

AQUATIC WEED CONTROL A PLEA FOR APPROPRIATE TECHNOLOGY FOR THE THIRD WORLD

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ABSTRACT

This paper proposes methods for controlling aquatic weeds and using them to best advantage, especially those methods of the now well-known *Appropriate Technology* (AT) that show promise for developing countries of the Third World. It emphasizes techniques for converting weeds for feed, food, fertilizer and energy production. It examines also biological control techniques in which herbivorous tropical fish, waterfowl, rodents and other animals convert the biomass of these troublesome plants directly to comestible products. In many situations, judicious use of aquatic weeds will contribute markedly to their control and they should be seen as useful tools in an integrated system of weed management, in which different control techniques complement each other and produce a usable product. Thus aquatic weeds constitute a free and enormous source of great potential value, especially in these days of universal energy crisis.

INTRODUCTION

A developing country like India has an urban society as modern and technologically advanced as almost any in the world. But there is another, rural India, where millions live by the same tools and rhythms as in centuries past. Recently in an attempt to close the gap between these two societies, India began to test an alternative to centralized technology—a technological approach that is at once radically modern and surprisingly traditional.

With roots reaching back to the Gandhian cry for self reliance ('Production by the masses and not mass production') *Appropriate Technology* (AT) has produced strong controversy in its spiritual homeland. Those who support AT are well aware that this radical policy threatens the vested industrial and economic interest of India's powerful elite. We acknowledge strong opposition from the relatively few who control India's wealth and means of production and who have profited by the country's remarkable growth in recent years. Those who favour continued development of centralized industries see AT as a step backward that India cannot afford! But for the millions who live below the poverty line, AT may offer new hope: recycling of sewage by aquatic plants, biogas plants that recycle sewage into fertilizer and fuel, the hand-weaving industry, the simple irrigation wells, the energy-balanced bullock carts etc.—all these are small in scale and relatively inexpensive to build or support. And they meet India's (for that matter, any developing country's) most pressing needs: jobs and income. All are tailored to resources already at hand, yet use advanced technology where appropriate.

Wanted—a new outlook on aquatic weeds

We have thus far been emphasizing the damaging aspects of aquatic weed growth. I want now to look at aquatic plants from another viewpoint. There is a striking paradox involved when efforts are directed towards destruction of these lush, green, prolifically-growing plants in the very same regions of the world where the human and livestock populations are suffering from a continuous lack of food resources, with few agricultural possibilities to alter the situation. A simplistic definition of pollution is a 'resource out of place'. Is this not perhaps

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true of aquatic weeds?

This report examines methods for controlling aquatic weeds and using them to best advantage, especially those methods that show promise for less developed countries. It emphasizes techniques for converting aquatic weeds for feed, food, fertilizer and energy production. It examines for example, biological control techniques in which herbivorous tropical animals—fish, waterfowl, rodents and other animals—convert the troublesome plants directly into lipid- and protein-rich meat.

Aquatic weeds have always existed but in recent decades their effects have been magnified by man's more intensive use of natural water bodies—his modifying them into canals and dams, polluting them with farm and city waste waters and introducing aggressive plant species into new locations. These plants, among the most prolific on earth, grow luxuriantly in the tropics, weigh hundreds of tons per hectare, and can be a serious hindrance to a nation's development efforts, due to the enormous amount of expenditure of money and energy involved in the attempt at their total eradication. Eradication of these weeds has proved impossible and even reasonable control seems to be difficult. Turning these weeds to productive use would be most desirable, but only limited research has so far been carried out in this area.

In many situations, judicious use of aquatic weeds will contribute markedly to their control—a sort of bio-feedback control. The advantages of weed utilization over chemical and many biological weed controls are: (1) the production of valuable end products: meat, eggs, fish, edible vegetation, fertilizer, animal feed, energy, paper pulp, etc.; and (2) the preservation of ecological equilibrium.

Biological control using herbivorous animals

A quick-growing fish that lives on plants is the Chinese grass carp (*Ctenopharyngodon idella* Val.) or white amur, which feeds voraciously on many aquatic plants and grows to weigh as much as 35 kg. In several countries it is now being tested for aquatic weed control (Vinogradov and Zolotova 1974). It has proved to be an exceptionally effective control agent for submerged weeds (Buck *et al.* 1975). Weed control is rapidly achieved if more than 75 fish per hectare are present (Cross 1969). Although the grass carp is native to cool water rivers of China, it thrives in warm tropical waters. Natural reproduction seldom occurs outside its native range, but the fish can be reproduced artificially. The main barrier to the wholesale release of the grass carp in some countries has been the uncertainty surrounding its possible effects on other aquatic animals. The fact that natural reproduction is not common in tropical regions may indicate that the fish needs a distinct change in seasonal temperature to initiate spawning. Research on this and other factors will provide administrators with technical underpinnings necessary to judge the wisdom of introducing the fish to a new waterway.

In ecophysiological terms, a food chain that grows fish on plant life rather than on higher organisms, for example, is a more energy saving and efficient way of providing food. It is not unpractical to visualize that the now undesirable vegetation in ponds and water expanses will be managed like pastures in the future, even to the extent of planting and culturing the plants solely for fish food.

Herbivorous fish have an important but yet under exploited role in fish farming using polyculture techniques. In this method pioneered centuries ago in China, fish species are selected for the different types of food they consume.

then they are put in the same pond together. The combination makes use of each of the food types available in the pond and thus maximizes the amount of fish food grown. Polyculture systems often combine grass carp with silver carp, *Tilapia zillii*, *T. rendalli*, *T. guineensis* (Payne 1975), and *Sarotherodon mossambicus*, an algae feeder (Bardach *et al.* 1972).

The manatee or 'sea cow' is indigenous to 40 tropical countries. A large, warm-blooded, air breathing herbivore, it is a docile, retiring animal that has been suggested as a weed control agent in South and Central America, and in West and Central Africa. The manatee can live in both fresh and salt water and is often observed in estuaries. They may consume as much as 5 per cent of their body weight each day. An adult manatee exceeding half a ton in weight and 3 m in length possibly consumes 20 kg of wet vegetation each day. They are a potential source of edible protein (Alsopp 1969, Bertram and Bertram 1973).

Among the best-exploited edible fresh water organisms are crayfish, close relatives of the lobster, which bring premium prices as gourmet food. In some countries crayfish are farmed on a large scale in rice fields, where they feed on aquatic weeds and other organisms. Their carcasses are high in Ca and N, both valuable fertilizer ingredients (Abrahamson 1972, Avault 1975).

If carefully managed, herbivorous animals like duck, geese, swans, sheep, pigs, donkeys and buffaloes can clear aquatic weeds remarkably well from ponds and waterways. In so doing they provide meat or eggs and they are particularly promising for small-farmer use in developing countries (Ross 1971, Williamson and Payne 1965).

Soil additives

Minerals as fertilizers are too expensive for many farmers in developing countries, yet there is a greater need now than ever to increase food production. As an alternative, the 1974 World Food Conference and more recently the Food and Agricultural Organization of the United Nations have stressed the need of reassessing organic fertilization, which includes green manuring and composting. Aquatic weeds can be used in both the processes (Bagnall *et al.* 1974). Many aquatic weeds contain appreciable quantities of N, P, K, and other fertilizer ingredients. Because of this, aquatic weeds become a fertilizer as well as a soil conditioner (Dalpadado 1976). As a mulch they suppress weeds, reduce evaporation and reduce rainfall run-off and the erosion it causes, and they improve finally the soil texture which is vitally important in sandy, lateritic and heavy clay soils (all of which are widely distributed in developing countries) (Poincelot 1975).

Processed animal feeds

Many types of vegetation that humans find inedible can be converted into meat, milk and wool by ruminants (Stephens *et al.* 1972). Aquatic weeds are usually between 10 and 26 per cent protein on a dry matter basis, which is higher than that of ordinarily-available food proteins. The leaf parts of aquatic plants such as duckweed and water hyacinth and some submerged weeds contain 25 to 35 per cent protein, which is exceptionally high (Bagnall *et al.* 1973). It is also reported that the lysine content in water hyacinth is equal to that found in milk (Byron *et al.* 1973). Submerged aquatic weeds such as hydrilla are particularly rich in carotenes and xanthophyll and could become new sources for these commercially-valuable pigments, which many countries add to poultry rations (Linn *et al.* 1975).

Aquatic weeds like the common reed, cattails, papyrus, bulrushes, etc., which usually grow in pure stands, have been harvested for centuries for food and fibre. As synthetic materials become increasingly expensive in the future, these aquatic reeds may be used for those purposes again (Little 1968).

Energy production

The recovery of fuel from aquatic weeds, even if on a small scale, has interesting implications, especially for rural areas in developing countries (Jewell 1975). As many developing countries have an apparently inexhaustible supply of aquatic weeds within their borders this potential source deserves further research and testing (Wolverton and McDonald 1976). In a pioneering effort of great significance researchers at the *National Aeronautic and Space Administration* (NASA) are working on converting water hyacinth and other aquatic weeds into biogas, which is rich in methane (Wolverton *et al.* 1975). Based on NASA's findings, water hyacinth harvested from one hectare will produce more than 70 000 m³ of biogas. This biogas burns readily. It can be used for virtually every application where natural gas is used: for cooking, heating and as a source of power (Singh 1972). Aquatic weeds are converted into biogas by capitalizing upon one of nature's processes for decomposing wastes, decay by anaerobic bacteria. The production of biogas removes carbon from the ferment but there is little loss of the other elements. These remain as a liquid sludge that is itself an organic fertilizer and soil conditioner (Shadduck and Moore 1975).

Waste water treatment using aquatic weeds

Recently research workers have discovered that some aquatic weeds can scavenge inorganic and some organic compounds from water (Wolverton and McDonald 1975, Wolverton *et al.* 1975a,b). The weeds absorb and incorporate the dissolved materials into their own structure. Effluent renovated by these weeds is stripped of its pollutants and when released into waterways, causes less environmental damage (McNabb 1976). The plant culture units clean water so rapidly and effectively that they are now seriously being considered for use as a 'final polish' in sewage treatment. Furthermore, the plants themselves can be harvested and used, thus providing additional benefit (Goldman and Ryther 1976). The technique can also be used for treating animal manure and other farm wastes. For developing countries this could become extremely important. Nitrates, ammonium compounds, phosphates, and organic carbon discharged from sewage treatment plants are fertilizer nutrients often needed in agriculture, which today cost developing countries increasing amounts of precious foreign exchange (Smithsonian 1976). For many rural farmers the price of the foreign product is prohibitive. Aquatic weeds thus provide an indigenous source of cheap fertilizer and soil conditioner available within the rural regions that need it most (Jong 1975). In addition, aquatic weeds can be used to partially strip traces of potentially harmful or odorous agents from drinking water, including cadmium, nickel, mercury, phenols, and potential carcinogens (Sutton and Ornes 1975).

CONCLUSION

One of the pleasures of belonging to our profession of biologists is that its membership provides us with a licence to dream! To my mind, dreaming is not only a professional privilege accorded to all of us, it is an honourable duty to be performed by all of us objectively! Above all it raises our expectations and

encourages us to tackle problems which, one might say, are almost beyond our wildest dreams. Nobody has captured the spirit of dreaming more vividly or with as much feeling and hopefulness as did R. Kennedy in his much-quoted lines:

'Some men see things as they are and say, why?
I dream things that never were and say, why not?'

Hopefully the day may come when waste from rural communities and industries will be purposely diverted into a well-designed holding area, where specially used, high yielding, high quality aquatic plant growth will be promoted or appropriate herbivorous species will be maintained. At designated periods, both the herbivores and plants might be harvested and used as economically viable food, feed or by-product enterprises. At this projected stage of development, the appearance on the scene of insects or microbial pathogens, capable of eradicating aquatic vegetation would be unwelcome and unnecessary. If this stage is reached, the present day curse would indeed be a valuable source and tool in maintaining a realistic ecological balance. Aristotle, one of the greatest of all philosophers that mankind has ever produced, speaking in an abstract way, defined every being as intrinsically beautiful and good: '*Omne ens est bellum et bonum*'. It is up to us biologists to find out the '*bonum et bellum*' of these aquatic weeds so that we may better realize the rationale of all the beings, living and non-living on this planet of ours.

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