IN QUEST OF CERTAINTY: AN ODYSSEY INTO THE CADANG-CADANG PROBLEM

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Introduction

Dr. R. B. Espino and I became introduced into the cadang-cadang problem in 1950 when we were made members of the Special Committee on Cadang-cadang of Coconut and Mosaic of Abaca in the Bureau of Plant Industry, DANR. I was made a member upon the suggestion of Dr. Espino, who perhaps thought that I should have something to contribute — I, having just returned from advanced training abroad. (I felt uneasy for being accorded a high estimate, when all I had was a little more book-learning.)

In our report on a first visit to the Bicol Region, we stated among others the following: "The weakness of the roots and the progressive reduction in the number and size of fruits seem to point to a defect in the water-balance of the plant, i.e., an unhealthy root system may cause a diminished water supply, while the few and small fruits may be the effect of a water deficit. (It is possible that the pathogenic organism hinders either the absorption of water or the upward movement of water, or both.) Faced with a gradually increasing water deficit, the plant undergoes a system of self-pruning. The older leaves turn yellow, dry up, and fall; so that, this yellowing of the leaves, which begot the name cadang-cadang is just a stage in "leaf-fall" (Espino and Velasco, 1950).

At that time, the consensus was that the disease was caused by a pathogenic organism; and since no bacteria or fungi could be isolated from the diseased parts, a virus was postulated as the causal organism. With this background, we nonchalantly assumed in our report that cadang-cadang was caused by a pathogenic organism. In retrospect, we may regard our first report as a rough approximation of the situation. The emphasis on the water-balance might be overdrawn but water-balance was certainly an important element in the picture. Of course, there other aspects of the disease which needed to be considered.

Diffidence at the Rubicon

For some time we did not probe into our hypothesis because we felt that a decision to work on the disease was almost as momentous as crossing the Rubicon. History tells us that Cesar made the momentous decision of crossing the River Rubicon and, in so doing, started a world empire. (The parallel in our case stops at making a momentous decision — not at starting a world empire). We considered the decision to study cadang-cadang quite momentous because it would tie up a major part of our time and resources. Thus, if we have to have cultures which should be shielded from stray infection by a virus, we must be ready to grow coconut trees in huge screened cages or huge green-houses. If we should duplicate the field incidence of the disease we must be ready to work and wait for 50 years or more. These unattractive prospects stymied our desire to probe into the veracity of our hypothesis; hence, we found ourselves in an uneasy time of indecision.

In the meantime, we indulged our tendency to re-examine premises and hidden assumption — the less euphemistic term is "tendency to quibble". For example: Much importance was given to the claim that the disease was spreading. The facts on which the claim was based were that the initial report of a case was made in San Miguel Island. Then there were subsequent reports of cases in several other places in the Bicol Region. The tacit assumptions in the claim were that, (1) the reports were contemporaneous with the incidence of the disease and (2) the later cases were offshoots of the initial case in San Miguel Island. The first assumption can be shown to be weak if we take as an analogous situation the discovery of the islands, which became known as the Philippines. We cannot presume that the islands were non-existent before Magellan discovered them. The second assumption is (logic-wise) fallacious. It is like saying that all the Filipinos who became born after the coming of Magellan were offsprings of Magellan.

The more we thought about that trackless void in our knowledge of the disease and about the insurmountable impediments which were likely to be met in its study, the more forbidding the task appeared; and yet, the more tempting and challenging was the problem.

To indulge the "itchiness to stick our finger" into it, we thought we would like to dig some roots to see if they were in fact unhealthy. Then, we thought we would do just one more thing, and no more: We would just spray some trees with minor elements to find if they would recover from cadang-cadang.

But our resolve "not to do anything more with cadang-cadang" had to be broken — only to be replaced by another resolve. After a few more resolves, we came to realize, much to our helpless consternation, that we were deeply involved in the study of cadang-cadang. By indulging "our itchy finger" we drifted through the *Rubicon* without making the momentous decision.

Of green spectacles and green hay

In our examination of hidden assumptions we became reminded of the tale about a farmer who induced his cows to eat more hay by fitting them with green spectacles. The poor animals thought all the while that they were eating green grass.

Of course, specialists are far from having the mentality of cows; however, they are sometimes accused of being carried away by the spectacles of their specialization. On the other hand, if they speak outside their line, they are branded as interlopers. In terms of the common cliche, they are in "between the two horns of dilemma". A way out is for specialists to determine if the subject is within the area of their competence; and if not, they should be candid enough to say so. Another way out is for decision-makers to weigh the merits of the pronouncements of each specialist; then pick out the aspects which are most common-sensical.

Looking back over the years, one may note that the country's effort in solving the cadang-cadang problem was not free from the bias of specialists. For instance: When the owners of San Miguel Estate asked in 1931 the U.P. College of Agriculture for assistance, the college authorities decided that since cadang-cadang was a disease, a plant pathologist would be in the best position to study it. (The tacit assumption was that the disease was caused by a pathogenic organism; it was rare that anybody would associate a disease with a physiogenic cause). The plant pathologist who was sent to study the disease was Dr. G. O. Ocfemia, a noted virologist who had just worked out the virus natures of abaca mosaic and of the bunchy top of abaca. After some years of cogitation, he came out with a short paper (Ocfemia, 1937), stating that there was a strong likelihood that cadang-cadang was viral in nature. Apparently, the main basis of his judgement was the similarity between the water-soaked specks of cadang-cadang and the pin-prick yellow spots produced by grass mosaic viruses, such as corn mosaic. With the stature of Dr. Ocfemia, other local plant pathologists, and for that matter other scientists, deemed it hard to ignore (if at all) his considered opinion.

Another instance illustrating the influence of specialization on the nature of one's judgement is the following: Randles and his colleagues (1975; 1979) observed some unusual nucleic acid particles in the cells of cadang-cadang affected coconuts. This led them to postulate that cadang-cadang was caused by a "viroid". The methods used for isolating the viroid were ion-exchange chromatography, gel filtration and gel electrophoresis — standard methods in biochemistry for isolating nucleic acids. The questions which may be raised are: (1) Are all nucleic acid fragments viroid in nature? (2) Assuming that they are, can we further assume that the viroid is the cause of the disease? — or that the viroid and the disease arise from a common cause? They are attempting to transmit the viroid inoculum using the water-soaked specks as criterion of success.

A moot subject in the elucidation of cadang-cadang concerns its diagnostic symptoms. By narrowing down on the water-soaked specks,[1] the plant pathologists probably missed some other (and perhaps more relevant) manifestations of the disease. In the early stages of the study, the workers would have done well to focus on the field aspects of the disease. For instance, by looking for, and finding water-soaked specks in the trees outside the Bicol Region, or in trees which are not visibly affected by cadang-cadang (as Velasco and Fertig, 1956, have in fact reported water-soaking in their culture) one may gain the impression that the specks are not unique to plants affected by cadang-cadang. By noting that in some patches, the trees die of the disease while relatively young (about 2 meters tall) in contrast with those in other patches where they die at a ripe old age (some 20 meters tall), a researcher may think of charting the course of dying-off in a few illustrative patches. He may find that in the plot of age on deaths, the intercept and the slope of the curves do differ from one patch to the other. He may even decide that the two parameters are a more relevant criterion of the severity of the disease than the occurrence of water-soaked specks.

These views, which are in the nature of hindsights, are being mentioned in order to underscore the need to be wary about wearing one's "colored spectacles" early in the exploration of an unfamiliar problem.

To heed a siren's fickle call.

When a mariner starts to hear an enticing, lilting song — now in front of him, and now behind him — this is a sure indication that he is lost at sea. For a long, long time, we had seemed to be in a similar state in our effort to track down the nature of cadang-cadang. Of course, in the same way that the mariner is convinced that he is at sea (and not up in the air), we were convinced that we needed to study the soil. The following are a few indications that

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[1]Kent (1953) summarized the symptoms used by plant pathologists as follows:

"The most characteristic symptoms of the disease can only be seen by removing one of the leaves about 1/3 to 1/2 the way back from the center of the crown. The pinnae from such fronds when viewed in reflected light first show small water-soaked lesions on the underside only. These lesions range from minute dots to a size of 2mm wide x 3mm long. At first the lesions are limited by the veins, but more dot-like, water-soaked areas appear which coalesce to produce larger, irregular, elongate, and blotchy water-soaked areas. While the water-soaked lesions tend to occur on the blade of the pinnae, they are also found on the midrib and petiole."

the soil could have an important contribution to the manifestation of the cadang-cadang syndrome: First, the disease varies in severity from one place to another. Rothkirch (cited by Sill, 1964) had this to say:

> "We made another interesting observation on this trip. In the northern part of Camarines Norte, around Paracale and Jose Panganiban, cadang-cadang manifestation seems to have come to a standstill. When I first saw this area in 1946, about 1 to 2 percent of the trees were infested; in 1960, infestation had increased to approximately 3 percent, and today it is still about the same. What is surprising is the fact that only about 15 kilometers from this area — around Vinzons and Talisay — large areas of coconuts have been practically wiped out by cadang-cadang during the past 10-12 years".

Secondly, we fertilized some affected trees with "heroic doses" of ammonium nitrate and they deteriorated very fast. On the other hand, those given ammonium phosphate became vigorous and productive (Velasco et al, 1965). This could mean that a detrimental soil constituent was more soluble as a nitrate and much less soluble as a phosphate.

Thirdly, many species of plants, other than coconut, were abnormal and died-off prematurely (Canoy and Velasco, 1964). Citrus trees (fig. 1) and a shade trees (*Erythrina fusca*) were con-

Figure 1. Citrus trees in various stages of deterioration. Like the coconut, they die off.

Figure 2. Neighboring coconut trees. One is in the terminal stage of cadang-cadang while the other is healthy or perhaps, in the incipient stage.

spicuous when they died-off because they were planted in solid stand. (It is seldom, if at all, that a pathogenic organism could be so wideranging in host relationship).

Once convinced that we should search the soil for the cause of cadang-cadang, our first impulse was to analyze the soil. But it was easier said that done, because we did not know what to analyze for.

To institute some semblance of a system in our approach, we postulated that the abnormality could be due to: (1) a deficient essential element, (2) an excess of an element, like aluminum, which is non-toxic in moderate amounts, and/or (3) an element which is toxic even in trace amounts.

We toyed for some time with the first alternative and obtained data on the comparative statuses of nitrogen, phosphorus and potassium (table 1). There seemed to be no striking differences in NPK contents between the diseased and the non-affected sample.

Hand in hand with our study of the major elements, we studied the essential minor elements (i.e., boron, copper, manganese, molybdenum and zinc.) At first we thought that copper was deficient in the affected soil (Velasco et al, 1957). Our bio-assay for copper gave clear indications that this was so. But then, we found that the procedure was not specific for copper, and that high levels of aluminum can produce results on the test organism similar to copper deficiency (Velasco et al, 1960).

Table 1. The Nitrogen, Phosphorous and Potassium Content of Soil Samples from Los Baños and Guinobatan

Soil Sample	Per cent Moisture	Constituents in per cent dry basis NH_4—N	P_2O_5	K_2O	MgO
Los Baños	14.12	0.13	0.089	0.91	—
Guinobatan (healthy tree)	16.92	0.17	0.13	0.17	2.85
Guinobatan (cadang-cadang)	23.39	0.42	0.15	0.80	2.22

As an offshoot of our effort to bio-assay for copper, we became curious about aluminum, and analyzed for it using aluminum as our reagent. We seemed to get higher levels in Bicol soil (Velasco *et al*, 1959) but the red-to-pink tinge was quite different.

Even before we could get definite indications for, or against the essential elements, we caught ourselves spilling over into the non-essential elements. We knew that we should be systematic in our approach, yet we could not restrain ourselves from proceeding unsystematically. (We were like a boxer who knew the rules; but, just the same, boxed below the belt — once in a while). Lest we leave the impression that we regard system and logic as the exclusive paths towards extracting information from Nature, we should emphasize that there are other paths. Our only excuse for guiding by them is that they are a means of keeping our sanity in the venture into the confusing labyrinths of the unknown.

By way of making up for the weakness in our data we retraced our steps and analyzed more soil samples for as many elements as our facilities would allow. The total and available amounts of the elements are presented in table 2. Aluminum tended to be high, but not consistently so. Organic matter, or loss on ignition was consistently higher in the Bicol Region.

To avail of more modern facilities, soil samples were sent to foreign laboratories for analysis with the emission spectrograph. Table 3 was kindly reported by Dr. R. Mitchell of the Macaulay Institute of Soil Research, U.K. It will be noted that none among the elements determined showed a tendency to be higher in the cadang-cadang samples (i.e., Guinobatan, Pili and Tigaon).

Another attempt was made to analyze for various elements, this time in the leaf ash. The data of Wallihan *et al*, (1965) show that silver tends to be higher in the cadang-cadang sample (Table 4). However, little importance may be attached to this observation

Table 2. Average of Chemical Constituents in the Different Soil Analysis

Province[2]	*A. Total amount, in per cent*					
	N	*AL*	*Ca*	*Fe*	SiO_2	*OM*[3]
Sorsogon	0.24	19.91	20.17	3.00	53.66	9.95
Albay	0.25	23.09	8.63	7.01	49.35	9.60
Camarines Sur	0.24	13.80	11.75	6.42	55.93	8.88
Quezon	0.17	14.74	6.78	5.78	54.97	6.53
Laguna	0.16	16.66	8.21	7.45	50.04	5.56
	B. Available amount, in mg/100 gram/soil					
	P	*AL*	*K*	*Fe*	*Mn*	*Cu*
Sorsogon	4.6	5.2	15.3	0.9	0.8	0.04
Albay	6.3	4.9	17.0	0.7	0.5	0.13
Camarines Sur	10.8	2.5	27.3	0.5	0.5	0.08
Quezon	4.3	2.8	22.6	0.8	2.4	0.11
Laguna	13.3	2.4	31.6	0.4	1.6	0.20

[1] Data derived from Velasco *et al*, 1959.

[2] The average for Sorsogon consisted of samples from Prieto Diaz (2 samples), Gubat (2), Castillo and Pilar; for Albay, samples from Albay town (2), Guinobatan, Ligao and Polangui; for Camarines Sur, samples from Bato, Iriga and Baao; for Quezon, samples from Atimonan, Pagbilao, Lucena, Sariaya and Tiaong; and for Laguna, samples from San Pablo, Calauan and Los Baños.

[3] Organic matter was obtained as loss on ignition.

not only because the order of magnitude is very low, but also because silver has not been known to cause problems in field culture of plants. Among the essential elements, boron was given some attention because the thick, brittle spear leaves of cadang-cadang diseased plants were suggestive of boron deficiency. It will be noted from Table 4 that, if at all, boron was higher in the diseased coconuts.

Since 1965, when the paper of Wallihan *et al* was published, our group had been groping for some likely soil constituent on which to pin our hope. At various times we determined organic matter, then germanium, the platinum metals, selenium, antimony, beryllium, the earth acids (titanium, niobium and tantalum), and group IIIb (gallium, indium and thallium). Sometime before we focused on the earth acids, we had some indications that there could be a difference between the diseased and the non-affected samples in the amount of rare earths. However, when we analyzed for the group according to the prescribed procedure we obtained inconsistent results.

In all our wandering across the periodic table, one question which kept coming back to us like a bad dream was, When do we drop work on one element? If we obtain one negative result from

Table 3. Elements Found in Soil from Various Coconut Groves, (in ppm. dry weight)[1]

Element	*Non-affected*		*Cadang-cadang*		
	College Laguna	*Tiaong Quezon*	*Guinobatan Albay*	*Pili, Camarines Sur*	*Tigaon, Camarines Sur*
Silver	1	1	1	1	1
Barium	600	1500	400	400	400
Beryllium	3	3	3	3	3
Cobalt	40	30	25	20	20
Chromium	30	30	8	10	15
Copper	200	150	100	100	80
Gallium	30	20	30	25	30
Germanium	10	10	10	10	10
Lanthanum	100	150	100	200	150
Lithium	25	20	15	15	20
Manganese	2000	2000	2000	1500	1500
Molybdenum	2	6	1	1	2
Nickel	15	25	10	10	15
Lead	30	30	30	30	30
Rubidium	300	300	300	300	300
Scandium	6	10	10	4	8
Tin	3	3	3	3	3
Strontium	300	2000	1000	600	1000
Titanium	9000	6000	6000	4000	5000
Vanadium	250	200	200	200	150
Yttrium	30	30	30	30	30
Zinc	1000	1000	1000	1000	1000
Zirconium	400	300	200	200	250

[1]Kindly determined by Dr. R. Mitchell (1963), Macauley Institute of Soil Research, U.K.

a test, is it enough indication that the element is not present in the system? The latter question is relevant because as you and I know, a negative result can indicate one of several situations: (a) the method was not pertinent, (b) a mistake was committed in the manipulation (c) the reaction was masked by an interfering substance or (d) the element was absent. Most of the time, we had to rely on our hunches — what Polanyi calls "tacit knowing" . . . And on several instances, we found that we did not know what we thought we tacitly knew.[2] And this was the reason why we returned to some elements a second or a third time. That was what we did as regards the rare earths.

One consolation we had in this repetitive orbiting on an element was that each time we picked up the task we learned what

[2]This is just to indicate that our tacit knowledge is far from infallible — not a repudiation of Polanyi's.

Table 4. Chemical Analysis of Coconut Palm Leaflets, In Per Cent Dry Weight (After Walliham *et al*, 1965)

Element	*Non-affected*[1]	*Condition of trees* *Cadang-cadang*[2]	*Unhealthy*[3]
Calcium	0.26	0.29	0.30
Magnesium	0.18	0.21	0.23
Potassium	0.91	1.58	0.82
Sodium	0.07	0.02	0.12
Phoshorus	0.14	0.14	0.13
Iron (ppm)	33.6	26.9	32.3
Manganese (ppm)	34.9	16.8	75.5
Zinc (ppm)	6.7	7.5	3.1
Copper (ppm)	2.5	3.7	2.7
Molybdenum (ppm)	0.85	0.45	0.20
Boron (ppm)	9.3	12.6	11.2
Non-essential elements in leaf ash determined by arc spectrograph (ppm)			
Silver	0.01	0.03	
Aluminum	12.00	10.00	
Barium	1.20	0.95	
Cobalt	0.30	0.10	
Chromium	0.20	0.06	
Nickel	0.50	0.20	
Lead	0.80	0.76	
Tin	0.40	0.25	
Strontium	5.00	1.90	
Titanium	3.0	1.9	
Vanadium	1.0	0.6	

[1] Healthy trees in San Pablo and College, Laguna.
[2] Trees in medium stage of cadang-cadang in Ligao, Albay.
[3] Unthrifty trees in Sariaya, Lucena, Pagbilao and Atimonan, Quezon.

mistake to avoid and what aspect needed further exploration. It was as if each little effort — each little push — made the pendulum travel a bigger and bigger arc of a circle. We amused and consoled ourselves by recalling that it was the concept which guided Lawrence in designing his cyclotron.

And we felt rewarded when we learned that iron had to be removed from the system if consistent results should be obtained in precipitating the rare earths as their oxalate (Velasco *et al*, 1977). Table 5 shows that the rare earths in the affected samples were in the order of six times as much as those in the non-affected samples.

Not much later, we came across some information in the literature which led us to pick up again the study of thallium. By removing the bulk of insoluble hydroxides (iron, aluminum, etc.), we were able to neatly precipitate the sulphide of thallium (Velas-

Table 5. The Amount of Rare Earths in Various Soil Samples

Locality	*Miligram per 200 gram soil*
Cadang-cadang affected:	
Bacon	443.8
Guinobatan	629.9
Pili	771.3
Non-affected:	
Los Baños	109.9
Pagbilao	96.7
Silang	84.5

Table 5a. Elements in the Crude Isolate (Per Cent)[2]

Sample	*La*	*Ce*	*Pr*	*Nd*	*Sm*	*Gd*	*Total*
Cadang-cadang affected:	0.02	0.07	0.02	0.06	0.01	0.01	0.19
Non-affected:	0.01	0.02	nd.	0.01	nd.	nd.	0.04

[2]Kindly determined by Dr. D. J. Bland, Institute of Geological Sciences, U.K.

co *et al*, 1978). Our results showed that while thallium was consistently present in the cadang-cadang samples, it was not detectable in the non-affected samples (Table 6).

Instead of getting one element to relate to cadang-cadang, we now have a group plus one. One element was hard enough to relate to the disease; by having the rare earths and thallium, we multiplied our task. We are still in a quandary.

However, we seem to see a beginning of "crystallization", as it were, in the chaotic, supersaturated solution. This seems to occur in group III of the periodic table. We may recall that the malformed, thick, brittle spear leaf is characteristic of the tree in the terminal stage of the cadang-cadang. This is reminiscent of boron deficiency. Boron is the first element in group III; the rare earths are a special offshoot of group IIIa and thallium is in the main group IIIa. It is likely that boron could have been displaced from active sites in the plant through competitive inhibition by the rare earths and/or thallium; hence, the boron deficiency symptoms. Besides this involvement with boron, the rare earths have other chemical and physiological properties. Their capacity to change valence can involve them in the oxido-reduction system of the plant. For its part, thallium is highly toxic to animals and plants. It will not be surprising if thallium would be demonstrated as the main cause of toxicity in areas where the disease is severe.

Table 6. Crude Isolate as Thallium Chromate
(in grams per 20 grams of soil)

Sample	Grams/20 grams	Per Cent
Cadang-cadang affected:		
San Miguel	1.7226	6.7
Guinobatan	1.3928	5.4
Pili	0.8180	3.1
Non-affected:		
Los Baños	n.d.	
Silang	n.d.	
Pabilao	n.d.	

We hope that the task would appear interesting enough for other researchers to venture into.

To out-do Doubting Thomas

In the course of our laboratory analysis, we often had to check ourselves and make sure that we did not get carried away by our enthusiasm for a given element. For example, at the time we were trying to probe the presence of beryllium, every precipitate we got with ammonium hydroxide appeared to be the substance we were after. Our isolate seemed to give the expected color reaction with curcumin; also, with quinalizarine. Hence, we had to remind ourselves constantly of the precept that "We see what we believe we ought to see." We deemed it necessary to confirm our observation by following an entirely different (if parallel) procedure. Adverting to the account about St. Thomas in the Bible, it was not enough that he saw the resurrected Christ; he should as well be able to touch His wound.

We should check and double check our data in chemical analysis because we deal with properties which are not exclusive to the element. As Lundell and Hoffman said, (1938) ". . . probably no method of chemical determination, whether it be gravimetric or volumetric, is based on a reaction that is peculiar to a single compound." The need to maintain a certain reserve of skepticism in assessing one's own data is even more imperative in instrumental analysis because in most cases the properties measured are simply electrical impulses.

Within grasp of the "will-o'-the-wisp."

In this odyssey, we experienced various moods. There were times when we felt uncontained elation over promising leads; there were periods of drabness, doing routine "busy-work"; then we experienced periods of resignation, and we asked ourselves, "Why bother?" This last mood got heightened when our failure to probe into our hypothesis was coupled with frustration over unavailability of funds, facilities and materials.

One will-o'-the-wisp which we pursued for sometime was the profuse frothing of the affected soil when treated by an oxidizing acid (say, nitric acid). We searched the literature for the elements which could exhibit this property. By turns, we analyzed for organic matter, selenium, tungsten, molybdenum. It was many years and many mistakes later that it dawned upon us that the frothing could be due to a high content of sulfide in the affected soil.

It appeared that the oxidizing acid converted the sulfide into elemental sulfur. The colloidal sulfur caused the frothing; furthermore, it made the lather stay longer when the solution was stirred vigorously by the stirring rod. Quite vexingly, the colloidal sulfur did not get brought up to a higher oxidation state (say, sulfate) by treatment with oxidizing acid — or at any rate with great difficulty. Hence, the persistence of the frothing.

Unhappily, our subsequent observations told us that the sulfide could not entirely account for the frothing. Samples fused with Na_2CO_3 and picked up in water frothed when treated with HCl.

In a sense the "wasted" effort was not wasted in vain, because it opened to us another window. It strengthened our resolve to look more closely at the thallium status of the affected soil. This is because the literature states that commercial thallium is obtained from sulfuric acid plants. Thallium is said to be associated with sulfur in its deposits; when sulfur is burned to make sulfuric acid, thallium is vaporized. On cooling it condenses and gets mixed with the clinkers.

This incident, wherein one activity leads into another, emphasizes to us the inter-connections and open-endedness of research.

To publish and/or perish

On the subject of publishing one's results no matter how tentative, opinions vary widely. Most of us in the Philippines tend to be perfectionists. We do not want to publish results unless we have proven beyond doubt that we have solved a problem. This would mean that our group should not publish on our effort to elucidate the cadang-cadang problem because we have no definite information for, or against our hypothesis. It was cautioned that if we made many false starts (like crying wolf a little too often), our credibility might greatly suffer. On the other hand, in the United States and other advanced countries, scientists go by the dictum — "publish or perish". In view of the contradiction, we felt that the dice is loaded against us: if we don't publish, we perish; if we publish what could be the mistakes, we perish just the same. For better or for worse, we opted for the latter alternative.

By way of rationalization, we told ourselves that a research undertaking has at least two aspects: the advancement in information and the advances towards gaining information. This is another way of saying that the two legs of science are contents and process. When we publish tentative results, we hope to attain the latter. We take the reader on a "guided tour" into the intricacies of that aspect of Nature that we are exploring; and incidentally, into the highways and by-ways of our thought process. The thought process could be defective, inadequate and debatable. If so, we expect other people to point this out. To be able to attract the critical view of the scientific community — to be able to start a bid in the market place of ideas — this is concession enough. If colleagues will just do better than turn a cold shoulder.

To tell the people.

Publishing is one important first step in communicating our results. To be of some value, the information which is communicated needs to be accepted, appreciated and applied. A large part of these latter processes rest with our public — that is, fellow scientists may or may not give credence to our finding. The intelligent lay public will have to attach some value of the findings; and the pertinent people will have to utilize the findings. Otherwise, our effort may come to naught.

History is replete with accounts of society's failure to attach value to scientific information. Mendel's discoveries on the inheritance of plant characters lay buried in an unknown publication in a remote library until the phenomenon (and his paper) were rediscovered. A more unfortunate fate was the lot of Galileo, who persisted in presenting proofs, that the earth revolves around the sun, contrary to accepted tenets.

Our experience in presenting our results of cadang-cadang has not been as unfortunate as that of Galileo; but we did meet with disappointments. To disagree with a renown plant pathologist in his observation and interpretation of cadang-cadang is not an easy task. The task is made even harder by the unhappy coincidence that all the experts funded by AID and FAO have chosen to prove that cadang-cadang is caused by a virus or a viroid. The following list of experts is virtually a "Hall of Fame" in plant pathology and virology. Otto Reinking (1950), Donald de Leon (1951-1953), George Kent (1953); R. S. Vasudeva (1955), C. S. Reddy (1956), W. C. Price (1956-1957; 1968-1973), Frank McWhorter (1958-1959), Karl Maramorosch (1960), Francis O. Holmes (1961-1962), W. H. Sill Jr. (1963), A. N. Nagaraj (1963-1967), F.

E. Nitzany (1967-1968), N. S. Wilson (1972), B. Zelasney (1976 to date) and J. W. Randles (1973 to date). The country owes them a debt of gratitude for their time and effort.

On the Filipino side, the following researchers made their unstinted contributions towards the total effort, either independently or in collaboration with Dr. Ocfemia and the foreign experts: A. E. Bigornia, A. Bustrillos, C. A. Calica, B. S. Castillo, M. S. Celino, T. G. Fajardo, A. B. Magnaye, J. L. Naron, D. B. Protacio, E. A. Rasa, E. P. Rillo, and M. S. del Rosario.

The usual reaction of the public is that with all this expertise and the amount of money and material being poured into the undertaking, it is hard to think that the experts could be anything but right.

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23. The following colleagues participated at various times in this study, although their reports were not cited in this paper: Oscar Baldovino, Teofila Cabrera, Elias Canapi III, Marlito Cardenas, Emma Crudo, Cecilia Enriquez, Luz de Guzman, Gilberto Layese, Feliciano Manuel, Bonifacio Mercado, Restituta Pamintuan, Natividad Platon and Marcos Vega. To them goes my grateful appreciation.

Avelino Bigornia, Ph.D., Discussant

The paper of Dr. J. R. Velasco, entitled "In quest of certainty: An odyssey into the cadang-cadang problem", is on the whole an admirable, most candid account of the frustrations, disappointments and meanderings of most scientists that worked with cadang-cadang research. While sharing with Dr. Velasco all the disappointments and frustrations inherent to working in this basic research, this commentator does not agree on a number of important points raised in the paper, among other things, the following:

1. The spread of the disease is put in doubt since "the claim that disease is spreading" is based only on the fact that "subsequent reports were actually subsequent cases" and the later cases were offshoots of the initial case in San Miguel Island". On the contrary, the main basis why the disease is said to be spreading are the results from the studies on the epidemiology of the disease, consisting of annual trip surveys of the Bicol region and epidemiology plot studies (7 plots of 5 ha each) for nine years, 1951-1959. Published papers on the epidemiological studies of the disease (Bigornia, et al. 1960 and Price, Bigornia, 1969) are unfortunately not included or ignored by this paper.

2. On "A moot subject in the elucidation of cadang-cadang concerned its diagnostic symptom", doubt is also implied since "more relevant" manifestations of the disease should have been observed to better understand the malady. In this regard, it should be pointed out that the current diagnostic visual symptoms currently in use today had been found most reliable by most cadang-cadang research workers, in the absence of a more precise method or technique. The small, numerous, irregularly-shaped yellow spots without necrotic centers, that are translucent by transmitted light but appears olivaceous or water-soaked by reflected light on the leaves, had been found most practical and reliable in field diagnosis, *as long as the increase in number and size of these spots follow the phyllotaxy of the palm.* The visual symptomatology of cadang-cadang may be found in a published paper of C. A. Calica and A. E. Bigornia, 1960. The biochemical essay for ccRNA is now currently in use at the ARC for more precise diagnosis of cadang-cadang, since this technique reveals cadang-cadang infection 17 months before leaf symptom expression.

3. Doubts are also raised as to the involvement of nucleic acid fragments being viroid in nature and/or causative of cadang-cadang. Evidence so far gathered at the ARC, PCA, have shown the following:

a. Close association of the ccRNA with disease.

b. Transmission tests using ccRNA as inoculum had produced visual cadang-cadang symptoms in some of the inoculated young palms.

c. The ccRNA may be recovered from inoculated test palms showing positive cadang-cadang foliar symptoms.

All these, quite follow KOCH's postulates.

Lastly, it is regretable that Dr. Velasco with his initiative and drive should retire from the "field to lick his wounds", the exploration in the involvement of elements in the periodic table must remain incomplete.

Julian Banzon, Ph.D., Discussant

I condensed my five page comments to one paragraph. What I gathered from the paper of the speaker is that it's very apparent that it's the effort and not the result that makes his paper very interesting. Whether cadang-cadang is due to the rare earths or to the biological factor or even to extra-terrestial beings, the cause of cadang-cadang remains an incomplete odyssey. May I say however that the oral presentation did very poor justice to the written paper. Please read the paper. It is an unusually excellent scientific assay, as rare as the rare earths.