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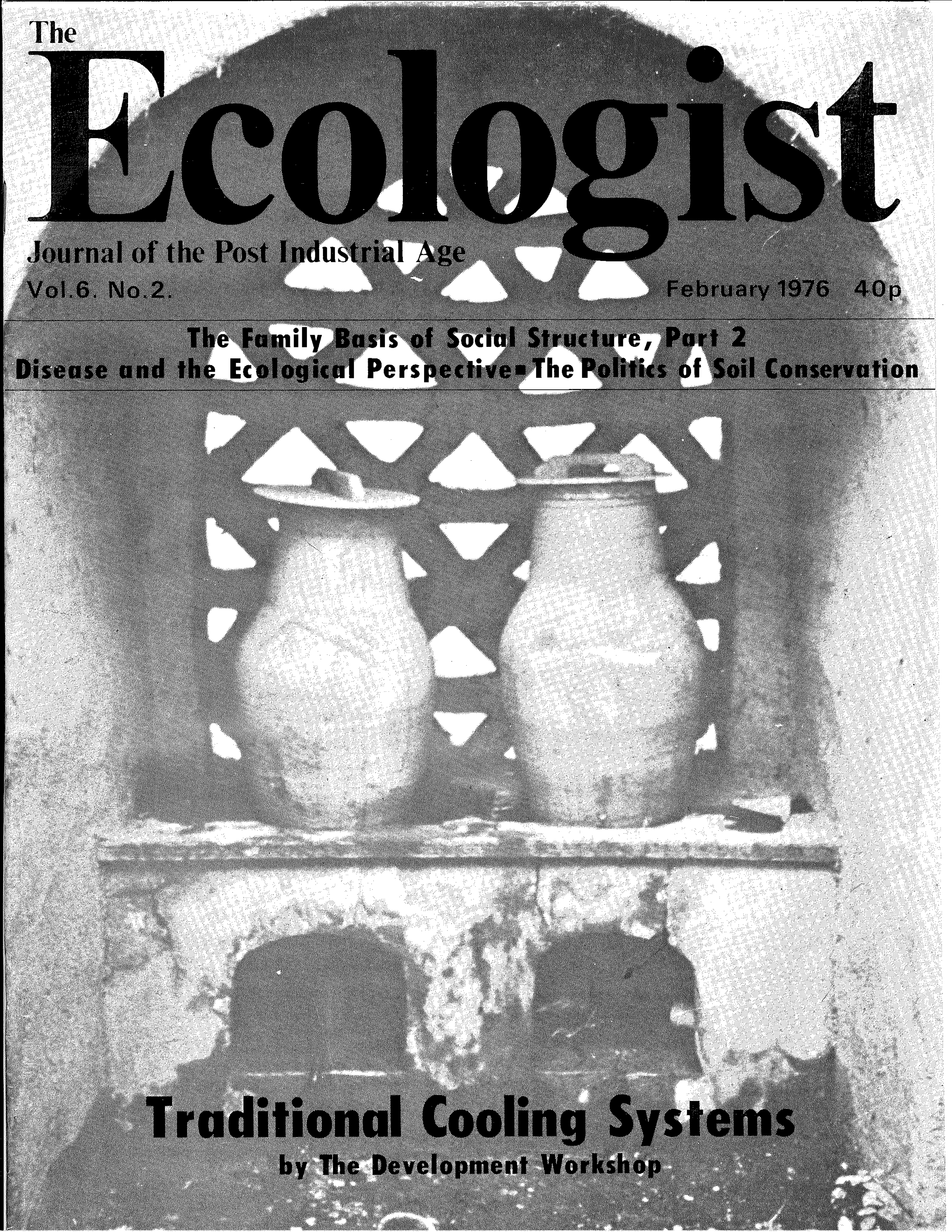
The Family Basis of Social Structure, Part 2

Disease and the Ecological Perspective ■ The Politics of Soil Conservation



Traditional Cooling Systems

by The Development Workshop

Traditional Cooling Systems in the Third World

by
Allan Cain,
Farroukh Afshar,
John Norton
&
Mohammad-Reza Daraie

Today more than ever the technology of the industrialised world is being exported intact to the developing world. Western industries depend on marketing their wares to the Third World in order to buoy up their own countries' failing economies. For example, in Britain now 50 per cent of the building industry is dependent on foreign contacts.[1] The West's technological development was founded on the cheap raw materials and energies taken from the colonial world. Developing countries today do not have a world of resources to freely exploit and a few are now beginning, out of necessity, to look towards a more self-reliant road to development.

Agricultural technology in the United States now demands 5 calories of energy input to produce 1 calorie of food; on the other hand, in China 1 calorie input of energy produces 20 calories of food – 100 times less.[2]

There exist in the Third World a wealth of indigenous technologies which have largely been ignored, if not actually suppressed, during the era of rapid growth in the industrialised world. However large numbers of people in the rural areas and old quarters of cities and towns in the Third World rely entirely upon indigenous technologies. These technologies are almost always identified as signs of underdevelopment because they are most often employed by the poorer classes of society. Those who have never had access to large amounts of expensive energy have invented technologies which are efficient in use of local materials.

Millions of pounds are spent on the research and development of 'Advanced Technologies' – advancing them further and further away from any relevance to the majorities of the world. We believe that we must research and develop those "simpler" and not unadvanced technologies which the majority of the people in the Third World use and live within. Such a scientific reassessment of the indigenous in Third World countries could form the basis of a real development.

This article deals particularly with the indigenous technologies of cooling, using largely natural sources of energy and techniques which have been developed by people locally.

Maziara Cooling Jars

The Maziara is a traditional water cooling and purification system used in rural areas of Upper Egypt. The evaporative cooling properties of large porous ceramic water storage pots are employed. Similar methods have been used in different parts of the world to keep liquids and perishable food cool.

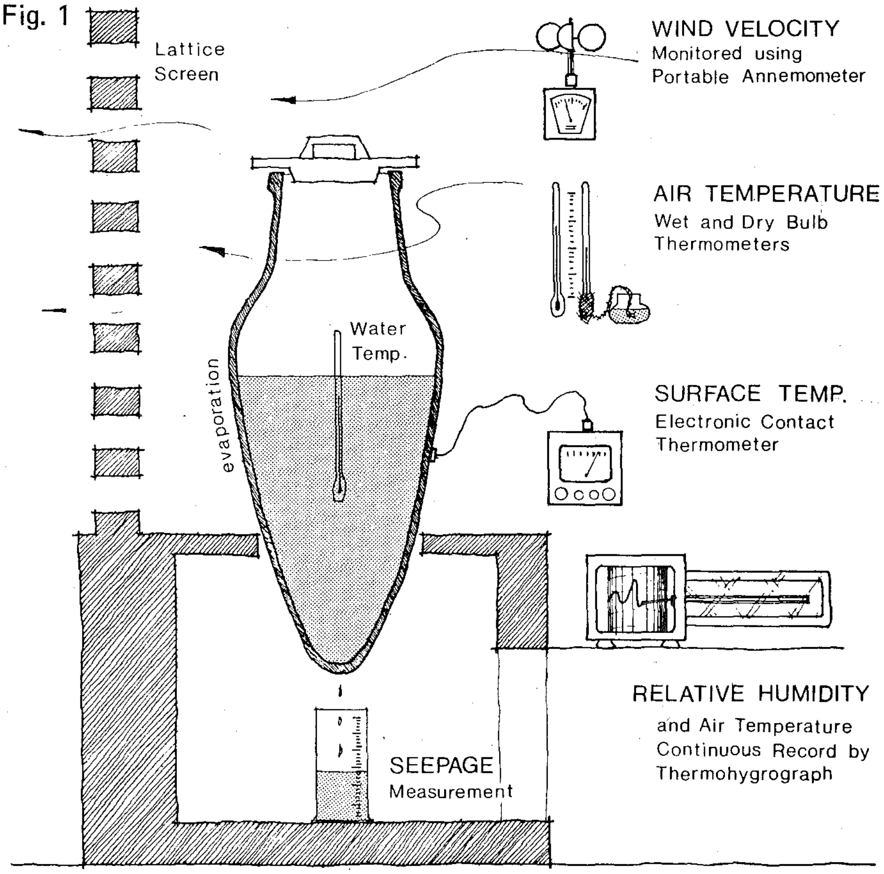
The supply of safe drinking water is a primary factor in the maintenance of public health in developing countries. Consideration must be given not only to the water source and its quality but also to the distribution and storage systems. In an Egyptian village area studied by the authors,[3] there was no modern system of piped water to individual homes. Water was available from wells or from the Nile River and its canals. Nile water and water from irrigation channels is unfit for drinking and often carries dangerous pathogens such as 'bilharzia larvae'. Shallow wells are also often polluted and clean water is only guaranteed from deep wells. Women collect water from these sources in the early morning and then carry water jars (bellas) on their heads back to their homes. Once home the water is stored in the Maziara. These large, unglazed ceramic jars hold the day's supply of water for drinking and domestic use.

The porous nature of the unglazed ceramic means that water seeps through the jar's wall, maintaining a wet outside surface. Some of the water evaporates and the rest drips down the sides of the jar and is sometimes collected. Drinking water is usually scooped out of the pot with a dipper, though it was discovered that water collected at the base after it had been filtered through the pot is much cleaner. The water in the Maziara is kept cool all day by the action of evaporation from the jar's outer surface. Evaporation, or the change of water from a liquid to a vapour, absorbs a considerable amount of heat energy (580 calories of energy for every cc. of water evaporated.) Heat is therefore continually drawn out of the water in the storage jars. The dry Egyptian climate means that the outside air can absorb a great deal of water vapour, and in turn a considerable amount of evaporative cooling can take place. The Maziara is usually situated so that it is in a draft, for air movement aids evaporative cooling.

An experiment was set up using portable meteorological testing equipment in order to evaluate the cooling action of the Maziara (Fig. 1) Water samples were taken at various stages in the system, to be measured later in the laboratory for purity.

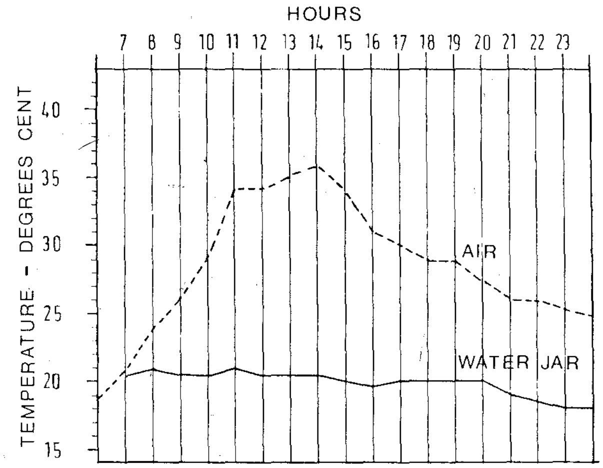
Results of the climatic tests showed that even though the outside air temperature ranged from 19°C. to 36°C. over the day, the temperature of the Maziara water remained relatively constant at 20°C. Since one feels comfortable in Egypt only between the narrow range of 21°C. to 26°C. the water feels refreshingly cool all day. The constant Maziara temperature (Fig. 2) may seem surprising with such a large air temperature range, i.e. 17°C. This can be explained by the fact that as the day progresses and the air temperature rises, the relative humidity (the amount of water vapour in the air) decreases (Fig. 3). As the air becomes drier more water evaporates from the water jar's surface and the cooling rate increases (Fig. 4).

Fig. 1



MAZIARA WATER JAR TESTING METHOD

Fig. 2



COMPARATIVE TEMPERATURES OUTSIDE AIR VS WATER JAR

Fig. 3

RELATIVE HUMIDITY OF AIR

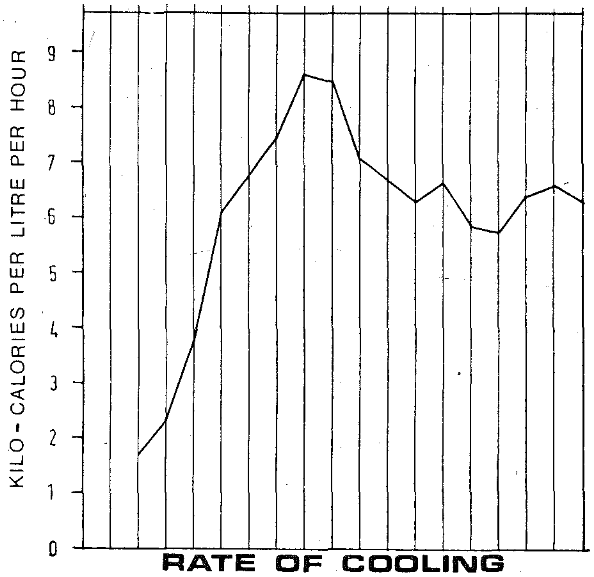
The Maziara though mechanically simple proves to be a very sophisticated system; its temperature self-regulation is a response to local climatic changes.

Over a 16 hour test period a single jar produced 1700 k. cal. of cooling. At the hottest time of the day the jar's cooling rate was 165 k. cal./hr. or about 192 watts (Fig. 5).

In order to test the Maziara's water purification action a series of laboratory tests were made on water samples. Into the Maziara was placed water collected from the nearby Nile River. Samples were taken from the river source and from the effluent runoff after water had been allowed to filter through the Maziara system. Other samples were taken from inside the jar. Samples were tested in the Government laboratories in the Luxor hospital and it was found that the filtered outflow water was pure to the Government's drinking water standards, even though the original Nile water that was put into the jar was contaminated.

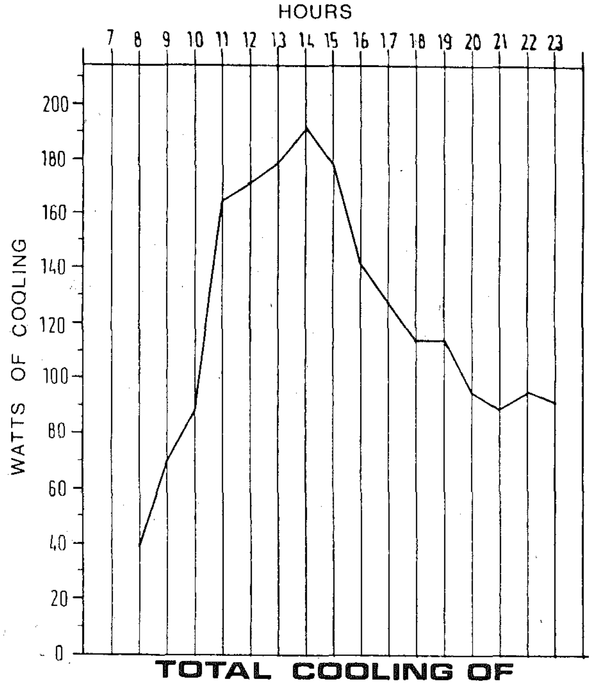
Pollutants can either be suspended in the water or chemicals dissolved

Fig. 4

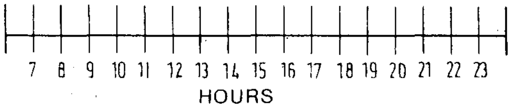


RATE OF COOLING PER QUANTITY OF WATER

Fig. 5



TOTAL COOLING OF WATER JAR



the Maziara removed some of the suspended pollutants, but filtering alone cannot remove harmful chemicals or all microscopic organisms. It is therefore assumed that there were no such elements in the original samples taken. If the cleaning action of the jars is to be maintained they would have to be rinsed periodically and sterilised with boiling water.

The result of the purification tests illustrates that chances of drinking water contamination can be reduced if the Maziara's filtering action is used.

Western Technology versus the Indigenous

It is interesting now to compare the indigenous Maziara cooling jar method to its Western counterpart, the mechanical cooler.

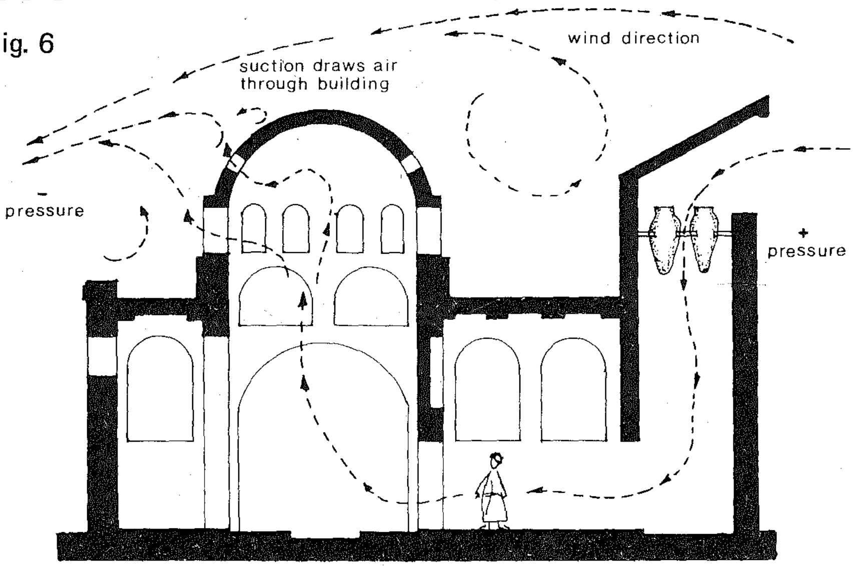
Technological sophistication is usually measured in terms of the number of transistors or moving air conditioner could be called a piece of advanced equipment. If we evaluate sophistication in terms of efficiency we find the opposite. An air conditioner producing 12,000 BTU's of cooling will in turn consume 2400 watts of electrical energy.[4] This means that an equivalent of about 70 per cent of the total cooling output is required in electrical energy to run the unit. The Maziara cooling jar method, on the other hand, requires no other energy than that required to fill the jar with water in the morning. It is, as well, totally self regulatory and responsive to climatic changes without the aid of a complicated thermostat. The inefficiency of these mechanical systems is compounded and in global terms: "200 million Americans use more electricity for air conditioning than 800 million Chinese use for everything."[5]

The hazards of modern air conditioning systems are rarely advertised in the glossy brochures distributed by companies' dealers in the Third World. Mild shock sometimes occurs at the entry of an excessively cooled building, if the temperature differences between inside and outside are too great. Mechanical air conditioners often produce pools of very dense cold air in the lower parts of rooms. Such stratification of temperature over long periods affects blood circulation, respiration and other bodily functions particularly in children and old people.[6] Indigenous cooling systems by the very fact that they are usually naturally regulated, avoid these dangers.

Most of the vast rural areas of the Third World do not have access to electricity in order to power a mechanical unit, and must therefore rely on some other non-energy consuming method. The average per capital income of people in many countries, if accumulated over several years, would hardly be enough to purchase the cheapest mechanical air conditioner. On the other hand, a large unglazed jar suitable for cooling, costs less than a pound, and can be made in a village kiln, and could if developed form the basis of a small industry.

Comparative experiments are currently being planned by the authors

Fig. 6



WIND-CATCHER WITH COOLING JARS

Air is cooled as it passes over evaporative cooling jars

in Iran, in the use of water jars for air cooling within buildings as against mechanical cooling. In theoretical terms, five or six water jars, each producing up to 200 watts of cooling, would be equivalent to a small window-mounted mechanical cooling unit of 1000 to 1200 watts.

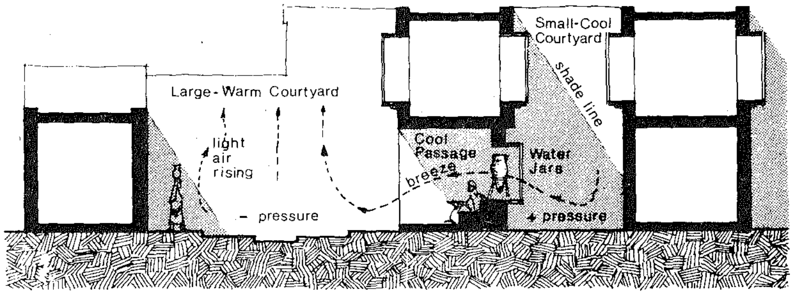
Development of Local Technologies

A wide variety of cooling solutions based on the principles illustrated above have been developed indigenously in Third World countries, and there is still much scope for their improvement and wider use. Porous water jugs and even simple dampened reed matting have been used in conjunction with wind catching towers, which funnel air down into rooms of houses after it has been conditioned by evaporatively cooled surfaces (Fig. 6). Professor Hassan Fathy, in a design for a wind catcher for a school in Upper Egypt, used beds of wet charcoal for air to pass over before entering rooms, and he reports a drop of 10°C. in air temperature.[7] In Iran, wind shafts often lead to basement water cisterns. Both the air and water is cooled by the effects of evaporation. The water being stored underground retains its coolness, and the air after being cooled is directed up into the rooms of the house. (More information on the wind catcher as an air cooling device can be found in *Architectural Design Magazine,* April 1975, pp 217-218, by the authors.)

The courtyard of the Middle Eastern or Mediterranean house has long been known for its cooling properties.[8] The court acts as a well to trap cool night-time air and retain it throughout most of the day. An interesting adaptation of the typical case is the two courtyard house. One court is small and deep and therefore generally shaded and cool; the other is wide and open to the heating of the sun's radiation. Air in the small courtyard, being cool and dense, has a higher pressure than the warm air of the large courtyard, which tends to be lighter and therefore rises. If an opening or passageway connecting the two courtyards is well positioned, there will be air movement induced by convection from the cool courtyard through the passage to the warm courtyard. The air's velocity is controlled by the size and nature of the passageway as well as the temperature and pressure differences between the two courtyards. Water cooling storage jars if placed in this passage will add to the cooling effect of the breeze (Fig. 7). In houses where this feature is employed, the inhabitants spend the hottest hours of the summer days in this cooled space between the courtyards.

In Muscat Oman, water jars have been mounted in specially designed window openings, not only for the provision of cooled water but to reduce the temperatures of the air passing over them and entering the room (Fig. 8). Similarly in India simple coarse woven mats over window openings when wetted cool the air passing over them into the room. Such matting usually needs rewetting by hand every 20 minutes. A recent development in India based on research into the indigenous method is an air conditioning unit (Fig. 9) using matting of khus-khus grass, which is widely available in Northern India and gives off a pleasant aroma when wet, in conjunction with a water reservoir and a small mechanical fan. The water reservoir maintains a controlled drip which is just enough to keep the matting wet. A low voltage fan, which could even be battery powered, is the only energy consuming part of the unit.[9] A development upon this could use a roof-mounted wind trap to provide air

Fig. 7



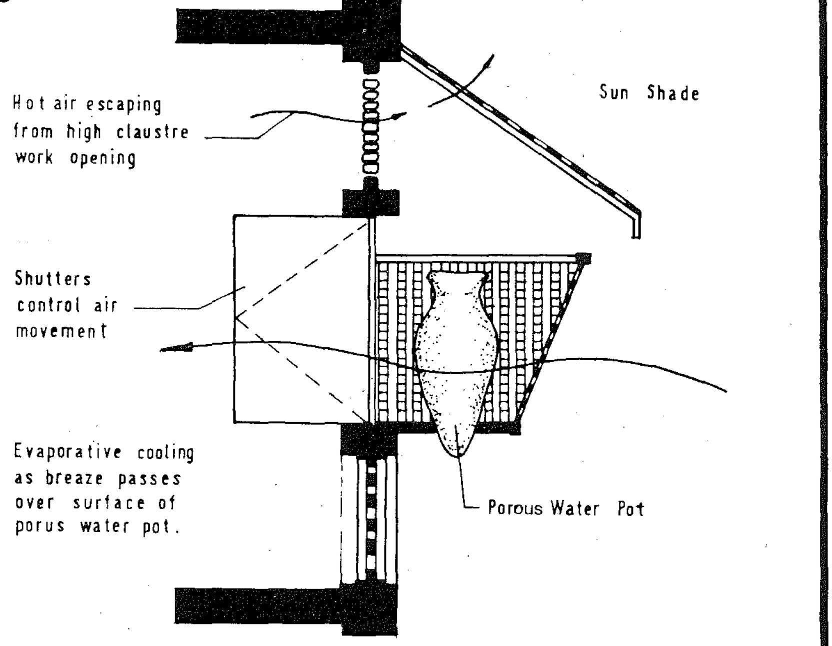
TWO COURTYARD HOUSE – AIR MOVEMENT INDUCED

Convection system between courtyards. Breeze is drawn across cooling jars back-up system.

Perhaps more important than air cooling is the cooling and storage of perishable foods. A large percentage of the total food produced in Third World Countries rots and is lost before it is eaten because of the lack of any cooling storage facilities. Again in India evaporative coolers have been used indigenously which could help alleviate this problem. A domestic cooler was developed using a porous outer water jar and a glazed inner jar as a dry compartment to hold the food (fig.10). The space between the two jars acts as a reservoir for water, which keeps the exterior porous jar wet. Evaporation of water from the surface of the outer jar keeps the whole system, including food stored within it, cool.

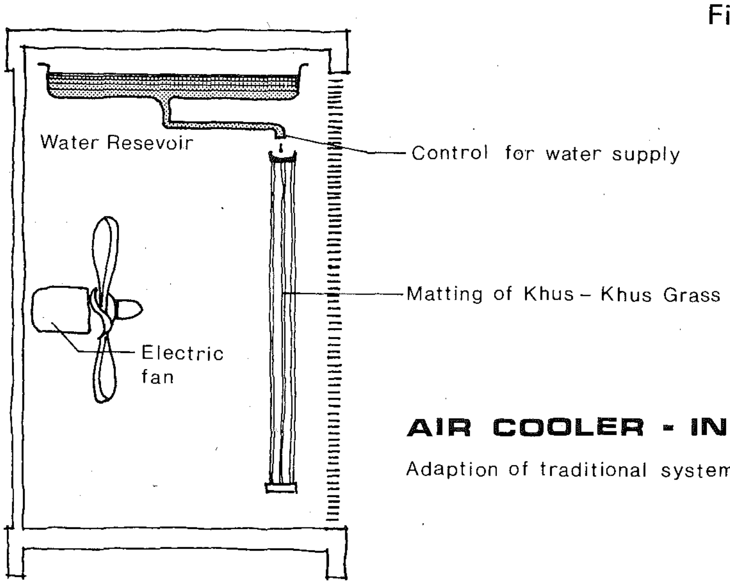
This article has dealt with some of the technological innovations that have grown out of an indigenous scientific approach to a basic problem — cooling — in many Third World countries. It should be seen as one example out of many such neglected systems which could be developed upon. Technologies adopted, as well as the approach taken to the improvement of indigenous methods of solving problems have a strong impact upon the direction of the road any society chooses towards development.

Fig. 8



WINDOW MOUNTED COOLING UNIT - MUSCAT

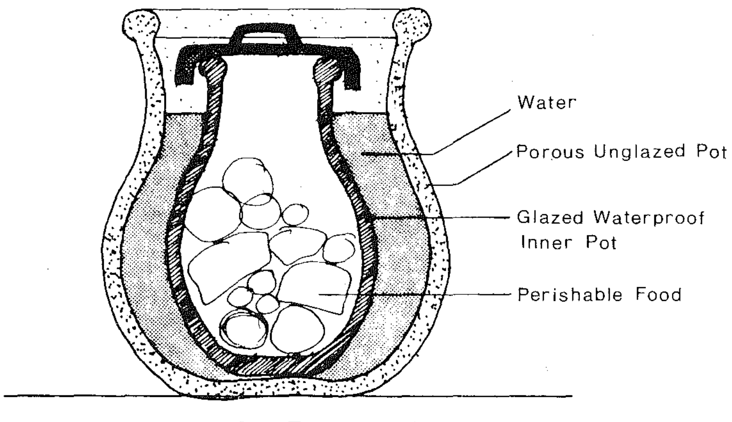
Fig. 9



AIR COOLER - INDIA

Adaption of traditional system

Fig. 10



FOOD STORAGE COOLING UNIT - INDIA

Evaporative cooling from moist exterior surface

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Note:
All photos, drawings and charts by the Development Workshop.