 1, \dots, n$ ,  $j = 1, \dots, k$ .

$$x_{ij} = X_{ij} - \bar{X}_j \quad \bar{Y}_i = \frac{1}{n} \sum_{i=1}^n Y_i$$

$$\beta' = (\beta_1, \dots, \beta_k) \text{ and } \epsilon' = (\epsilon_1, \dots, \epsilon_n)$$

If  $\hat{\beta}_i = (\hat{\beta}_1, \dots, \hat{\beta}_k)$  is the vector of least squares estimates of  $\beta$  equation (2) may be written equivalently as

$$(3) \quad y = x \hat{\beta} + e$$

where  $e$  is a vector of  $n$  residuals  $y - x\hat{\beta}$ . It can be established that  $\hat{\beta} = (x'x)^{-1}x'y$ . The mean and variance of  $\hat{\beta}$  are respectively  $\beta$  and  $\sigma_e^2 (x'x)^{-1}$ . Equation (3) may be expressed by

$$(4) \quad y = \hat{y} + e$$

where

$$(5) \quad \hat{y} = x\hat{\beta}$$

In terms of Dr. Encarnación's formulation (cf. eq. (1))  $y$  is the "predictor" of  $\hat{y}$ . Thus, the vector  $y$  consists of the vector of *explained* and *unexplained* parts,  $e$  being the latter portion. The total number of regression coefficients in his paper is  $K + J + 4$  which is equal to dimension  $k$  in this note, if his  $p$  and  $q$  are denoted by  $\hat{\beta}_{k-1}$  and  $\hat{\beta}_k$ , respectively. For a given element of  $\hat{y}$  in this note

$$\hat{y} = \bar{y} + a_0 + b_0$$

of that paper (cf. eq. (2), Encarnación's paper). The coefficients  $\hat{\beta}_1, \dots, \hat{\beta}_{k-2}$  here are the same as the coefficients of the discrete explanatory variables in that same paper.

### *Dummy Variables*

We may now view the problem addressed by Dr. Encarnación as extensions of a general linear model in certain aspects. In econometric work the introduction of discrete variables is generally meant the inclusion of "dummy" variables in the usual regression model. Suppose  $Y$  is income expressed by gross national product (GNP) and  $X$  is total investment. A linear model for two periods may be expressed

$$Y = \alpha_1 + \beta X + \epsilon \quad (\text{before the war})$$

$$Y = \alpha_2 + \beta X + \epsilon \quad (\text{after the war})$$

The two equations may be combined into a single equation

$$(6) \quad Y = \alpha_0 + \beta_0 Z + \beta X + \epsilon$$



where  $Z = 0$  before the war and  $Z = 1$  after the war. Hence,

$$E(Y|Z=0) = \alpha_0 + \beta X$$

$$E(Y|Z=1) = (\alpha_0 + \beta_0) + \sigma\beta X$$

Note that  $\alpha_1$  is now equivalent to  $\alpha_0$  and  $\alpha_2 = \alpha_0 + \beta_0$  (cf. lines 5 and 6 from the bottom, p. 2., Encarnación's paper). Hence, we may treat the problem as an ordinary linear regression problem, unrestricted case in the sense that no restrictions as imposed on the coefficients.

### Tests on the Coefficients

To make tests on the coefficients an additional assumption on the distribution of the residual term  $\epsilon_i$ ,  $i = 1, \dots, n$  in equation (2) is needed. Suppose the  $\epsilon_i$ 's are independently and identically normally distributed random variables with zero means and common variance  $\sigma_\epsilon^2$ . The L.S. estimate of  $\beta$  is

$$(7) \quad \begin{aligned} \hat{\beta} &= (x'x)^{-1} x'y \\ &= \beta + (x'x)^{-1} x'\epsilon \end{aligned}$$

Then

$$(8) \quad \begin{aligned} E(\hat{\beta}) &= \beta \\ \text{var}(\hat{\beta}) &= E [(\hat{\beta} - \beta)(\hat{\beta} - \beta)'] \\ &= E [(x'x)^{-1} x'\epsilon \epsilon' x(x'x)^{-1}] \\ &= \sigma_\epsilon^2 (x'x)^{-1} \end{aligned}$$

One sees from (7) that  $\hat{\beta}$  has a multinormal distribution over a  $k$ -dimensional space with density  $N_k(\beta, \sigma_\epsilon^2 (x'x)^{-1})$ . Hence, a linear function  $c'\beta$  has a univariate normal distribution with density  $N(c'\beta, \sigma_\epsilon^2 c'(x'x)^{-1}c)$ . The statistic

$$(9) \quad t = \frac{c'\hat{\beta} - c'\beta}{s_\epsilon \sqrt{c'(x'x)^{-1}c}}$$

will be distributed as Student's - t with  $n-k$  degrees of freedom, where  $s_\epsilon = \sqrt{e'e/(n-k)}$ .  $\hat{\beta}$  and  $e$  are independently distributed.

We can now compare coefficients of classificatory variables (e.g. the coefficient of the  $i^{\text{th}}$  income group of one region against coefficient of the  $j^{\text{th}}$  income group of another region). By choosing

$c$  appropriate to our hypotheses on the  $\beta$ 's, we can make the tests on the coefficients. Let  $c' = (0, \dots, 0, 1, 0, \dots, 0, -1, 0, \dots, 0)$ , the  $i^{\text{th}}$  element is 1 and the  $j^{\text{th}}$  element is -1 and zeros in other places. This is equivalent to testing  $H_0: \beta_i - \beta_j = 0$  or  $\beta_j$  against  $H_1: \beta_i \neq \beta_j$ . The probability is  $\alpha$  that  $|t| > t_{\alpha/2, n-k}$ , where  $t_{\alpha/2, n-k}$  is the tabulated value of  $t$  with  $n-k$  d.f.

### Concluding Remarks

The formulation of the general linear model given in (1) includes an assumption that the domain of the explanatory variables are real numbers and results derived therefrom apply also to the mixed case which Dr. Encarnación deals with in his paper.

Apart from the problem that units of measures in the variables are not easily interpretable when compared, working with correlations among variables are of frequent interest because the square of multiple correlation coefficient

$$(10) \quad R^2_{0.1,2,\dots,k} = 1 - \frac{\sum \epsilon^2}{\sum y^2}$$

explains directly the proportion of total variation in the dependent variable  $Y$  explained by variables  $X_1, \dots, X_k$ . Occasionally also the available data we have on the problem are expressed in correlation coefficients. Alternatively, the  $\beta$ 's in the linear regression model of equation (2) can be derived from correlations among the variables. We can compute the simple (zero-order) correlations between the variables  $Y, X_1, \dots, X_k$  and display them in matrix form  $R = (r_{ij})$  where  $r_{0j}$  ( $j = 1, \dots, k$ ) denotes the correlation between  $Y$  and  $X_j$  and  $r_{ii} = 1$  ( $i = 0, \dots, k$ ). Then the least squares regression  $y = \beta_1 x_1 + \dots + \beta_k x_k$  where  $y, x_1, \dots, x_k$  are deviates of variables  $Y, X_1, \dots, X_k$  from their respective means would have coefficients

$$(11) \quad \hat{\beta}_j = - \frac{s_0 R_{0j}}{s_j R_{00}}$$

where  $R_{0j}$  and  $R_{00}$  denote the co-factors of  $r_{0j}$  and  $r_{00}$  in the matrix  $R$ , respectively, and  $s_0$ , and  $s_j$  are the respective standard deviations of  $Y$  and  $X_j$ . An alternative expression for the least squares regression is

$$(12) \quad \frac{R_{00}}{s_0} y + \frac{R_{01}}{s_1} x_1 + \frac{R_{02}}{s_2} x_2 + \dots + \frac{R_{0k}}{s_k} x_k = 0.$$

The residual sum of squares  $\sum e^2 = e'e$  may be expressed as

$$(13) \quad \sum e^2 = \frac{e'e + Ke}{R_{00}}$$

where  $|R|$  is the determinant of matrix  $R$ . Since

$$(14) \quad \sum y^2 = ne^2, \text{ equation (10) becomes}$$

$$R_{00} = \frac{|R|}{R_{00}}$$

The only thing left to relate equations (11) and (12) to Dr Encarnación's model is to determine the standard deviations and correlations of the discrete variables. Note that the classificatory variable  $x_j$  has mean  $p_j$ , the proportion of individuals in the  $j^{\text{th}}$  class. Its variance is  $p_j(1-p_j)$ . The correlation between  $X_i$  and  $X_j$  in the same class is (c.f. Cramer, p. 313)

$$(15) \quad r_{ij} = \frac{p_i p_j}{(1-p_i)(1-p_j)}$$

Take characteristic group  $h$  of classificatory variable  $X$ . Assume that the first  $v$  of  $n$  individuals in the sample belong to  $h$ . Let the sequence of values of the continuous variable  $w$  in the  $h$  group be denoted by  $w_1, \dots, w_n$ . The pairs of values of  $X$  and  $w$  and their deviates are

Original values						Sums	Moments
$X:$	1	1	...	1	0	...	0
						$v$	$v^{2+}$
$w:$	$w_1$	$w_2$	...	$w_{v+1}$	...	$w_n$	
						$\sum_1^n w_i$	$\sum_1^n w_i^2$

Deviates

$$x: \quad 1-p \quad 1-p \quad \dots \quad 1-p \quad -p \quad \dots \quad -p$$

$$w: \quad (w_1 - \bar{w}) \quad (w_2 - \bar{w}) \quad \dots \quad (w_v - \bar{w}) \quad (w_{v+1} - \bar{w}) \quad \dots \quad (w_n - \bar{w})$$

Then

$$\sum_1^n x_i w_i = \sum_1^v (1-p)(w_i - \bar{w}) - \sum_{v+1}^n p(w_i - \bar{w})$$

$$\begin{aligned}
&= (1-p) \left[ \sum_1^v w_i - \frac{v}{n} \sum_1^n w_i \right] - p \sum_{v+1}^n w_i + p(n-v)\bar{w} \\
&= \sum_1^v w_i - p \sum_1^v w_i - p \sum_1^v w_i + p^2 \sum_1^n w_i - p \left[ \sum_1^n w_i - \sum_1^v w_i \right] + p(n-v)\bar{w}
\end{aligned}$$

This easily simplifies to

$$(16) \quad \sum_1^n x_i w_i = \sum_1^v w_i - p \left( \sum_1^n w_i \right)$$

since

$$p^2 \sum_1^n w_i = pv\bar{w} \text{ and } p \sum_1^n w_i = pn\bar{w}$$

The simple correlation between  $x$  and  $w$  is

$$(17) \quad r_{xw} = \frac{\sum_1^v w_i - p \sum_1^n w_i}{\sqrt{p_q s_w}}$$

where

$$s_w = \sqrt{\sum_1^n (w_i - \bar{w})^2 / (n-1)} \text{ and } q = 1-p$$

### Reference

H. Cramer: "Mathematical Methods of Statistics", Princeton University Press, Princeton, N.J., 1946

## RELATIVE CONTRIBUTIONS OF MIXED VARIABLE TO THE VARIATION OF A REGRESSAND

Burton T. Oñate, Ph. D.  
Discussant

Being the last discussant, I assume that Drs. Parel and Mijares would be able to cover perhaps 90 per cent of what should be said. But least squares and regression is a broad field and my paper will deal on their theoretical foundations. The four methods of estimation in a general linear form are (i) ordinary least squares, (ii) generalized least squares, (iii) maximum likelihood and (iv) best linear unbiased estimator (blue). Their equivalents are indicated depending upon the assumptions made.

Two well known points are worth mentioning, namely; (i) least squares estimation does not pre-suppose any distributional properties of the  $e$ 's other than finite means and finite variances; (ii) maximum likelihood estimation under normality assumptions lead to the same estimator,  $b$ , as generalized least squares; and this reduces to the ordinary least squares estimator  $b$  when  $V=d^2I$ . Therefore, one could see that the estimation procedures will require the use of some transformations which essentially was applied by Dr. Mijares to derive the estimators, and the variance and co-variance matrices. These results of Dr. Mijares could be compared with those given in the paper under discussion. Existing computer programs should be tested for "integrity" and using the ramifications indicated in Mijares' discussion paper.

A survey on the "Method of Least Squares" has been conducted by S. L. Harter which appeared in several issues of the International Statistical Review of 1974-75. Harter divided this era into four parts, (I) The Pre-Least Squares, (II) The Awakening, (III) The Modern Era I and (IV) The Modern Era II. A subject index to the references arranged in alphabetical order of the Code Letters was used to classify more than 5,000 papers/authors. The paper under review could fall in II, III and IV.

The uses of code and dummy (0, 1) variables are illustrated in the Philippines by the National Census Statistics Office indicators on income (salary). One would see that the code used would be called classificatory variable as the level and the category inside as the factors and inside the factor as level. In occupation, they have developed for example codes 1, 2, 3, 4, 5, 6. One criticism is that one cannot use the values because no relationship exists in terms of occupational status. And to get away from this problem, so called dummy variables are used. Another example is education as a factor (page 5) and there are many levels under education (factor). Here, there is some kind of order but even then this order is in terms of educational status. Again, dummy variables would be useful.

(2) *Generalized least squares*

On assuming that the variance-covariance matrix of  $e$  is  $\text{var}(e) = V$ , this procedure involves minimizing  $(y - Xb)' V^{-1} (y - Xb)$  with respect to  $b$  which leads to

$$\hat{b} = (X'V^{-1}X)^{-1} X'V^{-1}y.$$

When  $V = \sigma^2 I$ , the generalized and the ordinary least squares estimators are the same:  $\hat{b} = \hat{b}$ .

(3) *Maximum likelihood*

With least square estimation no assumption is made about the form of the distribution of the random error terms, which are represented by  $e$ . With maximum likelihood estimation some assumption is made about this distribution (often that it is normal) and the likelihood of the sample of observations represented by the data is then maximized. On assuming that the  $e$ 's are normally distributed with zero mean and variance-covariance matrix  $V$ , i.e.,  $e \sim N(0, V)$ , the likelihood is

$$L = (2\pi)^{-1/2N} |V|^{-1/2} \exp [-1/2(y - Xb)' V^{-1} (y - Xb)].$$

Maximizing this with respect to  $b$  is equivalent to solving  $\partial (\log_e L) / \partial b = 0$ . The solution is the maximum likelihood estimator of  $b$  is

$$\hat{b} = (X'V^{-1}X)^{-1} X'V^{-1}y,$$

the same as the generalized least squares estimator. As before, when  $V = \sigma^2 I$ ,  $\hat{b}$  simplifies to  $\hat{b}$ . The estimator  $\hat{b}$  is the maximum likelihood estimator, if we assume that

$$e \sim N(0, \sigma^2 I).$$

Two well-known points are worth mentioning about these estimators. First, least squares estimation does not pre-suppose any distributional properties of the  $e$ 's other than finite means and finite variances. Second maximum likelihood estimation under normality assumptions lead to the same estimator,  $\hat{b}$ , as generalized least squares; and this reduces to the ordinary least squares estimator  $\hat{b}$  when  $V = \sigma^2 I$ .

(4) *The best linear unbiased estimator (b.l.u.e.)*

For any row vector  $t'$  conformable with  $b$  the scalar  $t'b$  is a linear function of the elements of the parameter vector  $b$ . A fourth estimation procedure derives a best, linear, unbiased estimator (b.l.u.e.) of  $t'b$ .

The b.l.u.e. of  $t'b$  is  $t'(X'V^{-1}X)^{-1}X'V^{-1}y$ , and its variance is

$$v(\text{b.l.u.e. of } t'b) = t'(X'V^{-1}X)^{-1}t.$$

From among all estimators of  $t'b$  that are both linear and unbiased the one having the smallest variance is  $t'(X'V^{-1}X)^{-1}X'V^{-1}y$ ; and the value of this smallest variance is  $t'(X'V^{-1}X)^{-1}t$ .

3. In view of this equivalence, it may be worthwhile to use the results for the Ordinary Least Squares Method and apply the suggested transformation in reducing the original  $x, z, u$ , and  $v$  to  $N(0,1)$  instead of  $N(0, I\sigma^2)$ . Another suggested theoretical framework is the Principal Component Method.

### *Survey on Method of Least Squares*

4. H. Leon Harter (1974, 1975) wrote a series of articles entitled "The Method of Least Squares and Some Alternatives", in the International Statistical Review (ISR). These series of articles are summarized as follows:

- |      |                                                                                                                                |
|------|--------------------------------------------------------------------------------------------------------------------------------|
| Part | I Introduction, Pre-Least Squares Era (1632-1804) and Eighty Years of Least Squares (1805 - 1884); ISR (1974) 42, pp. 147-174. |
|      | II The Awakening (1885 - 1945); ISR (1974) 42, pp. 235 - 264, 282.                                                             |
|      | III The Modern Era (I) (1946 - 1964); ISR (1975) 43, pp. 1-44.                                                                 |
|      | IV The Modern Era (II) (1965-1974); ISR (1975) 43, pp. 125-190; ISR (1975) 43, pp. 273-278 (Addendum).                         |

A Subject Index to the references arranged in alphabetical order of the Code Letters was also made available (see Appendix Table A). A total of 148 Code Letters was used to classify more than

5,000 authors/papers. The paper under review could be classified under one or more of the Code Letters presented. If not, we could add a new Code Letter.

*Uses of Codes and Dummy (0,1) Variables*

5. An alternative analysis known as regression on dummy (0,1) variables has certain advantages but it may introduce into the linear model the problem of not of full rank. The NCSO uses codes in the presentation of detailed data on labor force, income and expenditure characteristics of household sampled. The regression of income (salary), expenditure and investment of sampled families on dummy (0,1) variables<sup>1</sup> may include class of worker (occupation), education and other characteristics which are coded: Examples of these codes are as follows:

**Level/Class of Worker (Occupation) - Factor**

- 1 - Worked for private employer
- 2 - Worked for government/government corporation
- 3 - Self-employed without any paid employee as defined in "4"
- 4 - Employer in own family-operated farm/business (with one or more regular paid employees or one or more hired employees most of the weeks of the last quarter in operation.)
- 5 - With pay on own family-operated farm or business
- 6 - Without pay on own family-operated farm or business

**Highest Grade Completed (Education)  
- Factor Level**

- 00 — No grade completed  
*Elementary*
- 11 — 1st grade
- 12 — 2nd grade
- 13 — 3rd grade
- 14 — 4th grade
- 15 — 5th grade
- 16 — 6th grade and 7th grade  
*High School*
- 21 — 1st year
- 22 — 2nd year
- 23 — 3rd year
- 24 — 4th year

**College Graduate  
Level**

- 31 — 1st year
- 32 — 2nd year
- 33 — 3rd year
- 34 — 4th year
- 35 — 5th year  
or higher

*For college graduates  
Specify the Bachelor's or highest degree  
completed and field  
of study.*

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<sup>1</sup> Searle, S.R. Linear Models.  
John Wiley & Sons, Inc.  
N.Y. 1971



The occupational and educational codes may be collapsed into 3 or 4 categories. One question is, "How can Occupation be Measured". One possibility is to measure it by the code numbers 1, 2, 3, 4, 5, 6. An inherent difficulty, however, occurs with the definition of  $x$  as a code number to measure occupational status. Although the six (6) categories of occupation or class of worker represent different kinds of occupation, the allocation of the numbers 1 to 6 to these categories as measures of occupational status may not accurately correspond to the underlying measure of whatever is meant by occupational status. The allocation of the number codes is, therefore, quite arbitrary. By giving a self-employed person an  $x$ -value of 3, we are not really saying that he has three times as much status as worked for private employer ( $x = 1$ ). But in terms of the model, what we are saying is that

$$E(\text{investment } (i) \text{ or Income } (In) \text{ of private employer}) = b\sigma + b_1$$

$$E(\text{ } (i) \text{ or } (In) \text{ of self-employed}) = b\sigma + 3b_1$$

Thus, allocating codes to the different categories is not entirely justified so far as the suggested model is concerned. Such category codes are also used in many characteristics of interest such as education, management level, malnutrition, source of raw material, treatment and plant location in an industrial process, etc. This problem on code number is avoided by using the technique of regression on dummy (0,1) variables. Estimation procedures as illustrated above will immediately imply that a sound and scientific sample is drawn from the universe and from this sample, estimates are made of the parameters in the linear model. Even if the sample is drawn on a sound and scientific manner, it would be extremely difficult to generate equal number of data or the so-called balanced data. More often than not, there would be unequal numbers of observations in each category or sub-class including perhaps some categories with no observations at all. This situation is called unequal numbers data, unbalanced data or "messy" data. Some difficulties will be met in the analysis.

6. In studying the effects of occupation, education or malnutrition, on investment or income behavior, we are interested in the extent to which each category of each variable is associated with investment. To acknowledge the measurability of the variable and the associated arbitrariness or subjectivity in dealing on their categories, the concept of "factor" and "level" may be introduced. The word "factor" denotes the occupation, education, malnutrition which in turn are divided into "levels". Examples were given earlier. The "factor" cannot be measured precisely by a cardinal value while the word "variable" is reserved for that which can be measured. Thus, investment, income or salary are variables. Note that each person falls into one and only one

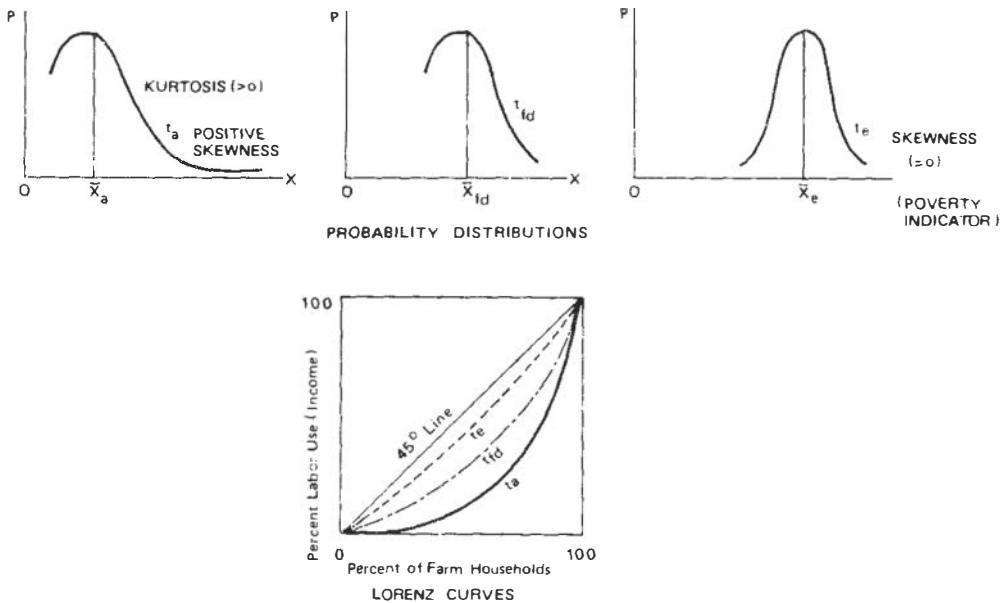
occupational or educational level to which he belongs to. Let the corresponding  $x$  take the value unity (1) and let all other  $x$ 's for that person to have a value of zero (0). Note that in the model of the paper under review, there is a mixture of both dummy (0,1) and measurable variables similar to  $y$ . Care must be taken to insure that the resultant  $X$  matrix is of full rank.

*Sampling Variation and Resultant Distribution*

7. Selected indicators will illustrate the level of and distributional property of poverty indicators though the major periods in the project cycle. i.e.,

- $t_a$  = prior to or at appraisal time,
- $t_{pe}$  = at completion time or at post-evaluation
- $t_{fd}$  = at full development, and
- $t_e$  = at end of project life.

**Chart A. Probability Distributions and Lorenz Curves of Indicators from ARD Projects.**



Some of the indicators are production oriented. They are, however, related to poverty indicators such as ownership, size of land and yield, employment and labor inputs, etc. All of the indicators are skewed to the right showing extreme inequalities at the beginning of the project life ( $t_a$  or  $t_{pe}$ ) except perhaps the data on price or value of paddy. Chart A shows empirically how the Project Benefit Monitoring and Evaluation System (PBMES) will be able to measure and illustrate the level and distribution of each poverty indicator which is relevant to the project site.<sup>1</sup> These distributions could serve as framework in the sampling procedures and to the levels of variation in the V matrix on a time series.

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<sup>1</sup>Oñate, B.T. Benefit Monitoring and Evaluation System as a Component of ARD Project Design. ADB. 1981

### Appendix Table A

#### METHODS OF LEAST SQUARES AND SOME ALTERNATIVES (H. LEON HARTER)

##### Glossary of Code Letters

AC	Arley's criterion (for rejection of outliers)
AD	Average (absolute) deviation
AE	adaptive estimators
AI	Adichie's estimators (of regression coefficients)
AM	arithmetic mean
AR	Anscombe's rules (for rejection of outliers)
AS	average slope (of regression lines)
AT	Andrew's tests (for rejection of outliers)
AV	average (all types)
BC	Bertrand's criterion (for rejection of outliers)
BF	Bartlett's (method of) fitting (straight lines)
BM	Brown-Mood estimators (of regression parameters)
BT	best two (out of three)
CC	Chauvenet's criterion (for rejection of outliers)
CD	censored data
CH	cliff hangers
CM	Cauchy's method (of interpolation)
CT	(Bliss)-Cochran-Tukey criterion (for rejection of outliers)
CU	Cucconi's criterion (for rejection of outliers)
DA	discard averages (trimmed means)
DC	Dixon's criterion (for rejection of outliers)
DH	differences at half range

DI	dispersion (measures of)
DQ	Quesenberry-David criterion (for rejection of outliers)
EA	equal areas (under joint p.d. curve) (Laplace's "most advantageous method")
EB	empirical Bayes approach (to outliers)
EE	van Eeden estimators (of location parameters)
EM	Edgeworth's modification (of Stone's second criterion)
EX	extremes (largest and smallest values in sample)
FC	Ferguson's criterion (for rejection of outliers)
FM	folded medians
GA	Gastwirth estimators
GC	Glaisher's criterion (for rejection of outliers)
GD	Gini's mean difference
GE	geometric midrange
GG	geometric range
GM	geometric mean
GP	generalized Pitman estimators
GR	Goodwin's rule (for rejection of outliers)
GS	Grubbs' criterion (for rejection of outliers)
HA	Hodges' alternative (to Hodges-Lehmann estimator)
HC	Heydenreich's criterion (for rejected outliers)
HE	Harter's estimators (1972)
HG	Hogg's revised estimator (1972)
HL	Hodges-Lehmann estimator
HM	harmonic mean
HO	Hogg's estimator (1967)
HQ	Hogg's estimators based on Q statistic.
HS	Hulme-Symms alternative (to the rejection of outliers)
HU	Huber's estimator
HV	Harter's regression estimators with variable boundaries
IC	Irwin's criterion (for rejection of outliers)
IR	interquartile range
JA	Jeffrey's alternative (to the rejection of outliers)
JE	Jureckova's estimators (of regression coefficients)
JO	Jorgenson's estimators
KC	Kudo's criterion (for rejection of outliers)
KE	Kraft-van Eeden estimators (of location parameters)
KT	Kendall's tau estimator (Sen)
LA	Laurent's analogue (of Thompson's criterion)
LD	largest (absolute) deviation
LE	L-estimators (linear combinations of order statistics)
LF	least (sum of absolute) first (powers) (Laplace's "method of situation")
LN	least number of deviations (least sum of zero powers)
LP	least (sum of) $p$ th (powers of absolute deviations)
LR	linear regression
LS	least squares
LW	linearly weighted means
MA	method of averages
MC	Merriman's criterion (for rejection of outliers)
MD	median
ME	M-estimator (maximum likelihood type)
MG	method of group averages
MH	Harter's modified estimators (1973)

MK	McKay's criterion (for rejection of outliers)
ML	maximum likelihood
MM	minimax method (minimize maximum residual)
MO	mode
MQ	median-quartile average
MR	midrange
MS	method of successive differences
MT	median and two other order statistics
MU	Murphy's criterion (for rejection of outliers)
MV	Moore's variable-bound estimators
MW	multivariate Wilks' criterion (for rejection of outliers)
MZ	Mazzuoli's criterion (for rejection of outliers)
M4	maximum (sum of) fourth (powers of p.d.f. of errors)
NC	Nair's criterion (for rejection of outliers)
ND	median deviation
NM	Newcomb's method (of treating outliers)
NR	nonlinear regression
NS	Nair-Shrivastava method (of curve fitting)
OM	Ogrodnikoff's method (of treating outliers)
OS	order statistics
PA	plus approximative methode (most approximative method)
PC	Peirce's criterion (for rejection of outliers)
PD	dispersion with norm $p$
PL	location with norm $p$
PM	power means
PS	Pearson—Chandra Sekar criterion (for rejection of outliers)
QA	quadratic average (mean)
QD	quartile deviation (semi-interquartile range)
QL	quasilinear estimators
QM	quasi-midrange (quasi-median)
QN	quantiles
QR	quasi-range
QT	quarter technique
RA	range
RC	Rohne's criterion (for rejection of outliers)
RE	R-estimators (based on rank tests)
RL	robust estimators of location
RM	range method
RR	robust estimators of regression
RS	robust estimators of scale
SA	stochastic approximation estimators
SB	semi-Bayesian approach (to outliers)
SC	Stone's (first) criterion (for rejection of outliers)
SD	standard deviation (or variance = $SD^2$ )
SE	sine estimator
SH	shortest half estimators
SI	successive interval method
SK	skipped procedures
SM	Stewart's method (criterion) (for rejection of outliers)
SN	Schuster-Narvarte estimator
SP	(method of) selected points
SR	semirange
ST	Student's rule (for rejection of outliers)
SW	Switzer's estimator

S2	Stone's second criterion (for rejection of outliers)
TC	Tippett's criterion (for rejection of outliers)
TD	transformation of data (and choice of model)
TE	theory of errors
TF	Tukey's FUNOR-FUNOM procedure
TJ	Topsoe-Jensen criterion (for rejection of outliers)
TM	Thompson's method (criterion) (for rejection of outliers)
TO	treatment of outlying observations
TR	trimming
VC	Vallier's criterion (for rejection of outliers)
WA	weighted average
WC	Wright's criterion (for rejection of outliers)
WH	Wright-Hayford criterion (for rejection of outliers)
WI	Winsorization
WK	Walsh-Kelleher estimators
WM	Winsorized means
WR	Walsh's rule (criterion) (for rejection of outliers)
WV	Winsorized variances
YE	Yanagawa's estimator

# Chromosomal Divergence in Three Natural Populations of Corchorus Olitorius Linn.

By Joventino D. Soriano, Ph. D., Academician

## I. INTRODUCTION

The role of chromosomal aberrations in species change has been a subject of wide-ranging investigations for some time. Not a few workers consider the restructuring of chromosomes a fundamental mechanism leading to genetic variability which may eventually bring about the divergence of populations of a species. Reports of spontaneous alterations in morphology of chromosomes of many species in the various regions of the world indicate the universal and dynamic nature of population change.

A cytological study of the genus *Clarkia*<sup>12</sup> showed that populations of several species had chromosomal differences as evidenced by the different types of restructured chromosomes in them. Chromosome repatterning could bring together adaptive gene complexes formerly dispersed on two or more chromosomes<sup>3</sup> thereby initiating genetic variation in a species. Rather than point mutations, rearrangements in the genetic material could be an effective means of achieving new patterns of genetic regulation<sup>23</sup> in a population. Chromosomal restructuring could result in reproductive isolation<sup>2</sup> of a population wherein chromosomally-altered plants develop a limited capacity to form hybrid seeds thereby serving as an isolating mechanism against possible genetic "contamination"<sup>19</sup>. In a related view, a structural chromosomal change in a population could cause adaptive uniformity resulting from a decreased rate of recombination, adaptive linkage, new adaptive gene frequencies and new adaptive mutant alleles<sup>22</sup>. In *Secale cereale*, a close relationship was found between repatterned chromosomes and changes in the breeding system where new linkage combinations possessed some adaptive value for colonizing species<sup>15</sup>.

Of general interest is the report<sup>5</sup> that many of the so-called single locus mutations frequently detected in natural populations are actually chromosomal deletions. The close relationship between chromosome restructuring and gross morphology of individuals in a population has been aptly stressed in the statement that "Morphological diversity is paralleled only by karyological diversity"<sup>16</sup>. Indeed, studies on chromosome repatterning have provided evidences for phylogenetic relationships among plant and animal groups and have served to check some speculative trends in the evolution of certain species.<sup>7</sup>

The plant, *Corchorus olitorius* Linn. (Tiliaceae), was reportedly introduced into the Philippines from India probably in pre-historic times and has since become widely distributed in the different areas of the archipelago. Very few studies, if at

all, appear to have been done on the nature of chromosomal differences among populations of introduced or migrant species as such. How much have the populations of such species diverged chromosomally from each other in their new habitats and from races indigenous to the place of origin is a subject of great biological interest. This work is dedicated toward nourishing that interest and is an attempt to study some aspects of the chromosomal repatterning process in populations of the species. This paper takes into account only the types and frequencies of different meiotic configurations in each population.

## II. MATERIALS AND METHODS

Young flower buds of *Corchorus olitorius* Linn. ( $N = 7$ ) were collected at random from large populations of the plant in Bantay, Ilocos Sur; San Miguel, Tarlac; and Janiuay, Iloilo. The plant materials were fixed in Farmer's fluid (3:1 parts ethanol and acetic acid) and stored in 70 percent ethanol at low temperature until at least a day prior to microscopic study. The cytological specimens were prepared employing the p.m.c. smear technique using aceto-carmin stain. Meiocytes at different stages of meiosis I were examined for chromosomal configurations due to the repatterning of chromosomes.

For the purpose of this work, the chromosomal configurations were grouped into three types, viz., interchange complex, anaphase I variants and altered chiasma associations at metaphase I. Although the mitotic chromosomes of *C. olitorius* are rather small, the meiotic<sup>6</sup> chromosomes are fairly large and suitable for analysis due mainly to the small gametophytic number of only seven bivalents. Validity of the cytological data from the Ilocos Sur population is evidenced by the report<sup>10</sup> that intensive harvesting of natural stands does not produce any chromosomal or genetic effect on the population.

## III. RESULTS AND DISCUSSION

Out of a collection of 1,116 plants from the three populations, only 45 plants or 4.03 percent gave evidences of repatterned chromosomes. The Iloilo population gave the highest frequency of chromosomally-altered plants of 2.69 percent while the Ilocos Sur and Tarlac population yielded only 0.63 percent and 0.72 percent, respectively. The higher frequency of aberrant plants in the Iloilo populations than the other groups may be due to the high percentage of interchange plants with the alternate orientation. It is generally known that such translocation heterozygotes are capable of transmitting their



interchange complexes to a large portion of their progeny<sup>6</sup>. Whether through self-fertilization or testcross involving individuals with the viable type of reciprocal translocation, approximately 50-75 percent of their progeny inherit the interchange complex.

Based on the random plant samples, the three populations also differed in the predominant type of meiotic configurations. The Ilocos Sur population was essentially an "anaphase I variant group" with approximately 66.15 percent of the total aberrant meiocytes bearing dicentric chromatic fragments. The Iloilo population was predominantly an "interchange complex group" with approximately 84.97 percent of the total variant meiocytes bearing ring, zigzag or chain quadrivalents or only bivalents. The Tarlac population was mainly an "altered chiasma association group" with 68.75 percent of the total variant meiocytes giving slightly more chiasma associations than the normal number of 9.00 chiasmata per cell. The predominant type of aberrant meiotic configuration in a group is possibly related largely to the extent of its distribution in the population which in turn may be brought about mainly by the type of restructuring process involved as well as the viability of the cell or cells bearing the altered chromosomes, number of generations the repatterned chromosome has existed in the population and transmission of the repatterned chromosome.

An analysis of the meiotic data was made to determine some features of the chromosomal configurations in each population. Regarding chromosomal interchanges, the Ilocos Sur population gave mainly the alternate type of orientation with about 40.91 per cent of the variant meiocytes bearing the zigzag configuration at metaphase I. This indicates a high rate of gametic fertility and superior chances for survival. The high frequency of chain quadrivalents and only bivalents at metaphase I shows that relatively short chromosomal segments were probably involved in the restructuring process of such chromosomes. In the Iloilo population approximately 51.83 percent of the variant meiocytes gave ring quadrivalents which presumably results from the adjacent type of interchange orientation indicating that relatively long chromosomal segments were possibly involved in the re-patterning process. The Tarlac population gave a similar interchange pattern as the Ilocos Sur population. The cytological significance of different types of interchange complexes in a population lies in the possibility that more than two pairs of repatterned chromosomes in the genome are involved. There is no doubt that the existence of many restructured chromosomes in a population could increase the rate of genetic divergence of a group from other populations of a species granting that such chromosomal changes are not lethal combinations.

In a survey of chromosomal aberration in plants<sup>6</sup> many species were found to carry interchanges as a typical component of their genetic systems and in *Clarkia angulata*, most of the structural changes were due to reciprocal translocations.<sup>14</sup> Some populations of *Oenothera deltoides* and *O. avita* were reported to have higher frequencies of translocation heterozygotes than other groups of the same species<sup>11</sup>. A cytological examination of natural populations of *Calycadena pauciflora* (Asteraceae) showed that a few individuals have reciprocal translocation<sup>7</sup>. In *Collinsia heterophylla* (Scrophulariaceae), the interchanges exhibited the alternate type of orientation giving zigzag and chain quadrivalents at metaphase I<sup>20</sup>. Compared to heterozygotes, interchange homozygotes in the same population were found to have larger average and maximum biomass values<sup>4</sup>.

The anaphase configurations consisted per cell of 2 dicentric bridges and 4 acentric fragments, 1 dicentric bridge and 2 fragments, 1 dicentric bridge and 0 fragments, and 0 bridge and 1 fragment. In the Ilocos Sur population, approximately 81.39 percent of the aberrant meiocytes in anaphase I has a dicentric bridge with or without an acentric fragment and in the Iloilo population, about 55.18 percent of the cells gave these configurations. The variant meiocytes in the Tarlac population were too few to be validly taken into account. The anaphase I variant configurations probably had their origins from structural changes of the A-type, as compared to the S-type<sup>17</sup>, as evidenced by the microscopically-visible chromosome associations. As such, their formation most probably resulted from the mechanical separation of restructured chromosomes as the homologues migrate toward the spindle poles. The frequency of cells bearing an anaphase I variant configuration is probably related largely to the number of repatterned chromosomes, type of restructuring process, site of breakage and transmission of the repatterned chromosome.

In Indian barley<sup>18</sup>, the occurrence of a dicentric bridge at anaphase I did not affect the percentage of aborted pollen grains compared to the standard strains. Anaphase bridges and acentric fragments at meiosis I are believed to have resulted from inverted duplications or from spontaneous chromatic breakage and re-union<sup>8</sup>. In some populations of several species in the genus *Clarkia*, most of the anaphase I configurations were found due to inversion.<sup>13</sup> It is quite probable that the dicentric bridges in anaphase I in *C. olitorius* may have similarly originated from heterozygous paracentric inversions and the acentric fragments may have resulted from closely adjacent breakages along the chromatic bridge.

The three populations of *C. olitorius* also differed in number of chiasma associations resulting in a slight change in chiasma frequency which is the mean number of chiasmata per cell at metaphase I<sup>21</sup>. Some investigators consider chiasma frequency as a general cytological measure for estimating the relative length of the genome<sup>9</sup> while others believe that it reflects the

amount of genetic recombinations over a wide range of organisms<sup>3</sup>. These assumptions are invariably based on the idea that chiasma frequency remains more or less constant in the normal meiocytes of an individual and individuals of the same species<sup>1</sup>.

The Tarlac population gave a slightly higher number of chiasma associations giving a chiasma frequency of 10.04 compared to the other groups. Although the difference is not statistically marked, the slight increase is obviously due to the meiocytes bearing more ring bivalents than in normal germ cells. All the 44 variant meiocytes of this population gave 4 rod and 3 ring bivalents or 3 rod and 4 ring bivalents as compared to the normal chromosome complement of 5 rod and 2 ring bivalents. The more significant aspect of this slight increase in chiasma frequency lies in the possible restructuring of at least 1 or 2 rod bivalents into ring bivalents probably at some point or points in the long evolutionary past of the population. This may have been accomplished through an increase in the length of the unpaired arms of the rod bivalents through some kind or kinds of chromosome repatterning processes. Similar changes may have taken place in *Limnanthes floccosa* where the increase in chiasma frequency from a range of 8.50 - 9.00 to 10.20 was due to the greater number of ring-type bivalents than the normal genome, each ring bivalent with two localized or subterminal chiasmata resulting in greater genetic variability through recombination and, in fact, eventually led to the development of autogamy in the species<sup>1</sup>.

## SUMMARY AND CONCLUSION

It is evident from the foregoing data that some degree of chromosomal divergence have taken place in the three natural populations of *C. olitorius* Linn. (Tiliaceae) in the frequency of chromosomally-aberrant plants, predominant type of meiotic configuration, frequency of anaphase I variant meiocytes and chiasma associations.

The higher frequency of plants with repatterned chromosomes in the Iloilo population than in the other groups may be ascribed to the capacity of translocation heterozygotes to transmit their interchange complexes to a large portion of their progeny.

As the predominant type of meiotic configuration and frequency of anaphase I variant meiocytes depend to a large degree on the kind of restructuring processes involved, it is not unreasonable to assume that different types of chromosome repatterning occurred in the three populations.

The change in chiasma associations probably resulted from the repatterning of at least 1 or 2 rod bivalents into ring bivalents at some points in the remote past of the population.

## LITERATURE CITED

1. Arroyo, M.T. K. 1973. *Evolution* 27:679
2. Avise, J.C. and J.R. Gold. 1977. *Evolution* 31:11.
3. Bodner, W.E. and P.A. Parsons. 1962. *Advances in Genetics* 11:1.
4. Bloom, W.L. 1977. *Evolution* 31:256.
5. Brewen, J.R. 1979. *Proc. Sixth Intern. Cong. Rad. Res.* Tokyo) p. 510.
6. Burnham, C.R. 1956. *Botanical Review* 22:419.
7. Carr, G.D. 1975. *Evolution* 29:681.
8. Frankel, O.J. 1949. *Heredity* 3:163
9. Hutten, M. 1974. *Hereditas* 76:55.
10. Harlan, J., J.K.J. de Wet and E.G. Price. 1973. *Evolution* 27:311.
11. Klein, W.M. 1970. *Evolution* 24:578.
12. Lewis, H. 1951. *Evolution* 5:142.
13. \_\_\_\_\_ 1953. *Evolution* 7:14.
14. \_\_\_\_\_ 1956. *Chromosoma* 18:287.
15. Muntzing, A. and S. Akdik. 1948. *Hereditas* 34:485.
16. Ross, M.R. 1973. *Copeia* 1973:163.
17. Savage, J.K.R. 1979. *Proc. Sixth. Intern. Cong. Rad. Res.* (Tokyo) p. 519.
18. Sharma, A.K. 1956. *Proc. Nat. Inst. Sci. India* B 22:246
19. Small, E. 1971. *Evolution* 25:330
20. Soriano, J.D. 1957. *Botanical Gazette* 118:139.
21. \_\_\_\_\_ 1960. *Genetics* 46:900.
22. Stebbins, L. 1966. *Science* 152:1463.
23. Wilson, A.C., V.M. Sarich and L. R. Maxson. 1974. *Proc. National Academy of Science* (Washington) 71:3028.

# CHROMOSOMAL DIVERGENCE IN THE THREE NATURAL POPULATIONS OF *CORCHORUS OLITORIOUS* LINN. I MEIOTIC CONFIGURATIONS

Adoracion Arañez, Ph. D.  
Discussant

The presence of chromosomal divergence in natural populations is an indication that although the genetic material is stable, it is capable of variation, making possible the formation of races, varieties and/or new species. Accumulated slight changes that occur from time to time in certain members of the population may lead to reproductive isolation. Various meiotic configurations are used as indications of the change in chromosome structure. Drastic changes in the chromosome like large deletions are lethal especially in homozygous condition and therefore are not efficient in producing variations which could be inherited. Changes resulting from reciprocal translocations and inversions may be passed on to progeny especially those in the homozygous condition because there is no change in the amount of genetic materials and normal pairing of homologous chromosome may take place during meiosis.

Translocation and inversion heterozygotes form various meiotic configurations as shown to us. Translocation heterozygotes could be fertile or sterile, depending upon the nature of segregation in anaphase I. Segregation in anaphase I could be adjacent-1, with homologous centromeres going to the same pole and adjacent-2 with non-homologous centromeres going to the same pole. Both adjacent-1 and adjacent-2 segregations lead to duplications and deficiencies at the same time which usually produce inviable gametes. Viable gametes are produced in alternate segregation, where the two normal chromosomes go to one pole and 2 chromosomes with a whole complement of genes. If the 3 types of orientations with reciprocal translocations go to the other pole producing gametes occurred at random,  $2/3$  of gametes are expected to be inviable. However, in some plants the alternate segregation occurs with a much higher frequency as in this case. Probably there are factors governing the orientation of a ring of chromosomes on the metaphase plate. The more flexible the ring, the greater is the opportunity for maneuvering the chromosomes to give the alternate disjunction.

In translocation heterozygote, the chromosomes involved in a ring are not inherited independently, since two normal chromosomes are inherited as a group, as are the two translocated ones. What were before two independent linkage groups are now united into one, despite the fact that the chromosomes exist as independent entities. As the translocation complex increase in size, the number of independent linkage group decreases until a point

where all the genome may behave as one large linkage group. This will sharply reduce the component of variability due to independent assortment of chromosomes. Recombination of genes is confined to the pairing ends of each chromosome as shown in the slide. Recombination is not only reduced, but there is also an isolation of blocks of chromatin that allows for the accumulation of genetic differences upon which natural selection can act. One source of speciation is the establishment of characteristic linkage relationship. A change in linkage or in position of some genes due to translocation and inversion may lead to position effect. This is a phenotypic effect which is dependent upon a change in position on the chromosome of a gene or groups of genes.

Duplications could probably give rise to increase chiasma frequency. Duplications could be tolerated by the organism and could provide a feasible method for the acquisition of new genes, and hence new physiological functions. Two identical genes can divert through mutation. In well-adapted organisms, mutations in general, lead to a loss or impairment of function and are consequently likely to be selected against in a population because of their adaptive disadvantage. Should a mutated gene be present as a duplication along with the normally functioning gene, the possibility of its retention and continued mutation, possibly in new directions, become enhanced.

A change in karyotype may also lead to some ecological isolation as in the marine snail. In this organism, 18-chromosome snails below the low-tide level, the 13-chromosome snails form at high-tide level, and the intermediate-numbered individuals in the intervening tidal zone. It appears therefore that the different chromosomal races exhibit ecological preferences. The varying number and structure of genome is due to centric fusion where variable chromosome number can occur without apparent gain or loss of chromatic material. Two acrocentric chromosomes may fuse to form one metacentric or sub-metacentric chromosome. Dissociation on the other hand, can transform a metacentric chromosome into 2 acrocentrics. Centric fusion or dissociation takes place without impairment of centromeric function.

Please allow me to congratulate Dr. Joventino Soriano for his study in chromosome divergence. Chromosomes are microscopic structures that are quite difficult to study and unless one has patience, interest and above all a good background of cytogenetics, a paper like that of the speaker cannot be prepared.

Before I end, I would like to thank the Academy for inviting me as a discussant and Dr. Soriano for suggesting my name. I have a question for Dr. Soriano. In the title he put as number 1 meiotic configurations. I'm curious to know the next one to follow.

DR. SORIANO:

That is a very good question. May be the second part of this research, granting that I have the time would be to identify the

specific chromosomes involved in these changes. These species has 7 pairs of chromosomes and it will be very interesting really to determine which of the chromosomes in the Iloilo population are involved in this formation of ring and chain and zigzag and also which of the chromosomes in the Tarlac population gave these bridges and all these segments that we saw in the slides. Another important, may be third part which will be using segments in aberrations to determine where specific genes or factors of economic value are located in these chromosomes. And that would possibly add very much to our knowledge as a whole.

DR. CARMEN C. VELASQUEZ:

I would like to ask one question, in the expression of the cytogenetics, but cultural knowledge of genotype did you work on the phenotype?

DR. J. SORIANO:

So far this has been a work on cytology or chromosome. I think that should be the fourth study following this.

# Experimental Desensitization to Anger - Producing Stimuli \*

By Alfredo V. Lagmay, Ph. D., Academician

## ABSTRACT

The experiment is a cross-validated study of desensitization of anger responses by using thematically heterogeneous anger stimuli which are unidimensionalized through a single type of measure, namely, skin conductance response (SCR) and by (2) utilizing cognitive relaxation training rather than motor relaxation procedures, that is to say, EEG-alpha relaxation instead of EMG relaxation procedures. Furthermore, relaxation levels were controlled through EEG-alpha monitoring during the visualization phase of desensitization, something which had not been provided for in previous studies of this phenomenon. Findings show significant positive desensitization effects on anger responses for the experimental group compared to those of placebo and non-treated controls.

Systematic desensitization has been widely used for eliminating or reducing anxiety as well as specific fears or phobias. Several methods have been employed to reduce anxiety by some variation of the counterconditioning procedure, but the most frequently employed technique has been that which was developed by Joseph Wolpe (1958), which uses relaxation as the counterconditioning response to the anxiety-producing stimulus. The basic idea is that by pairing a high-arousal stimulus to relaxation, which is a low-arousal physiological response, the high-arousal stimulus loses or reduces its power to produce fear or anxiety. The research work that has been devoted to this phenomenon has been quite massive since Wolpe brought out his monograph on psychotherapy by reciprocal inhibition. This has been appropriately reviewed by Paul and Lang (Franks, 1969), while enthusiasm for this clinical method continues unabated to the present time.<sup>1</sup>

The central idea in systematic desensitization, however, has been carried over from the reduction of fear/phobia responses to that of anger along analogous principles. Since anger is ten-

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<sup>1</sup> See, for example the *Psychological Abstracts* of the APA through the 70's for long entries under systematic desensitization.



sion bound, and since it involves activation of the autonomic system, as in anxiety/fear states, then some similar mechanism to that of fear desensitization has been assumed to be involved in the desensitization of anger, i.e., in pairing of an anger-producing stimulus situation with the relaxation response.

The earliest report of a successful utilization of the relaxation response in the reduction of anger in a non-experimental situation seems to have been that of Herrell (1971) who used it in a desensitization procedure to eliminate exaggerated anger in a patient to whom the stimulus to anger and violence was that of being ordered by a person in authority.

There followed a number of studies on the desensitization of the anger response, the most noteworthy of which has been by Rimm and his associates (1971), in which they demonstrated experimentally that a desensitization anger group showed significant reduction in GSR responses and subjective anger scores over those of a placebo group and non-treated controls. Rimm used 20-minute deep muscle relaxation as the counterconditioning response for desensitizing anger felt in vehicle driving situations. In this experiment, however, there was no measure for depth of relaxation during the counterconditioning sessions for desensitization. The experimenters merely *presumed* there was deep muscle relaxation as a result of the 20-minute relaxation training procedure.

In a separate study by O'Donnell and Worell (1973) of desensitization of anger generated by black racial stimuli in white males, a distinction is made between motor relaxation and cognitive relaxation: motor relaxation being that obtained by the Jacobson progressive relaxation method, where the subject is trained to discriminate the feeling of tension and release from tension, in successive muscle groups; and cognitive relaxation being that obtained by merely thinking of relaxation without going through the tension and release procedure. This experiment reports a significant improvement of a desensitization group using Jacobson's method over that using cognitive relaxation and that of a non-treated control. They however make the very important point that the depth of relaxation, irrespective of the form of relaxation procedure, just before the presentation of the aversive-high-arousal imagery material, may be the critical factor in achieving desensitization effects.

The Rimm and O'Donnell studies are take off points for our experiment.

## THE PROBLEM

While previous studies seem to have demonstrated the effectiveness of a desensitization procedure in the reduction of an anger response to an aversive stimulus presentation, a number of questions arise:

(1) If the high arousal state of the organism is the invariant target factor in the desensitization of the individual, a desensitization procedure should be valid irrespective of the topography, situation, or source of the anger response that is to be desensitized. The Rimm experiment made the anger response uniform with respect to a well-defined situation, i.e. anger in driving situations. The O'Donnell study utilized black racial reactions of whites as the stimulus for anger arousal, also a narrowly-defined stimulus for anger arousal. Since the GSR is a good measure of arousal whatever may be the source of arousal, it would be useful to experiment with anger arousal in terms of GSR solely as the unidimensional dependent variable irrespective of source and content of anger, in order to see whether Rimm's and O'Donnell's findings could be *cross validated* across any anger situation other than the driving and black racial stimuli situations with which they experimented.

(2) The important point was made by O'Donnell that relaxation level at the moment of presentation of the aversive imagery material is crucial to an understanding of the nature of desensitization, which requires relaxation as a method for counterconditioning. No study in the literature so far reviewed by the author, has undertaken to obtain independent data on relaxation level during training. And since the O'Donnell study raised this question with respect to the negative results he obtained in desensitization by cognitive relaxation, it would be important to experimentally control the relaxation level for a cognitive relaxation experimental group.

(3) Cognitive relaxation as defined by the O'Donnell study involves listening to relaxation instructions which did not involve actual practice for learning the motor skill of relaxation. There are, however, a number of cognitive methods available for producing relaxation, any one of them may be some version or combination of suggestion methods, a meditational/paying-attention-to-various-part-of-the-body procedure and imagining those parts as relaxing, etc. If any of these methods should be used for experimental purposes, it would still be necessary to monitor the relaxation state of the subject by electrophysiological methods. Almost all of the reported experiments on desensitization of anger responses have used relaxation by direct muscle motor relaxation training, not by cognitive methods. It would be of

some theoretical interest to depart somewhat from the usual procedure of desensitization by relaxation through direct muscle relaxation. Instead one could utilize a cognitive relaxation method, say a combination of suggestion and meditational techniques, provided one monitored the relaxation state of the subject. An alternative method to that of the EMG, for monitoring directly this relaxation state would be EEG-alpha (8-13 Hz), which would describe more appropriately the state of repose or tranquillity of the subject rather than muscle relaxation. Although laboratory experience has taught us that EEG-alpha is generally correlated with low EMG potential readings, this is not by any means always the case. The literature reports of cases where low EMG readings are accompanied by predominantly EEG-beta activity, which means that even if the muscles are deeply relaxed, there is some degree of autonomic arousal present which EMG readings are not able to detect.

So that if one could proceed in terms of producing relaxation by another method than skeletal muscle training (motor relaxation training in the words of O'Donnell), provided the relaxation level was monitored also by another method, such as by EEG-alpha readings, one would be in a position to validate previous findings by a different relaxation method and, therefore, prove the generality of the desensitization effects thus obtained. One also could therefore determine whether the O'Donnell negative finding for cognitive relaxation was in fact due to the cognitive relaxation procedures that he used.

## METHOD

*Subjects.* -- The 30 Ss for the experiment (10 males, 20 females) were students who participated as part of their course requirements in introductory psychology and were recruited on the basis that they had problems related to anger. All subjects were told of possible benefits from participation: that it might help them with respect to their anger problem besides enabling them to fulfill their course requirement for experience in a research setting.

Ss underwent a *fear-anger discrimination test*: they were asked to write down four experiences in which they were very angry and four in which they were extremely afraid. They were then asked to compare the four pairs of fear and anger experiences by indicating whether they could distinguish between their emotional feelings, a pair of anger-fear items at a time. All subjects who could not distinguish between the subjective feelings represented by a pair of anger-fear items were informed that they did not qualify for the study.

Those who passed the fear-anger discrimination test received a form containing three items designed to find out the intensity of his anger, the nature of his anger and the extent to which it bothered him. If the subject got angry to a greater degree than the average person, from his point of view, and was bothered by his anger, he was selected for the experiment.

*Apparatus & Instruments.* — An Autogen 70A Biofeedback Encephalograph gave data not to the S but to the experimenter who could then monitor brain activity, specifically, the relaxation state (EEG-alpha), of the S. The instrument was adjusted for feedback whenever the S emitted brain waves within alpha range.

The ASI standard electrode assembly was used for monitoring EEG activity, with two active electrodes set above the left ear Coordinate T3 of the Electrode Placement Coordinates as set forth by the International Federation of Societies for Electroencephalography and Clinical Neurophysiology and the proximal left side of the occipital region (Coordinate O1). The ground electrode was set over the S's right forehead.

A digital summator, Autogen S100 Digital Integrator and Waveform Analyzer, gave information at 10-second intervals on the percent time the S was in EEG-alpha.

On the other hand, an Autogen 3000 Feedback Dermograph was used to give data on skin conductance responses (SCR). This apparatus was set at delta-CL so that both slow shifts and momentary rapid shifts in skin conductance responses of the S could be monitored. The sensitivity of the dermograph was set at scale factor X1. Any skin conductance deflection from given base levels, defined as zero in a -10-0-10 meter scale, could be read directly at any given time, specifically, immediately after S was presented a critical anger arousal stimulus.

The E normally used a standard set of electrodes, which consisted of three finger electrodes: one ground electrode which was attached to the forefinger and two active electrodes which were attached to the third and fourth fingers. All electrodes were attached to the S's dominant hand.

The E used the silver/silver chloride recessed electrode assembly in cases where the standard set of electrodes malfunctioned. This set consisted of two active electrodes which were attached to the palmar surface of the S's dominant hand with the ground electrode attached to the dorsal surface of the same hand.

An Autogen S100 Digital Integrator and Waveform Analyzer unit was used in conjunction with the feedback dermograph. It was used to provide the E with a means of monitoring the S's progress in terms of his absolute skin conductance level. This was

provided for by setting the instrument to compute S's average skin-conductance level over intervals of 15 seconds with 0.1-second rest periods in between.

The 15.1 sec. recording periods were later utilized by the E as a cue for when a stimulus was to be given.

All sessions were conducted in an airconditioned room at constant temperature and humidity.

*Identification of subject anger responses/situations.* — Those who qualified were given fifteen 5 x 8 cards in which they were instructed to describe situations that made them angry but all situations of which related on one particular theme. For example, if riding in a bus were distressful and made them angry in specific situations therein, then each of the 15 cards was to describe a different situation related to the theme of riding on a bus. They were at first requested to describe a situation that made them angry. These were the limits of the subject's anger. They were then asked to continue describing in the cards situations the instigation values to anger of which lay in the middle and between the three limiting points, until they had 15 different situations. The different descriptions were then transferred to the 15 index cards.

Each of the descriptions were written in the first person in sentences of not more than 20 words. They did these at home and the cards were collected the following day from them. The cards were then checked and screened; if the descriptions were too long or were lacking in specificity or involved several themes they were rechecked or corrected accordingly during the hierarchy construction sessions which followed.

There was a wide variety of anger themes/situations produced by the Ss: sibling problems, anger over imposition of authority, over non-fulfillment of obligations, anger over lack of resources caused by unconcerned or neglectful significant others, and a wide variety of other family and social situations that lead to intense anger arousal. All of these were the bases for hierarchy construction preparatory to desensitization proper.

## HIERARCHY CONSTRUCTION

The hierarchy construction and pre-test were incorporated into a single session, which started with the construction of the hierarchy of anger-provoking situations. Each S was instructed to rank the content of the 15 cards from the least anger-provoking to the most anger-provoking situation. He was then to choose seven of the cards based upon the following criteria: that the seven situations

to be chosen were recent and recurring, so they could easily be remembered and felt by the S; that the seven cards would have situations unique to each other to prevent the repetition of similar scenes; and that the interval of anger between cards be kept constant.

Then the S was again asked to rank the seven chosen situations in the cards from the least to the most anger-provoking. These situations were presented by the E to the S in one of two predetermined but random orders. The S was asked to rate the anger value of each of the situations according to a 5-point anger scale. The rating procedure was utilized to check the ranking of anger-provoking situations by the S. If a discrepancy was noted between rating a situation received with respect to its rank, the card was re-ranked or re-rated until the ratings of the situations correlated with their ranking order.

For a Test Aversive Stimulus (TAS), the Ss were instructed to choose a situation whose anger value was halfway between that of the least and the most of the eight remaining cards.

The Ss were instructed to fill out two additional cards. One contained a description of a situation which was neutral in emotional value of the Ss. Neutral was defined for the S to be any situation which does not elicit any emotional response whatsoever. Examples of neutral scenes were then cited. One example is one where the S saw himself brushing his teeth or washing his hair.

The other card contained a description of a pleasant scene. Pleasant was defined for the S to be any situation which made him feel relaxed physically and mentally, leaving him feeling free and comfortable. Examples were given to the S. One example was a scene where the S saw himself lying down on a meadow watching the clouds float lazily overhead. Both situations were to be described in the first person point of view in not more than 20 words. Ss were later asked to describe 2 to 3 neutral scenes after the E noted that Ss tested during preliminary pilot sessions tended to tire and become restless from the use of a single neutral situation.

## PRETEST

*General Procedure.* — After the electrodes were attached and the connections checked for artifacts the S was asked to sit up straight with their eyes open for two minutes. This was followed by a 2-minute period when the S was asked to be as comfortable as they could. This was followed by 2-minute period where the TAS was presented. The whole procedure was repeated with the Ss' eyes

closed. This procedure was undertaken to determine the baselines of the Ss across normal and relaxed conditions, and to give the E an idea of the S's latency and duration of anger responses. Also it was used to determine in which conditions, eyes open or close, the Ss could best relive or reexperience the anger situation.

The neutral stimulus was then presented to the S. The S was asked to rate the clarity of the scene on a 7-point clarity scale and its anger value on the 7-point subjective anger scale.

The S was told to keep his mind blank until his skin conductance returned to its previous baseline or had stabilized.

Upon reaching the baseline level, the E presented the first of 7 anger stimuli. The stimuli, which had been ranked from the least to the most anger-provoking in value, were presented in one of two predetermined but random orders. After a peak in the S's skin conductance deflection was observed, he was asked to rate the anger value of the just-presented anger scene according to the 7-point subjective anger scale. He was then presented with a neutral stimulus until his skin conductance level reached the baseline level. Then the next stimulus was presented. The procedure was repeated for the remaining 6 stimuli.

Following the presentation of the last anger scene, the S was asked to visualize himself in a neutral scene until he reached and maintained his baseline levels for 2 minutes. The S was then informed that the session was over. The electrodes were removed, the areas of attachment on the skin cleaned. He was then dismissed after being told that he would be contacted for the next session.

*Procedure, details.* — Practice sessions were conducted by the E in order to familiarize himself with the pre-test procedure and to test and modify if necessary, the procedures used in measuring the anger skin conductance deflections of the Ss.

The E patterned the pre-test procedure on that used by Rimm et.al. (1971) to measure the S's skin conductance response (SCR) deflections in response to anger stimuli. This procedure incorporated the presentation of anger and neutral scenes in an alternate order. The presentation period of the anger stimulus was initially kept constant at 10 seconds during which the S's SCR deflection was taken. The S was then to give his rating of the anger value of the presented anger situation within two seconds after the end of the anger stimulus presentations. This was followed by the presentation of the neutral situation for a period of 30 seconds before presenting the next anger stimulus. All anger stimuli were presented by the E's reading the description



of the anger scenes in the cards of the S. These random orders used for the presentation were different from those used in the hierarchy construction.

The initial practice sessions conducted in the above manner, however, revealed defects with regards to the applicability of Rimm's procedure to this study. It was noted that the latency and duration of the S's anger response as indicated by his skin conductance deflections often exceeded the 10-second presentation period. The duration and latency of the S's response varied. Thus, readings taken after the end of the 10-second presentation period represented a baseline reading in cases of a long latency or only the initial deflection of a response whose peak occurred after the 10-second presentation period. It was also noted that the rating of the aversive or anger situation was enough to cause a deflection in the skin conductance level of the S. When operating on a fixed-time schedule, the E could not be sure if the observed peak deflection was due to a continuation of the S's anger responses or due to the act of subjective rating itself. These deficiencies necessitated the modification of the procedure.

The skin conductance deflection for a particular stimulus was derived from the observed maximum deflection of the needle from the zero mark of the 10-0-10 meter scale. The baseline was set before the presentation of each anger scene by depressing the auto button. The E presented the anger stimulus at the start of a 15-second recording interval and simply waited for the maximum deflection on the meter scale. The S was asked to rate the subjective anger value of the anger situation only after a decline in the SCR level was observed from the maximum level for two consecutive recording periods.

The initial period outlined by Rimm, et. al. called for the presentation of the neutral stimulus after the rating of the anger value of an anger situation. Any deflection due to the neutral scene was then to be subtracted from the deflection value of the anger stimulus.

The E utilized the neutral stimulus for another purpose. The neutral stimuli were administered, in order to allow the elevated skin conductance level to settle following the stimulus presentation and rating of the anger stimuli. It was further noted that the rating of the same neutral scene over the different stimuli tended to tire the S, which resulted in an increase in the basal skin conductance level (SCL) that was compounded by a sharp deflection due to the act itself of rating the neutral stimulus.

The E modified the procedure so that the Ss would rate the neutral scene once, before the presentation of the first anger situation. The anger deflection value for a particular stimulus was taken to be the simple difference between the baseline skin con-



ductance level during the presentation of the stimulus and the maximum deflection level.

There was no time limit set for the lowering of the skin conductance level to the baseline. The E waited until the observed level had stabilized or had reached the level before the preceding anger scene was presented.

The E resorted to the use of a standard set of neutral stimuli to prevent the S from getting fidgety over having to use the same neutral scene over and over again.

*Design and conditions.* — Subjects were formed into three random groups: Desensitization Group, Placebo Group, and Non-Treated Control Group. There were 10 Ss per group.

The Desensitization Group was given relaxation training and regular desensitization sessions which utilized their relaxation skill.

The Placebo Group was given the opportunity to talk about the situations described in the anger cards they submitted. Every Placebo subject had a corresponding yoke in the Desensitization Group with respect to time spent in the desensitization session, in order to equalize between groups for time spent in exposure to the experimental situation.

The Non-Treated Group was merely given a Pre- and Post-Test, which were also given the other two groups.

*Desensitization.* — The Ss were briefed on what was to be done during the desensitization session: that the session would consist of two stages, an initial relaxation phase followed by a desensitization phase. The principle and the purpose of the desensitization procedure were explained to the Ss before they were brought to the rear end of the room where the electrodes from the biofeedback instruments were attached.

The first 20 minutes were spent relaxing the S as deeply as possible using a cognitive method. The S's relaxation progress was monitored through the biofeedback instruments. It should be noted here that the feedback was available only to the E and not to the Ss. A S was considered to be relaxed if he satisfied concurrently the criteria that his absolute skin conductance level be lower than 100 micromhos and that he maintain his percent time in the alpha frequency at 80-100%.

The present stimulus was then introduced after the S reached the relaxation criteria stated above. If no upward deflection in the S's conductance level was observed, or if a continued decrease in his skin conductance level was noted, the S was then presented with the first of the 7 anger stimuli. The anger stimuli were pre-

sented in an increasing order of anger-provoking values. The anger stimulus was presented during a 15-second interval and was maintained for another 30 seconds. The S was then instructed to forget the anger scene and to shift to a pleasant scene. These instructions were complemented by further suggestions for relaxing even more deeply. The S was then presented with the same anger stimulus for 15 seconds, one minute after the presentation of the pleasant stimulus.

In cases where the S signified the presence of anger or where an upward deflection in the S's skin conductance level was observed, the S was immediately instructed to forget the anger scene and to shift to a pleasant scene. This was always accompanied by instructions to deepen the S's level of relaxation. The S was kept relaxed at the former or lower level of relaxation for 2 minutes before the next stimulus presentation. This procedure was repeated until no indications of anger nor skin conductance deflections was elicited by the anger stimulus. The anger stimulus was then presented with a pleasant stimulus before moving on to the next item in the hierarchy.

After the presentation of all the anger scenes, the S was asked to visualize the pleasant scene and to remain relaxed for 2 minutes. The S was "awakened" by the E and told that the session was over.

Prior to the treatment of the Desensitization Ss, four practice sessions were conducted. These were conducted to allow the E to familiarize themselves with the procedure and modify any part of the procedure if necessary. The initial presentation period of the anger stimuli was increased to 45 seconds because it took the E the full 15-second period to present the anger scene. The extra 15 seconds was added in order to visualize the anger scene more clearly and deeply while retaining his relaxed state. The subsequent presentation periods of an anger situation were kept down to 30 seconds since the S was already cued to the particular stimulus.

The other modification in the desensitization procedure involved the use of a standard set of pleasant stimuli to prevent the Ss from getting impatient over the repeated presentation of the same pleasant scene.

*Placebo.* — The placebo procedure involved the yoking of the Ss of the desensitization group with those of the placebo group such that placebo sessions depended upon the length of time it took to desensitize the yoked partner in the desensitization group. All placebo sessions were thus conducted after the conclusion of the desensitization sessions of the yoked Ss. The length

of time required for desensitization was noted and marked down as the allotted time for the yoked placebo S.

The placebo session centered on a discussion of the anger situations written down by the S on the 3 x 5 index cards. The Ss were told that a thorough discussion of the anger situations could be of help to the E and the Ss themselves in trying to understand as well as control their anger problem. The Ss were asked to recall each of the anger incident as vividly as possible. The Ss were often urged to seek out for themselves the solutions to the problems which bothered them. The E throughout the session offered the minimum of advice and instead directed the discussion towards the S's being able to formulate his own solutions.

The procedure was repeated across as many scenes as possible within the allotted time. The Ss were then dismissed after being informed that they would be notified for their next session.

*Non-treated Controls.* — The Ss in this group received only the pre- and post-tests.

## POST-TEST

The post-test procedures were identical to those of the pre-test. The E did not take down the deflection for the TAS since the S's magnitude and duration of the anger response was known from the pre-test results. All the anger stimuli were presented in a predetermined but random order.

The Ss in both placebo and non-treated control groups were given relaxation training at the end of the post-test following the presentation of the last of the anger stimuli.

## RESULTS

*Pre-test (baseline) data.* — Skin conductance level (SCL)\* measures in micromhos for the three groups in the pre-tests (Table 1) do not show any significant differences as groups (Duncan's Range Test:  $P < .05$ , 26 df  $R_p = 156.2$ ). There is a trend towards higher levels of basal physiological arousal for the desensitization group, which means that this experimental group had to be desensitized against greater odds than either of the placebo or non-treated control groups.

**Table 1. Pre-Test: Skin Conductance Levels (SCL)<sup>a</sup>**

DESENSITIZATION (D)	PLACEBO (P)	NON-TREATED (NT)
739.9	126.3	
198.6	206.4	116.3
132.6	88.3	318.4
313.3	197.6	432.6
356.9	337.3	446.7
200.0	89.6	109.3
150.7	101.0	133.9
522.1	106.7	63.1
146.6	134.1	69.4
343.5	203.7	144.4
3154.1	1591.3	1834.1
315.4	159.1	203.7

— baseline of group D significantly different from baseline group P at  $p < 0.05$ , 26 df,  $R_p = 156.2$ , using the Duncan's Range Test

--- no significant difference between baseline values of groups D and NT, and of groups P and NT at  $p < 0.05$ , 26 df,  $R_p = 145.9$ <sup>a</sup> The figures represent the absolute level of the Ss skin conductance across the seven anger stimuli. The baseline is the S's absolute skin conductance level at the moment immediately prior to the introduction of the anger stimuli.

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\* SCL, sometimes known as "basal skin conductance", is considered to be a measure of generalized activation of the physiological system under observation and the absolute value of which one may use as the base along which momentary skin conductance deflections (due to arousal stimuli) may be measured.

Table 2 shows averaged measures of skin conductance response (SCR) to anger cards for three groups in the experiment, and there are also no significant differences between the three groups (Duncan's Range Test:  $P < 0.01$ , 27 df,  $R_p = 25.6$ ).

**Table 2. Pre-Test Skin Conductance Deflections Values  
(in micromhos)**

Subject No.	DESENSITIZATION (D)	PLACEBO (P)	NON-TREATED (NT)
1	105.7	76.4	120.7
2	66.0	68.0	112.0
3	58.7	22.4	89.1
4	54.7	54.9	78.9
5	54.6	54.3	46.3
6	44.7	54.1	44.8
7	39.7	89.1	30.9
8	37.4	36.0	37.7
9	15.4	7.7	27.7
10	68.0	32.1	71.1
EX	544.9	495.1	659.3
$\bar{X}$	54.5	49.5	65.9

Least significant difference  $R_p = 25.6$  (by Duncan's Range Test  $\alpha < 0.01$ ,  $df = 27$ ); the difference between extreme mean values (49.5 and 65.9) must at least be 25.6. The groups belong to the same population.

As for the Subjective Anger Rating to the imagined anger situations (Table 3), there are no significant differences between the three groups (Kruskall-Wallis one way analysis of variance, 2 df,  $H = 0.99$ )

**Table 3. Pre-Test Subjective Anger Scale (SAS) Values\***

Subject No.	DESENSITIZATION (D)	PLACEBO (P)	NON-TREATMENT (NT)
1	5.7	4.1	3.4
2	4.0	4.4	4.3
3	5.3	5.3	4.4
4	3.7	4.9	3.9
5	4.7	4.7	4.0
6	3.8	4.7	6.0
7	3.3	4.6	3.0
8	5.1	3.6	4.4
9	4.1	4.1	3.7
10	4.6	3.9	5.3

EX	44.4	44.4	42.4
X	4.4	4.4	4.2
ER	148.5	139.5	177.0

$H \leq 0.99$   $df = 2$ , no significant difference between SAS values observed using KRUSKALL-WALLIS one-way analysis of variance

\* Mean value of SAS judgement of each subject for 7 cards.

One must note that the anger situations utilized in this experiment were thematically heterogenous across individuals within a group and therefore also across groups.

Table 4. Post-Test Skin Conductance Level (SCL) Values<sup>a</sup>  
(in micromhos)

	DESENSITIZATION (D)	PLACEBO (P)	NON-TREATMENT (NT)
	210.5	164.0	
	81.8	114.1	81.3
	179.8	73.7	118.7
	86.8	103.1	273.6
	122.2	90.6	157.8
	178.8	86.0	85.6
	68.7	166.4	171.6
	114.1	64.1	65.6
	78.0	83.1	110.4
	69.3	121.3	68.9
EX	1190.3	1066.6	1133.4
$\bar{X}$	119.0	106.6	113.3

— Differences between groups were not significant using Duncan's Multiple Range Test at  $p < 0.05$ , 26  $df$ ,  $R_p = 58.3$ .

<sup>a</sup>The figures represent the absolute level of the Ss skin conductance level across the seven anger-stimuli. The baseline is the S's absolute skin conductance level immediately prior to introduction of the anger stimulus.

*Post-test (after treatment data).* — Basal skin conductance levels (SCL) were not significantly different across desensitization, placebo and non-treated control groups, which means that general arousal levels in the post-test situation were relatively at equal levels for all groups. (Table 4)

But SCL levels for the desensitization group had gone down so dramatically that the reduction constituted a significant difference with respect to pre-test values. (Table 5) This means that

**Table 5. Skin Conductance Level (SCL) Reduction  
(Pre-Test Less Post-Test)**

GROUP	DIFFERENCE (in micromhos)	t
DESENSITIZATION	196.4	3.1*
PLACEBO	52.5	1.6
NON-TREATED	93.9	1.8

— The figures represent the average reduction in skin conductance levels per group. The reduction values was obtained by subtracting the post-test values from the pre-test values.

\* Significant at  $p < 0.01$ , 18 df, using t-test

this group learned to relax very well or that their physiological arousal level had been considerably reduced through EEG-alpha training.

Table 6 shows differences between post-test and pre-test measures of skin conductance response (SCR) to anger stimuli among the groups. The difference between the desensitization and placebo groups is significant at the 5 percent level by Duncan's Range test, but not between the desensitization and the non-treated control groups. By correcting for the possible loss of interest in the experiment by one S in the non-treated group, a recomputation (Table 7) shows a significant difference at the 1 percent level.

**Table 6. Differences in Skin Conductance Deflections (SCD)<sup>a</sup>  
Skin Conductance Deflection Reduction<sup>b</sup>  
(in micromhos)**

DESENSITIZATION (D)	PLACEBO (P)	NON-TREATED CONTROL (NT)
103.1	12.1	114.4 <sup>c</sup>
77.3	-18.0	8.6
53.7	3.3	8.7
58.8	39.3	38.0
58.3	32.0	-17.1
17.0	15.6	-11.7
34.3	19.0	29.4

	DESENSITIZATION (D)	PLACEBO (P)	NON-TREATED CONTROL (NT)
	25.6	39.3	34.0
	12.9	14.8	11.7
	63.5	21.4	57.6
EX	504.4	178.9	274.6
$\bar{X}$	50.4	17.9	27.5

Difference between groups D and P significant at  $p < 0.05$ , 27 df,  $R_p = 26.8$  using Duncan's Range Test.

Difference between groups D and NT not significant at  $p < 0.05$ , 27 df,  $R_p = 28.1$  using Duncan's Range Test.

- a The figures represent the average deflection for each S across the 7 anger stimuli
- b Difference equal to SCD pretest less SCD posttest
- c Possible deviance. S informed  $\bar{r}$  that he was no longer bothered by anger problem at time of posttest and did not want to participate in the experiment.

Table 7. Difference in Skin Conductance Deflection (SCD)<sup>a</sup>  
SCD Reduction (in micromhos)

	DESENSITIZATION (D)	PLACEBO (P)	NON-TREATED (NT)
	103.1	12.1	
	77.3	-18.0	8.6
	53.7	3.3	8.7
	58.8	39.3	38.0
	58.3	32.0	-17.1
	17.0	15.6	-11.7
	34.3	19.0	29.4
	25.6	39.3	34.0
	12.9	14.8	11.7
	63.5	21.4	57.6
EX	504.4	178.9	160.1
$\bar{X}$	50.4	17.9	17.8

- a The figures represent the average deflection for each S across the seven anger stimuli.
- Difference between group D and groups P and NT significant at  $p < 0.01$ , 28 df by Duncan's Range Test
  - Difference between groups P and NT not significant



Tables 8-A and 8-B show the same significant effects of desensitization procedures on anger responses by analysis of variance and by the Scheffe Test for difference between groups.

**Table 8-A. Analysis of Variance  
Skin Conductance Deflection Reduction**

SOURCE OF VARIATION	df	Ss	Ms	F
Between groups	2	7087.1	3543.5	6.3*
Within groups	26	14566.2	560.2	

\* Significant at  $p < 0.01$

**Table 8-B. Scheffe Test for Difference Between Groups  
Skin Conductance Deflection Reduction**

GROUP COMPARISON	F
Desensitization vs. Placebo	9.4*
Desensitization vs. Non-treated	9.0*
Placebo vs. Non-treated	.0001 <sup>a</sup>

\* Significant at  $p < 0.05$

<sup>a</sup> Not Significant

Table 9 shows some confirmatory evidence of how better the desensitization group did over the placebo and non-treated control group controls. The differences are significant by the Mann-Whitney U Test. The placebo did better than the non-treated controls, and this difference is also significant at the .05 level.

**Table 9. Subjective Anger Scale Rating Differences  
(Pre-Test Less Post-Test)**

DESENSITATION (D)	PLACEBO (P)	NON-TREATED (NT)
4.7	1.7	
0.1	0.4	0.4
3.7	2.0	0.4
1.7	0.3	0.3
1.8	0.3	0.4
1.7	0.6	1.0
1.4	1.4	0.4
1.6	2.0	0.1
2.4	2.4	0.7

	DESENSITIZATION (D)	PLACEBO (P)	NON-TREATED CONTROL (NT)
EX	2.6	2.2	1.1
$\bar{X}$	21.5	13.3	2.8
	2.2	1.3	0.3

Each figure represents the average reduction in the subjective anger scale ratings over the seven anger stimuli.

*GROUP COMPARISON\**

	<i>U</i>
D vs P	24.5 <sup>a</sup>
D vs NT	7.0 <sup>b</sup>
P vs MT	17.0 <sup>c</sup>

\*Using Mann-Whitney Test for difference between groups

- a. Significant at  $p < 0.05$       c. Significant at  $p < 0.001$   
b. Significant at  $p < 0.001$

### Discussion

This experiment was intended to find out whether the generality of the Rimm, et al proof of positive desensitization effects for anger responses could be extended by an experimental design that allowed for multi-thematic anger stimuli across individuals, provided the response measure, in this case, skin conductance response, was unequivocally unidimensional. This experimental design has confirmed identical positive desensitization effects on anger responses of a wide variety in non-clinical subjects.

There was the need also to give greater precision to relaxation levels utilized for desensitization, since O'Donnell and Worell posited that depth of relaxation might well be a critical factor in the effectiveness of desensitization procedures. By imposing criterion levels of repose, 80-100 percent time under EEG-alpha during relaxation training before the desensitization procedures that followed for the experimental group, it was possible to control for this particular factor that should leave no doubt as to its presence and therefore its effects. Also, the use of EEG-alpha instead of the EMG as the monitor for depth and stability of S relaxation state is a procedure that deserves attention, because the relaxation training method here utilized was mainly a cognitive relaxation method rather than the usual tension-and-release-of-tension method of Jacobson which usually requires the EMG for monitoring. The results of the experiments show that, under appropriate controls with respect to depth of relaxation, the negative findings of O'Donnell and Worell on the role of cognitive relaxation in the desensitization of anger need not be negative; the results here show positive effects. Future experiments in this area of work should, in fact, wherever possible, provide for quantification of relaxation levels utilized for desensitization by electrophysiological methods in order to obviate a major source

of unknown variation affecting the phenomenon being studied.

We come now to the original notion that brought about this experiment, which in part also explains the approach which placed some confidence in electing for a design that allowed for a heterogenous set of anger stimuli situations for one of the variables in the study. Long before the author came into contact with the Herell and Rimm studies, he thought that perhaps any tension/anxiety bound response such as anger, fear, hate, greed, responses, could be desensitized through the now well-known procedures rediscovered for us by Wolpe. The author had already started to work on an experiment on the desensitization of aggression responses when he came upon the Herell and, later, the Rimm studies quite by accident. He came to the conclusion that their methods could be modified to achieve greater generality and precision in the results. We had just done that. But the greater promise of the method, it seems, lies in its application to other tension/anxiety-related behaviors such as hate and greed, besides fear and violence-related responses. The concept of desensitization has lain far too long in the narrow confines of work on fear or phobic responses. It deserves exploration and extension into the classical human situations that have been associated with high physiological arousal.

## REFERENCES

- Franks, C.M. *Behavior Therapy: Appraisal and Status*. New York: McGraw-Hill, 1969.
- Herrel, J.M. Use of systematic desensitization to eliminate inappropriate anger. *Proceedings of the 79th Annual Convention of the American Psychological Association*. Washington D.C.: American Psychological Association, 1971, 431-432.
- Lang, P.J. The mechanics of desensitization and the laboratory study of human fear. In *Behavior Therapy: Appraisal and Status* (C.M. Franks). New York: McGraw-Hill, 1969.
- McGuigan, F.J. *Experimental Psychology*. 3rd ed. Englewood Cliffs, New Jersey: Prentice-Hall, 1978.
- O'Donnell, C.R. and Worell L. Motor and cognitive relaxation in the desensitization of anger. *Behavior Research and Therapy*. 1973, 11,
- Paul G.L. Outcome of systematic desensitization I: Background, procedures, and uncontrolled reports of individual treatment, and II: Controlled investigations of individual treatment, technical variation and current status. In *Behavior Therapy: Appraisal and Status*. (C.M. Franks). New York: McGraw-Hill, 1969.
- Rimm, D.C., de Groot J.C., Boord, P., Heiman J. and Dillow, P.V. Systematic desensitization of an anger response. *Behavior Research and Therapy*. 1971, 9, 263-280.
- Siegel, S. *Non-parametric Statistics*. New York: McGraw-Hill, 1956.
- Wolpe, J. *Psychotherapy by Reciprocal Inhibition*. Palo Alto, Stanford University Press, 1958.

## EXPERIMENTAL DESENSITIZATION TO ANGER PRODUCING STIMULI

F. G. David, Ph.D.  
Discussant

Maybe I will not have anything for discussion if only I can submit myself to desensitization to Dr. Lagmay and help demonstrate beyond doubt that his techniques succeed, but that is rather a too homely way of discussing with a colleague.

Permit me first to thank you for giving me this opportunity. To make one individual listen to you is a privilege enough and to make many listen to you, especially scientists, respectable as they are, is indeed a manifold privilege. Also, I like to thank Dr. Lagmay for inviting me to be one of his discussants. I like to believe that when he comes to like you, he will go out of his way to speak better for you than for himself. Maybe it is not too much of me to think that he likes me, which makes me relax.

Perhaps, there is really nothing much to discuss in the way of contention, debate or argument. So I'll discuss in the mild sense of discussion, just to talk and possibly to come out with some frame of thinking concerning set of opinions about desensitization.

One way or the other, it is the case in the breakthroughs in the many sciences that many of the breakthroughs concern commonly known phenomena. Everyone knows one way or the other that at some point of his maturity he discovers that it is wise to be relaxed or to institute some self-control. But it takes science to demonstrate that there is something behind the wisdom. And in the behavioral sciences one can point to the investigations and discoveries, as those of that elevate to the level of verification what has been known as common knowledge throughout the millenia. This is not to dismiss the importance of a contribution to the literature of science. Like desensitization and progressive relaxation by Jacobson, but to put the matter in proper perspective. I have only very few points to raise in a manner of discussion or discursive consideration. Mostly they have to do with the data. I presume that in the use of Duncan Multiple Range Test, which is an a posteriori test, that a suitable overall F-ratio has first demonstrated a significant main effect. So in resorting to a posteriori test, one may go into finer analysis, by comparison of all salient groups as dictated by the design. It is not, however, apparent or understood whether an overall F-ratio has been first performed, and therefore I would make some reservations about the findings based on Duncan Multiple Range Test. In this light, also given the fact that there are only three groups, I suppose

a simpler test like Tuckey's honestly significance difference test or least significance difference test would be perhaps better than the Duncan's, which works better with a bigger number of comparison groups.

Now concerning the more significant finding, the Table 5 comparing the pretreatment and treatment conditions, using I suppose a T-test of related samples, the performance of the desensitization treatment group might have been erroneously shown to be significant. This is a minor observation. Maybe the number of freedom is not eighteen, but only nine. But be that as it may, significant as it is, one may raise the question, is it possible that the difference may be an artifact of the high base line. That is mainly the finding on which this study stands on four feet or solidly. I would like to cast some questions concerning it.

Then another point to raise, that is unique in this study, concerns level of relaxation. I wonder why the design did not go on to a parametric manipulation of level of relaxation, differentiated in terms of length in percent of the amount of alpha observed. And perhaps with that one can even, if lucky, come up with some trend analysis or an analysis of a possible function relating relaxation with a decrease in responding to fear, anger or highly emotive stimuli.

On the whole, by the way, I like to believe that the design as it is perhaps can be submitted to an analysis of variance, something like split-plot factorial. You have three groups subjected to the pre-test, to the treatment and to the post-test, the subject in each group being repeatedly observed.

Now, lastly, given the facts as they are, believing in my colleague and Academician, one more question arises. What is behind the facts, what mechanism underlies them? Is it learning? Is it some associative process or is it simply sensory adaptation? If it is learning, then it should be relatively permanent, it should not be unstably bound to the transient situation of the test. And if it is sensory adaptation, then I suppose simple exposure to stimuli repeatedly will do the same trick. I am not making any conclusion, but I'm only guessing what is behind the facts. If it is sensory adaptation, is it through inhibition of the arousal system at the brain core, let's say of the reticular formation? A kind of inhibition known in the medical sciences or in neurophysiology as central inhibition known in the medical sciences or in neurophysiology as central inhibition. The literature is replete with indicative investigations, like the studies of Hernandez Peop, Galambus, and many others. If it were so, then one could perhaps vali-

date the findings with the psychopharmacological findings in the literature, demonstrating effects of tranquilizers or sedatives at the region. If that turned out to be the case, that could lead to generalize the findings, and increase consensus or agreement among scientists in the area. Knowledge is a consensus. Is it not?

## EXPERIMENTAL DESENSITIZATION TO ANGER-PRODUCING STIMULI

EDWIN T. DECENTECEO, Ph.D.  
Discussant

I would like to thank the Academy for inviting me, and Dr. Lagmay for suggesting my name as one of the discussants.

I think the effort of Dr. Lagmay to use desensitization and applying it to anger is noteworthy. There are over a hundred well controlled studies that demonstrate the effectiveness of desensitization when it comes to fear. As a matter of fact the question now is really why is it effective. Perhaps, by attacking a different problem in this case, anger and comparing the work on fear and on anger, one might be able to arrive at some suitable explanation for the effectiveness of the procedure. As things stand, there are at least five explanations for why it works and not one shown to be better than the others.

I think also his attempts to monitor the level of relaxation continuously is an important contribution. It has always been difficult technically to do continuous monitoring of relaxation level while doing a systematic desensitization procedure. Although, to be fair to those who have been working in the area of fear, they have used test situations which involve actual exposure to fear situations. When you are involved in an actual situation and you attempt to make physiological recordings at the same time, you come up with very noisy recordings.

In fairness to O'Donnel and Herell, perhaps a measure of intensity of anger should be taken. It is possible that in a study on anger using racial stimuli in a southern university in the United States, you might be utilizing high levels or moderately high levels of anger. And maybe that is why O'Donnel and Herell were not so successful. Of course it can not be determined now. But it would be important to determine how effective what level of relaxation is with what level of anger. The systematic desensitization literature on anxiety shows that cognitive methods, relaxation, and cognitive desensitization are less effective when you are at high levels of fear. They are more effective at low to moderate levels. Level of anger would also be very important in the clinical application of the procedure. I think what Dr. Lagmay has done is demonstrate that physiological reduction does occur. More work can be done to tease out the clinical implications as well as technical problems that come with applying something like this into real life. Levels of anger would be an important factor here because one might say that college students who are

volunteering for an experiment may not experience as much anger as someone else in a real life situation, say a harried secretary or someone in a field who has to answer to his boss. Those levels of anger might be higher.

One other comment I can make about the study is that I would have wanted to see other measures of reduction of anger not just on the physiological side. Particularly when you are inducing low to moderate levels of arousal, you may not have very good correlations between physiological responses and behavioral responses. We can not be sure that since there was a diminishing of the physiological response that there would be a consequent or correlated diminishing of the behavioral response. (Also, if one uses behavioral measures, one would be closer to real life situations.) But again, the technology of developing a behavioral test can be a difficult one, aside from raising ethical questions about inducing anger in experimental subjects.

It is known in the fear literature that real life situations will always lag behind treatment. That is, you can be on step 9 in treatment, but your performance will be only up to step 4 in real life. It remains to be seen whether the same thing will hold for anger. But just in case, one could begin to work on behavioral methods for reducing anger, that is, *in vivo* methods such as the barb technique where people take turns shooting verbal barbs at someone while he tries to control his anger. There is also literature on stress inoculation which covers a whole range of a stress stimuli which can be delivered in real life situations.



## ABOUT THE AUTHORS

**EDGARDO J. ANGARA**, Master of Laws, University of Michigan, U.S.A., 1964. He is president of the University of the Philippines (May 1981)

A practising lawyer, along with other named associates, before he was appointed to his present post. A well-known figure in legal parlance, he was elected president of the Philippine Bar Association (1975-76); the Integrated Bar of the Philippines (1978 to date) and the ASEAN Law Alumni Association.

Among his awards are DeWitt Fellow, Michigan Law School, University of Michigan, 1963-64; Columbia Law School Scholarship Grantee (1963), and was elected to Life Membership to the International Honor Societies of Phi Kappa Phi and Pi Gamma Mu.

**JULIAN A. BANZON**, Ph. D. Academician, 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.

**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 nationalist perspective. Among these 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.

**JOSE ENCARNACION, JR.**, Academician, Ph.D. in Economics, Princeton University. A Professor since 1960, named Dean at the School of Economics, University of the Philippines in 1974 — present. Among the various positions he have held include: Executive Director, Philippine Center for Economic Development, 1975; Chairman, Council for Asia Manpower Studies, 1974; Chairman, Economic Research Associates, 1975; Member, International Review Group of Social Research and Population and Development, 1976; Member of Advisory Board, Population and Development Review, 1977; and Member, Committee for Development Planning, Economic and Social Council, United Nations, 1978. A TOYM Awardee in 1963, he is also a recipient of the UP Distinguished Scholar award in 1968.

**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, 1976-1970; Assistant Professor of Botany, 1957-1964; Instructor in Botany, U.P., 1949-1957; Instructor in Biology, 1944; Army Officer, USAFFE, 1941-1946.

**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.

