CONTINUOUS COMPOST TOILETS IN TUNISIA

PART 1

JUNE 1980

SWECO

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Summary

SIDA, the Swedish International Development Authority, has started a pilot project involving the use of continuous compost toilets in Tunisia in order to gain experience on the type of toilets which could actively contribute to solving the sanitary problems faced by developing countries in hot climates.

An account of the pilot project will be published in two separate reports. This report, which has been written in co-operation with Mr. Leif Rosenhall, Head of SIDA's Industrial Section, is Part 1 and describes the project up to and including the completion of the facilities.

In a subsequent part, which is expected to be published in two or three years' time, an account will be given of the experience gained during the period in which the toilets have been used.

In the developing countries, sanitary conditions are often unacceptable when compared with the standards enjoyed in industrialized countries. Properly organized sewerage systems are in many cases completely lacking or are unsatisfactory from the sanitary point of view. This is especially the case in villages and suburbs of large towns. Arrangements for the hygienic disposal of excrement, kitchen waste etc. are lacking and fields and pastures in the vicinity of the houses serve as dumping areas for human faeces and urine.

As a result of these inferior sanitary conditions the groundwater becomes contaminated and diseases are spread.

Nitrogen from human waste can find its way into the groundwater from excreta on fields or from leaking pit latrines and pipes. The concentration of nitrogen-based pollutants in the groundwater can be considerable, especially in dry climates where nitrogen dispersal via plants is limited and the aquifer has a low rate of recharge.

High nitrogen values have been recorded in wells in Tunisia and other countries and can lead to changes in the composition of the blood, especially in the case of newly born infants. In addition, so-called nitrosomonas can be formed which are believed to give rise to cancer.

Disease-producing bacteria and viruses, such as intestinal worms and parasites from excreta, can be spread by direct contact, insects, water, waterlogged soil or cattle.

The carefully controlled disposal of excreta is therefore of paramount importance in the prevention of disease.

The excreta can be enclosed in watertight compost toilets which, as an end product, can provide a form of fertilizer which is fully acceptable from a hygienic point of view.

The composting process is described in the report and the important aspects regarding the function of the process are discussed, such as the nitrogen-carbon balance, air supply, temperature, humidity and the starting-up bed. Different types of compost toilet are also described, in particular the Swedish continuous compost toilets of the Clivus Multrum and Toa-Throne type as well as the in situ compost toilets specially developed for the project in Tunisia.

The pilot project in Tunisia has been preceded by a sociological study of attitudes carried out by Dr. Ridha Boukrâa from the University of Tunis. On the basis of this study, SIDA, in collaboration with local authorities, has selected Malloul, Brahmia and Rohia as being areas suitable for the pilot project.

In order to obtain as comprehensive an idea as possible of the way in which the compost toilet functions, several different types of Swedish and in situ manufactured units have been constructed in the different communities.

The toilets have been built by contractors in Malloul and Brahmia and, in the case of Rohia, by the users themselves. Mr. Lars Hermansson, a civil engineer from Tunis, has acted as the designer and technical advisor for the project. A total of 30 continuous compost toilets of the Clivus Multrum (2) and Toa-Throne (5) models as well as in situ manufactured variations (23) have been constructed during the first half of 1980.

The construction costs per compost toilet have amounted to SEK 4 000 to 6 000 for in situ manufactured units and to SEK 13 000 to 19 000 for toilets furnished with plastic receptacles imported from Sweden (SEK 1 = USD 0.24).

The "do it yourself" cost, i.e. the construction cost minus the cost of labour, is estimated to amount to half the mentioned cost.

CONTINUOUS COMPOST TOILETS IN TUNISIA

PART 1

Introduction

Problems concerning water supply and sewerage are of vital importance to human beings. In the industrialized countries resources are available for solving these problems in a satisfactory way as regards health aspects. This is not the case in the developing countries where both money and know-how are in short supply.

SIDA, the Swedish International Development Authority, has launched a pilot project employing continuous compost toilets in Tunisia in order to gain an idea of whether or not this type of toilet could actively contribute to solving the sanitary problems facing developing countries with hot climates.

The pilot project comprises 30 continuous compost toilets of the Swedish Clivus Multrum and Toa-Throne types as well as in situ manufactured variations. The toilets have been located in three separate places in Tunisia.

An account of the pilot project will be given in two separate reports. This report constitutes Part 1 and provides a description of the project up to the final installation of the units. For earlier project reports and literature on this subject reference is made to Appendix 1.

In a subsequent part, which is expected to be published in about two or three years' time information will be given on experience gained from the utilization of the units.

This report has been prepared in co-operation with Mr. Leif Rosenhall, Head of SIDA's Industrial Section.

Sanitary problems in developing countries

It is often the case that in developing countries the sanitary conditions are unacceptable if measured against the standards applied in industrialized countries. In many cases there is either a total lack of proper sewers or they are completely unsatisfactory from a sanitary point of view. This applies in particular to villages and the suburbs of large cities. Arrangements permitting the hygienic handling of excrement, kitchen waste etc. are non-existent and fields and arable land adjacent to the houses have to be used as disposal areas for human faeces and urine.

As a result of these inferior sanitary conditions, the groundwater becomes contaminated and diseases are spread. Nitrogen from latrines can find its way into the groundwater from leaking pits and sewers. The concentration of nitrogen pollution in the groundwater can be considerable, especially in dry climates where nitrogen dispersal by plants is limited and the speed of groundwater recharge is slow.

The World Health Organization, WHO, has a standard which it applies to drinking water where the highest value for nitrogen measured as nitrate, NO_3, has been set at 45 mg/l. European and Swedish standards stipulate similar values, 50 and 30 mg/l respectively.

Comparison with values recorded from wells in Tunisia

	NH_4	NO_2	NO_3
Rohia[1)]	0.48	0.019	3.2
Mornaghia[2)]	0.28	0.032	13.2
Harisa[3)]	0.28	-	130.0
Bir M'Zara[4)]	0.32	-	523.8

1) Isolated farm, no pit latrines
2) Farm cattle, gardens, no pit latrines
3) Densely populated farming area, pit latrines
4) Densely populated village, pit latrines and leaching trenches.

A single pit latrine in a sparsely populated area will not in practice give rise to any nitrogen pollution problems. However, when the population becomes denser problems will arise and in an urbanized area the natural assimilative capacity of the environment will be overloaded, and nitrogen will be brought to the groundwater both from pits, soakaways and the surface. The nitrogen content in well water gives a good indication of the amount of nightsoil deposition under the ground surface.

Nitrogen pollution can lead to changes in the composition of the blood, especially in the case of bottle-fed babies under the age of six months.
In addition, nitrosomonas can be formed which are thought to cause cancer of the bladder and stomach.

A high nitrogen content in groundwater also indicates that there is a risk of faecal bacteria and virus pollution. Disease-producing bacteria and viruses can be transported by the groundwater via cracks and porous layers of soil. Exactly how far they can be transported and still be a threat to health depends on the level of the water table, the nature of the soil, biochemical conditions and the speed and direction of the groundwater flow.

If circumstances are favourable, i.e. the difference in depth between the bottom of the latrine pit and the water table is more than 3 - 4 metres and the soil is silty sand with low transmissibility, a safe distance of 30 metres is acceptable. If, however, the soil contains layers of gravel, or the bedrock is very fractured and the water table is shallow, the pollution distance could be much longer.

Bacterial survival in groundwater is generally reported as up to 5 months with most reduction taking place in the first few days. Faecal coliforms survive for longer than salmonella, and can multiply in the presence of nutrients - such as when effluent reaches the groundwater and viruses may survive for 6 months or more.

In areas where there are many pit latrines, soakaways, unlined stabilization ponds or a recharge system, there will always be a risk of pathogenic viruses and bacteria reaching the groundwater. In pit latrines, soakaways and ponds, the waste-soil interface quickly becomes clogged with solids and thus more effectively retains these micro-organisms. The risks to health occur when the contaminated groundwater is used as a drinking water source. However, the pathogenic content of polluted groundwater will, in general, be very much lower than that of surface waters in the same area. Where untreated water is being used for domestic purposes there will therefore be a lower risk from wells than from nearby streams or ponds, and where water is chlorinated, the bacterial pathogenes will be effectively destroyed.

Particular care is required where untreated well water is being used in densely-populated areas as the only domestic source and where there is widespread use of soakaways or pit latrines. If routine water quality monitoring demonstrates a significant groundwater pollution problem then it is necessary either to supply piped water of better quality, usually the least expensive method, or to change the excreta disposal method. But in arid areas, where the number of productive wells is insufficient to meet the requirements of a whole village, the latter alternative is the only practicable solution.

Another reason for installing special toilets and not disposing of untreated waste on adjacent fields is to prevent the spread of intestinal worms and parasites which can be transferred to human-beings through direct contact, insects, waterlogged soil or cattle. A considerable number of different types of intestinal worms and parasites are known to be spread primarily by excreta, and consequently carefully controlled treatment of excreta is extremely important when trying to combat the spreading of disease.

One way of preventing nitrogen and pathogenes from reaching the groundwater and avoiding the spreading of excrement around the dwellings is to install watertight composting-type latrines. An added advantage of this solution is that they can also produce hygienically acceptable material which is well-suited for use as a fertilizer.

Alternative types of sewerage

In the industrialized world, human waste is for the most part conveyed by waterborne transport in pipes to a treatment plant where it is treated before being discharged in a relatively harmless condition into a recipient. From a hygienic point of view, the system is well-adapted to a society with a high technical standard but involves high installation and running costs. In developing countries, the annual per capita income is often on average lower than the annual costs of a waterborne sewerage system which means that a system of this type is generally speaking impracticable. In these countries, sanitary problems frequently have to be solved in other ways.

In villages and less-densely populated areas, separate sewerage facilities for each household can consequently prove to be a suitable solution. There are basically five types of household facilitity which do not require electricity or water connections:

1. Pit latrines
2. Pour-flush toilets
3. Compost toilets
4. Aqua-privies
5. Bucket latrines

This report deals with type 3, the compost toilet, and in particular the type known as the "Multrum" toilet.

Composting

The aerobic process

Composting is a rather slow biological process which involves the decomposition of organic material. The process is mainly aerobic, i.e. it requires the presence of air and the waste matter is decomposed into a stable, humus-like product. In comparison with nutrification, which is an anaerobic process, i.e. it does not require oxygen, no unpleasant odours are evolved in the composting process. Relatively high temperatures are reached in the early stages of the process but in order for effective decomposition to occur, certain conditions must be met.

Nitrogen-carbon balance

The mixture of nitrogen (which mainly comes from urine and faeces) and carbon (from paper, fruit peel and food residuals) should preferably be in the ratio of 1:30.

The energy exchange which creates the temperature rise is directly related to the composition of the compost mass. Since the nightsoil has a low energy content (most of it has already been extracted by human digestion) other residuals must be added to obtain the required energy input.

Tests indicate that carbon by itself in the form of cellulose (paper, leaves) does not give such satisfactory results as when food residuals are added to it.

Air supply

In order for optimum decomposition to occur, the entire mass of compost must be effectively aerated. In the case of the toilet in question the air enters the mass via down-draught from a long ventilation stack which must terminate above the roof of the toilet. The orifice should be covered by a fly-screen in order to prevent flies and other insects from reaching the compost. The vault must be airtight in order to force the air through the compost and, in order to facilitate air penetration, inverted PVC ducts should be installed in the vault. In addition, slits could be made in the base of the vault.

Temperature

The temperature of the air supply must not be allowed to fall lower than about $+15^{\circ}C$ if the process is to function properly (decomposition will stop completely if the temperature falls below $+7^{\circ}C$) Although the process is not adversely affected by even fairly long periods of chilly weather, the hot climates usually enjoyed by most developing countries offer the most favourable conditions for a successful composting process.

The aerobic composting process generates a considerable amount of heat and, as refuse and nightsoil have relatively good insulation properties when properly compacted, much of this heat can be retained within the mass thereby developing high temperatures. The most suitable operating temperature is in the range of 60 to $70^{\circ}C$ and at this temperature all the organisms of known diseases found in the excreta of infected persons will be destroyed.

Moisture

The moisture content of the mass must be within the interval of 40 - 60 per cent by volume, the optimal being 50 - 55 per cent. Should it be too dry, the micro-organisms will not work as drying is a well known method of preservation. Should too much water be present the mass will become soaked so that air cannot penetrate and energy production will decrease. The temperature will drop, the water will not evaporate, the moisture content will rise and with less air penetration and less temperature rise, there will be total soaking and consequent termination of the process. The installation of a drain in the bottom of the vault will usually help against occasional waterlogging.

If the mass becomes too dry, additional water must be added. This could be done either by more frequent use of the latrine for urination or by the addition of more waste water.

Checking the moisture content of the mass in the field is rather a complicated procedure and it is much easier to check whether the process is working well, i.e. to measure the temperature of the mass. Should the temperature only be the same as the mean air temperature of the last forty-eight hours, a simple inspection will usually give a clear indication of whether the mass is too dry or too wet.

The moisture content not only depends on the amount of liquid provided, it also depends on the relative humidity of the air. A dry climate and a high temperature, for instance on the edge of a desert, will evaporate considerable quantities of water from the mass, and surplus water will probably have to be added. If the air has a high moisture content, for example in a rain forest, there is a risk that moisture will condense in the mass and cause waterlogging.

Starting-up bed

Before a composting latrine is used for the first time, the bottom must be covered with a loosely filled layer of organic residue; grass, weeds, leaves, straw or similar. This serves to adsorb liquid, provide carbon for decomposition, increase the concentration of micro-organisms and prevent the compost from becoming too compact.

The compost

The energy production in the mass, the amount of liquid added, the ventilation and the humidity of the air, are all factors that will interact to produce favourable conditions for composting, but only trial operation can prove whether the compost toilet is operating successfully or not.

The proper functioning of a compost toilet is thus not only a technical problem. It is also largely a question of giving the user an idea of what the likely results of different courses of action are. In this way the user will be able to control the composting process to a greater extent, a procedure which is normally fairly simple and often well-known to people used to composting residues from farms or gardens for fertilizing purposes.

The design of the vault may have an influence on the function of the composting toilet. Differences in, for example, height, width, ventilation system and the slope of the bottom can have a bearing on the practical function, and various alternatives should thus be designed to find out what really is important in the design.

The processed mass, the compost, has a fertilizing effect similar to that of manure and a high humus content, properties which make it ideal as a product for soil improvement purposes.

If the temperature of the mass has been more than 55 to 65 ^{o}C for some time, the compost will, as earlier mentioned, be sanitarily harmless. Even if the temperature has not been that high, a long detention of the material in the vault will still result in a harmless product. The only problem might be, when the material is taken from the compost latrine, not to mix freshly produced nightsoil with the processed material.

Solid waste

The amount of solid waste produced in a society is a question of prosperity and cultural patterns. In industrial countries paper constitutes more than half the refuse, with metal and glass amounting to nearly a tenth. In rural areas in hot climates, leaves are used as well as paper for wrapping food, hungry goats help with disposal, and cans and bottles are sometimes kept and re-used.

All waste is thus disposed of in one of two ways: it is either put to some useful purpose or it is dumped. A rubbish dump is often a breeding ground for rats and insects which spread pathogenes to the environment. Other problems include fires which can be started by ashes and which in turn give rise to atmospheric pollution from the smoke. When rain passes through the refuse it leaches pollutants which contaminate both surface water and groundwater.

If the refuse is sorted into fermentable organic material, such as paper, peel and food residues, the material can be composted, preferably together with nightsoil, and produce a fertilizer. This sorting is best done at source where glass, metals and plastics can be separated much more easily than at the collection site where handling is complicated and hard to manage.

Consequently, if the householder adds fermentable refuse to the compost toilet at source there is far less likelihood of unsuitable material finding its way into the compost and the final product will be a high quality fertilizer.

The compost toilet

There are basically two types of compost toilet: batch and continuous loaded.

The batch loaded compost toilet has been used for centuries in India, China and South East Asia. In principle the unit consists of two vaults which are used alternatively, the most common version being the double-vault latrine from North Vietnam.

The continuous compost toilet was developed in Sweden 40 years ago under the name Clivus Multrum. The numerous country cottages in Sweden and Norway, the high standard of living enjoyed by the two countries and the great importance attached by the inhabitants to nature preservation have during the past ten to twenty years contributed to the rapid development of different types of toilet suitable for country cottages with little or no access to running water. Among all these different kinds of toilet there are a considerable number of compost toilets suitable for use either with of without electric heating. All of them are variations of the Clivus Multrum and one of the best known is the Toa-Throne.

The double-vault toilet

The North Vietnamese double-vault toilet was designed about twenty years ago and consists of two adjacent, watertight vaults which are used alternatively. The toilet is built of concrete or local materials, see Fig. 1, and the vaults are covered by a squatting slab which has two holes, one over each of the vaults. The holes are furnished with tightly-fitting lids and the whole unit is covered by a superstructure, at the back of which there are two covered openings for the removal of the stabilised compost. After each use, ash is thrown over the faeces to adsorb fluid and to prevent bad odour and the growth of fly larvae. Urine is drained off via a groove in the slab to a pot behind the toilet where it is dilluted with water and used for watering purposes. When one of the vaults is three-quarters full it is filled with earth and sealed. The contents are then allowed to decompose slowly without the presence of air (anaerobic process) during which time the other vault is used. The temperature in the sealed full vault can in a hot climate rise to about +50°C. After six months, when the other vault has become full and it is time to seal it, the first vault is opened and the contents are removed for subsequent use as fertilizer.

The Clivus Multrum Toilet

Drawings of this toilet can be found in Fig. 2 (the vault) and Fig. 3 (complete toilet).

The Clivus Multrum toilet consists of a large vault with a sloping base and inverted U- or V-shaped channels to facilitate good ventilation of the compost. The vault is equipped with a latrine hole, a hole for kitchen wastes, grass and rubbish and a long ventilation pipe, and when not in use both the waste openings are covered by tightly-fitting lids. The latrine hole is covered by a protective superstructure. Air is admitted through the back of the vault which is subdivided into a front compartment for human excrement, a middle compartment for kitchen waste etc. and a rear collection compartment for already decomposed compost. Glass, tin cans, plastic and branches etc. must not be put into the vault. Whilst undergoing aerobic decomposition the compost moves slowly along the sloping bottom until it reaches the collection compartment, by which time it has been reduced to less than 10 % of its original volume. After two to three years' operation the composted material can be removed from the vault via a cover in the rear of the unit and from this point onwards 10 to 30 litres of humus-like material per person and year can be extracted from the collection compartment. The material is odourless and harmless from a hygienic point of view and can be used for soil improvement purposes.

The Clivus Multrum toilet is available in concrete or in prefabricated parts made of fibreglass reinforced plastic. In Sweden, the starting-up bed is composed of approx. 15 cm of peat-mould, 5 cm of topsoil and 5 cm of grass, leaves etc. and is furnished with a threshold of compacted soil which rests tightly against the under-edge of the wall between the refuse and collection compartments. When the refuse compartment is almost full, which in a Swedish household generally takes at least a year or two, the threshold can be removed and the composted refuse is allowed to enter the collection compartment.

In Sweden's cold climate the vault must be insulated against the cold and heated up during the winter. In order to improve ventilation, the outlet pipe must be insulated above roof level and perhaps even be furnished with a small extractor fan. However, such heating and ventilation arrangements are not necessary in a warm climate.

The Toa-Throne toilet

Drawings of this toilet are shown in Fig. 4 (vault) and Fig. 5 (complete toilet).

The Toa-Throne is basically similar to the Clivus Multrum toilet with the exception that the vault has a considerably smaller volume, the air is admitted via openings in the base of the vault and there is no separate opening for refuse. Both kitchen wastes and refuse are discharged into the vault via the latrine opening.

The Toa-Throne is also normally equipped with a heating device for use in Sweden during the cold season. The extract air is regulated with the aid of an electric fan installed in the ventilation stack.

The Toa-Throne's vault is manufactured of prefabricated, fibreglass reinforced, plastic sections.

In situ manufactured compost toilets

The prefabricated compost toilets sold on the Swedish and Norwegian markets are made of fibreglass reinforced plastic which has a very high resistance to the extremely aggressive compost. On the other hand, the units are far too expensive to permit their export to developing countries except for the purpose of pilot tests.

For use in developing countries, the toilet seat commonly used in north-west Europe must be replaced by the traditional hole for squatting. Also the hole must be equipped with an easily-removable cover which fits so tightly that air does not normally leak out of the hole.

The compost vault must be built on site from concrete or cemented stones and must be made completely watertight so that urine cannot seep through and find its way into the groundwater.

Drawings of such in situ constructed compost toilets can be found in Figs. 6 and 7 where various suggestions are also given on how to make the vault watertight.

Compost toilets for developing countries must be so cheap as regards construction and running costs that they represent a reasonable proportion of the cost of a normal house built in the area in question. In the West, a reasonable price for sanitary installations is given as being 10 % of the total price of the house and a similar cost relationship should be aimed for in the case of developing countries.

Approach to pilot project in Tunisia

In 1977, SIDA's Industrial Division decided to investigate the possibilities of starting a pilot project using compost toilets in Tunisia. In October 1977, Mr. Åke Fleetwood, Lic. Eng. of the Royal Institute of Technology, Stockholm, went to Tunisia on SIDA's behalf to make a closer study of the conditions for such a pilot project. The findings are published in a report dated 1977-12-06.

The report concludes that the natural prerequisities exist (geological, hydrological, climatological and ecological) but that the required surplus of energy-rich material such as paper, kitchen wastes etc. needed to maintain the composting process may constitute a problem since such materials are in short supply in most households. With the aim of avoiding expensive mistakes it was recommended that the pilot project be preceded by a special sociological study of attitudes.

Sociological study

A sociological study of this type was carried out in 1978 by the University in Tunis under the leadership of Dr. Ridha Boukrâa.

The study was performed by students interviewing families in recognized areas. The main points on the form were:

1. The structure of the family
2. Economic structure
3. Hygienic standard of the house
   a) order of precedence of requirements
   b) current latrine habits
   c) sanitary habits and water
   d) sanitary habits and refuse
   e) attitudes to compost latrines

Certain questions were dealt with in more detail, e.g.:

3b. design of latrine, habits of different members of the family, use of nigthsoil as fertilizer,

3c. amounts of water used in family, water for washing-up, water for washing/bathing elderly and babies, water use in connection with prayers, water use during latrine visits, effluent disposal,

3d. refuse handling, amounts and constituents of refuse, organic and inorganic materials, occurrence of plastics, bottles and cans.

An account of the study is given by Dr. Boukrâa in "Compostments hygieniques et changement cultural, étude sociologique", Tunis 1978 (published in Swedish by SIDA, Stockholm dated 1979-01-10).

The study indicated that in certain areas the attitude to compost toilets was positive. There did not appear to be any direct obstructions to the use of the Multrum and there was no reason why a practical pilot project should not be implemented in certain selected areas.

Pilot project areas

On the basis of the sociological study, and in order to obtain as wide a spread of climatological conditions as possible, SIDA decided in co-operation with Dr. Boukrâa and local authorities to select Malloul in the vicinity of Kélibia on the Cap Bon peninsula in northern Tunisia and Brahmia which is situated near Sidi Bouzid in central Tunisia as pilot project areas. Both places have received aid from Sweden for a considerable number of years and co-operation with the local authorities has not presented any problems.

At the same time, co-operation was established with ASDEAR in Rohia, a village situated approx. 100 km. north of Brahmia with the aim of installing and studying, under ASDEAR's auspices, similar compost toilets as the ones in Malloul and Brahmia. ASDEAR (Association pour le Développement et l'Animation Rural) is a private organization for technical and economic aid to underdeveloped rural areas.

A general map of Tunisia is given in Fig. 8.

General information on Tunisia

Tunisia gained its independence in 1956 and since this time has been governed by the Neo-Destour Party under the leadership of President Habib Bourgiba. The country has an area of 164 000 km², a population of 6 million, a rate of population increase of 3 % per year, a literacy of approx. 40 % and a GNP of about USD 860 per inhabitant in 1977. The official languages are French and Arabic and the religion is Islam. The country has developed rapidly over the past twenty years and has now become one of the leading African states as far as income per inhabitant is concerned.

Along the north and east coasts down towards Sfax there are fertile agricultural areas with cornfields, orchards, olive groves and vineyards. The inland regions and southern parts of the country, however, are steppe and desert areas. Forests are only to be found in the north-west near the Algerian border and only one river carries water all the year round. Consequently, water supply is a serious problem in Tunisia.

The country has a warm Mediterranean climate with warm, occasionally humid summers and relatively cool winters. In the desert regions to the south the climate is hotter and drier. In the north the average rainfall per year is 600 - 800 mm whereas inland and in central Tunisia it is 400 - 600 mm. In the south the precipitation is less than 100 mm per year.

Administrative organization

Tunisia is subdivided into 18 governorates (counties) each with its own governor, all of whom are elected by the President or, in his absence, by the Prime Minister.

In times of great internal political pressure and dissatisfaction, governors are often replaced. Each governorate is composed of several provinces depending on its size and number of inhabitants.

"Le premier délégué" works directly with the governor whereas "Délégués", one for each province, are appointed to work directly under the governor. The Délégués are elected on the basis of a political election but developments during the last part of the fourth planning period and during the current fifth planning period show that more and more Délégués are being elected whose modern upbringing and way of thinking has forced them to realise that the basic requirement for the country's future social and economic development is a more equal division of income and that all citizens should have a chance to live under reasonable conditions. Many of them see their post as being more of humanitarian importance than as a step on a political career ladder.

In every community within a particular region an "Omda" is elected as the village representative and in pilot projects of this type it is important to first convince the Omda as to the value of the project. One very common occurrence is that the villagers are suspicious of everything that the national administration tries to introduce. The Omda is really the only person they are prepared to listen to, especially when most of the adults in the village can neither read nor write. In addition, the Omda always observes all the teachings of Islam and as such is also the religious leader. This is important especially with regard to sanitary matters since the Koran stresses the importance of hygiene.

Malloul

Malluoul, on the Cap-Bon peninsula, is situated close to the town of Kélibia where SIDA has carried out a number of important aid projects during the past fifteen years. The fishery school, hospital and sewerage system, including treatment plant, are all either wholly or partially financed by SIDA:

About 36,000 people live within the Kélibia region. As well as the hospital there are three clinics together staffed by a total of three doctors. Other facilities include fifteen primary schools and a secondary school as well as the fishery school. The majority of the working population are engaged in agriculture and the rest in industry, handicraft and fishing.

The Cap-Bon peninsula is Tunisia's richest agricultural district known especially for its large citrus fruit orchards. The land in the Kélibia region is unequally divided into large private or state-owned properties and small farms of less than one hectare. The income per capita varies dramatically from SEK 500 per year to SEK 7000 per year or more. It is therefore extremely important that the state representative for this particular district devotes considerably more of his time towards improving the living conditions of the poor than to building a political career for himself.

Malloul is in fact one of the poorest areas on the entire Cap-Bon peninsula and practically none of its inhabitants earns more than SEK 500 per year. There are even widows with children who have literally no income at all apart from a small amount from the Délégués budget every month which they need in order to be able to survive. Malloul's sanitary problems are enormous. These poor people have themselves turned to the Omda and asked for assistance in solving, amongst other things, the toilet problem and are willing to carefully follow all instructions concerning care of the toilets.

As is the case with so many other rural areas, women have a very hard life; they not only take care of children and the home but also work on the fields. Despite their severe hardships the women of Malloul do not show any form of aparthy and it is in fact these women who have raised the question of the toilet problem with the Omda. It is also the women who will supervise the care of the toilets under the supervision of female social assistants.

There are on average 5-7 people in each family.

A map of Malloul is given in Fig. a.

Brahmia

When the Sidi Bouzid region became an independent governorate five years ago, it was decided that the community of Gammouda (now Sidi Bouzid) should be planned for a population of approx. 5,000. Today the town has expanded and the number of inhabitants, which is constantly on the increase, is approx. 24,000, a factor that has led to considerable problems as regards drinking water and sewage. For instance there is still no sewage treatment plant in Sidi Bouzid and the drinking water is often seriously contaminated.

The climate is semi-dry (approx. 200 mm of rain falls per year) and the evaporation rate is high, especially in the summertime, as a result by the relatively high average wind force and low relative humidity. The area under cultivation is flat and consists for the most part of sandy clay. The town itself lies in a depression.

In Sidi Bouzid there is an ordinary hospital with 48 beds and a maternity hospital with 18 beds, together staffed by 8 doctors. In addition there are three private doctors in the town and seven dispenseries are spread out in various parts of the district. During the dry summer months there are large numbers of scorpions and poisonous snakes and for this reason somebody is always on call in the 170 primary schools which are well-equipped with serum against snake and scorpion bites.

The part of the town known as Brahmia lies adjacent to the hospital and about 2 km from the nearest school. Here the state has built what is known as popular housing for which the tenants pay a deposit of about SEK 2000 and thereafter a monthly rent of about SEK 28 for 15 years,after which the house becomes the property of the tenant. Brahmia is a newly-developed district with straight streets and houses which are constructed in such a fashion that householders can extend them if and when they want or can afford to. Most of the families have 6-7 children and the average income varies considerably from SEK 3000 per year and family to SEK 12,000 per year and family. Most people are either craftsmen, agricultural workers, pedlars, teachers or employees of the administration,and all families belonging to a particular tribe were at one time nomads. The drinking water situation is difficult, especially during the summer and when the normal supplies stored in a water tank run out. Drinking water is obtained from a tanker which delivers water to the whole district.

Maps of Sidi Bouzid and Brahmia are given in Figs. 10 and 11.

Rohia

The village of Rohia is the main town on a plain located 800 m above sea level. It is a poor agricultural area where people are forced to live under very primitive conditions. An estimated 6,000 people live on the 3 x 10 km plain who live either from agriculture or fruit and vegetable production. The farms are for the most part small and irrationally run.

During the winter months, the River Sgnifa, which runs through the plain, often floods considerable areas of land which are subsequently unusable for cultivation for long periods of time because of the salts which are precipitated during the flooding. During the winter, strong cold winds blow across the plain from the north and the summer months are dominated by the sirocco which blows from the south. During 50 to 100 days per year winds stronger than 15 m/s blow across the area. Frost occurs during the winter, mainly at night, and the difference in temperature between the hottest and the coldest months is considerable. Temperatures of up to +40°C are quite common in the summer.

Rohia has a cottage hospital with one doctor and there are three primary schools within the region. Illitteracy is in the order of 20 % in the case of young people and 50-60 % when it comes to the older generation. Many people from the plain work part of the time in other parts of the country or in France or Libya. A day worker who earns SEK 10 to 20 per day in Rohia can earn twice that amount in Tunis or three times as much in Libya.

The water supply is based on about 180 excavated wells each 10-25 m deep. The water is extracted with the aid of diesel pumps or mule-driven hydraulic wheels. Certain areas of the region are irrigated with water from the river.

A detailed study of Rohia and its surroundings can be found in a report dated 1979-08-07 which was written by a group of student architects from Lund University in Sweden in cooperation with ASDEAR. With the help of financial assistance from SIDA, in 1979 the group made a five-week field trip to study the problems in the region.

Types of toilet

In order to gain a comprehensive idea of the way the compost toilet functions from a technical, sociological and climatological point of view, several types of Swedish and in situ manufactured models have been built in the various project areas.

The number and type of units is given in Appendix 2 and the size of the compost vault and the technical differences between the various types of toilet can be found in Appendix 3.

In the case of all the models the superstructures are made of concrete block. The sites for the various toilets have been chosen to suit the topography.

Malloul is a rural village that has developed on the slopes of a valley without any form of planning. This has led to considerable flexibility both in the in situ manufactured and the prefabricated toilets. In addition it has been possible to adapt the toilets in a flexible way to the irregular system of plot boundaries.

Brahmia is a flat area with its own town plan, a fact that has led to problems in connection with the adaption of the units.

Rohia is a farming village with detached houses positioned in an irregular fashion on a flat plain, which is why it has been possible to use a considerable amount of freedom over the choice of sites for the toilets.

The positions of the toilets in Malloul and Brahmia can be seen from the maps in Figs. 9 and 11.

Should the pilot project fail to succeed, the intention is to convert the toilets into traditional "Turkish type" units.

Project co-ordination

Through the aid office in Tunis, SIDA has appointed Dr Boukrâa to co-ordinate the pilot work during the estimated 2 to 3 year project period. He has selected suitable families to take part in the pilot project on the basis of the sociological study and will continually follow-up the work and make regular reports to SIDA on the progress of the project from both a technical and a sociological point of view. At the end of the project Dr Boukrâa will compare the results gained with those obtained during the course of the sociological study.

Technical consultant

Mr Lars Hermansson, Civ. Eng. of the SIAC (Société des Ingenieurs et Architectes Conseils) Tunis, has served as technical consultant during the building stage.

Mr Hermansson has had the following duties:

- to prepare and carry out intitial studies,
- to design technical solutions well-adapted to local conditions and to prepare comprehensive tender documents,
- to help select local contractors,
- to authorise contractors' bills for payment, and
- to carry out building inspections.

Purchasing and management

The local development committees in Malloul and Brahmia have had complete responsibility for making sure that the units have been built in accordance with the instructions of the technical consultant.

The committee in Malloul has been led by the Délegué in Kélibia, M. Badreddine Harbi, who was given detailed information on the project by the aid office in Tunis.

The committee in Brahmia has been led by the Mayor of Sidi Bouzid. Since he has not had time to deal with purchasing and the management of the contractors, a Swedish-speaking French agronomist, M. Albert Rolland, has acted informally as the project leader in Brahmia.

In Rohia, ASDEAR, through M. Philippe Lebâtard, has had independent responsibility for carrying out the work under its own auspices.

Contractors and construction time

The contractors in Malloul were Entreprise Mohammed Habit Ben Massaoud, Kélibia, who primarily used labour from Malloul.

The contractors in Brahmia were Société El Amel, Sidi Bouzid, who used their own workmen on the project.

As already mentioned, ASDEAR carried out the work in Rohia under their own auspices using local labour.

The toilets were for the most part constructed during the first half of 1980.

Construction costs

According to available cost specifications, the capital costs in Swedish Kronor per toilet, excluding the cost of starting-up beds, are as follows. The costs are based on an exchange rate of 1 Tunisian Dinar to 10:60 Swedish Kronor.

	SEK/toilet
In situ manufactured	
Type I a	5,071
I b	3,897
I c	5,523
Type II a	6,335
II b	4,753
Toa-Throne	
Type III	18,964
Clivus Multrum	
Type IV	12,820

The division of the costs into local costs in Malloul, Brahmia and Rohia and into purchase and transport costs for the plastic vaults imported from Sweden is shown in Appendix 4.

For work on the Type III compost toilet in Rohia,the construction costs are subdivided into material, transport etc. and labour costs. The respective percentages are 51.4, 9.5 and 39.1. The "do it yourself" cost for constructing a toilet can therefore be estimated at half the above-mentioned total construction cost. When both the as yet unfinished toilets in Rohia have been completed, a wider basis will be available on which to calculate the cost for an individual to construct a compost toilet himself and where only the costs of material etc. are included.

The total cost of all installation work of the project (28 toilets) excluding starting-up beds is as follows:

	SEK
Local costs	
Malloul	80,045
Brahmia	58,903
Rohia	5,778
Costs for plastic vaults from Sweden	83,076
Total installation cost	227,802

To this shall be added costs for:

- SIDA's own efforts
- preliminary studies (Mr Fleetwood)
- sociological study (Tunis University)
- project co-ordination (Dr Boukrâa)
- technical consultant (SIAC)
- local project management (local development committees in Malloul and Brahmia; ASDEAR)
- technical advice etc. during implementation (SWECO)
- local assistants (through Dr Boukrâa)

Project implementation

Before use is made of any finished and approved compost toilet a starting-up bed shall be laid along the bottom of the vault.

The function, composition and arrangement of the starting-up bed are described elsewhere in this report under the headings "Composting, starting-up bed" and "The Clivus Multrum toilet".

Starting-up beds of the type normally used in the compost toilets in Sweden (15 cm of peat-mold + 5 cm of top-soil + 5 cm of grass, leaves etc.) are difficult to acquire in countries like Tunisia. Instead it has been suggested that starting-up beds in the Tunisian pilot units should consist of 20 cm of selected household compost.

Before the starting-up beds were inserted, several of the vaults had to be drained of fluid, mainly in the form of urine. Certain toilets had in fact already been used despite the fact that the starting beds had not been put in.

A description of the composition and laying of the starting-up beds is given in Appendix 5.

The toilet building shall contain a brush for brushing off the toilet hole plate.

A box containing ashes, dry soil or sawdust should be provided for spreading over the excrement after each use to prevent the spread of bad odour and the growth of flies and insect larvae. The material will also help to absorb excess fluid.

A jug of water for washing the anus should also be provided as well as a small container for portioning water from the jug.

Project follow-up

Dr Boukrâa, with the help of well-informed local assistants, will follow up the utilization of the toilets by making visits once or twice a month. The families concerned in the project will be interviewed on the basis of a questionnaire drawn up by Dr Boukrâa which will take up both technical and social aspects of the scheme.

The temperature of the air, the vault and the starting-up bed will be measured and recorded during the course of the visits.

A preliminary work programme for checking how the toilets are functioning and how the families are reacting has been drawn up by Mr Fleetwood, dated 1980-01-09, and is attached as Appendix 6.

A set of condensed operating instructions in Arabic dealing with the care of the unit should be put up on the inside of the door of each toilet. The assistants should inform the families and explain to them what the instructions mean.

Suggested instructions are given in Appendix 7.

In Rohia there is a newly-installed Vietnamese, double-vault compost toilet, see description under chapter with same title and Fig. 1. During the course of follow-up visits to Rohia this toilet should be inspected too for the sake of comparison.

Information gained during the course of these visits, as well as observations made, should be compiled by Dr Boukrâa every three months.

SIDA plan to follow up the progress of the project by visiting the various sites after the toilets have been in operation for six months or so.

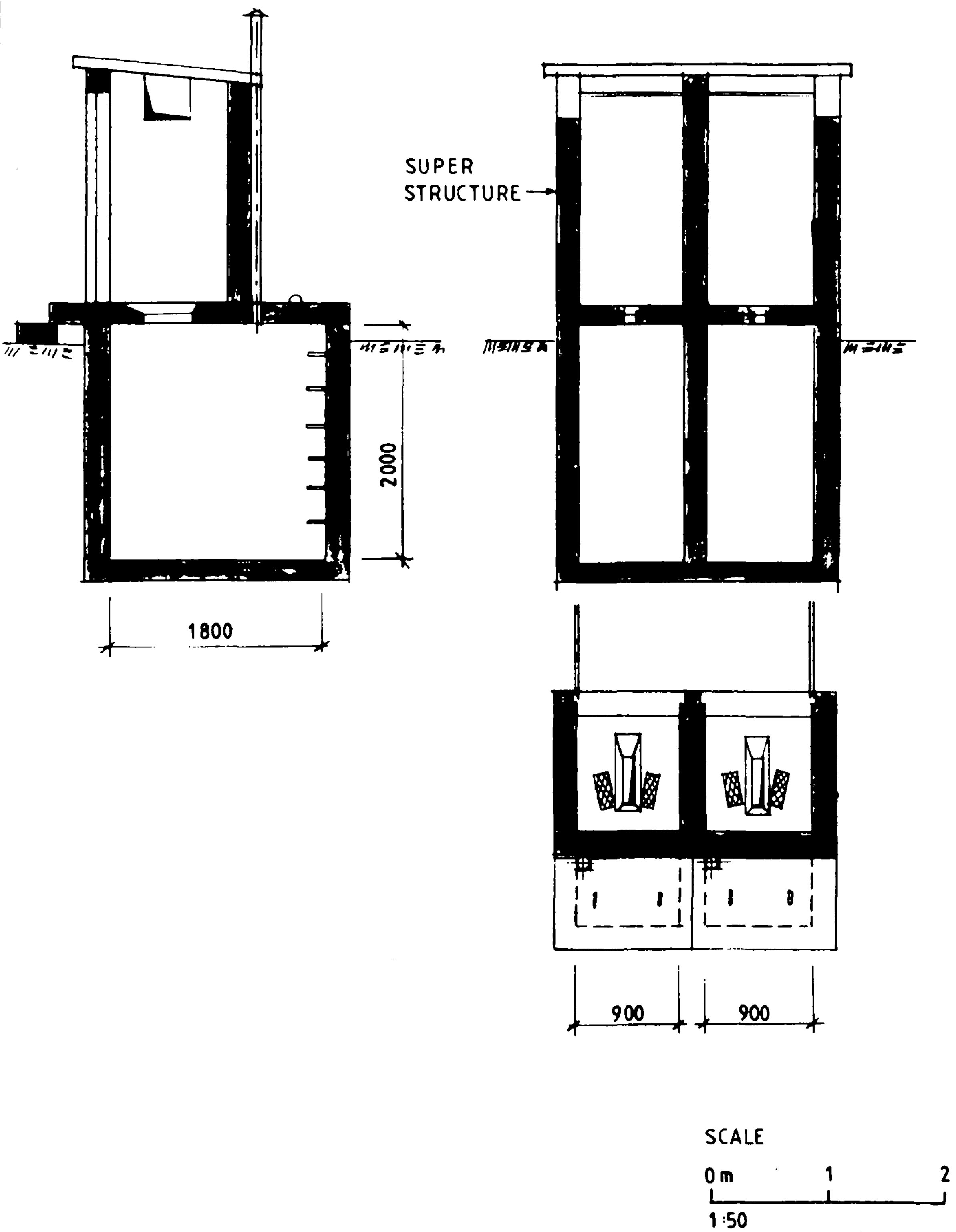
Stockholm, June 6, 1980
SWECO

Rune Loohagen

Rune Loohagen

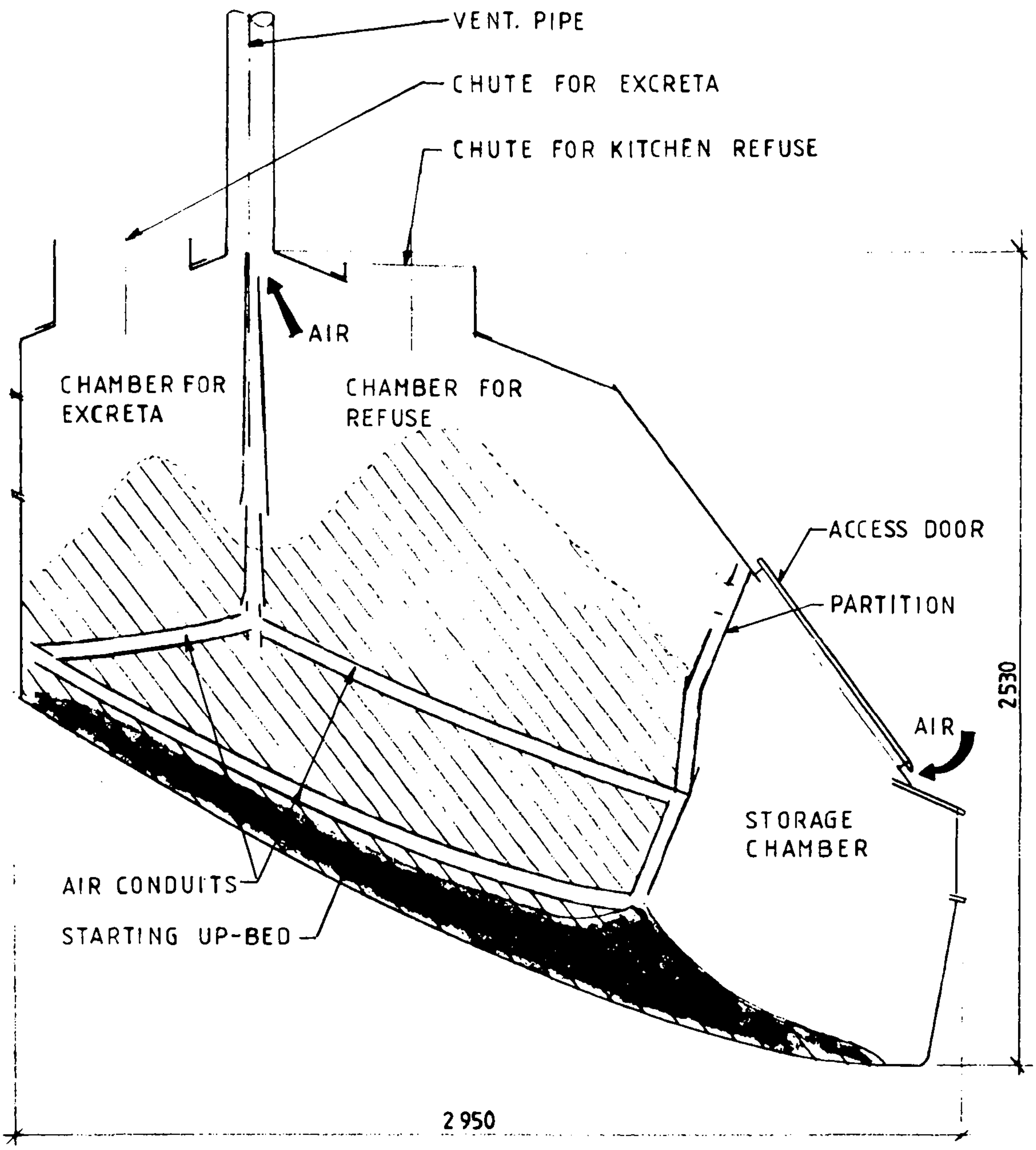
VIETNAMNESE DOUBLE-VAULT TOILET

FIG. 1



THE CLIVUS MULTRUM TOILET

FIG 2

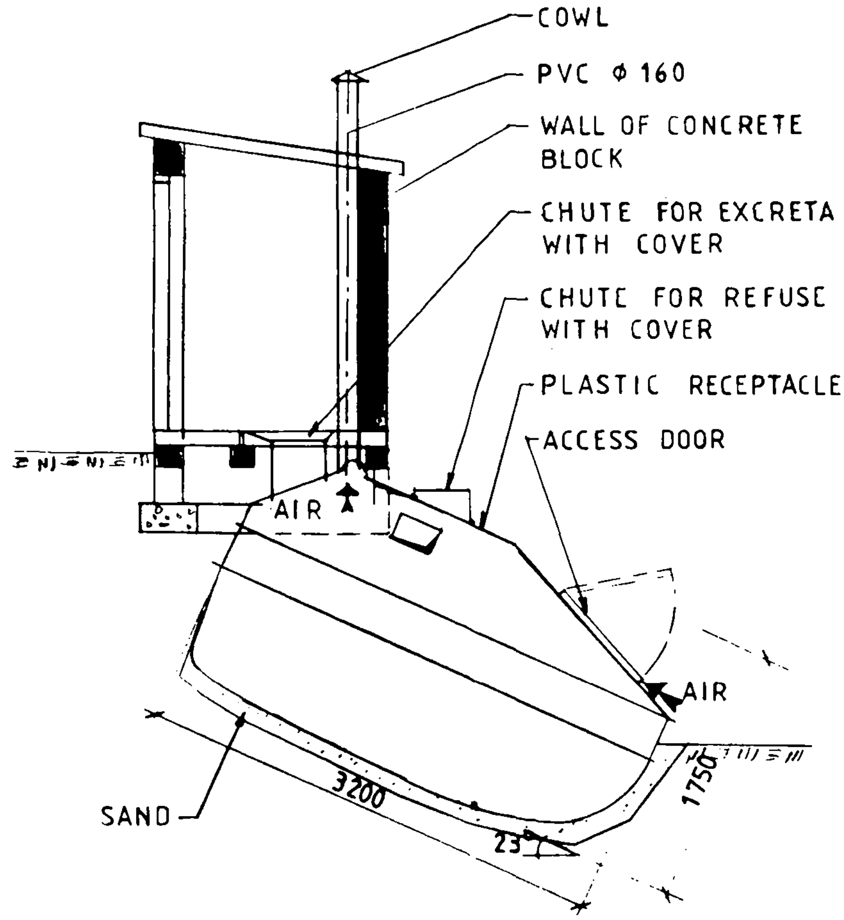


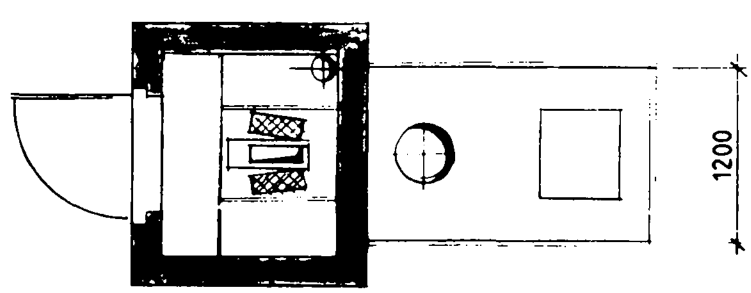
WIDTH 1200

SCALE
0m 0,5 1,0
1:20

COMPOST TOILET
TYPE IV CLIVUS MULTRUM

FIG. 3

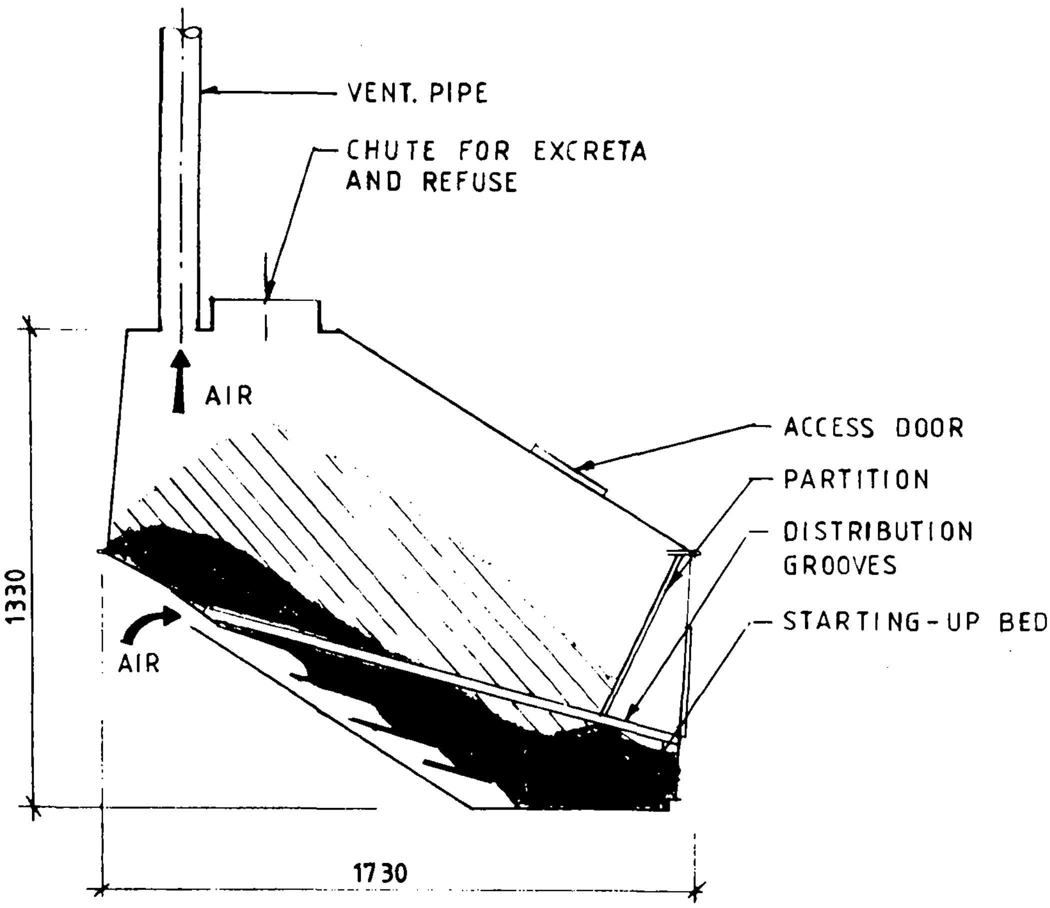




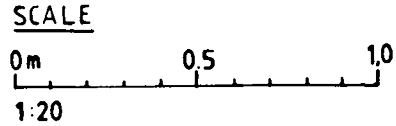
SCALE
0m 1 2
1:50

THE TOA THRONE TOILET

FIG. 4

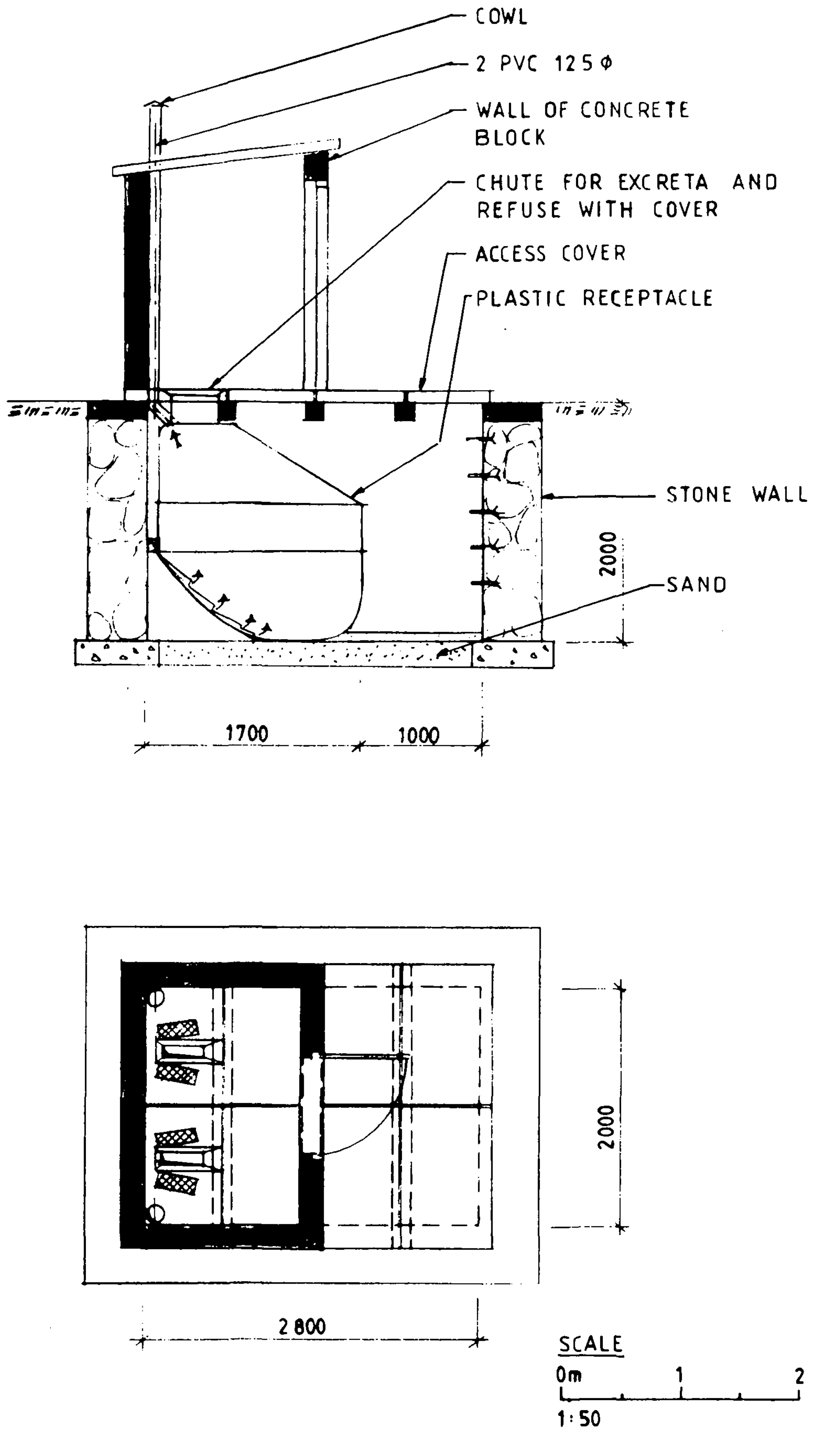


WIDTH 1090



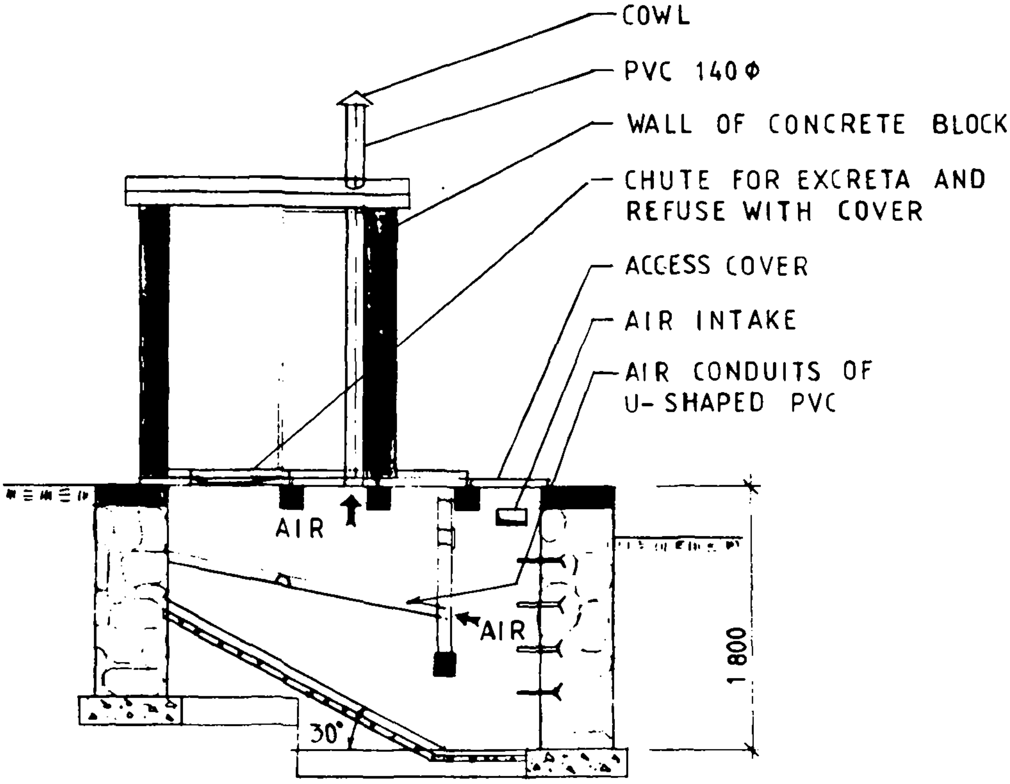
COMPOST TOILET
TYPE III TOA-THRONE

FIG. 5

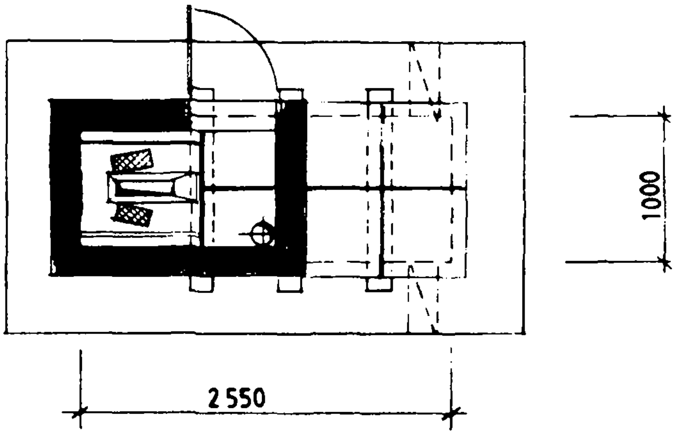


COMPOST TOILET
TYPE I
IN SITU MANUFACTURED

FIG. 6



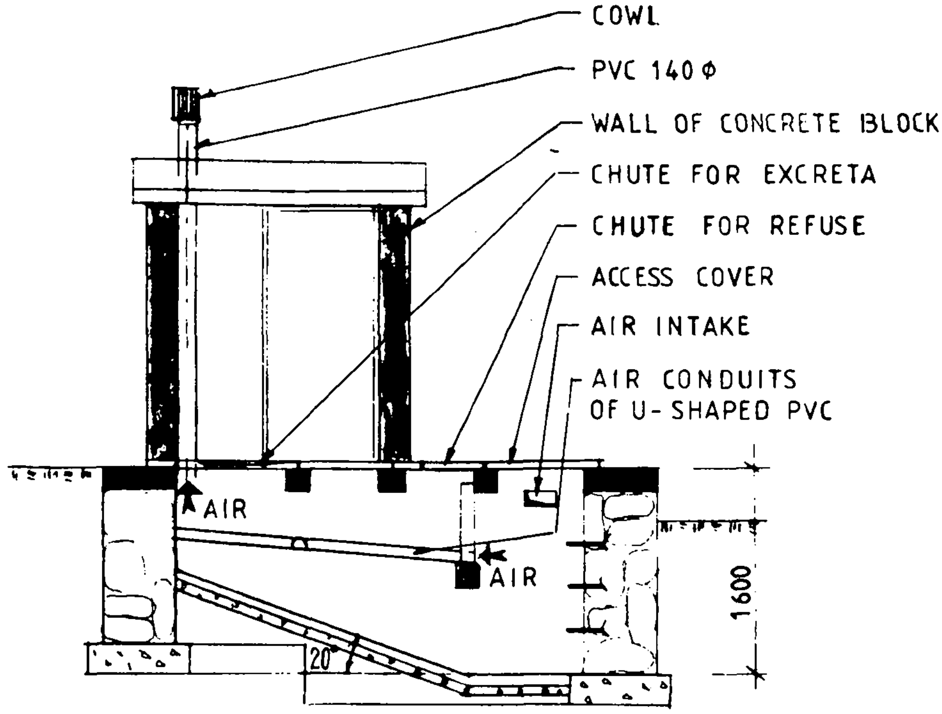
STONE WALL		TYPES Ia AND 1c
WALL OF CONCRETE BLOCK		TYPE Ib
SEALING OF WALLS WITH	PLASTER + DERBIGUM	TYPE Ia
——— " ———	WATERTIGHT PLASTEX	" Ib
——— " ———	PLASTER + FLINTCOTE	" Ic



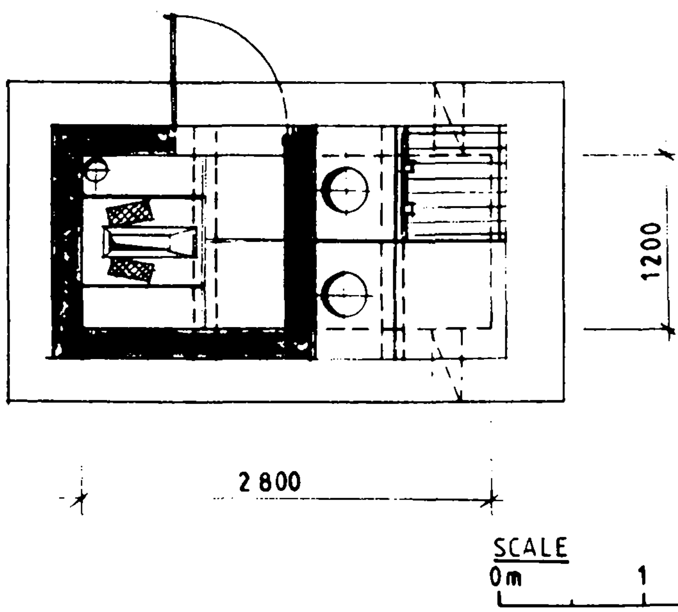
SCALE
0m 1 2
1:50

COMPOST TOILET TYPE II IN SITU MANUFACTURED

FIG. 7



STONE WALL	TYPE II a
WALL OF CONCRETE BLOCK	" II b
SEALING OF WALLS WITH PLASTER + DERBIGUM	TYPE II a
——— " ——— WATERTIGHT PLASTER	" II b



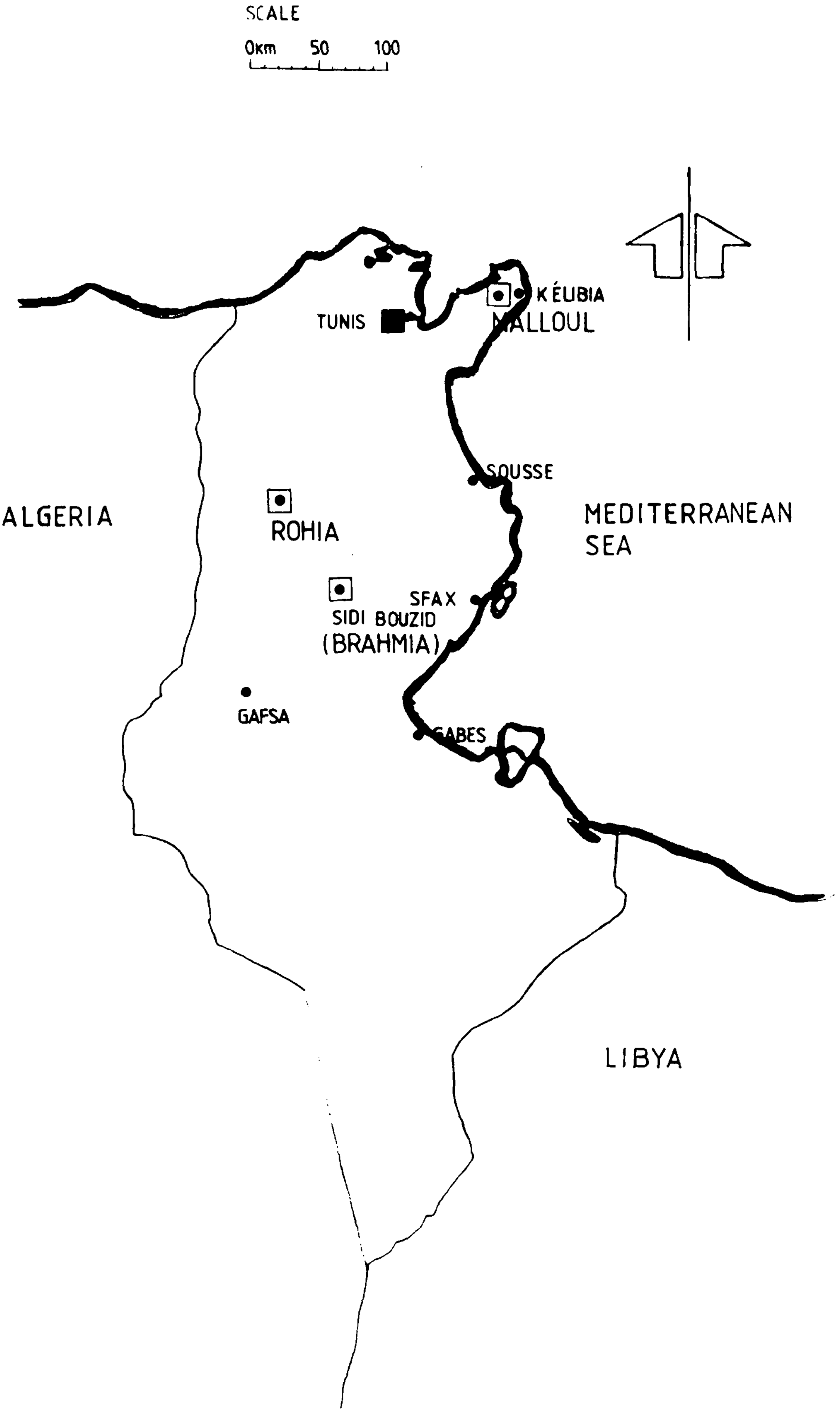
SCALE

0m 1 2

1:50

MAP OF TUNISIA

FIG. 8



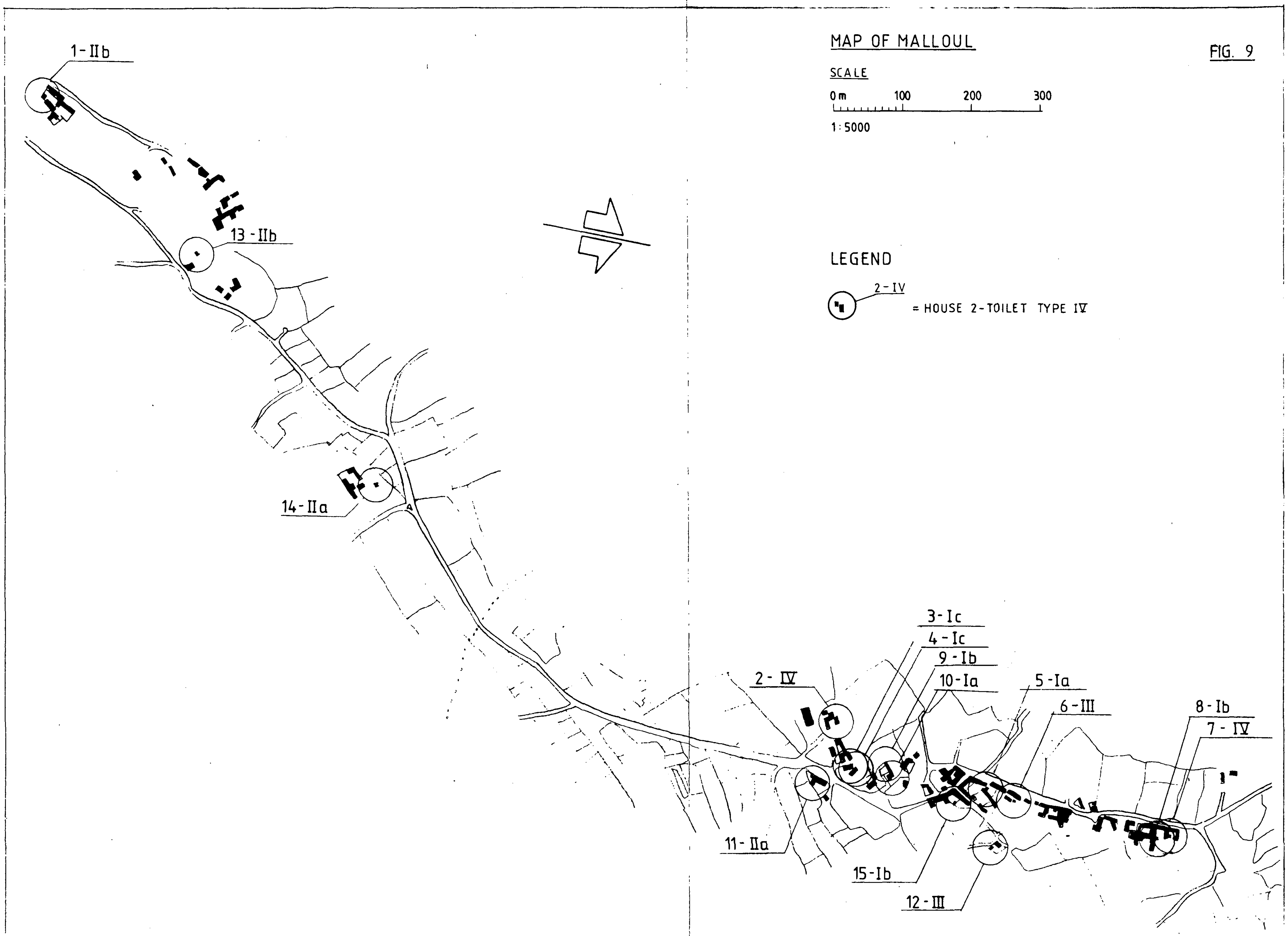
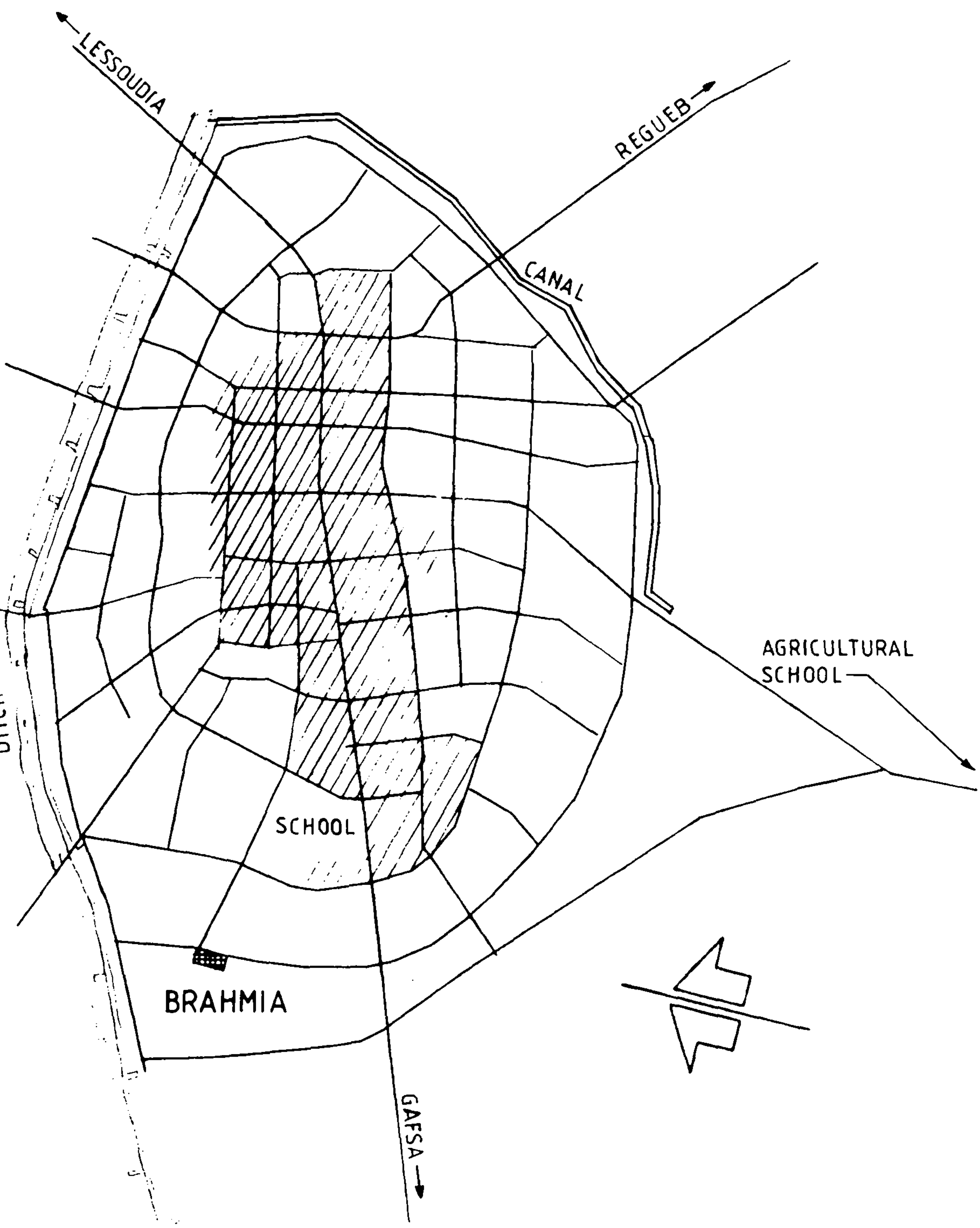


FIG. 9

MAP OF MALLOUL

MAP OF SIDI BOUZID

FIG. 10



MAP OF BRAHMIA

FIG. 11

SCALE

0 m 50

1 : 1000

LEGEND

3-Ia = HOUSE 3-TOILET TYPE Ia

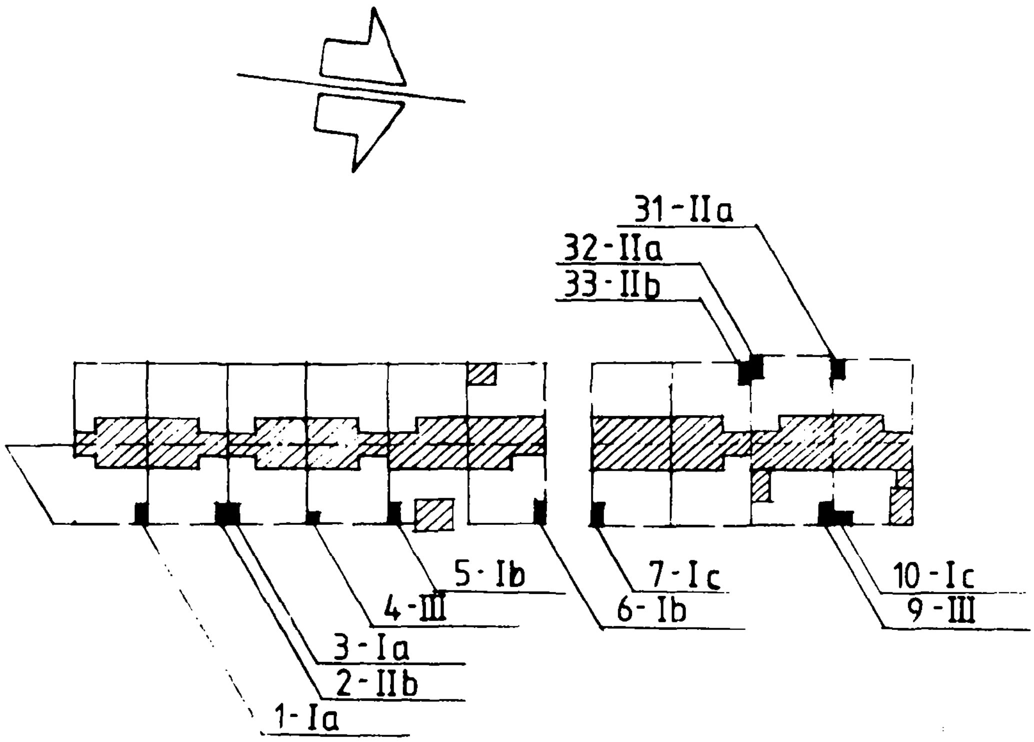
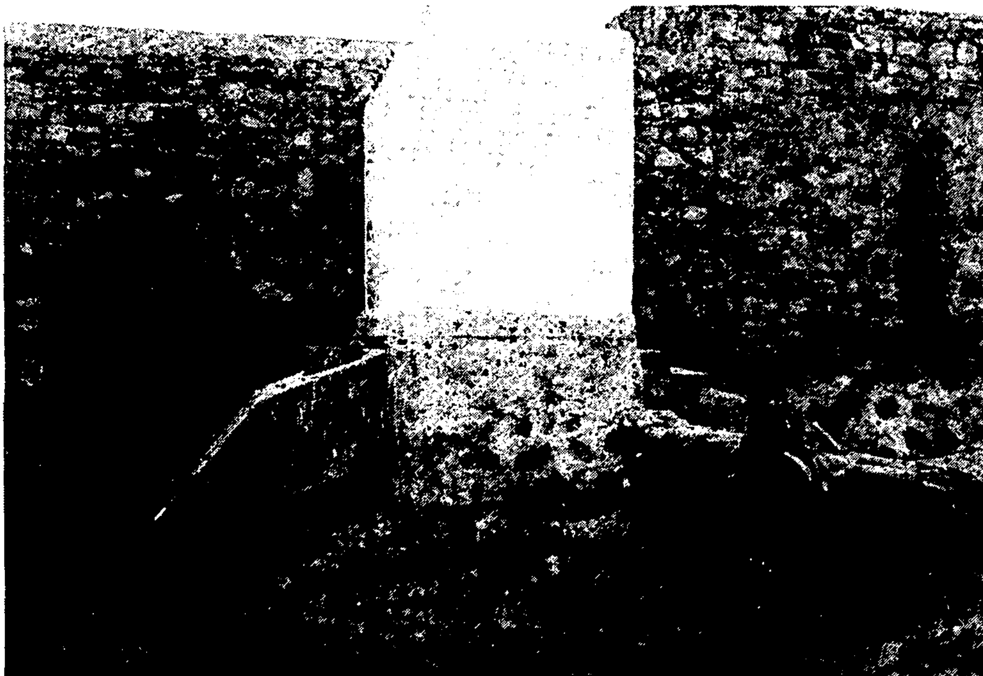


Fig. 12

MALLOUL



Mme Baccar - SIDA

Type IV

Type IV

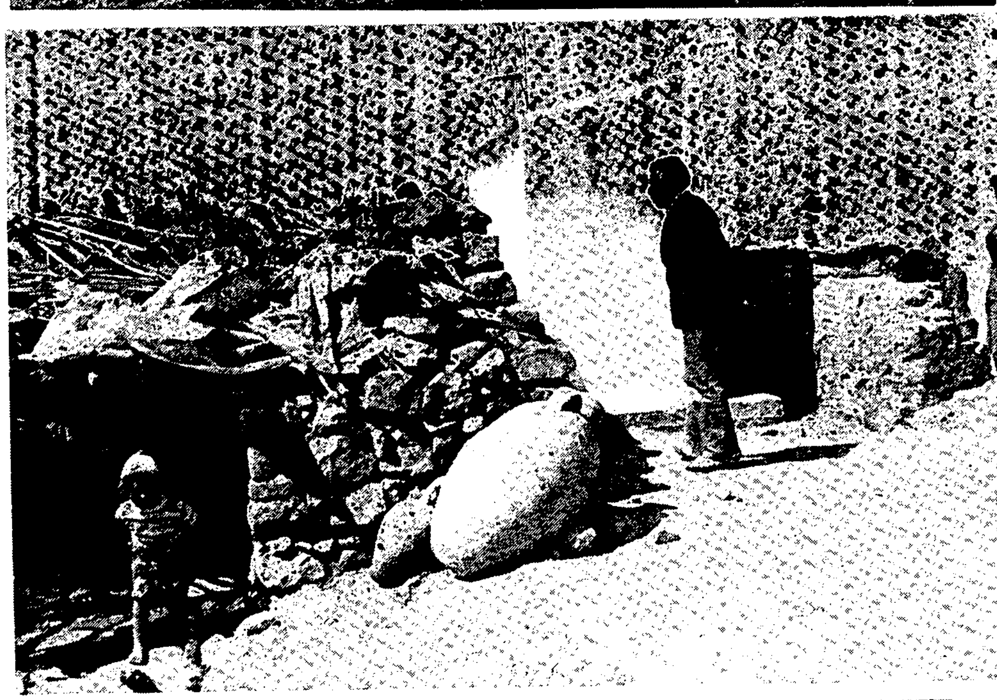
Type I b

Type I b

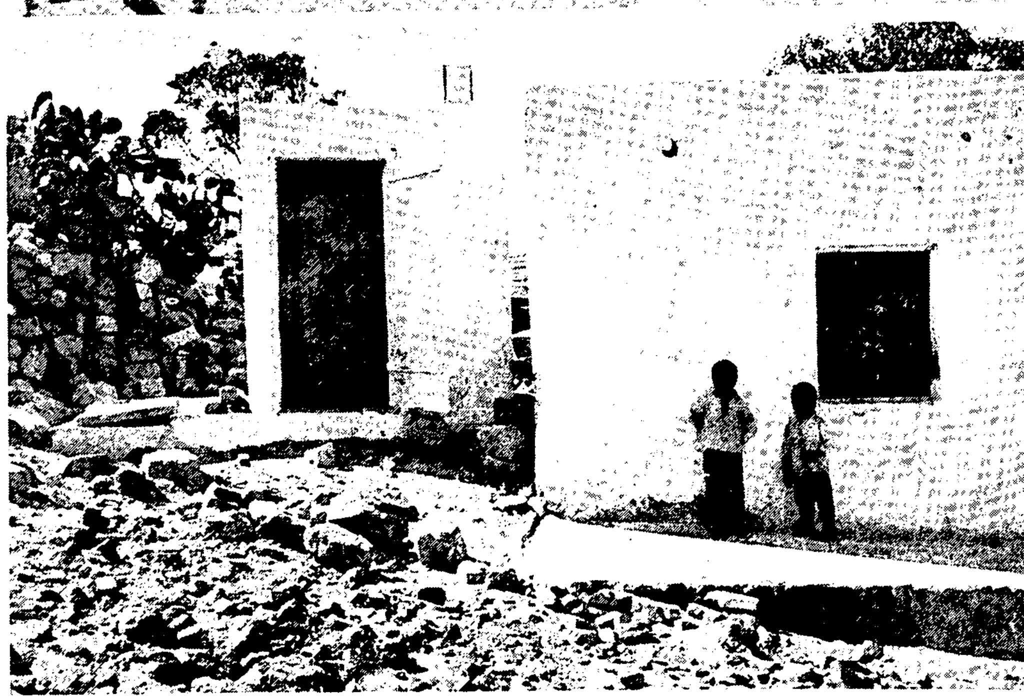
Type I b

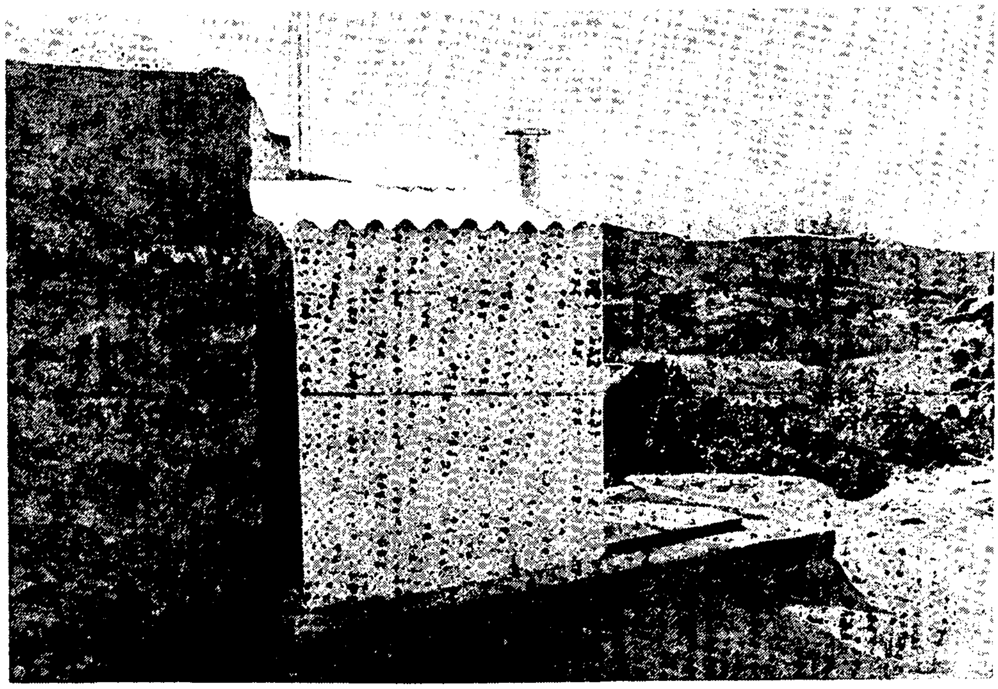
Type II b

Type I a

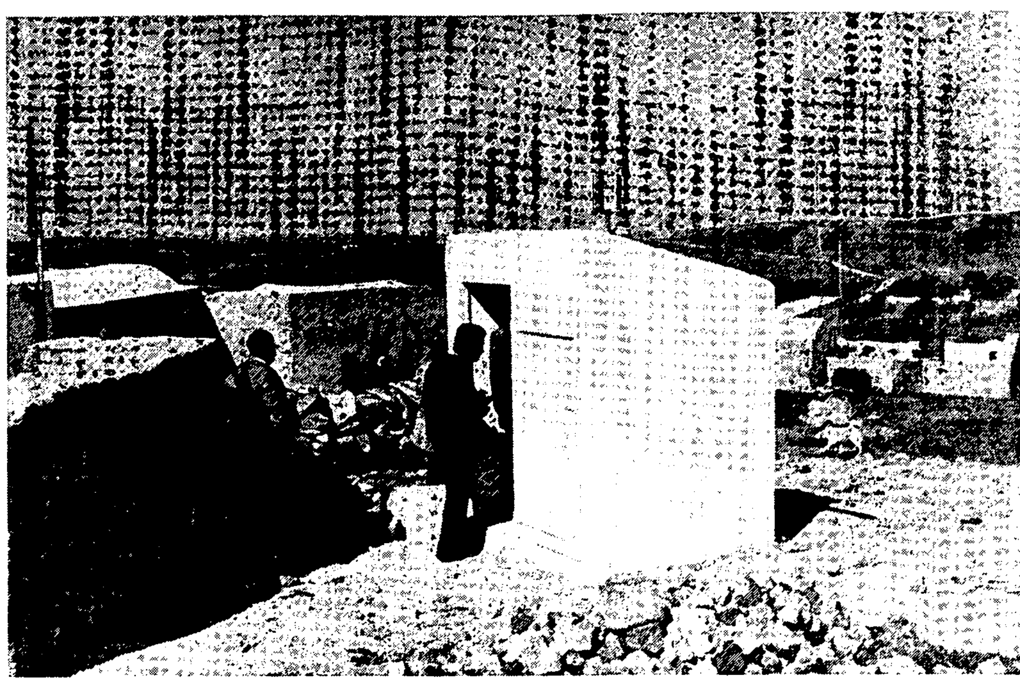


Type II b





Type II b



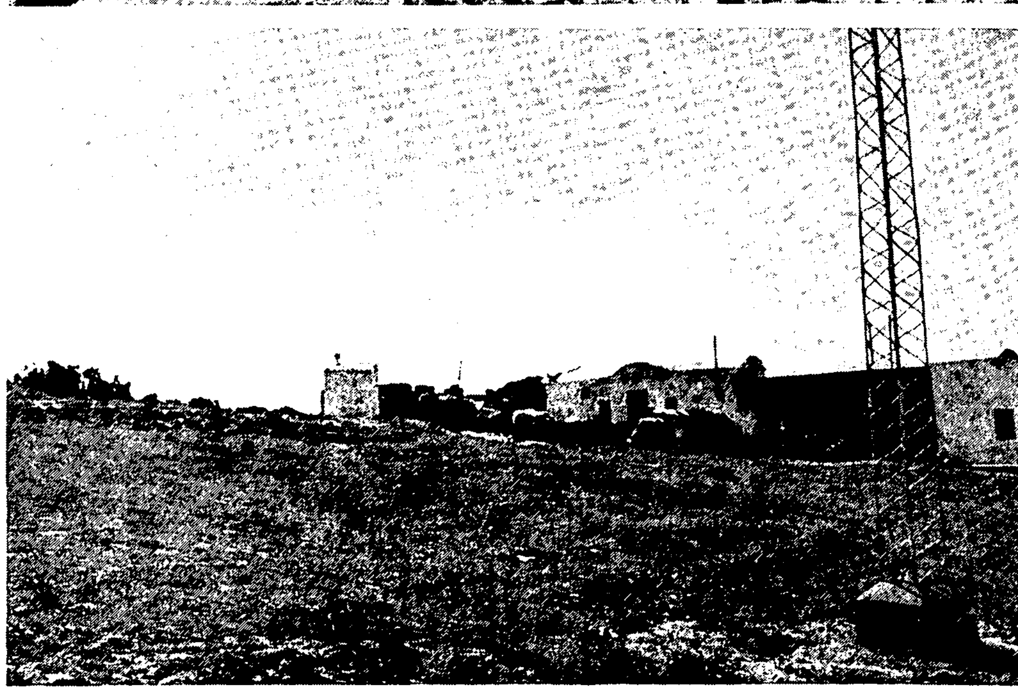
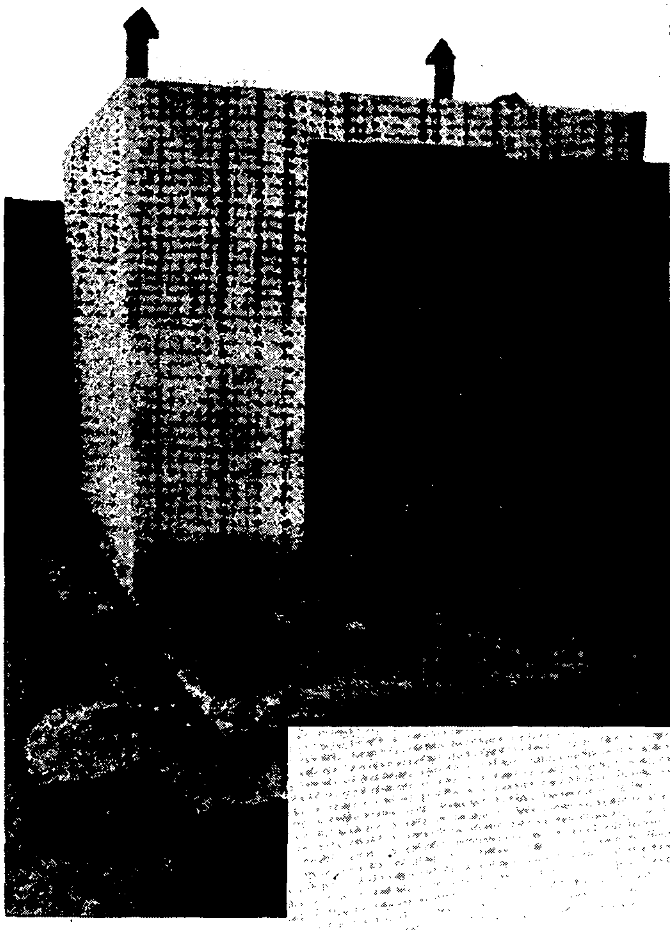


Fig. 16



M.Rolland M. Hermansson
M. Horchani-Société El Amel

Type III
Toa-Throne

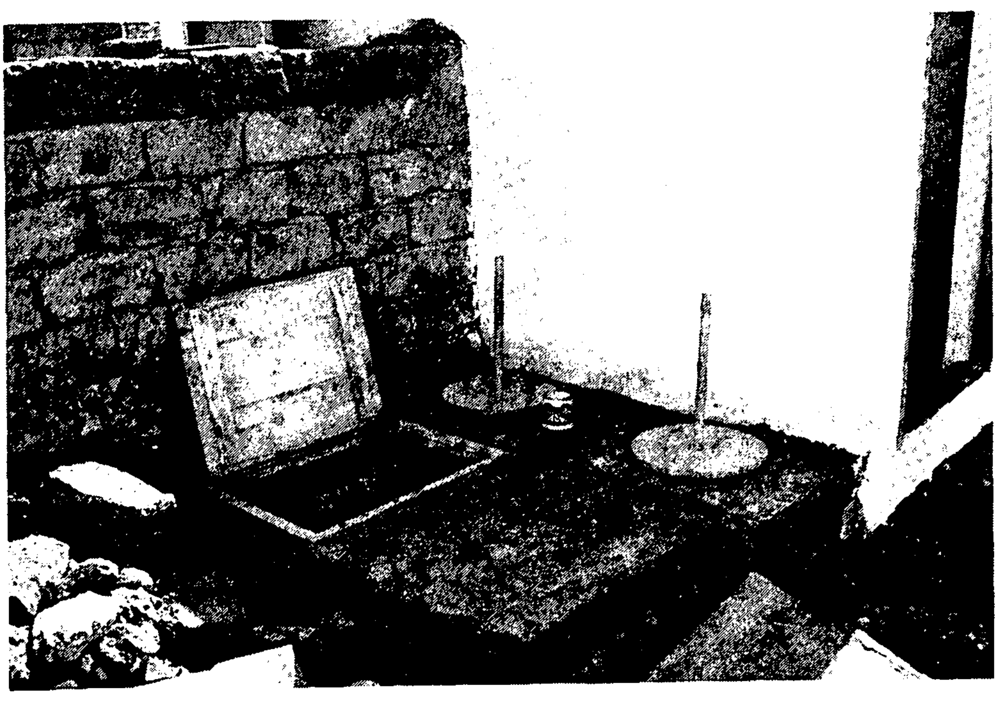
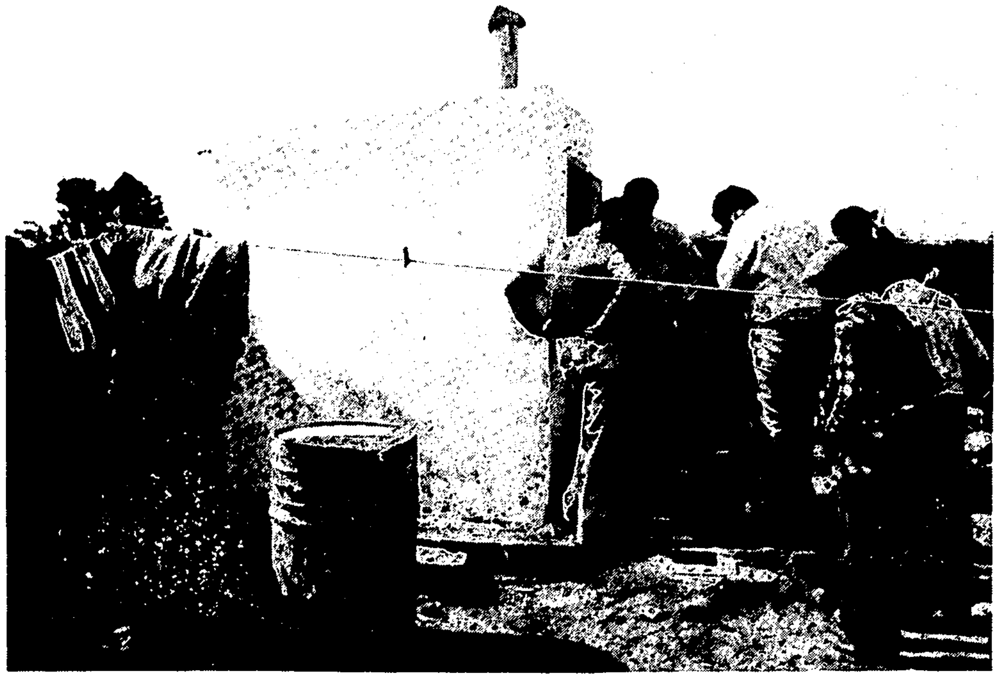
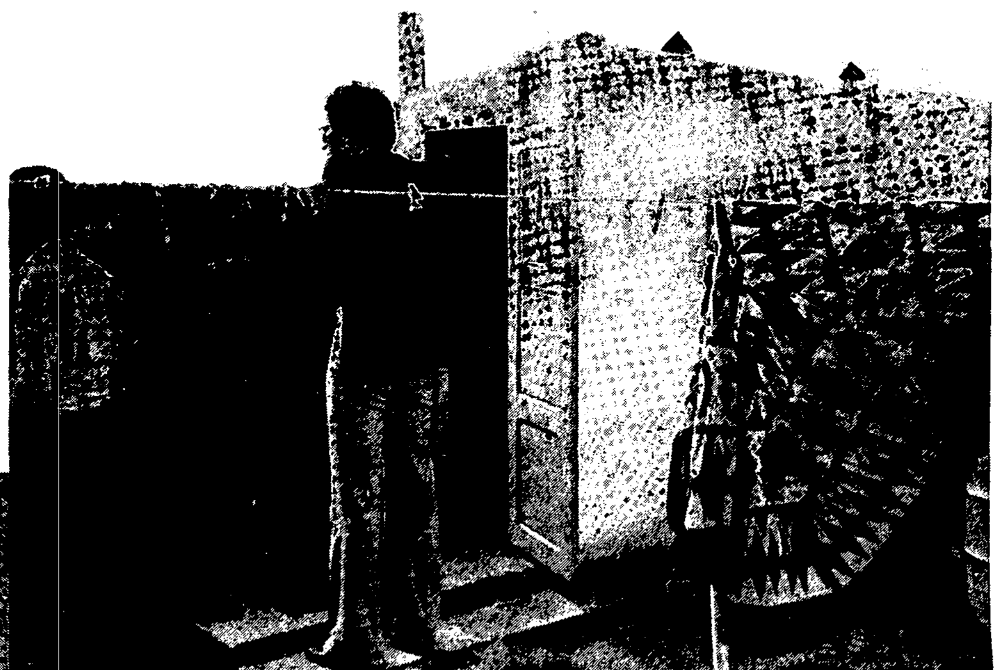


Fig. 18

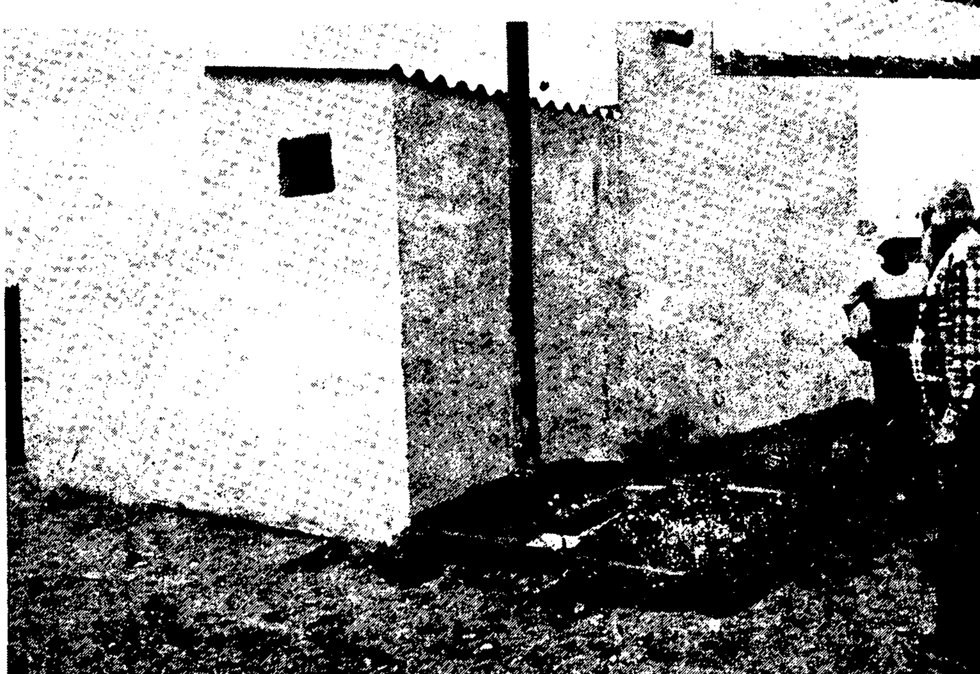




M. Boukráa

Type III
Toa-Throne

M Lebâtard
M Hermansson



Latrine
á la Vietnam

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   c) Analysis of bacerial populations in the final product of the Clivus Multrum - W. Nichols, 1976-12-07, Saint Louis, USA.

   d) The soil invertebrate community of composting toilet systems- D. Daniel, L. Leviton, 1976, Uppsala, Sweden.

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NUMBER OF DIFFERENT TYPES OF TOILET
AT THE VARIOUS PROJECT SITES

Type	Malloul	Brahmia	Rohia	Total
In situ manufactured				
type I a	2	2	-	4
I b	3	2	2 x)	7
I c	2	2	-	4
II a	2	2	-	4
II b	2	2	-	4
Toa-Throne				
type III	2	2	1	5
Clivus Multrum				
type IV	2	-	-	2
Total	15	12	3	30

x) still not completed on 1980-05-30

DIFFERENT TYPES OF TOILET USED IN PILOT PROJECT

Techical differences between different types of toilet

Type		Walls under the ground	Sealing of walls	Ref. Figure
In situ manufactured	Ia	50 cm stone wall	Plaster+Derbigum x)	6
In situ manufactured	Ib	20 cm concrete block	Watertight plaster	6
In situ manufactured	Ic	50 cm stone wall	Plaster+Flintcote xx)	6
In situ manufactured	IIa	50 cm stone wall	Plaster+Derbigum x)	7
In situ manufactured	IIb	20 cm concrete block	Watertight plaster	7
Toa-Throne	III	50 cm stone wall	Plastic vault	5
Clivus	IV	-	Plastic vault	3

x) rubber sealant
xx) 2 coats

Estimated volume available for compost

Type	I	2.5 m^3
	II	3.4 m^3
	III	4.0 m^3
	IV	4.0 m^3

CONSTRUCTION COST PER TOILET

Excluding starting-up bed.
Swedish kronor.

	Local costs per toilet Malloul	Brahmia	Rohia	Purchase and transport costs per plastic vault	Total average cost per toilet
In situ manufactured					
Type Ia	5 376	4 765	-		5 071
Ib	4 468	3 325	- x)		3 897
Ic	5 640	5 405	-		5 523
Type IIa	6 803	5 867	-		6 335
IIb	5 329	4 176	-		4 753
Toa-Throne					
Type III	7 338	5 914	5 778 xx)	12 621	18 964
Clivus Multrum					
Type IV	2 835	-	-	9 985	12 820

x) still not completed on 1980-05-30

xx) 2 968 or 51.4 % of which for materials (cement, sand, stone and lime)

EXTRA WORK REQUIRED IN CONNECTION WITH STARTING UP AND RUNNING COMPOST TOILET

1. Empty all water and urine from vault.

2. Lay a 20 cm thick starting-up bed in the bottom of the vault consisting of material from a nearby compost heap.
   The function of the bed is as follows:

   - to absorb fluid
   - to add carbon to facilitate decompostion
   - to raise the concentration of micro-organisms
   - to prevent the compost from becoming too compact.

   The bed must not contain glass, plastic, tin cans, bones from large animals, rubber-soled shoes etc. or excessive quantities of straw. Neither must it contain too much clay or muddy soil.

   The bed must not be too wet or too dry and the material shall be thoroughly chopped up before it is put into the vault.

   The bed must be positioned carefully in place so as to provide a flat surface and so that the plastic aeration channels are not disturbed.

   The bed shall be furnished with a threshold of packed soil which shall seal the space between the base and the rear dividing wall between the compost and collection compartments.

   After the first batch of completely composted material has been removed from the collection compartment, "its first emptying", the threshold shall be removed. The unit can normally be emptied for the first time after the toilet has been used for about two years.

Institute for Agricultural Hydrotechnics
Royal Institute of Technology
Åke Fleetwood

STUDY OF OXIDATION TOILETS IN TUNISIA

Continuous work programme 1 - 1980-01-09

1. INTRODUCTION

Oxidation toilets of the Multrum type can lead to a considerable improvement in the hygienic and environmental conditions, especially in developing countries. In order to try to establish how these toilets could function in such countries, a first step comprising technical and sociological studies has been taken in Tunisia under the direction of SIDA: The toilet facilities are currently in the process of being built.

The problem of an alternative toilet system is not purely technical; it is just as much a social problem. The technique must be adaptable not only to the ecological conditions but also to the prevailing cultural conditions. The studies indicate that the basic conditions are favourable.

However, it is not possible to predict entirely what sort of problems will be met with when the facilities are actually in operation since both technical and social difficulties may prove to complicate the use of the oxidation toilets.

2. PRELIMINARY WORK PROGRAMME

2.1 Technical operation

It is only worth making an initial inspection of the practical operation and function of a compost toilet when the unit has been in operation for at least 4-6 months. The operating conditions of the unit, represented by the temperature of the compost mass, should be followed continuously, for instance once a month, once the unit has started to be used. A supervisory programme should then be set up on the basis of the experience gained.

2.2 Social conditions

The staff who will be following developments directly on site must be well aquainted with the type of technical and social problems that can arise.

2.2.1 Information to be given to field personnel

The staff must be well informed of the technical requirements governing the functioning of the oxidation toilet with particular emphasis placed on the conditions required for the composting process. Important points to observe in this context are: the carbon-nitrogen relationsship (excreta - other waste of an organic nature such as fruit peels, food wastes etc), moisture content of 40-60 % (not too dry and no surplus fluid in the form of puddling at the bottom of the vault) and temperature. In addition,the refuse question must be stressed; glass, plastic and metal cannot be decomposed in the compost and impair the possibility of using the compost for soil improvement purposes.

The information must be given orally on one or more occasions depending on the response and a check must be made to ensure that it has really been assimilated.

2.2.2 Information to toilet user

The information should only be given by the field staff in order to as far as possible obtain the required conditions. After a suitable interval, for instance 6-12 months, a follow-up session should be held to find out what the users have really grasped and their impression of how they think the toilet should work.

2.3 Technical and social operation

The field staff are to make notes on a regular basis on technical and social conditions at each individual unit. Important questions are how many people use the toilet, how much refuse is added, whether or not there is any great difference between the types of refuse used at different sites, whether large quantities of water are added apart from urine etc. Furthermore, the technical function of the toilet should be checked as far as possible - the moisture content or possible excess liquid etc. should be noted whenever possible.

Social reactions must be noted including the reaction of the family and their guests and any difficulty met with in adapting to the new conditions etc.

2.4 External social aspects

Other social reactions must be observed, e.g. social relationships within the community such as possible reactions between villagers with different types of toilet system, etc.

INSTRUCTIONS FOR USE OF COMPOST TOILET

Insert: Kitchen waste in the vault via the latrine hole (or in the case of certain types of toilet, through the refuse hole at the back of the superstructure).

Also insert: ashes and refuse obtained during the day-to-day cleaning of the house. Once or twice a week it is also a good idea to add a certain amount of grass, straw or leaves.

Never insert: glass, plastic, tin cans or other foreign matter which cannot be decomposed in the vault.

Also never insert: burning matter such as cigarette ends.

Use as little water as possible whenever you go to the toilet.

Never use the toilet as a "bathroom".

Insert ashes in the vault after each use.In this way you will avoid the presence of flies and bad odour.

Always replace the lid over the latrine hole after use.