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OCEAN FISH CULTURE

by

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ABSTRACT

A brief account is given of the principal work in oceanography which has a bearing on ocean culture. The possibilities of this type of culture are outlined and the use of nitrogen fixing algae is discussed. Lagoons as starting points for algal culture are considered.

INTRODUCTION

(1) For many centuries, fish culture was essentially confined to fresh water, later to brackish water and inshore shellfish culture. More recently, the construction of hides for fish and crustacea has proved profitable in making areas of shallow sea much more productive. Good sea food species have been transferred to areas poor in good types making the new areas more productive (of sea foods); very large areas of relatively barren water are available. This use of the sea has as yet barely touched on the basic principle of fresh water fish culture as developed in South East Asia where relatively small areas of water are cultivated to produce the right types of food at the right time to ensure a supply of good quality marketable fish - on schedule.

(2) Fishermen have known for a long time that some areas of the sea are more productive than others. Recently some ocean surface currents have been shown to be not only more productive, but parts of the same currents are very much more productive than others. Increase in productivity in fish comes from eddies and upwellings which somehow either increase the food available for fish or make living conditions better for some species. Configuration of reefs also may produce eddies, and knowledge of these often leads to success in ocean fishing. These richer areas make a good starting point for oceanic fish culture.

Can suitable culture material be introduced at one or more points in an ocean current? Can the end product be removed 3,000 - 5,000 miles away? There is good evidence to show that this may well be so.

(3) It is fitting, however, to quote from a recent book by McKee (1967 p. 100) who writes:

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> "In order of increasing difficulty are fresh water fish, brackish water and sea fish. And with the latter, there is a great divide between the sea fish in fenced water and sea fish in open sea. It is the latter which has the greatest potential....."

Problems in the tropical Pacific Ocean are perhaps greater still than in any of the seas of the world. It is the aim of this discussion to see what has been done in the past twenty (20) years which has a bearing on the problem of ocean fish culture, how the information may be used and what experiments may be carried out on an oceanic scale to assist in the production of sea foods.

OCEANIC WORK IN THE PAST TWENTY (20) YEARS

Following are the principal lines of work which have been carried out and which have important bearing on ocean fish culture:-

(1) Atomic bombs distributing radio-active material in Pacific and Indian Oceans have been exploded since 1946.

(2) Large scale oceanographic investigations determining the extent of radio-active fallout have covered large parts of the Indian and Pacific Oceans.

(3) Basic productivity of the sea determinations using modern techniques have been made over wide areas covering many current systems.

(4) Much oceanographic work has been done proving new surface and deep currents. Flora and fauna have been assessed quantitatively.

(5) The richer areas of the tropical waters have been fished at times intensively and it is believed are becoming poorer. Fishermen are becoming increasingly aware of the richer inshore areas.

Efforts to increase productivity have been small but in discussions held on inshore fish culture at the Indo-Pacific Fisheries Council Meeting in 1966, pond fish culture was described by one speaker as relatively small and unrewarding compared with sea fishing - will the cultured production from ocean currents then be proportionally greater?

POSSIBILITIES OF OCEAN CULTURE

(1) Before considering ocean culture, it is appropriate to ask some questions referable to the great amount of work which has been carried out on ocean studies:

(a) Can ocean culture be planned in the same way as pond culture?

(b) Is it to be greatly different from inshore fish culture?

(c) Can the principles of seeding practised in fresh and salt waters be used?

(d) Are the quantities of nutrient salts in the tropical surface currents so critically small that any attempt at large scale increase in production is doomed to failure?

(e) Is it necessary to concentrate in areas of upwelling and small eddies which could be managed or even start in atoll lagoons or inside fringing reefs?

(f) Can we use radio-activity (Rapson in press) to clear the seas of unwanted organisms, such as the jelly fish (and other in the main useless organisms which sweep the seas clean), and replace these predators with food chains including diatoms and crustaceans and fishes?

(g) Can nitrogen fixing algae with the minimum phosphates available, make the ocean more productive?

(2) Does ocean culture give a country better claim to the resources in the ocean current concerned? Should the work be on an international scale which then permits participating nations to share the results?

(3) Some of the questions as a-b may be answered briefly. Ocean culture cannot be planned in the same way as pond culture but at least where the currents sweep the shores of tropical islands or reefs, it takes on some of the aspects of inshore fish culture, and experiments could be initiated inshore.

(4) With regard to c, recent developments on land show that seeding and fertilizing on a large scale is not only practicable, but highly economic. Diatom cultures may be produced at moderate cost and easily distributed, and whereas the development of land techniques of producing plants rich in nitrogenous material is well advanced, production of diatoms for sea culture is only just starting. Nitrogen producing algae are known and the species may be the key to the successful increased production of food for humans from ocean currents. They deserve much greater attention than they receive.

A brief extract from the Commonwealth Agricultural Bureau, 1962, Bulletin 46, p. 125, is appropriate:-

> "The autotrophic habits of the blue-green algae represent a real opportunity for the tropical agriculturalist to "get something for nothing", and research on the blue-greens in tropical countries should be strongly amplified."

This bulletin also lists diatom genera fixing nitrogen: Nostoc*, Anabaena*, Cylindrospermum, Aulosira, Calathrix*, Tolypothrix, Anabaeniopsis, Mastigocladus. Stewart (1966) includes only those marked*, but also Fischerella. It is of interest that Nostoc commune has been found on aerodromes in New Guinea so thick that they have to be closed to traffic.

(5) Biologists say we do not know enough of the mechanism of the diurnal rise and fall of organisms from deep water to near the surface to determine just what are the requirements of oceanic species, that they must get a large part of their needs from waters below the limits of the surface current. This is to some extent true, but there are also some principles of pond culture where the use of fertilizers can speed up production as on land. In part some biologists say that as soon as phosphate or nitrogen is released in tropical waters, there is some organism present to use it - the turnover is very fast. The direction of the programme of work would be to ensure that the right type of diatoms and higher or larger organisms in the food chains or end product are present.

(6) Large scale upwelling in the tropical Pacific is relatively small - the generally "Pacific Breezes" are in this regard literally only too true and it is probable that worthwhile upwelling occurs only when the offshore winds exceed 30 m.p.h. and this is not often. (The New Guinea Yule Island Crayfish Industry for Panulirus ornatus is believed to be dependent almost entirely on upwelling caused by wind storms of short duration blowing offshore in which the cold water from lower levels comes up and drives the crayfish from their habitat at a depth of 50-100 feet, into the shallow water).

(7) Plankton (f above) collected from the ocean and used as food has been tried on rats and one ocean mariner also used it. There are certain toxic elements present or a correct balance is not normally found and although this work appeared conclusive, a good many years ago, little further information is available. Evidence suggests that there are many bad types of organisms in the ocean; biological experiment has done little to correct this.

Should we continue to accept as normal the continued occurrences of red tide which normally do little damage but occasionally kill great quantities of fish and sometimes an unfortunate human?

Sometimes the sea is swept bare for hundreds of square miles by shoals of jellyfish. Should we allow completely useless marine animals to dominate great areas of ocean making them less productive? There is good reason to believe that by planting diatoms and subsequently crustacea and fishes, we can make the ocean currents yield more. However, it may be first economic to have a destruction campaign to eliminate the unwanted types of organisms. Can radio-active material do this? Evidence from some atomic blasts indicates that it can.

(8) As discussed above, it may be that the success of oceanic culture depends on one critical factor, the nitrogen fixing algae. Research has shown (Stewart, 1966) that under some conditions, very low concentration of phosphates, perhaps in concentrations of several mg. per metre^3 may be used by some algae and that the nitrogen fixing algae are as hardy as some of the nitrogen fixing plants.

It appears that in the warm ocean waters, turnover is not only more rapid, but a condition similar to that described in recent work in Australia must occur, that when there are large stocks with ample food the ecological relations of the predator at the end of the chain is made more direct and the rapid turnover of waste products permits speedy utilisation. In fact, long food chains which in pond culture take much time to be effective in production may not in actual practice in the ocean be wasteful but provide a variety of organisms which safeguards the end species of the chain. Footnote - a recent report by C.S.I.R.O. has shown that with heavy stocking on suitable pastures, less fertilizer is required than with light stocking - an analogous position to the use of four species of carp in one Asian type of pond culture?

(9) The task of fertilizing a square mile of ocean with fertilizer or seeding with diatoms creates small technical problems but is not very complex, nor is the cost of the material in the concentration used very much. Most people, too, would agree that rather than seed several square miles of ocean current, work in a large atoll lagoon would be preferable. However, suitable lagoons are not as common as may be expected and in New Guinea there are only about 10 with possibilities and of these, only about four are suitable for economic and other reasons. Lagoon areas inside fringing reef also offer possibilities, with more easy access for observation.

Between New Britain and New Ireland, there is a large eddy - the Bismark Sea in which ocean culture could be commenced. It is the largest of the possible sites for ocean culture. Normally it is rich in fish - could it be made richer?

Fertilization of inshore waters too may be economic by using deep water which is normally richer in nutrient salts. In some fringing lagoons bordering deep water, this may be relatively inexpensive by using tidal pressures to bring deep ocean water from 1,500 feet into the lagoon. Pumping too, would be relatively simple and perhaps economically practicable.

With the present interest in tropical development, Port Moresby has grown from a city of a few hundred people in 1950 to over 50,000 in 1968, the use of cold deep water could be used for cooling and air conditioning as well as fertilizing inshore waters.

RECOMMENDATIONS

(1) That the South Pacific Commission seek further information on the occurrence of nitrogen fixing algae in ocean currents and arrange through governments, IPFC and FAO for assistance in developing a programme to test the possibility of using nitrogen fixing algae to improve the productivity of ocean currents.

(2) That the economics be examined of using deep cold water for fertilizing the inshore and for air conditioning and cool storage, and consideration to be given to the fact that sea phosphate in situ is worth more than on the land.

(3) Consideration to be given also to the biology of tunas on a greater scale and particularly to the three common species of most importance, striped, yellow fin and little tuna, with the aim of determining food chains of greatest importance for oceanic development starting with the nitrogen fixing algae.

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