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Dehydrogenase Activity and Physico-chemical Characteristics of Park Soils in Seoul

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서울 공원 토양의 탈수소효소 활성과 물리화학적 특성

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ABSTRACT

The relationships between microbial activity and disturbance level of soil were investigated from 15 parks in Seoul and undisturbed area. The physico-chemical characteristics of soil and dehydrogenase activity(DHA) as an index of soil microbial activity were analysed. There were ranges of 3.84~7.37 in pH, 9.63~40.33% in moisture content, 3.41~21.49% in organic matter, 0.36~0.79g/g in water holding capacity and 0.03~0.53% in total nitrogen in investigated sites. DHA values of soil were 8.64~146.76 μg/g in park soil and 545.14~1,198.80 μg/g in undisturbed area. DHA of park soil with high traffic density and contamination source from human activities was much lower than that of undisturbed area. DHA was positively correlated with moisture content, organic matter, water holding capacity and total nitrogen.

Key words : Microbial activity, Disturbance, Dehydrogenase activity, Contamination, Organic matter

INTRODUCTION

Environmental pollution is concomitant with development of human industrial history. Soil pollution is a serious problem in industrialized countries. Increasing concern over problems of environmental pollution and disturbance has stimulated research to evaluate possible impact of stresses on ecosystem. These researches include interactions with enzymes or other elements in soil (Tate 1987, Doelman and Haanstra 1989) and the effect of pollutants on microorganisms (Harris and Birch 1987).

Microorganisms play an important role in the functioning of any soil ecosystem: they are involved in litter breakdown, cycling of nutrients and the formation of stable micro-aggregates and structural development (Alexander 1977). The soil microbial biomass can act as a source and sink for the nutrients essential for plant growth and is largely responsible for transformation of carbon, nitrogen, phosphorus and sulphur and their flow through the soil ecosystem(Ausmus *et al.* 1976, Paul and Voroney 1980).

The urban environment is very different from natural rural one in many aspects. That involves a lot of human activities contaminating the urban soil. The contamination source of that soil are reported to include heavy metals from vehicular and industrial emission, flaking paint, fossil fuel and tyre rubber(Moir and Thornton 1989, Hewitt and Candy 1990, Thornton 1990).

The present study investigated the differences in microbial activity and associated physico-chemical properties of soils taken from urban parks of Seoul and undisturbed areas.

STUDY SITES

The soil samples were collected from 15 parks in Seoul and from Ch'olwon, Yanggu, Hyangnobong and Kosŏng as undisturbed area(Fig. 1). Many people use those parks as public places for walking and play ground. They are located near the busiest main road with high traffic density in Seoul.

The samples of undisturbed area were collected from DMZ far from human activities.

Sample collections were carried out for 3~13 Sep. 1992 in park, 28~29 Mar. in Ch'olwon, 29~31 May in Yanggu, 27 Apr, 23 Aug in Hyangnobong and 25~27 Apr, 1992 in Kosŏng.

MATERIALS AND METHODS

Soil sampling and analysis

The soil samples were collected at random by taking 20 × 20 cm quadrat with depth of 5 cm from the soil surface. Three samples were taken per site. The samples were placed in a sterile plastic bags and brought to the laboratory and chopped under aseptic conditions and stored at 5℃ until they were analyzed. Subsamples of soil were taken for pH, moisture content and water holding capacity(WHC) determinations. The remainder of the samples were air-dried, lightly ground with mortar, passed through a 5 mm stainless steel mesh sieve, and used for total nitrogen(T-N) by Kjeldahl procedure, and for organic matters(OM) by loss on ignition.

Measurement of microbial activity

Microbial activity was estimated by dehydrogenase activity(DHA). DHA indicates the activity for the soil microbial population because dehydrogenation is the oxidation of carbon compound and is used as an index of respiration in the soil. The method used was the colorimetric determination of 2,3,5-triphenyl formazan(TPF) produced by reduction of 2,3,

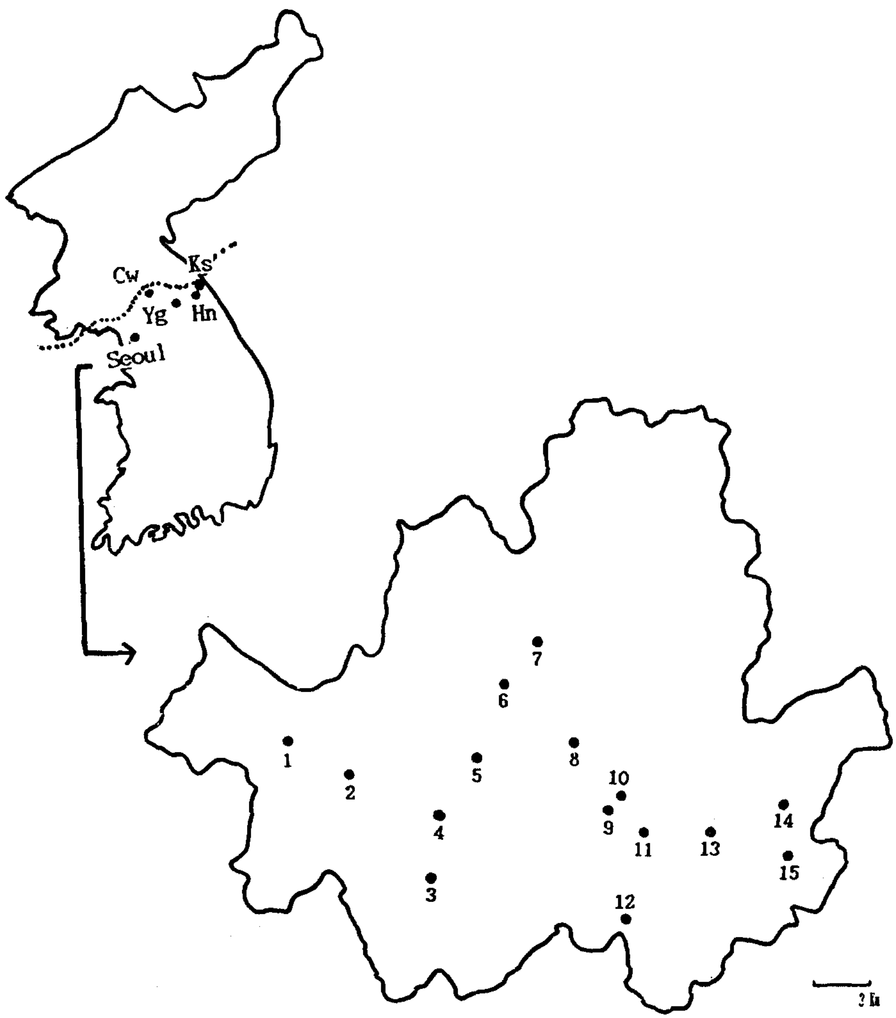

Fig. 1. Location of the sampling sites in Seoul and undisturbed areas.
1. Ujang Park, 2. Paris Park, 3. Poramae Park, 4. Ankara Park, 5. Hyoch'ang Park, 6. Sajik Park, 7. Samch'ong Park, 8. Changch'ungdan Park 9. Haktong Park, 10. Tosan Park, 11. Samnung Park, 12. Citizens Garden, 13. Asia Park, 14. Olympic Park, 15. Ogum Park, Cw. Ch'olwon, Yg. Yanggu, Hn. Hyangnobong, Ks. Kosŏng

5-triphenyl tetrazolium chloride by soil microorganisms(Tabatabai 1982). 0.03g of $CaCO_3$, 3g of fresh soil, 1ml of 3% Tetrazolium salts and 2.5ml of sterile distilled water were added into a test tube. That sample was incubated for 24hours at 37℃, added methanol and filtered. Absorbance of that filtrate was determined in spectrphotometer at 485nm.

Statistical analysis

Simple regression analysis of variance using the Statgraphics Package(Statistical

Graphics Corporation 1987) was used for the physico-chemical and microbiological soil characteristics.

RESULTS AND DISCUSSION

Soil chemistry

Mean values of physico-chemical characteristics of the soil samples are shown in Table 1. There were ranges of 3.84~8.05 in pH, 9.63~40.33% in moisture content, 3.41~21.49% in OM, 0.30~0.79g/g in WHC and 0.03~0.58% in T-N. The pH was not significant with sites($r=-0.1499$), but moisture content, OM, WHC and T-N were significant with sites ($P=0.001$). The values of OM, WHC and T-N were higher in undisturbed area than in park soil of Seoul. Especially in the content of T-N, the undisturbed areas were about ten times higher than park soils.

Microbial activity

Fig. 2 shows DHA as expressed by TPF formed($\mu g \cdot g^{-1} \cdot 24h^{-1}$) in the investigated site.

Table 1. Mean values(±standard deviation) of physico-chemical characteristics of the investigated sites

Site*	pH	Moisture content (%)	Organic matter (%)	WHC (g/g)	T-N (%)
1	4.85±0.19	21.29±0.52	6.73±0.58	0.54±0.04	0.12±0.03
2	5.11±0.05	9.63±2.11	8.86±0.46	0.40±0.01	0.09±0.01
3	5.82±0.13	15.57±4.97	5.79±0.80	0.39±0.08	0.07±0.02
4	8.05±0.18	20.26±2.76	5.24±0.09	0.36±0.03	0.03±0.01
5	6.30±0.13	13.84±0.46	9.86±0.05	0.55±0.05	0.17±0.02
6	6.36±0.10	10.39±1.24	3.41±0.29	0.44±0.03	0.11±0.01
7	3.84±0.03	22.88±7.23	8.65±3.88	0.69±0.17	0.31±0.07
8	5.62±0.29	17.95±2.43	6.22±1.20	0.43±0.02	0.12±0.03
9	5.13±0.15	20.00±3.60	7.34±0.93	0.53±0.03	0.08±0.03
10	5.73±0.14	18.68±2.36	8.46±0.24	0.53±0.04	0.09±0.03
11	7.37±0.10	15.89±0.09	7.58±0.29	0.40±0.00	0.08±0.03
12	5.71±0.08	22.37±0.66	8.95±0.22	0.50±0.03	0.09±0.07
13	7.09±0.16	12.38±3.32	5.75±0.05	0.30±0.07	0.05±0.02
14	4.45±0.06	20.00±0.00	8.83±0.42	0.58±0.08	0.06±0.03
15	4.89±0.05	16.16±1.56	9.25±0.08	0.49±0.04	0.15±0.04
Cw	5.46±0.36	40.33±0.21	12.27±6.12	0.51±0.07	0.44±0.32
Yg	5.52±0.13	17.53±0.83	21.49±6.77	0.79±0.18	0.53±0.29
Hn	5.03±0.44	36.69±4.92	17.99±0.73	0.79±0.15	0.48±0.10
Ks	5.41±0.76	28.10±6.76	19.33±5.51	0.78±0.13	0.58±0.12

* Numbers and initials of sites are shown in Fig.1.

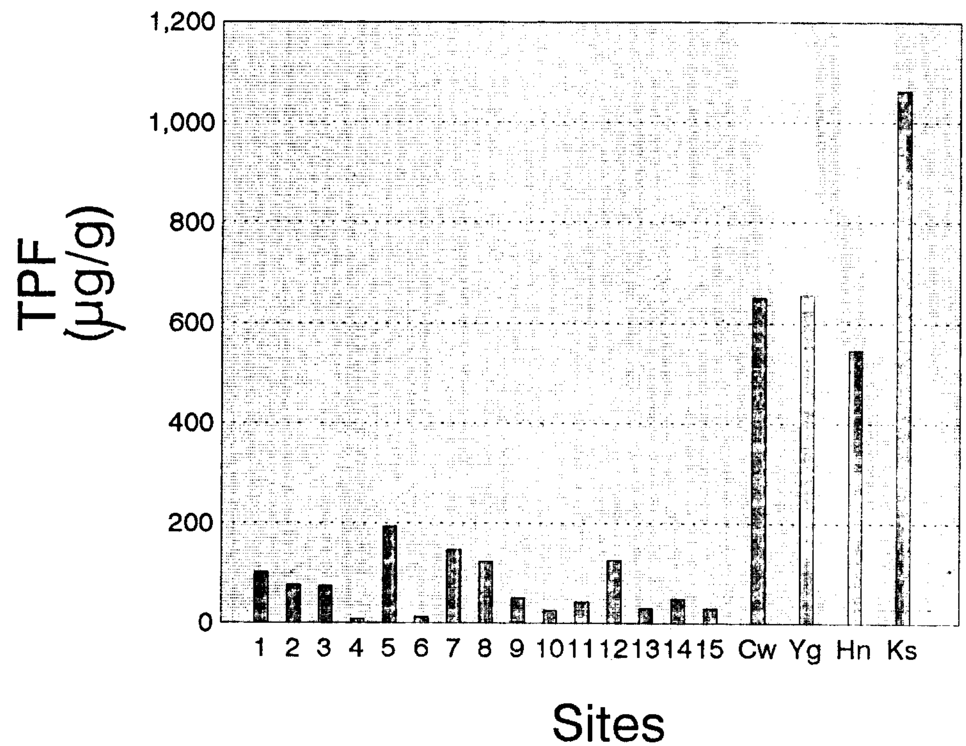

Fig. 2. Dehydrogenase activities of the investigated sites. Numbers and initials are shown in Fig. 1.

DHA was in the range of 8.64~194.16 μg/g in park soils and 545.14~1,198.80 μg/g in undisturbed areas. Soils of Kosŏng showed the highest value with 1,306.62 μg/g.

DHA is generally regarded as an index of total endogenous soil microbial activity, having been reported as correlating significantly with release of CO_2, proteolytic activity and nitrification potential, but not with microbial numbers(Skujins 1973). Also those parameters indicate the disturbance level of any soil sample(Harris and Birch 1990). According to Pancholy *et al.*(1976), DHA was much higher in the control soil than bare Zn smelter site. Killham(1985) compared the ratio of respired C:biomass-incorporated C with respired C and dehydrogenase activity as indicators of environmental stress of soil and leaf litter microbial communities. These results are consistent with the study of Kim and Birch(1992) where the relationship between Pb, Zn, Cd and the microbial biomass and activity were investigated in public park soils of London.

Many environmental factors affect soil characteristics including microbial activity in urban soil because of the diversity of pollution sources(Thornton 1990). Urban parks are generally contaminated with car exhaust, pedestrian litter, tyre rubber and air pollutants. Therefore, DHA of park soils contaminated from many pollution sources is lower than that of undisturbed areas.

DHA is significantly correlated with moisture content, OM, WHC and T-N. Especially OM and T-N have high positive correlation with DHA($r=0.8085$, $r=0.7177$, respectively) by the results of single regression analysis. This tendency agrees with the results of Kim and Birch(1992). Fig. 3 shows the relationship between DHA and OM in investigated sites. Organic matters include organic carbon and organic nitrogen for the growth of soil microorganisms. They are by-products of microbial metabolism as well as very important in nutrient pool for microorganism. Carbon compounds are partly lost by decay of organic matters by microorganisms, but new microbial tissues are produced. Loss rate of carbon is related with soil structure and fertility, and is an indicator of level of biological activity.

This study was carried out only for comparison between contaminated and undisturbed sites, but additionally heavy metal contents, the relationships between their contents and DHA, and contamination level in location of parks will be analysed and discussed later.

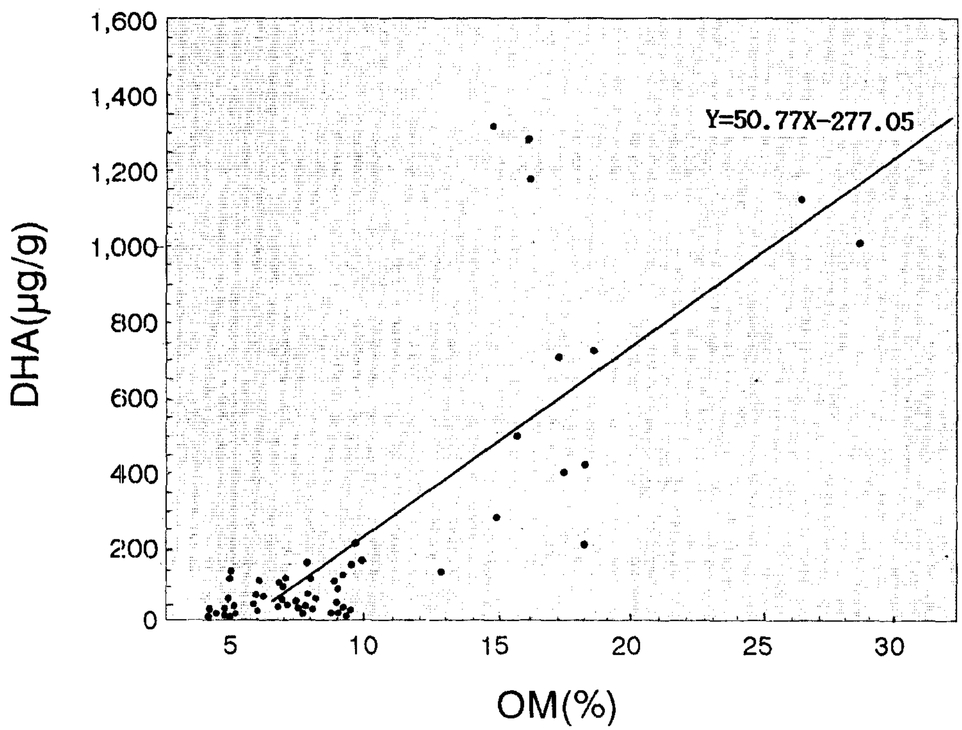

Fig. 3. The relationship between DHA and organic matter in investigated sites

적 요

서울 시내에 위치한 도시공원 15지소와 대조구로서 철원, 양구, 향로봉, 고성의 비무장 지대의 토양에 대한 pH, 함수량(moisture content), 유기물 함량(organic matter), 전질소(total nitrogen:T-N), 용수량(water holding capacity:WHC)와 토양 미생물의 활동도를 나타내는 탈

수소효소 활성(dehydrogenase activity:DHA)을 측정하여 비교 분석하였다.

도시공원의 organic matter는 3.13~12.66%, T-N은 0.02~0.37%, WHC는 0.23~0.88g/g, DHA는 8.92~228.04μg/g의 범위에 있었고, 대조구 지역은 각각 16.10~29.31%, 0.34~0.86%, 0.85~1.25g/g, 203.29~1,3064.62μg/g을 나타내었다.

주변 도로의 교통량이 많고 인간 간섭이 심하며 각종 오염물질이 버려지는 도시공원에서 토양의 DHA는 대조구에 비해 상당히 낮았고, 이 DHA는 각 지소의 moisture content, organic matter, T-N, WHC와 상관관계가 있었다.

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