

EFFECT OF DISTILLERY WASTE ON THE BIOTA OF RIVER CAUVERY, INDIA

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ABSTRACT

Sugar and distillery industries rank among the major industries in India. There are more than 215 sugar mills and about 100 distilleries. Extreme pollution of rivers and foul smell in the vicinity of sugar mills and distilleries are commonly experienced. It is estimated that 500 million litres of effluent per day are discharged into River Cauvery from various industries. Of these, 6.75 lakhs litres of effluent per day are discharged from one of the distilleries into the Uyyakondon Channel, a branch of River Cauvery. The distance between the point of discharge and effluent mixes in river waters is about 20 km. The impact of effluent on the physico-chemical nature of water bodies and biological communities has been studied. The study area includes 13 tanks, 20 lakes, 20 km of the Uyyakondon Channel length and the River Cauvery waters at Grand Anicut, Thanjavur District, India. Among phytoplankton, Cyanophyta was the tolerant group. Zooplankton density in the channel and river waters was recorded. Water mites and stone flies are common in river waters but are absent in the channel water. However, larval gastropods were found to be more abundant in organically rich areas. *Tubifex tubifex* was recorded and sometimes forms a "red-carpet" on the stream bottom, mingled with organic debris.

During summer months, the low flow of water magnified the effect of effluents and there was a depression in the biological communities. In the polluted zones, the biological communities are reduced numerically and so are the number of species. There was no sign of replacement community observed.

During the monsoon season there is dilution of distillery effluent, consequently the physico-chemical and biological conditions showed a marked improvement. The breeding periodicity of the carp *Cirrhina reba* was also studied. The study suggested the possibility of a "living filter" mechanism for the treatment of waste, which could be utilized for aqua culture studies.

INTRODUCTION

Rivers, reservoirs, lakes and tanks are ecologically deteriorating due to unabated discharge of effluents from various industries. Industries are generally located in the proximity of the rivers. It is therefore common to see foam, floating debris and

marked turbidity around the discharge end of the industries. The result is diminution or alteration of aquatic life.

The effluent generated in distillery industries varies vastly in composition and pollution loads. All effluents cannot be classified as pollutants and will depend on constituents and their concentration. The spent wash that is sent out from the distillery is highly coloured and acidic containing a high percentage of dissolved inorganic and organic materials. The dissolved organic matter is responsible for the high biochemical oxygen demand and polluting nature of the waste. In general, the spent wash contain a higher amount of potash, which ranges from 7% to 15% of the total solids.

Owing to the high temperature and high BOD, the effluent is collected in the lagoons. Thus the wastes are biologically treated and the processes are anaerobic, with anaerobic digestion and anaerobic lagooning. At the end of the treatment of the waste, the colour yet persists and the BOD is reduced from 33,000 ppm to 2,500 ppm. The effluent is diluted and used for irrigation in the dry land areas for sugar cane cultivation. The sludge is recovered from the lagoon and is used as manure.

However, for an industry located near the wet land areas the effluent disposal is different. The treated effluent is diluted and mixed at the close proximity of the river channel.

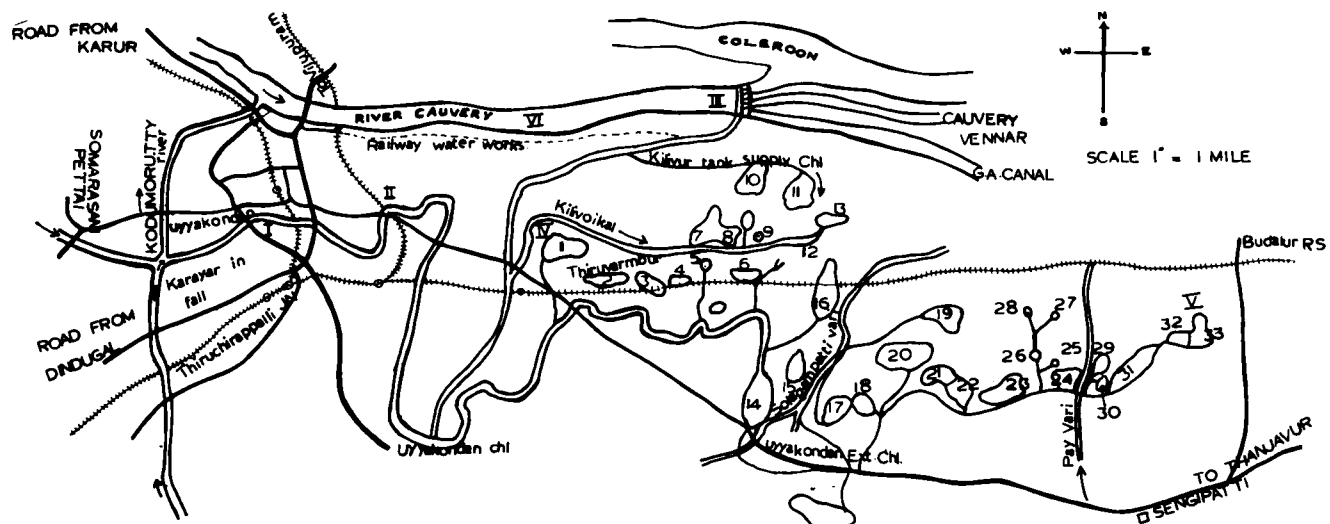
Due to the colour, high BOD and suspended solids, the river channel is polluted, fact which affects the productivity of the water. During the course of its runoff it also pollutes the River Cauvery and a number of tanks and lakes also (Fig. 1).

Recently Tamil Nadu Water Pollution Board has drawn the attention of industries to the prevention and control of pollution Act 1974. Accordingly, any industry which pollutes the water bodies is punishable. Hence, effluents are being treated with the available biotechnology methods.

The present investigation attempts to find the effect of distillery wastes on the water quality and phyto zooplankton distribution along the length of Uyyakondon channel, tanks and lakes and the River Cauvery waters. The present study reports on the microfauna of invertebrates collected from various stations and also on the impact of waste on the intra-ovarian development of carp Cirrhina reba.

MATERIALS AND METHODS

The present study was conducted in four major water sampling stations along the Uyyakondon channel and the river Cauvery. The Uyyakondon channel in which the distillery effluent is discharged runs up to a distance of 45 km. feeding a number of rain-fed tanks and lakes. The present investigation was made from four major sampling points along the Uyyakondon channel and River Cauvery, and 33 sampling points comprising 13 tanks and 20 lakes. The sampling points were fixed to cover the effluent outfall and the tributaries and distributaries of the channel. In the first phase four major sampling points, and for the second phase 33 points



1. KUTAPAR PERIA ERI.
2. SEVENTHA KULAM.
3. KRISHNA SAMUDRAM
4. NAVAR KULAM
5. THONDAMAN PATTI TANK
6. KOTTRA PATTI TANK
7. KAMATH ERI
8. KUTHUGUDI

ERI (LAKE)

NO: 1, 3, 7, 8, 17, 19, 21, 22, 23, 24, 25, 26, 27,

20, 28, 29, 30, 31, 32, 33.

9. PILLYAR KULAM
10. VILANGULAM
11. KILLIYUR TANK
12. PATHLAPATTI MELA KULAM
13. PATHALAPATTI KELA KULAM
14. VALANTHAN KOTTAI TANK
15. THIRUNEDU KULAM
16. MANGANAM TANK

17. DEVARAYAN ERI
18. NAVALUR TANK
19. SORAKKUDI PATTI ERI
20. OLAMUTU ERI
21. MARUTHI ERI
22. NEPPIKAI ERI
23. VENDAYAN PATTI ERI
24. SANDAN ERI

25. ODAI ERI
26. VERRI ERI
27. KAMATHI ERI
28. KAMATHI PUDU ERI
29. SALI PIDI ERI
30. VELAMADURAM ERI
31. SAYA KUDI ERI
32. ALAGA PATTI ERI
33. SERANDI ERI

TANK

NO: 2, 4, 5, 6, 9, 10, 11, 12, 13,

14, 15, 16, 18.

Fig. 1. Sketch Showing the Course: Uyyakondan Channel. (I: Above Uyyakondan Channel Station; II: At the point of discharge of effluent station; III: Admixture of effluent with river cauvery; IV: 2, 5, 6, 9, 10 to 16, 18: Zone of partial Recovery Tanks Station; V: 1, 3, 7, 8, 17, 19, 20 to 33: Zone of complete recovery lakes station; VI: Clean water river cauvery station)

(tanks and lakes) were taken for study.

Station I is fixed above the point of discharge of effluent from the distillery factory, Station II being the zone of discharge of effluent, Station III being the zone of admixture of effluent with River Cauvery waters. Station IV is a zone of partial recovery which includes tanks. Station V is the zone of complete recovery of effluent along the Uyyakondon channel, which comprises lakes. Station VI is the zone of clean water in River Cauvery.

TABLE I

Name of the sampling points and station numbers along the Uyyakondon channel in the Cauvery river system, and the names of the tanks and lakes (Eri) taken up for study in 1976 and 1981-'83.

Station I: Above Uyyakondon channel

Station II: Below Uyyakondon channel

Station III: Admixture of effluent in the Uyyakondon channel in River Cauvery

Station IV: 13 tanks in Fig. (1) 2. Seventha kulam 4. Navar kulam 5. Thondaman patti tank 6. Kottra patti tank 9. Pillyarkulam 10. Vilangulam 11. Killiyur kulam 12. Pathalapatti mela kulam 13. Pathalapatti Kela kilam 14. Valanthan kottai tank 15. Thirunedu kulam 16. Manganam tank and 18. Navalur tank

Station V: 20 lakes (Eri) in Fig. (1) 1. Kutapar peria eri 3. Krishna samudram & Kamath eri 8. Kuthugudi 17. Devarayan eri 19. Sorakkudi patti eri 20. Olamutu eri 21. Maruthi eri 22. Neppikai eri 23. Vendayan patti eri 24. Sandan eri 25. Odai eri 26. Verri eri 25. Kamathi eri 29. Salipidi eri 28. Kamathi pudi eri 30. Velamaduram eri 31. Saya duki eri 32. Alaga patti eri and 33. Serandi eri

Station VI: River Cauvery water

The measured quantity of water was filtered from all the stations for chemical analysis (APHA, 1975). Likewise, the planktons were collected using bolting silk number 10, and were preserved in 5% formalin. They were classified and identified up to generic level and are expressed in number of organisms per ml. Macrofauna are expressed in number per square meter. Owing to the abundance of phytoplankton in the waters of River Cauvery, attention was focussed only on the study of the dominant forms. The present study aims to understand the impact of distillery effluent in the channel, river waters and also tanks and lakes.

RESULTS AND DISCUSSIONS

Unchecked release of waste to the stream of rivers, either in small or large quantities deteriorates the ecosystem causing health hazards through the food chain. River pollution caused fish mortality was studied (Malden, 1943). Hawkes 1957 states that

river pollution caused fish mortality was mediated by physico-chemical agencies but it is essentially a biological phenomenon. Pollutants in the waste cause an immediate and long term effect. The distillery effluent released into the Uyyakondon channel and River Cauvery water, and a few tanks and lakes, were found to have affected their waters quality and the distribution of organisms. The wastes are dark brown in colour and the channel water gets coloured to a distance of up to 20 km. The tanks and lakes which are located at the proximity of Uyyakondon Channel are also coloured. Apparently, the light penetration was affected and thereby the productivity of the water bodies is being interfered with. Bartsch 1960 states that colouring materials discharged by industries led to decreasing photosynthetic activity and also depletion of oxygen. Such phenomenon is clear in Station II and III of the present study.

The flow and volume of water is an important factor in determining the physical, chemical and biological conditions of the river. During the summer (April-June) the low flow of water in the Uyyakondon channel magnified the effect of distillery wastes. The impact of this could be seen in a few tanks. However, during the monsoon season (September-December) the effluents get diluted and a number of rain fed tanks and lakes are reached.

The tanks which form nursery ground for rearing fingerlings are apparently affected due to want of dissolved oxygen. The high flow rate of water in the Uyyakondon channel and in River Cauvery diluted the effluent to a maximum extent possible, thereby an improvement in the biological community was observed in the down stream. Due to the seepage, a number of tanks became coloured. According to Tarzwell 1957, the sediments are the result of erosion and the solids and turbidity prevent light penetration and photosynthesis. In the present study, even when the distillery effluent is diluted the colour persists and the waste contains an excess of dissolved solids which are above the permissible level, hence the biotic population is at a minimum. In the Uyyakondon channel the maximum flow of water is only 368 cusec. The discharge of waste is considered dependent upon the flow of water in the channel. During the diel cycle, studies of the oxygen recovery could not be determined even at a distance of 30 km in rivers or tanks. The waste material gets stagnated in the channel due to low volume, and gets washed during maximum flow of water.

The surface temperature was found to be uniform in the channel, tanks, and lakes. However, during the monsoon season, changes in the surface temperature were noticed. In Station II there was apparently no dissolved oxygen present. The absence of oxygen is also recorded in Station III. However, when the study was extended to 13 tanks and 20 lakes it was found that tanks No. 2, 4 and 14 were directly affected by the waste, whereas tanks No. 15, 16 and 18 were unaffected (Fig. 1) forming the control for the others (2, 4, 5, 6, 9, 10, 11, 12, 13 and 14). The water quality altered significantly depending upon the discharge of the waste materials. In the case of lakes 24 through 33 were unaffected by the discharge of waste material. A comparison between these with that of polluted lakes numbering 1, 3, 7, 8, 17, 19, 20 through 23 were found to be affected by the discharge of waste. The intensity of the effect

could be seen in lakes 1, 7, 8. Due to the large flow of water there is dilution of wastes. However, the water quality is affected. Butcher 1940 states that dissolved oxygen content in a stream falls due to the activity of bacteria. In the present observation in the Uyyakondon Channel and in the River Cauvery waters, the results favourably compare with the above observation.

In the recovery zone in tanks IV B and lake VB there was gradual build up of dissolved oxygen. Hynes 1963 in his studies found a decline in the organic matter in the recovery zone, which results in the uptake of oxygen from the atmosphere, and may be compared with the present study.

In all the stations the pH was alkaline. Alkaline pH is believed to provide optimal conditions for favourable growth of plankton (Villadolid *et al* 1954). The optimal pH in the river has resulted in a bloom or abundance of phytoplankton organisms.

Klein 1957 reported that the chloride content depends on the presence of industrial wastes. Chloride content increases the intensity of pollution. In the present study, Station II recorded high Chloride content.

The micro nutrients such as silicates, nitrates and phosphate are important for the phytoplanktonic organisms. They are present in organically enriched waters rather than in clean waters. There is an increase in phosphates in the point of discharge and less phosphate in Station III indicates that phosphates have been consumed by the microbial population.

Silicates are related with the bloom of diatoms (Round 1972). A decrease in the silicates suggests utilization by the diatoms.

Nitrates are utilized by different species of algae. The organic source which is decomposed by microbes influences the algal growth. Density of the algae is related to the amounts of nitrates.

During the period of investigation, algae belonging to the 4 major divisions, such as Bacillariophyta, Chlorophyta, Cyanophyta and Euglenophyta were recorded. Totally, 63 genera of algae, comprising 27 genera of Bacillariophyceae, 22 genera of Chlorophyceae, 12 genera of Cyanophyceae, and 2 genera of Euglenophyceae were encountered. During the course of study only those genera which were in bloom, abundant or common were recorded. The density of the populations varied in different stations during the different periods of study. However, a general trend in the phytoplanktonic population is that the Bacillariophyceae and Chlorophyceae were recorded in grossly polluted regions, however, in clean waters, Chlorophyceae contributed to the total bulk of phytoplankton.

Among phytoplankton, Cyanophyceae and Bacillariophyceae were either in bloom or abundant in Station II, the zone of discharge of effluent from the distillery. Among Chlorophyceae, *Ceratophora* were abundant. In in group Bacillariophyceae, *Nitzschia*, *Fragilaria* were found to be in bloom and considered as pollution tolerant genera. They are also in bloom or abundant in Station III, which is the zone of admixture of waste into the River Cauvery. The

Cyanophyceae Oscillatoria, Microcystis and Spirulina were found in bloom in Station II suggesting pollution tolerant genera of algae (Table II).

Among Chlorophyceae, Spirogyra exclusively was present abundantly in the pure waters in tanks and also in the waters of the river Cauvery. Among Bacillariophyceae, Nitzschia and Cyclotella were either abundant or in bloom in pure water bodies. In River Cauvery waters, Nitzschia and Fragilaria were abundant. Among the Cyanophyceae, Oscillatoria and Microcystis were found to be abundant in polluted tanks and polluted lakes. But they were also represented in the clean water bodies of River Cauvery.

The study indicated clearly that 6 genera of phytoplankton tolerate the intensity of pollution below the point of discharge of waste by the distillery industry (Station II). They are also found in the mildly polluted water (Station III). This indicates utilization of the inorganic sources of nitrogen or phosphate which is found in decreased quantities in Station III.

Algae are recognized as indicators of pollution by various workers. It was Kolkwitz and Mareson 1908, that first classified species of algae on the basis of their tolerance to pollution and pointed out that the presence of certain species of algae could help to define different zones of degradation in the river. Accordingly, they recognized five such zones.

1. The polysaprobic zone - characterized by a high content of purifying organic matter.
2. The Gamma mesosaprobic zone - the first stage in the recovery from pollution.
3. The Beta mesosaprobic zone, where most of the organic matter had been mineralized.
4. The oligosaprobic zone, an area in which mineralization is complete.
5. The Katharobic zone, characterized by clean water, a zone comparable to mountain streams.

In the present study, Station II is considered as a polysaprobic zone where a high degree of pollution is present. Cyanophyceae are found to tolerate distillery waste.

Station III could be compared to the mesosaprobic zone, where pollution tolerant Chlorophyceae, such as Closterium and Chaetophora are commonly present.

Station IV and V could be compared to the oligosaprobic zone and it is the zone of partial and complete recovery. This is clear from the chemical analysis of water and also from the phytoplankton samples which consist of Spirogyra, Nitzschia, Cyclotella, Fragilaria, Oscillatoria and Microcystis. Station IV B, V B and VI could be compared with the Katharobic zone characterized by pure water. In this zone Spirogyra, Nitzschia, Fragilaria, Oscillatoria and Microcystis were recorded.

RESULTS

TABLE II

<u>CHLOROPHYCEAE</u>	<u>STATION II</u>	<u>PROTOZOANS</u>	<u>STATION II</u>
Volvox	C	Colopodium	R
Chlorella	C	Epistylis	C
Ankistorodesmus	R	Vorticella	C
Pediastrum	C		
Spirogyra	R	<u>ROTIFERS</u>	
Chaetophora	A	Rotaria Motatoria	A
		Keratella	A
<u>BACILLARIOPHYCEAE</u>		Brachonus	A
Nitzschia	B	Filinia	A
Synedra	R	Diurella	A
Gyrosigma	R	Mutilina	A
Pleurosigma	R	Thilodina	A
Fragilaria	A	Plantias	A
Navicula	R		
Cyclotella	R	<u>ANNELIDA</u>	
Melosira	R	Tubifex tubifex	A
Staurones	R		
Amphors	R	<u>CLADOCERANS</u>	
		Moina	R
<u>CYANOPHYCEAE</u>		<u>COPEPODS</u>	
Oscillatoria	B	Mesocyclops	R
Spirulina	B	Cyclops	R
Microcystis	B	Cletocimptus	R
Lyngbya	C		
Nostoc	R	<u>INSECTS</u>	
Merismopedia	R	Eristalis	C
		Chironomids (Tendipes)	R
<u>EUGLENOPHYCEAE</u>		Stonefly Nymphs	R
Euglena	R		

B = BLOOM (above 1000)

A = ABUNDANT (below 1000)

C = COMMON (50-100)

R = RARE (1-50)

Patrick 1965 came to the conclusion that Euglena and Oscillatoria are highly pollution tolerant genera and therefore reliable indicators of eutrophication. Ranjitha 1983, while studying the tannery effluents on phytoplankton stated that Oscillatoria formosa, Navicula lanceolata and Nitzschia scalaris are the pollution tolerant species.

Rathnasapathy, 1975 has reported that Oscillatoria, Euglena, Chlorella and Ankistrodesmus are typical inhabitants of heavily polluted waters. Palmer, 1969 viewed that Cyanophyceae are very tolerant to pollution. Rana, 1977 studies algal flora of a stream in U.P. India polluted by sugar factory waste. The polluted stream water had high plankton turbidity (Secchi disc value 0.5 ft) and had a flora dominated by filamentous Cyanophyceae and Euglenoids. The diatoms were represented by a unique species of Navicula.

In the present study it may be said that Spirulina, which is exclusively blooming in the distillery wastes and is not represented in other waters, suggests its tolerance to the intensity of waste.

Among Zooplankters, no protozoans were recorded in Station II, but an abundant population of rotifers were seen. They include Rotaria rotatoria, Keretella, Branchionus, Filinia, Diurella, Mutilina Thilodina and Plantias. Among these, none are represented in Station I, but Mutilina, Thilodina and Plantias are abundant in the population in Station III. In Station IV A and IV B were recorded Rotaria rotatoria, Asplanchna, Keratella and Brachionus, suggesting rich inorganic nutrients to which their abundance is due.

An interesting feature noted is that the annelid sludge worm Tubifex tubifex are in bloom in Station II. They are always present during the summer season and rarely present during the monsoon periods.

Tubifex tubifex forms a "red carpet" in Station II and mingles along the suspended organic materials. It is not present in any of the other stations at any time during the period of study.

Among ostracods, Cypris are found in abundance in clean waters of tanks IV B and lakes V B. However, copepods such as Mesocyclops and Cyclops are abundant in Station III, the mildly polluted water region. Mesocyclops are also found in abundance in the mildly polluted tanks of Station IV A and lakes V A. The copepod Clectocimotes has been recorded in abundance in the waters of River Cauvery.

Insects are the major invertebrates which contribute to the bulk of the biotic community. Corixa are abundant in Station VI although other insects were represented in other Stations. Nymphs such as Stone fly nymphs and May fly nymphs are abundant in Station V B.

Gaufin 1957 indicates that the presence of May flies, Stone flies, and Caddies flies in a stream is indicative of clean water, and their absence means that rich organic wastes and low dissolved oxygen supply are present. The current study favourably compares with the earlier observation made by Gaufin in 1957. The Chironomid larvae belonging to the genera Tendipes were recorded from Station II and can be considered a pollution tolerant species. A benthic survey in the Norwegian lake indicated Chironomid larvae predomi-

nantly present in the bottom, which was rich in organic detritus (Sivertsen, 1974). Molluses are represented but are neither in bloom nor abundant.

The intra ovarian development of the carp Cirrhina reba collected in Station VI and below the admixture of effluent in Station III indicated differences in the stage of maturity of the eggs. The mature eggs of Station VI had a diameter of 42-45 micrometers, while the mature eggs taken from the mildly polluted region had a diameter of the ovary of 36-39 micrometers.

The morphometry study indicated less growth in the populations which are affected by the dilute effluent. It could be mentioned that food is the main reason for the growth and survival of the carp, which it could obtain in more clean waters. The biota of the Uyyakondon channel, River Cauvery, tanks and lakes, positively reflects the conditions existing in the environment, and the data collected are being utilized for biological monitoring of water pollution levels.

The study is now continued on the treatment of distillery waste by culturing the microscopic organisms which are tolerant to the distillery wastes. These organisms will form the "living filter" in treating the distillery wastes as has been done with the beet sugar factory wastes (Shayegan and Sanai, 1980). During the process, methane can be saved and the treated waste will form a good medium for the aqua culture.