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Characteristics and Distribution Pattern of *Eupatorium rugosum* at Mt. Namsan in Seoul

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서양등골나물의 생육특성과 남산에서의 분포

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ABSTRACT

The taxonomic characteristics of *Eupatorium rugosum* were reviewed and growth responses under different light intensities were investigated. Changes of soil and vegetation environments at experimental plots on Mt. Namsan were surveyed and the distribution pattern examined.

The distribution of *E. rugosum* was closely related to the content of total nitrogen and available phosphorus in the soil. No competitors which could inhibit the growth of *E. rugosum* were present. Growth of *E. rugosum* was highest at a light intensity of 7,500 lux, but dry weight was highest at a light intensity of 15,000 lux followed by 30,000 and 7,500 lux. Growth in height of *E. rugosum* under a light intensity of 1,500 lux continued even though the amount of growth was small. *E. rugosum* is found throughout the area of Mt. Namsan, and its density is higher at the roadside and in valley regions. *E. rugosum* appeared at 25 of 50 quadrats on Mt. Namsan, and the mean coverage of *E. rugosum* in survey quadrats was 12%.

Key words: *Eupatorium rugosum*, Light intensity, Mt. Namsan, Distribution pattern

INTRODUCTION

Naturalized plant is defined in this study as "non-native species in a country which have been introduced anthropogenically or naturally, and can reproduce and survive in natural habitats by themselves". These species represent a serious problem internationally, affecting not only biological diversity, but human health, productivity in agriculture, and fisheries as well (McNeely 1996).

225 species have been reported as naturalized (Koh, *et al.* 1996) in Korea and cover about 5% of the total number of plants listed. However, naturalized plants have not been recognized as a serious problem until recent years. In fact, most of the naturalized plants are not a problem because their increases are part of the natural 'boom and bust' cycle of a natural system (White and Haber 1993). However, some of them have the potential to threaten our natural

ecosystem and *Eupatorium rugosum* is regarded as a typical example of that. Most of the naturalized plants can only live in a sunny place. But, *E. rugosum* lives well in semi-shady places, enabling to invade forested areas. This is why this species should be paid special attention.

E. rugosum by appearance occupies most of the understory vegetation layer of Mt. Namsan, and it needs to be controlled by any means possible. However, we have no information on the specific character of *E. rugosum* which makes it difficult to find proper management tools for this species. So, this study was conducted 1) to know the ecological characteristics of *E. rugosum*, and 2) to find the distribution pattern of *E. rugosum* on Mt. Namsan.

MATERIALS AND METHODS

Taxonomic overview of *Eupatorium rugosum*

E. rugosum is an erect, perennial, herb with stiff stems and grows up to 1.5m tall. This species has a fibrous root mass and white flowers, which explains its English common name of white snakeroot. The simple cordate/ovate leaves (up to 15 cm long) have serrated margins and an acute tip. The small white flowers are borne in composite heads of up to thirty and the heads are grouped into distinctive loose terminal corymbs. Including *E. rugosum*, there are four *Eupatorium* species and 3 varieties growing in Korea (Lee and Yim 1996). *E. rugosum* has 15 to 25 flowers forming each corymb, but other *Eupatorium* species have as few as 5 flowers. The leafstalks of *E. rugosum* are 2~6 cm long, and the bract of it is arranged in one row while others have shorter leaf stalks and their bracts are arranged in two or three rows.

E. rugosum is native to the eastern US and Canada, usually growing in open woods on moist land with a rich basic soil. Spreading occurs particularly after tree felling but does not persist on fully cultivated soils (Hardin and Arena 1974, Radford *et al.* 1968, Tampion 1977). In Korea, this species was reported and named by Lee and Yim (1978). Presently, it has dispersed to the central region of Korea, especially in the Seoul area (Park 1995).

The characteristics of the invaders are summarized as follows: high seed productivity, distinctive reproductive method, rapid growth and early flowering, widespread dispersal, and high adaptability to a new site (Groves 1986, Newsome and Noble 1986). Species of the family Compositae often have fruits which are morphologically adapted to disperse efficiently. Such plants are more highly to be moved around providentially by wind and by birds, or by animals grazing on a 'new' site (Groves 1986). *E. rugosum* also belongs to this category and has fruits which are likely to be moved by wind.

The onset of symtoms is gradual and include nausea, abdominal pain, weakness, vomiting, constipation, thirst, and collapse often leading to coma and death. The danger to humans is usually the result of drinking milk from cows which have eaten *E. rugosum*. In the past, poisonings were widespread but highly localized in the USA. Occurrences of severe poisoning has now been reduced by proper control of animals and milk products but could occur again under 'substance' farming conditions (Tampion 1977).

Establishment of experimental plots and investigation of soil environment

Mt. Namsan is located in central part of Seoul, so this mountain is notorious that its forest ecosystem has been impacted by the air pollution from 1970s. Nowadays, it has been noted that its ecosystem has been occupied by naturalized species, such as *Robinia pseudoacacia*, *Phytolacca americana*, and *Eupatorium rugosum*, etc. From that reason, this mountain was selected as study area.

Twelve fixed experimental plots were established at Mt. Namsan in July, 1995. Six of them were established on the south slope, the others were on the north slope, the size of each plot was 20m×4m. The composition of plants growing at each plot was surveyed in July and October from 1995 to 1996.

Soil samples were collected monthly at each plot from April to October in 1996. They were brought to the laboratory where chemical properties, such as soil moisture content, soil pH, content of organic matter, total nitrogen, available phosphorus, and exchangeable cations (Ca^{2+}, K^{+}, Mg^{2+}) were analyzed. Chemical analysis of soils were carried out followed by the methods proposed by Allen *et al.* (1986) and RDA (1988)

Growth of *E. rugosum* by different light intensities

Seedlings of *E. rugosum* were collected at Mt. Namsan in July, 1996, and transplanted to pots filled with soil, leaf mold and peatmoss. After the seedlings were stabilized in pots, they were divided and placed into one of four growth chambers. Fourteen or fifteen pots were placed in each chamber. The light intensities in each chamber was 1,500, 7,500, 15,000 or 30,000 lux, and the photoperiod was 18 hours. The temperature and relative humidity in each chamber were fixed at 25℃ and 70%, respectively. The experiment was run for 83 days. The amount of growth in height was measured four times and the dry weight of each plant part was taken after harvest.

Distribution of *E. rugosum* on Mt. Namsan

Fifty quadrats were selected on Mt. Namsan as the proportion of trees reported by Lee (1986) to learn the distribution patterns of *E. rugosum* relative to the different types of upper layer vegetation. The number of quadrats and kinds of communities investigated in this study are shown in Table 3. The size of each quadrat was 5m×5m, and the coverage of *E. rugosum* was measured at each quadrat.

RESULTS AND DISCUSSION

Characteristics of the *E. rugosum* habitat

Table 1 shows the soil properties of experimental and control plots. There were no significant diff-

Table 1. Soil properties of experimental and control plots on Mt. Namsan

Months		Moisture content (%)		OM(%)		pH		Total N (mgN/g)		Available P (mg/100g)		Exchangeable cation(meq/100g)					
												Ca		Mg		K	
		N	S	N	S	N	S	N	S	N	S	N	S	N	S	N	S
3	Control	13.75	25.40	8.10	12.89	5.39	4.90	1.92	2.10	0.28	0.45	4.89	3.56	1.24	1.24	1.09	1.31
	Exp.	20.10	29.69	8.73	8.88	4.42	4.48	1.05	3.15	1.03	1.30	3.95	3.17	1.21	1.25	0.85	1.19
4	Control	22.24	19.90	7.78	14.04	4.62	4.57	1.12.	2.22	0.10	0.48	1.49	4.72	1.21	1.19	1.31	1.45
	Exp.	28.08	28.46	11.40	9.26	4.39	3.94	3.23	2.83	1.23	1.92	4.34	3.45	1.20	1.26	1.31	1.42
5	Control	17.01	24.79	9.08	11.23	4.68	4.03	1.13	2.18	0.20	0.79	4.71	3.43	1.11	1.18	1.36	1.76
	Exp.	20.28	26.17	8.80	10.11	4.80	4.78	2.33	3.00	0.77	1.52	4.75	3.13	1.15	1.18	1.47	1.82
7	Control	31.52	20.25	11.47	13.12	4.02	4.20	2.28	3.30	0.68	0.04	4.25	2.41	1.98	0.64	0.70	0.57
	Exp.	25.32	26.63	10.88	4.94	4.84	3.95	2.33	2.38	1.37	3.66	2.04	2.87	1.18	1.34	0.49	0.66
8	Control	21.11	22.37	8.55	10.29	4.39	4.20	1.15	1.53	0.03	0.53	2.91	2.28	1.19	1.18	0.32	0.57
	Exp.	19.27	28.53	7.40	9.34	4.30	3.94	1.60	2.17	1.32	1.79	3.11	2.45	1.13	1.19	0.35	0.63
9	Control	26.58	24.08	12.11	11.17	4.32	4.30	2.43	1.90	0.34	0.04	2.35	2.06	1.10	1.13	0.52	0.29
	Exp.	13.59	24.71	8.01	9.76	4.83	4.27	1.30	2.00	1.22	1.65	3.07	2.35	1.16	1.17	0.50	0.38
10	Control	23.41	20.62	12.12	10.38	4.49	4.19	2.48	2.15	0.24	0.67	2.45	1.70	0.10	1.10	0.48	0.58
	Exp.	14.92	17.61	8.44	9.68	4.51	4.42	1.37	2.05	1.13	1.55	2.30	2.28	0.12	0.17	0.45	0.56
avg.	Control	22.23	22.49	9.89	11.87	4.56	4.34	1.79	2.20	0.27	0.43	3.29	2.88	1.13	1.09	0.82	0.93
	Exp.	20.22	25.97	9.10	8.85	4.58	4.25	1.89	2.51	1.15	1.91	3.38	2.81	1.02	1.08	0.77	0.95

* North slope, ** South slope

Table 2. Floral composition of experimental plots established in 1995

Site		South slope	North slope
Dominant species on herblayer		*Eupatorium rugosum, Oplismenus undulatifolius, Disporum smilacinum Robinia pseudoacacia, Parthenocissus tricuspidata*	*Eupatorium rugosum, Oplismenus undulatifolius, Disporum smilacinum, Parthenocissus tricuspidata*
Main species	Over layer	*Quercus mongolica, Ailanthus altissima, Pinus densiflora*	*Quercus mongolica, Robinia pseudo-acacia, Prunus serrulata* var. *spontanea, Acer pseudo-sieboldianum*
	Mid layer	*Styrax japonica, Lespedeza bicolor, Rubus crataegifolius, Celastrus orbiculatus, Zanthoxylum schinifoium*	*Sorbus alnifolia, Rubus crataegifolius, Stephanandra incisa, Smilax sieboldii, Rhododendron mucronulatum, Zanthoxylum schinifoium*
	Under layer	*Commelina communis, Persicaria blumei, Pilea mongolica, Polygonatum odoratum* var. *pluriflorum, Liriope spicata,*	*Commelina communis, Achyranthes japonica, Polygonatum odoratum* var. *pluriflorum, Dryopteris gymnophylla, Asperula odorata, Artemisia keiskeana*

erences in moisture content, organic matter, soil pH, or exchangeable cations between the values of the control plots and the experimental plots. But, total nitrogen was slightly higher at the experimental plots and available phosphorus was quite different between the control and experimental plots. Swincer (1986) reported that the most important macronutrients for invaders are phosphorus, nitrogen, potassium, calcium and magnesium, of which the first two are probably in greatest demand. So, it can be extrapolated that the distribution of *E. rugosum* are closely related to the contents of total nitrogen and available phosphorus. Also, there were no significant differences between the values of the south and north slopes.

Table 2 shows the name of the species presented and the dominant species at the experimental plots. Overstory layers of the experimental plots of the north slope were occupied mainly by *Robinia pseudoacacia*, *Prunus serrulata* var. *spontanea*, and *Acer pseudo-sieboldianum*, etc. Main understory layer species were *Eupatorium rugosum*, *Oplismenus undulatifolius*, *Disporum smilacinum*, and *Partennocissus tricuspidata*. These understory species, except *E. rugosum*, have a common characteristic in that they are short. On the other hand, *E. rugosum* grows 1~1.5m tall and this means that there are no competitors for light and space. The situation of the south slope is similar to that of the north slope. Thus *E. rugosum* need not suffer a severe struggle for survival. This fact is supported by Johnstone's (1986) point of view. He reported that the functional dissimilarity between invader and resident species often resulted from differences in plant architecture, such as lifeform.

Growth of *E. rugosum* by different light intensities

The vertical growth of *E. rugosum* was the greatest at the light intensity of 7,500 lux and least at 1,500 lux (Fig. 1). The vertical growth rate decreased rapidly after 48 days of experiment at light intensities

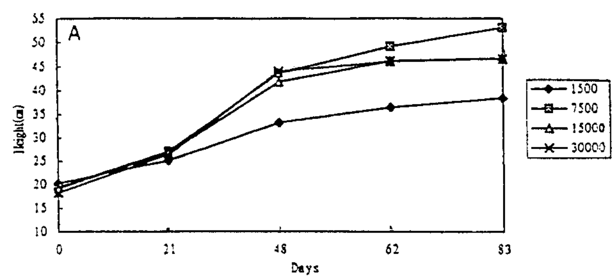

Fig. 1. Vertical growth patterns of *E. rugosum* grown under light intensities of 1,500, 7,500, 15,000 and 30,000 lux.

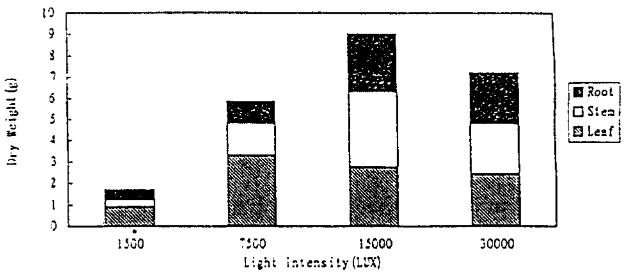

Fig. 2. Dry weight distribution of roots, stems and leaves of *E. rugosum* grown under light intensities of 1,500, 7,500, 15,000 and 30,000 lux.

of 7,500, 15,000 and 30,000 lux, but there was no significant change at the intensity of 1,500 lux. Dry weights of *E. rugosum* after 83 days of experiment is shown in Fig. 2. Contrary to the results of the vertical growth pattern, the dry weight of *E. rugosum* was highest at the light intensity of 15,000 lux followed by 30,000, 7,500 and 1,500 lux. This means that individuals of *E. rugosum* grown at the lower light intensities, such as 1,500 and 7,500 lux, allocated their energy on vertical growth. This is supported by the fact that the percentage of dry weight distribution differed between individuals of *E. rugosum* grown at a lower light intensity and the ones grown at higher light intensities. In other words, the percentage of dry weight of roots in the former was much greater than that of the latter. From that reasons, *E. rugosum* grown at the lower light intensity have greater advantage over the other herb layer species in Mt. Namsan.

Physical factors such as light, temperature and humidity may separately or interactively impede the invasion of a species (Swincer 1986). Brothers and Spingarn(1992) also reported that the main factor limiting invasion was probably the low light availability in forest interiors. Most naturalized plants, in fact, cannot invade into the forest because of the low light intensity. However, as seen in Fig. 1, *E. rugosum* can continuously grow in lower light intensity conditions even though the amount of growth is not high. If we disregard temperature and humidy conditions, the light intensity of 1,500 lux is equal to that of densely planted forest. This means that *E. rugosum* can be regarded as a tolerant species, and as such, can live in the forest and compete well against other species.

Distribution of *E. rugosum* in Mt. Namsan

E. rugosum was found throughout the Mt. Namsan area. But, the density was higher at roadsides and in valley regions (Fig. 3). Comparing the results of surveys between 1995 and 1996, it is estimated that *E. rugosum* expanded its habitat more along the valley regions. However, it is difficult to say whether this species will be continued to increase in the future or not, because some seedlings of shrubs and trees, such as *Rubus* and *Acer* species have the potential to grow and compete with *E. rugosum* for space and nutrients.

Table 3 shows the number of quadrats investigated and mean coverage of *E. rugosum* on Mt. Namsan by different kinds of upper layer trees. *E. rugosum* appeared at 25 quadrats among 50 quadrats, and mean coverage of *E. rugosum* in the survey quadrats was 12%. Mean coverage was calculated by dividing

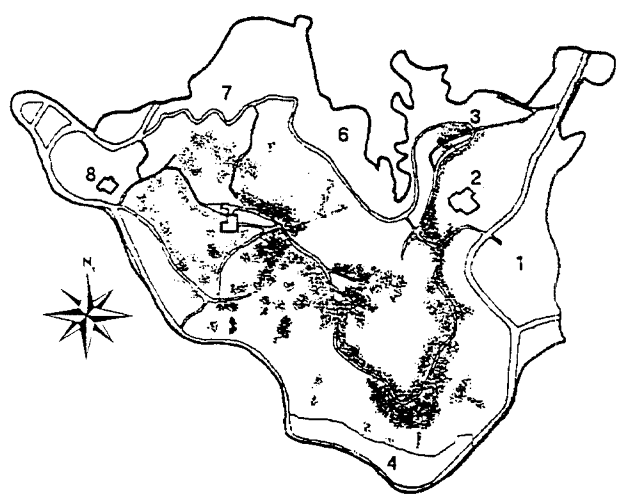

Fig. 3. Distribution map of *E. rugosum* by coverage on Mt. Namsan(1: Tower Hotel, 2: National Theater, 3: Dongguk University, 4, 6: Residential Districts, 5: Palgakjung, 7: Sungwui Girl's High School, 8: Namsan Municipal Library).

Table 3. Number of quadrats investigated and mean coverage of *Eupatorium rugosum* on Mt. Namsan by the different types of upper layer trees

Community types	No. of quadrats	No. of plots *E. rugosum* recorded	Mean Coverage of *E. rugosum*(%)
Prunus sargentii - Styrax japonica	1	0	0
Pinus rigida	1	0	0
Metasequoia glyptostroboides	1	1	30
Prunus sargentii	1	0	0
Pinus densiflora	8	6	18
Pinus densiflora - Prunus sargentii	1	0	0
Pinus densiflora - Quercusmongolica	1	0	0
Pinus densiflora - Sorbus alnifolia	1	0	0
Quercus mongolica	13	3	2
Quercus mongolica - Alnus hirsuta	1	0	0
Quercus mongolica - Sorbus alnifolia	1	1	10
Robinia pseudoacacia	14	11	25
Robinia pseudoacacia - Alnus hirsuta	1	1	60
Betula platyphylla var. *japonica*	2	0	0
Pinus koraiensis	3	2	37
Total and average	50(100%)	25(50%)	12

the summed coverage of *E. rugosum* in all the quadrats by the total area of the quadrats.

The coverage of *E. rugosum* was highest (60%) in the *Robinia pseudoacacia-Alnus hirsurta* community followed by *Pinus koraiensis* communities (37%), *Metasequoia glyptostroboides* communities (30%), and *Robinia pseudoacacia* communities (25%). However, *E. rugosum* was seldom seen in the *Quercus mongolica* communities which was assumed to be due to the higher density of the interior of these forests.

적 요

우리 나라의 대표적인 귀화식물 중 하나로 알려져 있는 서양등골나물의 분류학적 특성을 알아보았으며, 생태적인 특성을 파악하기 위하여 여러 가지 광도 조건에서의 생육실험을 실시하였다. 또한 서양등골나물이 집단적으로 자라고 있는 남산에 고정 조사구를 설치하고 식물상 및 토양환경의 변화를 알아보았으며, 동시에 남산 전역을 대상으로 분포 정도를 파악하였다. 그 결과를 요약하면 다음과 같다.

1. 남산의 서양등골나물 서식지의 토양을 분석한 결과 서양등골나물은 남사면과 북사면 모두에서 총질소와 유효인산의 함량이 높은 곳에 주로 분포하는 것으로 나타났으며, 사면별로 차이는 나타나지 않았다.
2. 서로 다른 광조건(1,500, 7,500, 15,000, 30,000 lux)에서의 서양등골나물의 생장실험 결과, 길이생장량은 7,500 lux에서 가장 좋았으나, 건중량은 15,000 lux에서 자란 개체가 가장 좋았다. 1,500 lux에서도 길이생장은 비록 적은 양이지만 실험 기간 중 계속 이어졌다.
3. 서양등골나물은 남산 전역에 걸쳐 출현하고 있었으며, 특히 도로변이나 계곡 부위에 집중적으로 나타났다. 남산에서 출현한 서양등골나물의 피도는 12%로 계산되었고 전체 방형구에서 서양등골나물이 출현한 방형구의 빈도는 50%이었다.

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