Report to: Richard Shutler, Jr.

From: J. Schoenwetter

Title: Palynological Investigations of Archaeological Sediments from the New Hebrides: Preliminary Report.

Introduction

Shutler (1962) pointed to the value of pollen analysis as a research tool in archaeological investigations of Pacific islands. His own attempts to recover significant quantities of pollen from sediments of archaeological context in Hawaii, the Marquesas, and Sarawak met with frustration for the pollen yield was so low as to make the samples useless for analysis.

A series of 97 sediment samples from islands in the New Hebrides was submitted to this laboratory for specific purposes. First, I was commissioned to discover a technique by which sufficient pollen for analysis could be extracted from the sediments. Second, I was to search for pollen of economically important plants in the samples. Third, I was to ascertain if there was evidence of environmental change occurring through time in the various stratigraphic series.

It was soon determined that pollen could be recovered in quantity, economic pollen types were incorporated in the samples, and there was significant variation in the pollen floras of stratigraphically superimposed samples - probably a function of environmental change through time. But it also became clear that the recovery of data from these samples would be a long and expensive process. It was estimated that two months of research, at a cost of two thousand dollars, would yield insufficient data

for reliable conclusions on the nature of the prehistoric economic floras and their variation through time, or on the nature of such environmental changes as occurred. In view of this it was decided only to garner sufficient data to demonstrate conclusively the limitations and potentials of the technique of pollen analysis in the New Hebrides and to extract as much pollen as possible from the samples submitted.

The Laboratory Work

The sediment samples from archaeological and surface proveniences contain large quantities of organic material in various states of decomposition, clay and silt size mineral particles, shell, coral and bone. The amount of pollen in the average sample is probably on the order of 50-100 grains per cubic centimeter, with many samples containing much less. Fortunately, vast amounts of the sediment can be decomposed by chemical processes which do not affect the pollen contained. By working with large enough samples of sediment it is possible to concentrate all the pollen in a small volume of matrix to be viewed under the microscope. The extraction technique thus becomes time consuming and, for this laboratory, expensive because of the labor costs involved.

A few sediment samples from bogs were submitted among the series. These did not necessitate specialized extraction techniques because they were quite polliniferous and sufficient pollen could be extracted from 10 cc's of sediment by normal laboratory methods. These samples were not our prime concern, however, since they were not from archaeological proveniences.

The following extraction technique was that applied to all

but the bog samples. Sufficient sediment was used to supply 25-40 cc's at step 2, as the samples we were provided were not too large. For samples which yield insufficient pollen for analysis the process can be repeated using 2, 3, or 4 times the volume of original sample. I would estimate that 75-80 percent of the samples submitted are of sediments which contain sufficient pollen for analysis if a large enough volume of sample is processed. To insure that sufficient volume of sample is available, it would be ne
volume (1/2 to 3/4 pint) of sample originally.

Step 1. A sieve with a mesh size of 80 microns is placed in a funnel leading to a clean 50 ml nalgene centrifuge tube. About 30 cc's of sample is placed on the sieve and a distilled water jet used to wash the smaller particles through the sieve into the tube. Centrifugation and decantation continue until all small particles have been collected, after which another 30 cc's of sample are placed on the sieve. This process continues until 25-40 cc's of matrix is collected in the tube. This normally involves 75-200 cc's of sample.

Step 2. The matrix is given two successive rinses with distilled water.

Step 3. The matrix is transferred to a large clean, beaker and cold conc. HCl added until emission of gas ceases even when stirred. By successive centrifuging and decanting steps the matrix is then returned to the centrifuge tube.

Step 4. Cold conc. HF is slowly added to the matrix with continuou stirring. The matrix has been sufficiently reduced by Step 3 that the 50 ml centrifuge tube will accomodate

20 or more cc's of HF. Reactions are rarely violent but caution should be used. The matrix is left in HF overnight.

Step 5. If, after centrifugation and decantation, the matrix is not less than 20 cc's in volume, fresh cold HF is added and the whole given a boiling water bath for 10 minutes.

Step 6. 10% HCl is added to the matrix and the whole given a 10 minute boiling water bath. By the end of this step the matrix is usually reduced by at least 65% of its original volume.

Step 7. The matrix is given a rinse with glacial acetic acid.

Step 8. Acetolysis mixture (Erdtman 1943 p. 28) is added to the matrix and the whole given a five minute boiling water bath.

Step 9. The matrix is given a distilled water rinse.

Step 10. 10% KOH is added to the matrix and the whole given a 10 minute boiling water bath.

Step 11. Successive rinses with distilled water are given until the supernatant is clear. For most samples this involves eight to twelve rinses. If, at the end of this step, the volume of matrix is still more than 5 cc's, steps 8 through 11 are repeated. If less than 2 cc's volume remains, steps 12 to 14 are eliminated. Many samples will, even after steps 8 to 11 are repeated, yield between 2 and 10 cc's volume. For such samples steps 12 to 14 are necessary.

Step 12. Clorination of the matrix by the technique used by Kelling (1947, p. 22). 5 ml of a 9:1 mixture of

glacial acetic and conc. HCl is added to the matrix and, after stirring, 3 or 4 drops of 33% sodium chlorate solution is added. Stirring is continued for a short whil

Step 13. The matrix is given two distilled water rinses.

Step 14. Repeat steps 8 to 11 above.

Step 15. Transfer to 1 dram shell vial with alcohol jet, centrifuge and decant.

Step 16. Add a few drops of glycerol as preservative and label.

Some samples, particularly those from rockshelters, contain a larger amount of mineral matter than others. This will be apparant when, after step 6, the volume of sample is not much reduced and a sandy matrix is evident in the bottom of the centrifuge tube. For such matrices it is advisable to halt after step 6, transfer the matrix to a clean nickel crucible with HF and place the whole over heat. After boiling in HF for 10 minutes (replacing HF as it boils off), transfer the matrix back to the centrifuge tube, centrifuge and decant. Repeat step 6, then continue with the extraction proceedure.

Through this technique 75-200 cc's volume of sample are reduced to 1-5 cc's matrix (in most cases), concentrating all the pollen in a small volume. As far as I was able to determine the processing technique does not affect specific types of pollen, for very few grains had the characteristic eroded appearance of partial chemical destruction and even very large grains were rarely broken. The processing is tedious and time consuming. Working with 16 to 40 samples at a time an experienced lab technician averages 4-5 hours per sample and this rate increases if fewer samples are processed at once. Steps 1 and 3 take the longest

time; a technician can spend an hour on one sample at step 1 if the sediment contains little in the way of small particles. The technique seems, by contrast with those ordinarilly applied to bog and lacustrine sediments, extremely harsh and destructive. Certainly it is not "traditional" to repeat the acetolysis treatment up to three times under boiling water bath conditions. Yet it works and it does yield pollen in sufficient quantity for analysis. If some pollen types are destroyed by the treatment, which I have not been able to check but which I doubt, it still seems better to get some pollen than none.

The Microscope Work

The sample series from site FUR3 12, a rockshelter in the interior of Futuna Island, was selected as a demonstartion series. Observation of samples from ATR33, a coastal rockshelter on Anietyum Island, and AT7, an open village site on Anietyum, showed less pollen per sli[illegible] Levels 3 and 4 at FUR312 yield more than 1000 grains per slide, so the observation of 500 grains from each of these levels was accomplish far more rapidly than the surface sample, which yielded only 300 grains per slide.

This laboratory has no reference collection of South Pacific pollen types, and I am not familiar with the pollen of this area. I also did not have available a list of the plants of the New Hebrides which might have been expected in the pollen flora. Thus my identifications of pollen observed proceeded basically by recognition of morphologically distinctive types. I then attempted to relate these types to the descriptions and illustrati of Erdtman (1954) Tsukada (1964) Selling (1947) and Cranwell (19

which were the references immediately available. The identifications I have made are, therefore, not to be considered more than tentative and preliminary. These identifications were sufficient to fulfill the needs and the time limitations of the project and no more than that was attempted. Proper pollen analysis of even these few samples would take a great deal more research than time committments allowed.

Photographs were taken of almost all morphological types recognized, and some single grain reference slides were made. The photographs are not intended for publication; they were taken in a spirit of experiment to serve as memory aids in the analysis and do not invariably represent a good record of the observed pollen type. Because of my lack of familiarity with the pollen of this area, and because I did not know what pollen types to expect, some morphological taxa have a broad range, and probably include more than one taxonomic category. Even fresh reference pollen shows some range of morphological variability; when one performs works with fossil material it is necessary to be liberal in such a preliminary study as this one about the creation of morphological taxa.

Before undertaking pollen counts I endeavored to familiarise myself with illustrations of economic pollen types from this area. Without reference slides for most species, however, my identifications of even these economic plants should be checked by someone more familiar with Pacific floras. Dr. L. C. Smith loaned me reference slides of Ipomea, Pandanus, and Cocos Nucifera. The grains on the Cocos slide do not match the description or photographs given by Selling (1947 p. 337, plates 53 and 54, figs, 869-872).

-872).

In addition to the eighteen morphological types there were a series of pollen types which I felt could be given preliminary identifications. Pollen, of Chenopodium, Pinus, Gramineae (uncultivated taxa), Compositae (both Liguliflorae and Tubuliflorae), Croton, Hibiscus, Gossypium, and Ipomea were recognized. I have also recognized, what is probably Colocasia (common taro) Boerhaavea, and Eugenia malaccensis (mountain apple). A small pollen grain similar to Eugenia malaccensis but not syncolpate was recognized as being like E. waianensis described by Selling. Perhaps this is E. jambo (rose apple).

Morphological Type I is tricolpate, microreticulate, usually prolate but sometimes subprolate, and between 30 and 45 u (microns) in longest axis. [illegible] surface sample and probably is referable to some member of the presently local flora. A photograph (Fig. 1) of this type is available but no single grain mount.

Type II is a large reticulate type. It seems to be tricolpate but often appears monocolpate in its fossil condition. The type varies from 60 to 85 u in longest axis, usually prolate but not uncommonly subprolate. It reaches its greatest frequency in the surface sample and is probably of a locally available plant or plants. A single grain reference slide was made of this type.

Type III (Fig. 2) is a tricolpate, scabrate, oblate or suboblate type. It is 35-40 u in longest axis and has resemblences to Ranunculus and Viola types illustrated by Selling. It's distribution in the sample series is quite anamolous, for it amounts to 23% of the spectrum of level 3 but to less than 4.0% in any

other level. I could find no description of an economic pollen type similar to Type III but believe that if it is of a species which is utilized by man its distribution in the sequence is most satisfactorily explained.

Type IV (Figs. 3-6) is tricolporate with equitorial endexinal thickenings under the furrows which are often prominent in polar view. The surface texture ranges from lightly granular to lightly scabrate, it is suboblate to spherical in most cases but occasionally subprolate, and it is about 20-25 u in longest axis. This morphological type probably encompasses a number of actual plant taxa. It most closely resembles the photographs and description of Pelea (type I variety) of Selling, but there are other types (Broussaisia and Ficus) which also look similar to some of those observed. Selling mentions that Artocarpus (breadfruit) may sometimes be triporate. If this is the case with local breadfruit pollen some may have been included in this type category.

Type V was a catagory of grains similar to type IV but with a thicker, exine and more scabrate texture. When it was observed that types IV and V graded into each other all were lumped as the Type IV-V catagory. Type IV-V grains composed the majority of those observed in the FUR312 series. It seems likely that this type is referable to a wind-pollinated species now at the locality. Single grain mounts of Type IV-V have been prepared.

Type VI is monocolpate, reticulate and prolate (Fig. 7), and is 38-45 u in longest axis. The type is only common in the surface sample. This seems likely to be a species in the lilly family which grows locally.

Type VII (Fig. 8) is a very large, monoclopate type with a finely microreticulate exine. It stains more like a pollen grain than a spore but may not actually be pollen. It is usually prolate in shape but is probably globular, assuming a prolate form under the cover slip. It matches Sellings description of Tacca leontopetaloides but is about twice as large; it also conforms, except in its large size to descriptions of Cocos nucifera and Pritchardia given by Selling. It is most common in the surface sample and was observed in some frequency in the uppermost level at ATRS3, pit 1.

Type VIII (Fig. 9) is tricolporate and reticulate with characteristic narrow transverse colpi. Most pollen of this type was recovered from the surface sample. A single grain reference slide was prepared.

Type IX (Figs 10, 11) is usually observed as a tetracolporate type but occasionally was tricolporate or pentacolporate. The large circular pores are sometimes equatorially elongated but very characteristic. The surface is psilate to finely granular, the shape is ordinarilly oblate spheroidal, and the size range is 42-47 u in longest axis. The distribution of this easily recognized pollen type indicates its probable utility as an index of environmental change.

Type X (Figs. 12, 13) is a large (45-52 u) tricolpate spinuliferous type. It's globular shape is easily crushed and folded so that definition of the three furrows is quite rare though one furrow is often easily seen. Its distribution may be most consistant with a hypotheses of economic utilization.

Type XI is tricolporate, reticulate, prolate and rather inconsistant in the 30-45 u size range. As shown by the two figures (14 and 15) it is probable that more than one taxon is represented

in this type. Basically this morphological category served for the tricolporate-reticulate grains that were not of type VIII. All of the Type XI grains of level 4 were like figure 15. The distribution of the type leads me to suspect it is from one or more economic plants.

Type XII (Fig. 16) is very much like Type II except for the occurrence of a vague transverse [illegible] It is not impossible that Type II grains are really only Type XII grains on which this transverse furrow was not definable. Like Type II, Type XII principally occurrs in the surface sample. A reference mount was made.

Type XIII was not photographed. One grain was observed in the surface sample and described as tricolpate, granular, definately prolate, 57 u in longest axis, and with the rods forming the granulations distinctly separate.

Type XIV (Fig. 17) is syncolpate with the three furrows meeting at the pole, microreticulate, or scabrate, and has a polar diameter of 30-40 u. Other than being quite larger it is similar to Eugenia malaccensis. The type is almost exclusively limited [illegible]

Type XV (Fig. 18) is another of the large (60-80 u) reticulate grains. Rather than a separate type it may be a variant of the same taxon as Type II and Type XII. Type XV has evident transverse colpi subtending the furrows, Type XII has vague furrows, and Type II seems to have no furrows. All are very large pollen grains which otherwise appear similar. A single grain reference slide was prepared.

Type XVI (Fig. 19) is 10-12 (?) stephanocolpate, reticulate, prolate, and ca. 50-55 u in longest axis. It's distribution indicates it is a member of the local flora but of little ecological

or economic significance in the fossil record. A single grain reference slide was prepared.

Type XVII (Fig. 20) was only observed in quantity in level 4. It is a large (48-55 u) tricolpate, rough scabrate, oblate type with a characteristically eroded appearance to the exine.

Type XVIII (Fig. 21) is a small (18 u), tricolpate, reticulate, prolate type. Only one grain (level 6) was observed. It might be referable to the Cruciferae cf. Lepidium.

A single grain reference slide was prepared of Colocasia. Photographs were taken of Croton (Figs. 22, 23), Colocasia (Fig. 24), Gramineae (Fig. 25) Chenopodium (Fig. 26) Eugenia malaccensis (Fig. 27), Eugenia (?) sp. (Fig. 28), and Comepositae (Fig. 29).

Pollen identified as Hibiscus and Ipome was observed in fragmentary form, so not photographed. The pine pollen observed could be a laboratory contaminant. It is found in very low frequencies (2 grains out of 1737) and pinyon pines were pollinating heavily during the period these samples were being processed. The Colocasia pollen is a little larger, in general, than that observed by Selling (1947 p. 339) but this could be because my processing technique includes KOH steps.

No record was kept of the types and numbers of spores observed. There are a great many in the archaeological samples and most of the microfossils in the bog samples are spores rather than pollen grains.

RESULTS AND INTERPRETATIONS

Table I illustrates the results of the preliminary analysis under-taken. Until the various morphological types are identified,

% Pollen

Level	Surf.	3	4	5	6	
Pinus	0.2				0.7	
Gramineae	2.0	0.8		12.9	4.9	*
Chenopodium	0.2			1.1	29.5	*
Tubuliflorae	1.0	29.6	5.0	3.2	2.8	✓
Liguliflorae	0.2	0.2				
Boerhaavia		0.2				
Croton	0.6					
Hibiscus	0.4				1.4	
Ipomoe	0.2					✓
Colocasia	7.6	0.4	4.4	1.1	2.1	✓
Eugenia malaccensis		2.4	0.6		2.8	
Eugenia (?) sp.		2.2	0.4	1.1		
Type I	1.6	0.2	0.4		0.7	
Type II	4.4	0.2	0.8			
Type III		23.0	2.4	3.2	0.7	*
Type IV&V	61.8	25.6	36.8	72.0	28.8	*
Type VI	3.2	0.2	0.4		0.7	
Type VII	4.8	0.4	3.4	1.1	2.8	
Type VIII	3.6	0.2	0.2	1.1		
Type IX	1.0	12.6	2.2	1.1	4.1	*
Type X	0.2	0.4	17.4		0.7	✓
Type XI	2.6		17.8	1.1	1.4	✓
Type XII	1.4	0.4	0.2			
Type XIII	0.4					

Type XIV	1.0				6.7
Type XV	0.6	0.2			
Type XVI	1.0	0.2	0.4		1.4
Type XVII			7.2	1.1	0.7
Type XVIII					0.7
Total observed	500	500	500	93	143

* variation probably due to environmental change

/ variation probably a function of culture

Of course, only the grossest interpretations can be made and even these must be considered provisional. Yet some reasonable statements can be made from the available data.

There are two striking phenomena evident. First, of the 29 taxa recognized only 6 were not observed in the surface sample, and only two of those six ever reach frequencies greater than three percent in other levels. It seems quite unlikely, then, that during the period of time covered by these samples major variation has occurred in the floristic composition of Futuna Island. The ecological niches of the island now available to the inhabitants seem likely to have been available throughout this period of time.

Second, no two levels yield significantly similar pollen statistics. That culture has inadvertantly affected the pollen statistics is very clear. It would be difficult to account for the anomolous distributions of Tubuliflorae, Type X and Type XI in any other way. And, of course, the statistics of one taxon in a level affect the statistics of others, since the total sum of all the grains equals 100 per cent. But this probably does not account for all the variation one can observe. The variations in grass and Chenopodium pollen, for example, seem likely to be due to changing environmental conditions, as do at least some of the variations in the Type IV-V pollen statistics. It would seem, then, that though the ecological niches now available on the island were available through the period of deposition they were not available throughout this time in the manner in which they are now observed. Environmental variation seems to have been sufficiently great to vary the distributions and extent of the

nitches and thus make specific plants and plant associations more or less of a resource than now occurrs.

Another interesting feature of the analysis is that some taxa show quite a bit of consistancy from level to level. The statistics of Type IV-V pollen, for example, are not significantly different in levels 3, 4, and 6 even though there are great differences between other taxa in those levels. If some regularity remains [illegible] in important components of the pollen flora, despite the fact that cultural forces must be recognized as affecting the pollen statistics in these midden samples, it seems reasonable that at least some components are true reflectors of environmental conditions.

Levels 5 and 6 contained less pollen per unit volume than levels 3 and 4, and levels 7, 8, and 9 contained so little that analysis could not be undertaken with the size sample available. This was due to a higher quantity of sand-size particles of mineral matter in the sediments. It may be significant that levels 5 and 6 contain the highest frequencies of wind-pollinated types, particularly Chenopodium and Gramineae pollen. This, along with the higher amount of mineral matter, might be consistant with a drier, windier, environmental condition. Levels 1 and 2 also contained too little pollen for analysis, but in those cases the sedimentary sample was almost entirely of organic debris.

It seems likely to me that the problem of low pollen yields from the majority of samples also is related to environmental conditions. Under the Pacific Islands climate there is much alternate wetting and drying of the sediments which serve as pollen traps, and this destroys some pollen. But the pollen

that is found is so well preserved that this alone cannot account for the lack of pollen. The fact that there is pollen in almost every sample, and the fact that the pollen is almost invariably quite well preserved, leads me to suspect that the low yield of pollen per sample is not due to destruction of the grains after they rain down from the sources.

Under the climatic conditions of most of the islands, where rainfall values are quite high, one can imagine that wind pollinated species are at a decided competitive disadvantage. Raindrops, particularly the large ones that fall from conventional storms common in the islands, have been shown (McDonald 1962, 1964) to be very efficient at washing pollen from the atmosphere. The wind currents of islands, particularly small ones, would also tend to blow much pollen of wind-pollinated species out to sea or away from the producing plants unless they were in sheltered locations. Under climatic conditions similar to those now existing, then, it seems reasonable that over a period of millenia wind-pollinated members of the flora would be at a competitive disadvantage to set seed as contrasted with insect pollinated species. They would probably adapt to sheltered niches, or evolve to develop periods of pollination when climatic conditions were maximal for their needs.

Most of the morphological types recognized in the FUR312 series seem to me to be more consistant with insect-pollinated species, as do most of the identified types.

Insect-pollinated species produce less pollen than wind-pollinated species on the average, and less of their pollen becomes

deposited on the forest floor to be incorporated into sediment. Given the tropical and subtropical climates of most islands, there is a lot of erosion and organic decomposition to create large volumes of sediment in short periods of time. As a preliminary hypothesis, I am willing to advance the idea that the lack of pollen of the sediment samples is due not to destruction of pollen but to a relatively small quantity of pollen being produced in any given season and a relatively large volume of sediment being deposited. Thus little pollen is available per unit volume of sediment sample and pollen analysis can only proceed with large samples in these areas. Fortunately, the sediments are of such a nature that they can be easily decomposed to extract the small amount of pollen they contain.

The question of the nature of the environmental changes and their import to culture history cannot be resolved without more adequate pollen identifications. But even if all the types recognized had been identified the problem would not necessarily be resolved by the type of analysis so far accomplished. First, those components of the pollen flora which can be recognized as being primarily controlled by cultural practises (e.g. Colocasia) should be removed from the pollen sum. In that way variation in their statistics will not affect the statistics of components which have ecological relevance. Second, the present-day ecological index values of the non-cultural components have to be evaluated to determine exactly what a high or low pollen statistic means.

For example, let us say that Type IV-V pollen is correctly

identified as Pelea sp. In Hawaii the genus Pelea is composed of numerous species of shrubs and small trees of the montane rain forests and the fossil distribution of the pollen type seems to indicate that high frequencies of Pelea pollen mean very wet conditions (Selling, 1947 pp 213-14). Thus variation through time in Pelea values would be an index to greater or lesser wetness. But this might or might not be information of value to the resolution of archaeological problems. If the archaeologist is interested in the history of taro growing, and it is determined that the physiological requirements of taro and Pelea pollen is completely irrelevant to the archaeologist regardless of how interesting the information might be to a paleometeorologist.

It is important for archaeologists to recognize that if the resolution of cultural problems is to be approached through pollen analysis, it is up to the archaeologist to structure the pollen study in cultural terms. The archaeologist does not have to do the pollen work himself; in fact he has other jobs which need his talents and ordinarily has not the training for such specialized work. But he does have to know just what it is that pollen analysis, or any other paleoecological technique, can and cannot do to resolve his problems and he must learn to frame and advance problems in such terms that the pollen work will be effective. It is insufficient to ask: has environmental change occurred. "Environment" is a broad catagory of phenomena which are constantly undergoing change - day to day, season to season, century to century - and to simply document that change occurs is meaningless. The problem must be posed in specific, meaningful,

terms: has environmental change occurred which would necessitate a change in specific agricultural techniques or specific cultural practises regarding plant utilization.

SUMMARY

This project has been successful in its intentions, though it must be admitted that these intentions, because of financial limitations, were not particularly grandiose. The project has developed a method for extracting sufficient pollen for analysis from sediments associated with archaeological finds in the New Hebrides. There seems no reason why this method would not be successful in other Pacific islands from similar contexts. Of the 97 samples submitted, only a few were given microscope analysis. The pollen of the other samples was extracted however and work can be begun on them.

This project also successfully demonstrated that variation in pollen statistics does occur through the period of time encompassed by human occupation on Futuna Island. At least some of this variation seems due to non-cultural environmental controls on the vegetation patterns of the island. There is evidence, however, that vegetation types and ecogogical niches did not undergo such marked variation that wholly different floras existed within the period of time dealt with. The distributions and extents of niches now existing, however, seem to have been different in the archaeological past.

Another question this investigation hoped to answer was whether the economic flora of the island was affected through time. The resolution of this problem was hampered by a lack

of critical pollen identifications, but it was also hampered by the lack of a more specific problem. The pollen of economic plants is found in the fossil micro-flora, and the pollen statistics of these types does undergo change. Whether these changes are meaningful, however, depends upon the question posed. We are not simply concerned that change occurrs, we wish to know if culturally relevant change occurrs. To determine this, we must first define culturally relevant changes in terms that pollen analysis can hope to resolve. This is a problem the archaeologist must struggle with before the pollen analyst can begin to offer the assistance his specialized techniques.

SUGGESTIONS

This project has not resulted in sufficient data to warrant the publication of more than a short note informing other members of the profession of the probabilities of successful work in the future. Even this would not be very good without at least two more steps being taken.

(1) The photographs, reference slides and slides observed should be turned over to someone more familiar with pollen types from this part of the world. Dr. Lucy C. Smith has offered her assistance to the project and it would be an excellent idea to send the material to her. Perhaps more identifications would thus be obtained. She should also receive a copy of this report.

(2) At least one slide should be made up of each of the processed samples and an estimate made of the amount of pollen extracted. In this way a table of quantitative

data can be obtained to indicate (a) the percentage of samples which will allow analysis (b) whether specific site types or site locations are more likely to yield data than others, and (c) about how much time should be programmed for "normal" analyses of samples from this area. In regard to (c) above, the critical factor is the amount of pollen per slide. Levels 3 and 4 of FURS-2 had over 1000 grains per slide: a 500-grain count for one of these levels took about four hours. The surface level had about 300 grains per slide; a 500-grain count took about ten hours.

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