ECOLOGY OF VEGETATION NEAR TO THE DRAINS OF POLLUTED EFFLUENTS INDUSTRIAL AREAS OF KARACHI

M. ZAFER IQBAL*
M. MUNIR*

SUMMARY: Ten different types of plant communities were identified along the banks of polluted effluents drains of industrial areas. The vegetation was herbaceous but floristically poor in species composition. Two of the monocotyledonous species (Paspalidium geminatum and Cynodon dactylon) were the most dominant and frequent in almost all types of polluted channels. However, one dicotyledonous species (Eclipta prostrate) was also present dominantly in two of the stands.

A significant correlation was observed between different plant communities and the effluents properties (pH, levels of chloride, calcium, carbonate, bicarbonate, dissolved and undissolved solids) of the polluted drains. P. Geminatum, C. dectylon and Paspalidium-Cynodon communities showed wide ecological amplitude and were found growing at diverse habitat conditions along the polluted disposal channels of the industrial sites.

Key Words: Ecology, Paspalidium geminatum, Cynodon dactylon, Eclipta prostata, pollution.

INTRODUCTION

There are several different kinds of industries in the city as chemicals, pharmaceuticals, tannery, textiles, paints and food. Most of these are discharging their waste effluents containing very high degree of organic impurities and toxic inorganic substances without any kind of pre-treatment. The volume of the industrial waste effluents is increasing several times as fast as that of sewage as the result of growing per capita output of goods and the increasing degree of processing per unit products. The polluted effluents of the industries are carried away through the drains or by surface flow. The vegetation close to these drains are adversily affected by the industrial waste effluents.

Many of the workers have described the damage to vegetation caused by the industrial waste effluents. Water plants have been particularly affected (7, 8). However, some of the species like monocotyledons have been shown to sustain little long-term damage than the dicotyledons (2, 3, 10).

The aim of the present investigation was to identify certain vegetation types, which occurred along the drains of polluted effluents of the industrial complex and to relate them with the effluents characters.

MATERIALS AND METHODS

The vegetation along the banks of polluted effluent drains of the industrial areas of Karachi was randomly sampled by quadrats, measuring 4 meter x 1/2 meter in size. Overall 47 stands were studied and a complete list of species was made. Coverage of each species was estimated according to the method of Braun-Blanquet (4).

Polluted effluents from each stand was also collected for chemical analysis. pH of the effluent was found by pH meter. Amount of chloride, calcium, carbonate, bicarbonate, dissolved and undissolved solids was determined according to American Public Health Association (1).

*From the Department of Botany, University of Karachi, Pakistan.

RESULTS

Vegetation near to the banks of the waste effluents drains of industrial areas was herbaceous and floristically very poor. Monocotyledonous species like *Paspalidium geminatum* (Forsk.) Stapf and *Cynodon dactylon* (L.) Pers. were the most dominant and leading species in almost all the channels of polluted effluent. Some of the monocotyledonous species such as *Typha angustata* Bory and Chaub. and *Juncellus laevigatus* (L.) Clarke were also present in some of the stands. *Eclipta prostrata* (L)L. Mantiss. which is a dicotyledonous species occurred in two stands as a leading dominant species, while *Ipomea aquatica* Forsk. was present only in one stand (Table 1).

According to Braun-Blanquet (4) scale of dominance, ten different types of plant communities were identified near the banks of the polluted effluent drains based on the percentage of coverage. These communities are given as follow:

1. *Paspalidium geminatum*
2. *Paspalidium-Cynodon*
3. *Paspalidium-Typha*
4. *Paspalidium-Ipomea*
5. *Paspalidium-Typha-Cynodon*
6. *Cynodon dectylon*
7. *Cynodon-Paspalidium*
8. *Cynodon-Eclipta*
9. *Cynodon-Juncellus*
10. *Eclipta-Paspalidium-Cynodon*

Table 1 showed that *P. geminatum* played the most dominant role in five out of ten communities. Moreover, out of total 47 stands which were studied, *P. geminatum* formed a pure community in 19 stands (covarage 69.0%). *C. dactylon* on the other hand occurred in four communities as the most dominant species. In six stands, *C. dactylon* was present as a single species forming a pure community (coverage 71.0%). The association between *P. geminatum* and *C. dactylon* was very much clear in most of the stands. However, these two species also formed associations with *T. angustata*, *J. laevigatus*, *I. aquatica* and *E. prostrata*.

Effect of pH on plant communities:

A significant correlation between the vegetation types and pH values was found (Table 1). *P geminatum* was the most common and widely distributed dominant species along the waste effluent drains. It formed a pure population in diverse types of habitats with pH values ranging from 6.3 to 9.2. At the highest pH (9.5) it formed an association with *T. angustata*, while in one stand at pH 6.4 it was found associated with *I. aquatica*. *C. dactylon*

Table 1: Effects of the effluents of the polluted industrial drains on plant communities.

Name of community	No. of stands in which community occured	PH	Chloride (mg/l)	Calcium (mg/l	Carbonate (mg/l)	Bicarbonate (mg/l)	Dissolved solids (mg/l)	Undissolved solids (mg/l)
1. Paspalidium geminatum $^{69.0*}$	19	6.3-9.2	70.9-426.0	50.1-481.0	30.0-300.0	91.5-1342.2	0.5-417.5	27.5-1170.5
2. Paspalidium$^{58.0}$-Cynodon$^{17.0}$	10	6.9-8.7	53.2-426.0	64.1-208.4	30.0-420.0	122.0-915.0	194.0-504.5	57.0-934.5
3. Paspalidium$^{70.0}$-Tpha$^{25.0}$	1	9.5-9.5	141.8-141.8	64.1-64.1	150.0-150.0	305.0-305.0	2.0-2.0	37.5-37.5
4. Paspalidium$^{60.0}$-Ipomea$^{35.0}$	1	6.4-6.4	106.4-106.4	60.1-60.1	30.0-30.0	183.0-183.0	80.0-80.0	71.0-71.0
5. Paspalidium$^{45.0}$-Typha$^{28.0}$-Cynodon$^{15.0}$	2	7.0-8.8	88.7-195.0	64.1-144.3	30.0-135.0	244.0-305.1	206.0-243.5	369.5-384.0
6. Cynodon dactylon$^{71.0}$	6	7.7-9.0	106.4-426.0	30.1-144.3	30.0-720.0	30.5-518.6	127.0-663.5	93.5-672.0
7. Cynodon $^{72.0}$-Paspalidium$^{17.0}$	3	6.3-8.7	88.7-407.8	96.2-144.3	30.0-60.0	244.0-488.1	142.5-315.5	263.0372.5
8. Cynodon $^{80.0}$-Eclipta$^{8.0}$	2	7.2-7.7	88.7-141.8	40.1-64.1	30.0-210.0	152.5-335.6	73.5-73.5	75.0-108.0
9. Cynodon$^{65.0}$-juncellus$^{25.0}$	1	8.4-8.4	141.8-141.8	176.4-176.4	30.0-30.0	274.5-274.5	47.0-47.0	129.5-129.5
10. Eclipa$^{45.0}$-Paspalidium$^{30.0}$-Cynodon$^{15.0}$	2	8.0-8.4	124.1-266.0	72.1-120.0	60.0-210.0	427.1-549.1	0.5-269.5	41.0-342.0

was the second common and widely distributed dominant species after *P. geminatum*. It formed a pure community at higher alkaline of waste effluents, where the pH values ranged between 7.7 to 9.0. *C. dactylon* also form many association with other species at different pH ranges. For example, with *P. geminatum* as first dominant, *C. dactylon* found at three stands between pH 6.3 and 8.7. While as second dominant with *P. geminatum* it was present in eleven stands at pH range of 6.9-8.7. At higher pH (8.4), *C. dactylon* was found growing with *J. laevigatus* as a first dominant species, while at comparatively lower range of pH (7.2-7.7), it occurred with *E. prostrata* in two stands. *E. prostrata* on the other hand as a leading dominant species occurred along with *P. geminatum* and *C. dactylon* at pH 8.0 and 8.4.

Effect of chloride and calcium on plant communities:

A significant correlation between the distribution of plant communities and the level of chloride and calcium of polluted effluents was also observed (Table 1). *P. geminatum* community was found at a wider range of chloride (70.9-426.0 mg/l) and calcium (50.1-481.0 mg/l) concentrations of polluted water. Similarly, *Paspalidium-Cynodon* community occurred at a wider range of chloride level (64.1-208.4 mg/l) was not so great. All the other communities were present comparatively between narrow range of chloride levels of waste effluents except the pure population of *C. dactylon*. *C. dactylon* community was found at those stands where the concentration of chloride was between a fairly wider range (106.4-426.0 mg/l) as compared to calcium level (30.1-144.3 mg/l). More or less similar pattern was observed for *Cynodon-Paspalidium* community. On the other hand *Cynodon-Eclipta* community was present at comparatively lower concentrations of chloride (88.7-141.8 mg/l) and calcium (40.1-64.1 mg/l) along the banks of two localities.

Effect of carbonate and bicarbonate on plant communities:

P. geminatum, *Paspalidium-Cynodon* and *C. dactylon* communities occurred at a fairly wider range of carbonate and bicarbonate levels of polluted effluents (Table 1). However the range of carbonate and bicarbonate for the occurrence of other plant communities was not to extensive. *Paspalidium-lpomea* and *Cynodon-Juncellus* communities were found at two different stands where the concentration of bicarbonate was at a medium level but the level of carbonate was extremely low (30 mg/l).

Effect of dissolved and undissolved solids on plant communities:

A significant relationship was found in the distribution of plant communities with relation to the levels of dissolved and undissolved solids of the waste effluents (Table 1) *P. geminatum*, *Paspalidium-Cynodon* and *C. dactylon* communities occurred at a wider range of dissolved and undissolved solids levels. *Eclipta-Paspalidium-Cynodon* community was also found at a wider range of dissolved and undissolved solids, but the range was not so great as mentioned for the above communities. Some of the communities prefered to grow on comparatively lower concentrations of dissolved and undissolved solids. *Paspalidium - Ipomea*, *Cynoden-Eclipta* and *Cynodon-Juncellus* communities were found at the lower concentration of dissolved and undissolved solids, whereas *Paspalidium - Typha* community occurred at the lowest level dissolved (2.0 mg/l) and undissolved (37.5 mg/l) solids.

DISCUSSION

The effluent of all the drains of the industrial areas was turbid and coloured of different degree. The light penetrating through such effluents was probably not as much as in clear water. Therefore, this might be one of the main factors which could be responsible for the complete absence of aquatic flora from all the channels of the industrial effluents. Kulberg (7) also observed the complete absence of aquatic plants in stream which was polluted by paper mill effluents. He suggested that lack of light is responsible for the absence of aquatic flora rather than any other factor like dissolved substances. Roberts (9) and Besch and Roberts-Pichette (3) also observed the adverse effect of polluted effluents on aquatic submerged plants.

The vegetation along the banks of the polluted effluents drains was herbaceous and floristically poor. Almost all the stands in the study area was dominated by monocotyledonous species particularly *P. geminatum* and *C. dactylon*. These two species have got fibrous root system and probably tolerate to adverse conditions of the polluted effluents. However, few of the other monocotyledonous species e.g. *T. angustata* and *J. laevigatus* were also found growing near to the banks of the polluted drains but did not show any significant importance. Moreover, these species were present only in few of the stands in association with either *P. geminatum* or *C. dactylon*. *E. Prostrata* and *I. aquatica* were the only two dicotyledonous species which showed their appearance in some of the stands in association with *P. geminatum* or *C. dactylon*. However, *E. prostrate* occurred as the leading dominant species in two out of 47 stands. Although, the study which was conducted by Iqbal and Qadir (6) at the industrial sites showed more or less similar pattern of species distribution which occurred along the waste effluents disposal drains but the study was not so extensive and wide as described in this paper.

Some of the workers (2,5,10) also found that perennial species are less affected of polluted conditions of the waste effluents as compared to annual plants. Sopper (10) has suggested that perennial grasses are more suitable for wastewater sites because of their fibrous root systems, sod forming capabilities, wide environmental tolerance, long period of growth and high nutrient uptake.

A significant correlation between the pH values of polluted effluents and different plant communities was observed in this study. *P. geminatum* was found growing as a pure population or along with other species both at low and high pH values. Similar results were obtained for the levels of chloride, calcium, carbonate, bicorbonate, dissolved and undissolved solids. *C. dactylon*, which was the second dominant plant also occurred as a single dominant species or in association with other species on diverse habitat conditions. But the range of its occurrence was not so wide as seen in *P. geminatum*. No such work was reported elsewhere, therefore, it hardly became possible to compare the work with other people. However, Iqbal and Qadir (6) had demonstrated that *P. geminatum* was the most common and widely distributed dominant species along the waste disposal drains. It occurred as a first dominant plant in diverse types of habitat with pH values ranging from 10.8 to 6.2. In the present study, pure community of *P. geminatum* showed an average coverage of 69.0% in 19 stands, occurred between pH 6.3 to 9.2 (Table 1). On the hand, *P. geminatum* covering 70.0% area was found growing as the first dominant species along with *T. angustata* at pH 9.5. This work which is probably more comprehensive also confirmed a wide tolerance of *P. geminatum* at various pH levels.

In this investigation, the presence of few species along the polluted water course probably indicate the seriousness of the problem. Meanwhile, *P. geminatum* was found growing dominantly in almost all types of habitat environment along the polluted effluents of industrial drains. This indicates its wide ecological amplitude. Moreover, *C. dactylon* was another important monoctoyledonous species, which could also tolerate adverse habitat conditions of the polluted effluents. The resistance of monocotyledonous species in relation to heavily polluted water had also been demonstrated by Besch *et al.* (3).

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Correspondence:
M. Zafer Iqbal
Department of Botany,
University of Karachi,
PAKISTAN.