Acta Palaeobot. 35 (1): 99–103, 1995

PLANT MACROREMAINS FROM Z'BIB N ELIAS. A SUBFOSSIL MIDDENS FROM A PREHISTORIC CAVE IN THE HOGGAR, CENTRAL SAHARA

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ABSTRACT. The study of plant macroremains recovered from a ^{14}C dated subfossil middens of hyrax (*Procavia capensis* Pallas) found in a cave in the Taessa Mountain in the Hoggar massif of the central Sahara, constitutes a useful palaeobotanical tool for the reconstruction of the vegetation history around 4900–4600 yrs bp. The results of the carpological analysis show that the vegetation at that time period differed little from that existing at present in the central Saharan mountains.

KEY WORDS: Holocene, Sahara, vegetation, carpology, *Procavia capensis* Pallas, middens

INTRODUCTION

The present paper aims at exploring a recently developed palaeobotanical tool useful for the reconstruction of the vegetation history in dry regions in general and in the the Sahara in particular during the Holocene. So far, all serious attempts to study the past vegetation in the region have been directly linked to archaeological sites, this is mainly due to the fact that pollen analysis is almost impossible except in some Holocene lake sediments (Ritchie et al. 1985). We are thus limited to charcoals and charred macroremains from household hearths and occupation middens in prehistoric sites, and while in many of the Neolithic sites in the Sahara, charcoal is plentiful, well-preserved macroremains are very rare. This leads to the loss of an important part of the information necessary for a sound reconstruction of the vegetation.

The midden deposits accumulated by the hyrax (*Procavia capensis* Pallas) over a considerable period of time in a cave in the Hoggar National Park in Algeria, offer an interesting opportunity for a different insight into the vegetation history than that usually observed through archaeological plant material. The potential of the middens accumulated by the herbivorous *Procavia capensis* Pallas as a source of data for palaeoenvironmental studies in Africa due to the presence of pollen grains has already been pointed out (Pons & Quezel 1958, Scott & Cooremans 1992, Fall 1990). The study of the large quantity of uncarbonized macroremains (seeds and fruits) present in the excrements has however, rarely been reported (Fall 1990).

The results of the carpological analysis of the deposit are presented and discussed, furthermore, a quantitative approach is presented, discussed and proposed with some ideas. Finally an attempt to interpret the results qualitatively in order to understand the vegetation during the Holocene in the region is carried out.

LOCALITY AND NATURE OF THE SAMPLES

The site is located on the granite chain of Taessa Mountain (23°10' N, at an elevation of 2150 m a.s.l.), some 40 km north of Tamanrasset within the Hoggar massif (Fig. 1). It constitutes a hardly accessible cave, 20 m up the cliff. Within the cave the organic deposits of plant fragments and fecal pellets covered by the crystallised animal urine were accumulated. These are middens of the hyrax (*Procavia capensis* Pallas) which take the form of a dark coloured solid mass sticking to the rock

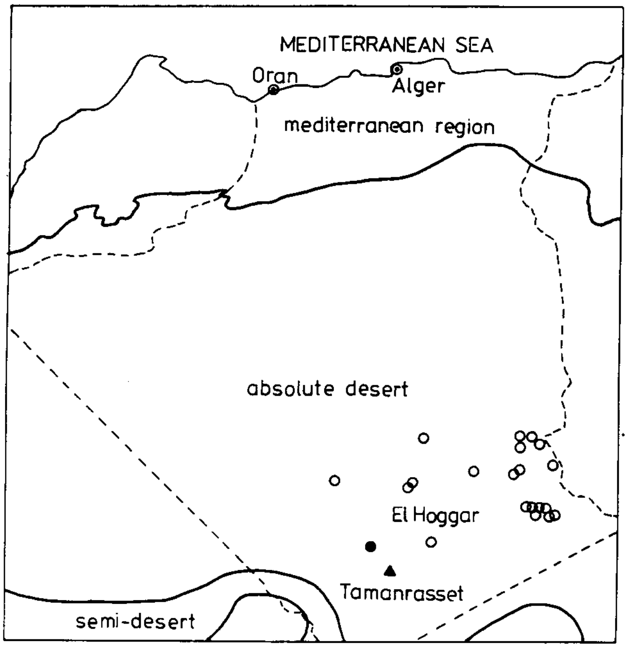

Fig. 1. Map of Algeria showing the position of Z'bib N Elias ● and the geographical range of *Procavia capensis* Pallas ○ after Kowalski & Rzebik-Kowalska 1991

wall of the cave. The latter was used as shelter by the hyrax over a long period of time during the Holocene. The collapse of the lower part of the opening sometime ago has probably rendered the cave useless as a shelter.

Samples from the main midden mass have been recovered during a 1990 expedition to the site by Drs A. Ballouche & M. Thinon, and handed over to the writer for carpological analysis and to Drs A. Ballouche & M. Reille for palynological analysis (Ballouche et al. in prep.).

For the purpose of ^{14}C dating, fragments from the deposit surface and innermost layer were chosen, those have yielded dates of 4630 ± 80 and 4910 ± 80 yrs bp respectively. These dates show that the deposit has relatively rapidly accumulated, during the final phase of the late Neolithic period (10000–4000 bp) in the Sahara (Wendorf & Schild 1980), and is contemporary with the round-headed bovine period in the rockart of the central Sahara.

It is noteworthy to mention that at the foot of the cave, there is a prehistoric site distinguished by the abundant lithic artefacts on the surface, it is still unexcavated and could be of interest.

THE METHODOLOGY OF THE RECOVERY OF THE PLANT REMAINS

The 3 samples handed over for carpological analysis were soaked in hot water for 24–48 hours. Afterwards, they were sieved under water on a series of 1.6–0.8 and 0.4 mm mesh sieves, in order to recover all vegetal debris mixed with much hair and insect remains. The mixture was further air-dried and then sorted manually to separate the vegetal macroremains (fruits, seeds and charcoal), which were then classified into 24 morphological types.

PROBLEMS OF IDENTIFICATION

The problems met with while trying to identify the seeds and grains in the samples, as have been mentioned in Wasylikowa (1992), are due to:

1. The little we know about the history of the vegetation and plant distribution in the Sahara during the Holocene.
2. The lack of information on the morphology of seeds and fruits in the floras of the region and in published archaeobotanical works.
3. The lack of good carpological collection of African plants; the herbarium collection is often inadequate, because fruits and seeds are either absent or collected during an earlier stage of maturity.

The identification of the macroremains was carried out making maximum use of the collection in the Saharan herbarium at the IMEP (Institute for Mediterranean Ecology and Palaeoecology) in Marseille, the floristic works on the region as well as the carpological collection at W. Szafer Institute of Botany, Polish Academy of Sciences, Cracow.

As a result of these problems, the identification was often limited, except for the well-represented taxa, to the genus and sometimes even to the family level. Further analysis under more favourable conditions would enable us to determine more taxa to more precise levels of identification.

THE RESULTS OF THE CARPOLOGICAL ANALYSIS

The representation of the results

The results of the carpological analysis are shown in Tables 1 and 2.

The quantitative representation of the re-

Table 1. The results of the anthracological analysis

Taxon	Sample 1	Sample 2	Sample 3
Pistacia atlantica	0.5 g (22.7)	0.18 g (8.18)	1 fragment
Olea laperrini	3.835 g	4.707 g	
Rubus cf. *sanctus*	35	8	
Polygonum nodosum	3	40	
Withania sp.		39	
Solanum nigrum	378	368	
Nepeta cf. *mirei*	10	78	
Panicum turgidum	13	6	2
Brachiaria deflexa		14	3
Digitaria type	18	125	
Andropogonae type		1	
Gramineae	1	1	
Silene cf. *arenaria*	9	7	
Vaccaria type			1
Amaranthus sp.		2	
Polygonum sp.		1	
Oxalis cf. *corniculata*	2	8	
Compositae (a)	3	2	
Compositae (b)	11	6	
Compositae (c)	5	5	
Umbelliferae	1	5	
cf. *Rhamnus* sp.	1		
Myrtus nivellei	262	251	10
Unidentified (11)		5	

Table 2. Semi-quantitative representation of the results in the form of number of species per family and the percentage of total number of species

Family	No of species	% of total spp. no
Gramineae	7	28
Compositae	2	8
Solanaceae	2	8
Caryophyllaceae	2	8
Polygonaceae	2	8
Umbelliferae	1	4
Labiatae	1	4
Rosaceae	1	4
Oleaceae	1	4
Anacardiaceae	1	4
Oxalidaceae	1	4
Plantaginaceae	1	4
Amaranthaceae	1	4
Rubiaceae	1	4
Rhamnaceae	1	4
Myrtaceae	1	4

sults in Table 1 posed some problems because large-sized seeds were frequently found in the form of fragments. Instead of counting the number of fragments which would be of little meaning, the fragments were weighed and the weight is shown in the table followed by the corresponding minimal number of seeds (having weighed a single whole seed). For all other remains, the number of seeds or fruits is indicated. This quantification in the form of the exact number of specimens gives an idea about the abundance of each taxon in the sample and might be used as an indicator of the importance of the more abundant taxa in the vegetation.

In Table 2, I tried a more general semi-quantitative approach, the results are represented in the form of the numer of taxa identified per family, and the percentage of the total number of taxa. This approach has 2 advantages:

a. The reliabilty of the identification to the family level is quite high.

b. This representation is a common practice when describing the present day flora of the region (Ozenda 1977), the results could thus be easily compared.

From Table 2, we find that the best represented family is Gramineae, followed by Compositae and Caryophyllaceae etc. Similar values are given for the Saharan flora (Ozenda 1977): Graminae 20%, Leguminosae 12%, Compositae 8%.

DISCUSSION

The present-day phytogeographical distribution of the more important taxa in the samples

From Table 1, we could notice that the most abundant taxa are *Pistacia atlantica* Desf. (Fig 2: 1), *Olea laperrini* Batt. et Trab. (Fig 2: 2), *Solanum nigrum* L. (Fig 2: 6), *Nepeta mirei* (Fig 2: 7), followed by the Gramineae complex of *Panicum turgidum* Forssk. in addition to other less precisely identified grasses.

1. *Pistacia atlantica* Desf. is an endemic species in the central Sahara, mainly found at the foot of the Atlas Mountains in Marocco and Algeria (Ozenda 1977).

2. *Olea laperrini* Batt. et Trab. is another endemic species in the Saharan mountains common in the Hoggar region between elevations 1500 and 2000 m (Ozenda 1977).

3. *Rubus sanctus* Schreber (Fig. 2: 3) is found over the Sahara from Libya to Marocco,

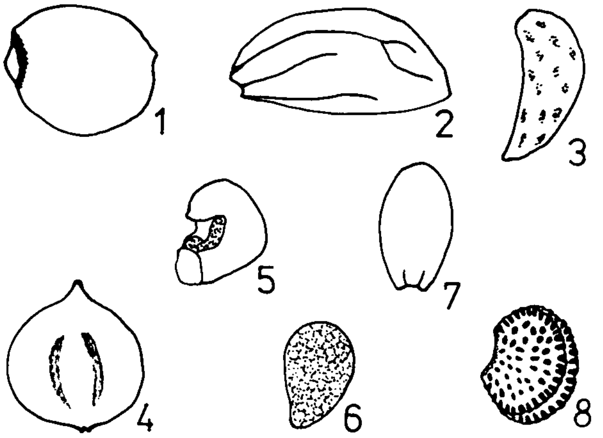

Fig. 2. Some macroremains from Z'bib N Elias. 1 – *Pistacia atlantica* × 5, 2 – *Olea laperrini* × 8, 3 – *Rubus* cf. *sanctus*, × 5, 4 – *Polygonum nodosum* × 10, 5 – Unidentified (M. T. 5), 6 – *Solanum nigrum* × 10, 7 – *Nepeta mirei* × 15, 8 – *Silene arenaria* × 20

it is of medicinal interest due to its astringent leaves (Boulos 1983).

4. *Solanum nigrum* L. (Fig. 2: 6) is a cosmopolitain weed, found in the central Sahara close to inhabited localities within cultivations. The same goes for *Polygonum* and *Withania* sp.

5. *Nepeta mirei* Quézel is also endemic in the Saharan mountains, met with at elevations of more than 3000 m on volcanic rocks (Quézel 1954, 1965).

6. *Oxalis corniculata* L. is found in the central Sahara, in Tibesti (Quézel 1965).

7. *Panicum turgidum* Forssk. is by far the characteristic element and the most important wild grass in the Saharan landscape, it is common in wadi beds and borders within the *Acacia-Panicum* plant community, and at lower elevations all over the Sahara and to the south (Ozenda 1977, Quézel 1954, 1965, Täckholm 1974). It is thought to have been more abundant earlier (Harlan 1989).

8. *Brachiaria deflexa* C. E. Hubbart and *Digitaria* spp. belong to the components of the kreb meadow in the western Sahara and have long been harvested as wild grains on a large scale

9. *Silene* (Fig. 2: 8) is the most important and abundant caryophyllaceaen genus in the north African flora, it is represented by over 100 species. *Silene hoggariensis* is an endemic of the Hoggar region.

10. *Myrtus nivellei* Batt. et Trabb. is an endemic central Saharan tree, growing in wadi beds of the upper region in the Hoggar mountains (at 1800 m) mostly close to permanent water points.

THE RECONSTRUCTION OF THE VEGETATION

The reconstruction of the vegetation relies upon the fact that the analysis of pollen grains found in recently accumulated middens of the hyrax gives a reasonably true image of the present day vegetation in South Africa (Scott & Cooremans 1992), the animal being non-migratory, with non-discriminating taste and collecting plants growing near its nest (Fall 1990). We might thus consider that the floristic list in Table 1 sheds some light on the vegetation in the area during that part of the Holocene as well as on the feeding habits of the hyrax.

Comparing the present day flora to the list resulting from the carpological analysis, we could find many common features:

a. Practically all the taxa identified in the fossil samples are found at present in the region, many other taxa are missing from the list (e.g: *Periploca angustifolia, Rhus tripartita, Globularia alypum*, etc.), this is doubtlessly due to the feeding habits of the hyrax, related to palatability of the missing taxa.

b. *Olea laperrini, Pistacia atlantica* and *Myrus nivellei* are the dominant taxa in the fossil samples; *Olea* and *Myrtus* are still a dominant species in the present-day vegetation, there are a few old trees of *Pistacia* in the vicinity of the site.

The hyrax is thought to feed mainly on seeds and leaves of *Acacia* spp. (Kowalski & Rzebik-Kowalska 1991). The absence of leguminous seeds in the samples might be attributed to the digestibility of the seeds rather than to their palatability, so that even if the plants were consumed by the animal, they did not survive the digestion and were not found in the samples.

CONCLUSION

The Holocene vegetation in the vicinty of the site

Detailed carpological as well as palynological analyses of fossil hyrax middens from the

Taessa Mountain show that the flora of the region around 4600 yrs bp differed little from that existing at present. *Olea laperrini, Pistacia atlantica* and *Myrtus nivellei*, 3 endemic species still well-represented in the flora, dominated the vegetation, in addition to many other central Sahara endemics and Sahara taxa. This is in contrast to earlier interpretation of palynological analysis of hyrax middens samples from the same cave by Pons and Quézel (1958) as indicating the presence of a Mediterranean type of vegetation in the central Sahara during the mid-Holocene.

This must have been towards the end of the climatic optimum phase (10000–4000 yrs bp) which was characterised by the higher rainfall and the northward extension of southerly elements into the flora (Ritchie & Haynes 1987, Neumann 1989a, b), and the beginning of the return of the arid, then the hyperarid conditions by 4000–3000 yrs bp (Le Houérou 1992, Petit-Maire 1989). This aridification process was probably not only due to the climatic change but also due to a human impact. The desert was becoming a desert again.

ACKNOWLEDGEMENTS

The author wishes to express her sincere thanks to Prof. K. Wasylikowa for her help and encouragement during the identification of the plant remains and for allowing her to make use of the reference collection at W. Szafer Institute of Botany, Polish Academy of Sciences, Cracow.

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