S U M M A R Y

1. Three experiments making use of the algae: Oscillatoria Spp., Anacystis nidulans and Scenedesmus obliqus in Baroda raw stained sewage were carried out under laboratory conditions when the temperature ranged between 27.5°C to 29.4°C and the intensity of lighting about 400 lux and lighting was kept throughout day and night.

2. In the case of the controls containing Baroda raw strained sewage only the following percentages of reduction were seen within 6 days: 65 to 74% reduction of BOD_5 and 64 to 66% reduction of COD. pH ranged from 7.5 to 8.3 and Am-N and PO_4 did not show significant reduction. The improvement is ascribed to bio-flocculation, bio-precipitation and surface aeration.

3. Two of the three algal growth cultures studied showed the following changes:-

   (a) In case of Oscillatoria Spp. pH ranged from 7.8 to 9.6 while in that of Anacystis nidulans 7.5 to 9.7.

   (b) Percentage of reduction of Am-N was found to be 95.8 and 80.2 in the case of Oscillatoria and Anacystis nidulans respectively.

(c) Within six days Oscillatoria Spp. showed 91.5% reduction of PO_4 Anacystis nidulans 74.3% reduction of PO_4.

(d) The amounts of reduction in BOD_5 were 92% and 92.2% for Oscillatoria Spp. and Anacystis nidulans respectively.

(e) 87.6% and 92.14% were found for COD reduction within 6 days for Oscillatoria Spp. and Anacystis nidulans respectively.

(f) Percentages of reduction of biochemical tests for Scenedesmus obliqus alone were; within 6 days: 86.6%, 82.7%, 66.7%, 60.3% and 88.1% were shown in free sugar, total sugar, protein, Amino acid - Nitrogen and Organic acids respectively.

4. Relation between Sawyer's formula and Mckinney's formula. It is found that the Sawyer's formula which is based on BOD gives values which corresponds to nearly two third of Mckinney's formula which is based on COD.

5. Within six days 310, 204,& 286 mg/l algal growths were found in the case of Oscillatoria Spp. Anacystis nidulans and Scenedesmus obliqus respectively.

6. Percentage of efficiency of light utilization by Oscillatoria Spp. was 2.80% and in the case of Anacystis nidulans, 1.83%.

7. The correlation between total bacterial biomass according to Mckinney's formula and the determined algal biomass values have been found and the former is nearly half of the latter.

8. Carbon dioxide production from organic matter in the three cases fell short of the requirements for algal production by 34.5%, 16.12% and 1.1% on 2, 4 and 6 days in case of Anacystis nidulans while Oscillatoria Spp. showed 43.8%, 22.1% and 17.9% on 2, 4 and 6 days and Scenedesmus obliqus showed 20.1%, 4.49% and 1% on 2, 4 and 6 days, respt.

9. Photosynthetic oxygen produced was more than that required for the bio-oxidation of organic matter in sewage by 38.9%, 17.6% and 13.5% in the case of Oscillatoria Spp. and 29.6% and 4.7% on 2 and 4 days in the case of Anacystis nidulans and for Scenedesmus obliqus 1.4% and 8.6% on 2 and 4 days.

10. Oxygenation factors were 1.33 and 1.56 within 6 days for Oscillatoria Spp. and Anacystis nidulans respectively.

11. The bacterial sludge was very low and contained numerous filamentous forms which were pale

yellowish brown to dark that may be iron bacteria i.e. Leptrothrix ochraceae and the significance of their presence is not understood.

12. Lucane Spp. was found as the indicator of purification in Oscillatoria Spp. culture.

13. Bacterial oxidation, photosynthetic reduction and algal synthesis take place such that excess oxygen is made available for complete aerobic bacterial oxidation and stabilization of organic matter and production of an abundance of algae.

14. These biochemical reactions are rendered possible on account of the penetration of radiation energy into the shallow depth of the culture flasks throughout day and night excepting for a few hours of darkness resulting from periodical current stoppage.

15. Mixing for a few hours every day helps in distributing oxygen throughout the liquid medium and in maintaining the bacterial sludge in an aerobic condition so that biostimulatory nutrients are released into the medium for algal synthesis. Also, it is another way of increasing the photosynthetic efficiency of the algal cells.

16. The entire biochemical process resembling those taking place in the euphotic zone of a shallow pond in the tropics.

17. The rate of algal synthesis is maximum during the first two days, when BOD_5 used up is also maximum 65 to 74% and photosynthetic oxygen production is also maximum. On subsequent days (2 to 6) the algal production is considerably lower; and this period would seem to correspond with the period of endogenous respiration, when nutrients are released back into the system for further bacterial growth.

18. Coliform reduction, though amounting to 99%, still the absolute number of organisms present in the medium on the sixth day is comparatively higher, The total colonies count indicates the presence of still larger numbers inspite of a sizeable amount of reductions, and this has to be attributed to cellular synthesis taking place along with the bacterial oxidation.

19. During the phase of bacterial oxidation of organic matter, complete oxidation of organic matter, cellular synthesis and bacterial solids formation do take place along with endogenous respiration of bacterial sludge, in the presence of excessive amount of photosynthetic nascent oxygen and newly formed algal cells.

All these processes are taking place almost simultaneously with the result that an abundance of algal cells alone is visible, of course intermixed with the skeltons of bacterial sludge and newly formed algal cells. These reactions are continous so that it is not possible to say which of the biochemical reaction is taking place first and which next.

20. A theory of "total oxidation" has been developed involving the use of microbial metabolic reactions to account for the absence of excessive bacterial sludge as in the case of the complete oxidation sludge process (Mckinney, 1962). In fact, there is a certain amount of similarity between the extended aeration activated sludge process and the high-rate aerobic oxidation pond system especially in regard to the comparatively smaller accumulation of sludge and the presence of a large amount of oxygen.

21. More algae is produced than what is possible with the help of organically produced CO_2 for, a little more of CO_2 from atmosphere and the alkalinity of water is possible.

22. In India, ponds resembling high-rate aerobic pond system, have been in existence for the past several centuries with permanent blooms of blue-green algae, the like of which exist nowhere else in the world. They are highly organically contaminated (of course not with sewage),

and it will be of great scientific interest and practical value if the biochemistry of a few of them are thoroughly studied.

C O N C L U S I O N (Credit)

1. A method for quantitative evaluation of integrated algal-bacterial symbiosis taking place in high-rate aerobic ponds has been deviced for the first time making use of the two indispensible parameters: COD and algal biomass.

2. These studies have also provided some basic principles which can be used for prediction of operational performance of new and existing ponds from the determined COD values of organic waste waters. It is possible to predict the quantity of algae that can be produced from them and also how much of photosynthetic oxygen can be made available for bio-oxidation of organic matter in the waste.

3. A high degree of direct correlation between algal growth and their corresponding used up COD values has been found.

4. A quantitative correlation between total bacterial biomass calculated according to Mckinney and the actually determined values of biomass has been

established and the former is found to be about one half of the latter.

5. From determined values of algal biomass and intensity of light the energy conversion efficiencies of two algae have been determined.