HISTOIRE ET CIVILISATION

RECENT RESEARCH IN THE PALEOECOLOGY OF THE HIGHLANDS OF MADAGASCAR AND ITS IMPLICATIONS FOR PREHISTORY

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INTRODUCTION

The history and prehistory of the highlands of Madagascar has long attracted scholars of many disciplines and with diverse approaches. On the one hand, historians, folklorists, social anthropologists, linguists, and archaeologists have described the human side of the Malagasy past and the relations of the Malagasy with other peoples of the Indian Ocean. On the other hand, natural scientists, from paleontology, geology, physical anthropology and geography, have provided independent evidence of the changing natural world of Madagascar, which illuminates the past and allow us to select amongst many competing hypotheses. While the research methods and goals of the human and natural sciences are often quite different from one another, their results complement one another. A complete understanding of the past requires a synthesis of all relevant information, no matter how difficult for scholars to work in areas beyond their normal limits of competence (Schoenwetter, 1990).

Madagascar represents an excellent example of a place where our knowledge of the past is enriched and reformulated with information and understanding coming from the natural sciences. Specifically, we wish to discuss some recent findings in palynology and paleoecology. These research results are very important in the development of our understanding of the early prehistory of the highlands. These findings are primarily the product of collaborative efforts of foreign and Malagasy researchers working together under the auspices of the Musée d'Art et d'Archéologie and the Service de Paléontologie of the Université d'Antananarivo. This work is still in progress, and is in no sense limited to central Madagascar, but this discussion will focus on recent publications relevant to the prehistory of the highlands of Madagascar (Burney, 1987a, 1987b, 1987c).

THE PALEOECOLOGICAL RESULTS

A primary research method is the analysis of stratified fossil pollen assemblages found in sediments from the bottoms of lakes and marshes. The lake bottoms are sampled by the removal of a long core of sediments through the insertion of hollow metal pipe. When extracted the pipe contains the sediments as a linear core, which preserves the stratigraphic order. Thus, the sediments near the bottom of the core are the oldest, and as one moves up through the core towards the modern surface of the lake bottom, the sediments are from progressively more recent periods. Sections of the core at intervals along its length are removed and the carbon within them dated by the radiocarbon method. This gives an absolute chronology of the time at which the sediments sank to the bottom of the lake. The core is then sliced at smaller intervals for the detection of the fossil pollen contained within the sediments. The pollen samples, along with microscopic fragments of charcoal, are extracted from the sediments and examined with a microscope. The paleoecologist then attempts to identify the types of plants that contributed pollen to the lake bottom sediments at each point sampled along the core. The assemblage of plants represented provides a first look at the nature of the plant communities that lived in the region surrounding the lake at different times in the past. A quantitative measurement of the amount of charcoal present in the core, along with a determination as to the nature of plant material burned, provides a measure of the frequency and importance of fires in periods contemporary with the deposition of the lake sediments. Finally, the fossil assemblages are compared with pollen assemblages from the modern sediments of lakes from diverse regions. This provides an opportunity to find modern plant communities that leave behind similar pollen assemblages in lake sediments (Burney, 1988).

These methods, applied widely around the world, offer the best way of detecting changes in the vegetation in a region over time. It works well because the pollen fossils and charcoal fragments captured in lake sediments are durable and preserve in an identifiable condition over very long periods, and because many plants produce pollen which can be accurately identified. In Madagascar, fossil pollen analysis has previously been done for periods in the very distant past, i.e., in sediments more than 70 million years old. However, Burney's results are the first to be reported from Madagascar that span the period between 30,000 years ago and the present. They are the first to describe the vegetational history of the island in the several thousand years before humans arrived here and for the many centuries of human occupation.

Over the past decade cores have been taken from many regions, but our focus is the results derived from corings of lake and marsh sediments from the regions of Antsirabe-Betafo (Vakinankaratra) and from the Itasy, which indicate that :

1.- over the last ten thousand years, the highlands were never covered by a completely closed forest, but by vegetation which ranged from grasslands to a patchy woodland even before human arrival;

2.- natural fires were present and were frequent on the highlands throughout the last ten thousand years;

3.- changes in the environment in the direction of modern conditions seem to begin about 1300 years ago in the Itasy, and, with less precision, they seem about coeval in the Vakinankaratra. These changes may have intensified about 600 years ago in the Itasy.

CHRONOLOGY

Burney's reconstructed history of the vegetational changes in the highlands can serve to guide the chronology of the human settlement of the highlands. If it is possible to identify changes in the fossil pollen samples that are of human, as opposed to natural, cause then the timing of those changes provides a chronology of the onset of significant human modification of the environment. Of course, certain kinds of low density or infrequent visits to the region might not have caused sufficient environmental perturbation to be detected in the pollen samples. Thus, this kind of evidence cannot by itself establish with certainty the date of the first human visits to the region. The problem of the chronology of human occupation of the highlands is presented in more detail in Wright, *et al.* (1991). At present, there are indications of human environmental disturbance as early as the VIIth century, with very impressive changes clear in both the Itasy and Vakinankaratra during the XIVth century. Analysis of other cores from the highlands and elsewhere in Madagascar will bring further data to bear on the very interesting question of the timing of significant human impact on the vegetation. A final determination of the specific nature and timing of the human migrations to Madagascar remains to be resolved, but the palynological data provide new information for historians and archaeologists to consider.

THE ORIGINAL ENVIRONMENT

The first and perhaps most important result of the palcoecological work is the demonstration that the environment of the highlands was neither fixed nor stable during the last 10,000 years. It is thus illogical to try to imagine the "primordial" environment of the highlands, since it changed with the dynamic of climatic changes, and was the product of the many natural fires and climatic regimes to which it responded over time. What we can discuss, instead, is the nature of the environment of the highlands at the presumed time of human occupation. Without going into too much details, we can summarize the vegetational history of this region for the past several years as follows. First, in the final centuries of the Pleistocene, the highlands were apparently an open landscape primarily clothed in a low vegetation of grasses and shrubs that may

have borne some resemblance to high altitude landscapes above the treeline. Interestingly, both on the highlands and elsewhere in Madagascar, there is evidence of important and relatively frequent natural fires. Following the end of Pleistocene, 10,000 years ago, the landscape responded to an apparent warming of the mean annual temperature, and perhaps to an increase in rainfall or to change in its seasonal distribution. Whatever the precise suite of causes, the highlands gradually gained a progressively more diverse and woody plant cover. The plant species involved seem to have slowly spread from areas of lower elevation where they had survived the Pleistocene. This process is similar in many ways to the vegetational history of northern Europe where the early Holocene was a period of slow expansion to the north of many trees and plants that had been unable to survive the earlier frigid periods. The difference in Madagascar is that the plants spread from lower elevations to higher elevations, rather than from south to north. The lemurs that inhabited until recently the highlands may also have migrated from the eastern forests (Richard and Dewar, 1991).

The establishment of new plant species on the highlands followed the climatic changes and led to the establishment of what is called a "woodland mosaic" by about 4000 years ago, at least as inferred from studies in the Vakinankaratra (Burney, 1987c). After about 1300 years ago in the Itasy (Burney, 1987a), and perhaps a little earlier in the Vakinankaratra, there was an increase in charcoal in the sediments, an increase in the pollen of grasses and other sun-loving plants, and a marked decrease in the pollen of woody species. This marks the period in which the woodland mosaic itself was transformed into the modern plant communities we can now observe in these regions.

What is meant by saying that a region is covered by a woodland mosaic? First, by mosaic we imply that the vegetation in a given area is not uniform in appearance or in the component species, but rather has the appearance of different patches of different kinds of vegetation. By saying woodland, we are referring to landscape where trees are common, but where they do not form a continuous canopy shading the ground, as one can see in the forests of the eastern escarpment. Instead, in a woodland mosaic one might see some thick forest bordering the river, with nearby areas of other species of trees separated by patches of ground well supplied with sunlight and with a vigorous coverage of shrubs, and in other places perhaps a savanna where large areas of grasses and low plants are peppered with shrubs, palms or trees. Similar woodlands (*miombo* woodlands) are among the most common patterns of vegetation found today in southern Africa. The most comparable modern vegetations in Madagascar are found in areas of the north of Madagascar where forest, grassland and wooded savanna exist close to each other (Burney, 1988). The variation in the vegetation is controlled by differences in the natural habitat : soils, moisture content and drainage, differences of slope, elevation, aspect, and recent fire history.

In the past most scholars have proposed that at least the eastern highlands were covered by continuous dense forest (cf. Perrier de la Bathie, 1921, 1927;

Humbert, 1927). In fact, many people have spoken of the ancient highlands as having once had a forest like that still to be seen today in higher elevations along the eastern escarpment, for example at Andasibe. It has been suggested that the prehuman environment was more likely a mosaic because of the great variety of animals known to have lived there in the centuries preceding human arrival (Dewar, 1984, 1986) or because the diversity of the flora suggested that forest remnants seem to have existed in relative isolation from each other for a long time (Koechlin et al, 1974). The recent paleoecological discoveries now resolve this issue. First, none of the fossil pollen samples analyzed are at all similar to the kind of pollen spectra one finds in recent sediments in ponds in forests like that at Andasibe (Burney, 1988). The woodlands of the highlands have both different species than are represented in modern pollen samples from ponds and bogs in the humid eastern forests, and also quite different patterns of diversity. Second, the pre-human settlement pollen assemblages bear much closer resemblance to the pollen found in recent sediments from areas of the north and west, where modern conditions are those of a vegetational mosaic.

In the ancient mosaic there would have been areas of fairly heavy forest, probably ranging along the watercourses and on certain slopes. In other areas, the sunlight would have reached the ground, and grasses and sun-loving shrubs would have had a place as well. Indeed such open areas must have been relatively common in order to account for the quantity of grass, herb and shrub pollen found in all of the pollen samples from the cores in the highlands. Unlike the modern environment, though, there would have been ample supplies of trees for lumber and firewood. As such, the environment encountered by the first inhabitants of the highlands would have afforded a greater number of opportunities and resources than either the dense eastern forest, or the nearly treeless landscapes of the modern highlands.

OPPORTUNITIES FOR PEOPLE IN A WOODLAND MOSAIC

Since the original vegetation of the highlands was significantly different from both the modern environment that has succeeded it and from the modern eastern humid forest, we can be sure that it presented its first settlers with ecological possibilities different from those of either region today. It is a task for archaeologists to discern the nature of early economic systems of the highlands. While the initial settlement of the highlands may well have involved a migration from the east coast as both oral traditions and the most modern scholars attest, such settlers would not have found the same conditions on the highlands that they had once exploited further to the east. They would have found an environment, like today, both cooler and with more seasonal rainfall, and they would have found the greater variety of kinds of vegetation implied in the term mosaic. This suggests that they may well have shifted to new forms of agricultural and economic activities.

While the first settlers may have arrived with an agricultural system based upon itinerant slash and burn agriculture, the landscape of the highlands would have differed in important ways from the heavily forested east. The rainfall regime of the highlands was more seasonal, the annual temperatures lower, and the reduced extent of forest would in all probability have led to at least some modification of the agricultural practice. For example, a primary need of farmers is the clearance of natural vegetation in the preparation of fields. If the most heavily forested areas of the highlands were along river courses, the clearance of fields by felling and burning forest would have meant that such fields also would have been near rivers. Such areas would have soil, slope and hydrological characteristics presenting different agricultural opportunities than the more steeply inclined hillsides of much of the east. There also would have been much less area exploitable by this method than in the more uniformly forested areas along the east coast. Since the ecological transformations of the highlands seem not to have been limited to the riverine forests, it seems unlikely that the agricultural exploitation of the highlands was limited to those areas most similar to the east. Thus, any suggestion that the transformation of the highlands was accomplished purely by itinerant slash and burn cultivation seems less likely today than it did when we believed that the highlands were initially cloaked by a uniform and dense forest.

CAUSES OF RECENT ECOLOGICAL CHANGES IN THE HIGHLANDS

In fact, while Burney has documented the ecological history of the highlands over the last 1500 years, the causes of these changes are still incompletely known. In part, some recent changes may have been due to climatic fluctuations, certainly a dominant cause in the period before human impact. A second factor may have been the widespread burning that seems to have accompanied human occupation. Again, some of these fires may have had natural causes, and others human origins. Among fires set by humans, some may have served to clear vegetation for fields, while others may have been set for other purposes. The modern bush fires of the highlands, which have very important effects on the vegetation, are not lit to clear fields. A third hypothesis, which remains to be demonstrated, is that the introduction of cattle, goats and sheep may have been important in transforming the vegetation of the more open areas of the mosaic. Recent ecological histories of areas as widespread as tropical Central America, the arid American southwest, and the island of Hawaii have all shown the enormous and remarkably rapid effects that grazing by cattle can have on an environment. Probably, all of these, in combination with the direct transformation of natural landscapes into agricultural fields, played a role. For the present, the relative importance of these causes, and of others, is unknown. It is a critical task to establish the history and pattern of the development of the human economies of the highlands, for without an understanding of the underlying patterns of the human ecology, the precise causes of the transformation of this landscape will remain conjectural.

CONCLUSION

The paleoecology of the highlands is now being documented in a new way, and many remarkable conclusions can be drawn. First, it is now clear that the vegetation of the highlands has been changing for thousands of years, and took many different forms, both in the period before human occupation as well as after. Second, fire was an important component of the natural environment for many thousands of years before human arrival. While fires set by people may have been important in changing the vegetation, it is unlikely that such a change happened overnight. Third, we are now able to show that the environment found in the highlands by the first settlers of the region was different in many ways from any modern vegetation in the highlands of Madagascar. It was neither a dense humid forest very similar to that found along the eastern escarpment, nor an open steppe or savanna like that so common today in the highlands. These new findings provide an opportunity for archaeologists and historians to reinterpret old evidence and to seek new evidence casting light upon the initial occupation of the highlands.

REFERENCES CITED

BURNEY, D. A., 1987a- Late Holocene vegetation change in central Madagascar, *Quaternary Research* , 28, pp. 130-143.

BURNEY, D. A., 1987b- Late Quaternary stratigraphic charcoal records from Madagascar, *Quaternary Research* , 28, pp. 274-280.

BURNEY, D. A., 1987c- Presettlement vegetation changes at Lake Tritrivakely (Madagascar), *Paleoecology of Africa* , 18, pp. 357-381.

BURNEY, D. A., 1988- Modern pollen spectra from Madagascar, *Paleogeography, Paleoclimatology, Paleoecology* , 66, pp. 63-75.

DEWAR, R. E., 1984- Recent extinctions in Madagascar : The loss of the subfossil fauna, *Quaternary Extinctions* , edited by P.S. Martin and R.G. Klein, University of Arizona Press, Tucson, pp. 574-593.

DEWAR, R. E., 1986- Ecologie et extinctions des subfossiles de Madagascar, Traduit par P. Vérin, *Taloha* , 10, Université de Madagascar, Musée d'Art et d'Archéologie, pp. pp. 25-41.

HUMBERT, H., 1927- Destruction d'une flore insulaire par le feu : Principaux aspects de la végétation à Madagascar, *Mémoires de l'Académie Malgache* , 5, pp. 1-80.

KOECHLIN, J., GUILLAUMET, J-L., and MORAT, P.- 1974, *Flore et Végétation de Madagascar*, J. Cramer, Vaduz.

PERRIER DE LA BATHIE, H., 1921- La végétation Malgache, *Annales du Musée Colonial de Marseille* , 9, pp. 1-266.

PERRIER DE LA BATHIE, H., 1927- Fruits et graines de sement de subfossiles d'Ampasambazimba, *Bullétin de l'Académie Malgache* (n.s.), 10, pp. 24-25.

RICHARD, A. F. and DEWAR, R. E., 1991- Lemur ecology. *Annual Review of Ecology and Systematics* , 22, pp. 145-175.

SCHOENWETTER, J.S., 1990- Lesson from an alternative view. In *Powers of Observation : Alternative Views in Archeology*, Archeological Papers of the American Anthropological Association Number, 2, pp. 103-112.

WRIGHT, H.T., ANDRIANAIVOARIVONY, R., BAILLIFF, I., BURNEY, D., HAAS, H., RAHARIJAONA, V., RAKOTOVOLOLONA, S., RASAMUEL, D., DEWAR, R., 1991- Datations absolues des sites archéologiques du centre de Madagascar : présentation des déterminations, *Taloha*, 11, pp. 121-145.

RESUME

L'étude du contexte végétal dans lequel ont vécu les anciens Malgaches a fait l'objet d'hypothèses qui sont maintenant infirmées par ces nouvelles découvertes palynologiques. Jadis, Humbert et Perrier de la Bathie pensaient que la totalité des Hautes Terres possédait une couverture végétale continue et dense. Or, celle-ci était plutôt un "patchwork" de milieux différents que l'intrusion de l'homme, par les feux notamment, a bouleversé. Mais antérieurement à l'homme, des modifications de ce milieu sont aussi intervenues. Il reste à associer les analyses palynologiques avec la stratigraphie des sites habités dont aucun, parmi ceux qui ont été jusqu'ici découverts sur les Hautes Terres, n'est plus ancien que le XIè siècle, alors que l'homme a perturbé le milieu, peut-être dès le milieu du premier millénaire de notre ère, ou même avant.

FAMINTINANA

Noporofoin'ny fikarohana vaovao momba ny vonin'ny hazo voarakitra tany ambanin'ny tany fa diso ny fiheverana ny toetry ny zava-maniry nandrakotra ny hodi-tany teto Madagasikara taloha. Nolazain-dry Humbert sy Perrier de la Bathie fa voasarona zava-maniry matevina sy feno ny teto anivon-tany. Ny marina anefa dia faritra maromaro samy nanana ny toetrany (ala, savoka, ahitra isan-karazany) no nikorontana nony tonga ny olombelona, ary talohan'izany aza dia efa nisy fiovana ihany koa nitranga. Ny fampitahana ireo vokatry ny fandinihana ny vonina hazo tavela ireo amin'izany dia hita amin'ny toerana nonenan'ny olombelona sisa no tokony hatao, na dia vao tamin'ny taonjato faha-9 aza no ela indrindra amin'ireo toerana ireo, nefa ny olona dia efa nanomboka niasa ny manodidina azy tany amin'ny taonjato faha-5 tany.