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An Experimental Study on the Effects of Greenery in the Assessment of Residential Street Scenes Based on the Seasonal Changes

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Abstract

The purpose of this study was to clarify the effect of greenery on residential street scenes and the difference of the effect between seasons. This was done by using color slides taken in August and in early May at the same sites. According to the ratings of the slides by forty three university students, the close relations between feeling of greenery, and greenery ratios in the slides of both seasons were shown. Although the difference of the effect of greenery on the assessment of street scenes by the two seasons were not so great, the results showed that there were relatively larger variances of ratings in the case of early May and higher correlation between ratings of some semantical differential scales and ratings of feeling of greenery in the case of August.

Key Words: Residential area, Street scene, Greenery, Assessment

Introduction

As reported by Ulrich (1980, 1981), Kaplan (1980) and Aoki *et al.* (1985), in recent years some investigations have found the importance of natural elements especially greenery in urban landscape. In a previous paper the authors showed the effect of greenery on street scenes using color slides (Asakawa and Komatsu 1985). But there are very few papers written about assessing seasonal changes, especially with respect to greenery.

Seasonal difference of the greenery in Hokkaido, the Northern part of Japan, is large, because it is too cold to plant evergreen broad leaf trees. Then, if we run a comparison as the pictures taken in season with leaves of deciduous trees and in season without leaves at the same sites, we should be also to know the effect of greenery directly and clearly. Furthermore, the seasonal difference of greenery may be considered in quantity and also quality. Hence, it is very important to know the seasonal difference of the effect of greenery on the assessment

of residential street scenes for planting and landscaping.

In this paper, first, the relations between feeling of greenery and vegetation ratios in the slides taken in early May and August are shown and next, the difference of feeling of street scenes in the two seasons were investigated.

Method

Color slides were taken at thirteen typical residential areas in Sapporo in early May and August at the same sites. In early May, although a few kind of trees and shrubs already have bloomed or set forth leaves, most of the deciduous trees and shrubs have not put forth their leaves in Sapporo. Each area formed a part of the following area. : Shinkotoni, Koyo, Azabu, Okadama, North 20 to 24 Jo and West 6 to 8 Chome, Yamanote, Meien, Soen, Kosai, Kotoni, Misono, Hongo and Makomanai. These areas are almost flat. Details of the areas were shown in previous papers (Asakawa and Tonosaki 1982, Asakawa 1984). The color slides were taken in the center of the streets and with a focal point of infinity straight ahead at eye level. Although Aoki (1987) pointed out that the effective focal distance at the normal street level where people view the landscape along the visual line was 50 mm, a wide angle (35 mm) lens, the field of vision of which is similar to that of the human eyes was used.

From the 175 pairs of color slides, 35 pairs were chosen in order to reduce the rating time. In November 1982, each of the scenes were shown by means of a slide projector to a class of 43 students (male ; 36, female ; 7, including 5 students of the landscape architecture course) of the School of Agriculture at Hokkaido University. The projected size of the slides were about 1.2 meters in length and 1.7 meters in width.

The slides were arranged randomly and scenes were presented for about 10 seconds. During that time, each student was asked to rate the scene on the following 7 point scales :

- (1) x) an abundance of greenery — y) lack of greenery
- (2) x) good residential area — y) bad residential area.

From left to right in each scale ; extremely x, quite x, slightly x, neither x nor y (or equally x and y), slightly y, quite y, extremely y. This scale ran from 7 points to one point.

On a separate day in November 1982, 15 pairs from the 35 pairs were used as the stimuli of the Semantical Differential test. The slides were shown to 37 students (male ; 31, female ; 6, including 4 students of the landscape architecture course) of the School of Agriculture at Hokkaido University. The subjects were asked to rate 15 adjective scales by 7 point scales.

Results and Discussion

1. *Vegetation-covered ratios in the photographs*

Vegetation-covered ratios in the 35 pairs photographs which were used as stimuli for experiments were measured as the background for the next analysis.

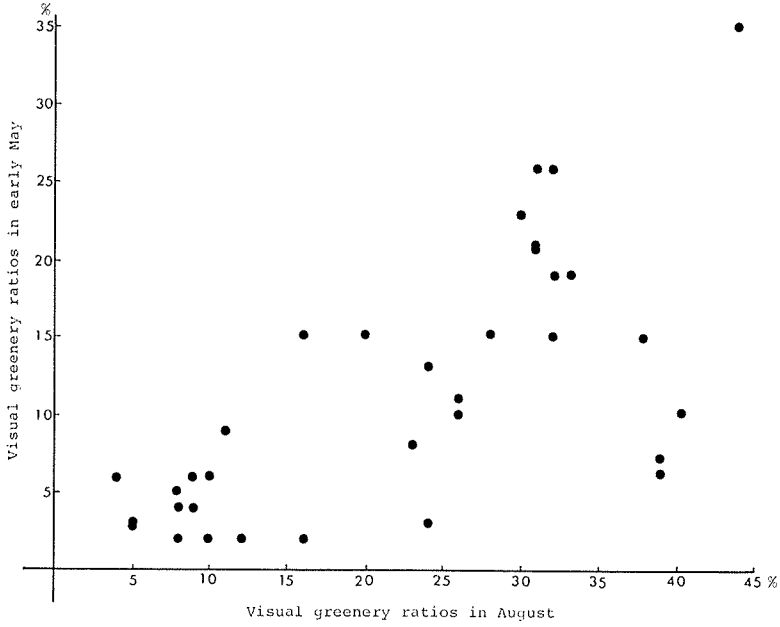


Figure 1. Change of the visual greenery ratios (Vegetation covered ratios) in August and early May.

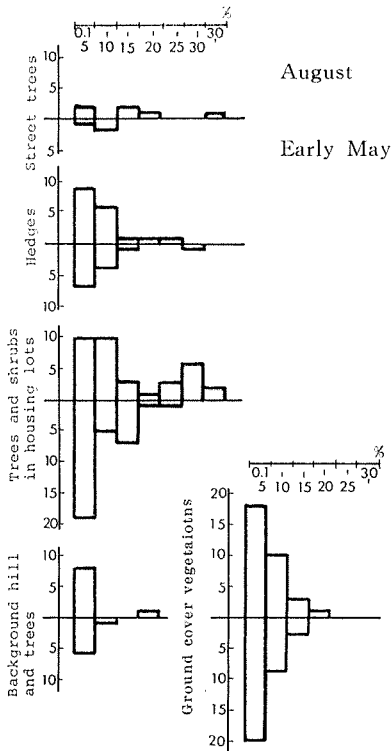


Figure 2. Frequency of each kind of vegetation ratio appearing in the photographs.

Note; Photographs in which each kind of vegetation area is under 0.1% are excluded.

The area of vegetation in the photographs measured as a percentage of the whole was called the visual greenery ratio.

Figure 1 shows the change of visual greenery ratios in the two seasons. The mean greenery ratios in early May and August were 11.2% (S.D.=8.37) and 22.5% (S.D.=12.13), respectively. It is easily suggested that the main reason of the change is due to deciduous trees and shrubs. Figure 2 shows the difference of the greenery ratios according to places where vegetations were planted. A large decrease of trees in housing lots was found and although the photographs with street trees were not in great numbers, greenery ratios of them decreased sharply in early May.

2. Relationship between visual greenery ratio and assessment

When we examine the relations between the mean scores of the "an abundance of greenery — lack of greenery" and the visual greenery ratios, they showed high correlation coefficients. Figure 3 is a scattergram which shows the relations between the mean ratings of them based on both seasons. If the mean ratings of the "an abundance of greenery — lack of greenery" are used as dependent variable and the visual greenery ratios (%) are used as independent variables, the linear regressions are estimated as follows:

(Based on the slides taken in August)

$$Y = 0.091 X + 2.393 \quad R^2 = 0.81 \quad (1)$$

(Based on the slides taken in early May)

$$Y = 0.067 X + 2.037 \quad R^2 = 0.48 \quad (2)$$

$$Y = 0.088 X + 1.877 \quad R^2 = 0.57 \quad (3) \text{ excluding 2 slides}$$

(Based on the slides taken in the both seasons)

$$Y = 0.098 X + 1.966 \quad R^2 = 0.76 \quad (4)$$

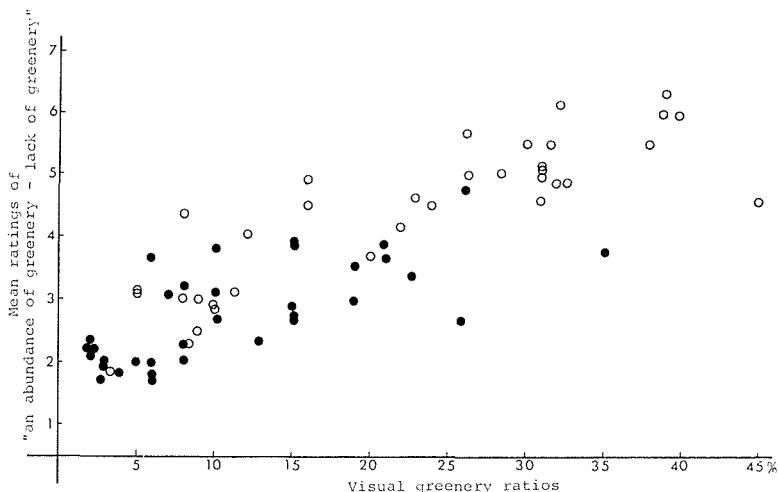


Figure 3. Relationship between the visual greenery ratios and mean ratings of the feeling of greenery.

Note; ● slides taken in early May, ○ slides taken in August.

Although the regression coefficient of the equation (2) is smaller than the equation (1), the coefficient of the equation (3) is not so different from the equation (1). And the equations (1), (3) and (4) were nearly in accordance with the results of a previous investigation (Asakawa and Komatsu 1985). Then we can suggest that the relations between feeling of greenery and visual greenery ratios are stable. But the equations show a higher R^2 in the case of August than in the early May. It is suggested therefore that the effect of greenery in early May has a large variance. The reason is not so clear, but it may be due to the difference of qualitative attributes such as type of vegetation and planted areas. And the influence of trunks and branches without green leaves which were not counted as greenery ratio must be scrutinized.

If the mean "good residential area — bad residential area" rating is used as the dependent variable, and the visual greenery ratio is used as the independent variable, the regression equation will be as follows :

(Based on the slides taken in August)

$$Y = 0.040 X + 3.464 \quad R^2 = 0.47 \quad (5)$$

(Based on the slides taken in early May)

$$Y = 0.028 X + 3.398 \quad R^2 = 0.19 \quad (6)$$

(Base on the slides taken in the both seasons)

$$Y = 0.042 X + 3.344 \quad R^2 = 0.48 \quad (7)$$

The results show that the equation (6) is insufficient to estimate the assessment of street scenes in the season.

If the mean ratings of the "good residential area — bad residential area" are used as the dependent variables, and the mean ratings of the "an abundance of greenery — lack of greenery" are used as the independent variable, the regression equations are as follows (a scattergram is shown in Figure 4) :

(Based on the slides taken in August)

$$Y = 0.476 X + 2.264 \quad R^2 = 0.66 \quad (8)$$

(Based on the slides taken in early May)

$$Y = 0.492 X + 2.343 \quad R^2 = 0.66 \quad (9)$$

(Based on the slides taken in the both seasons)

$$Y = 0.449 X + 2.423 \quad R^2 = 0.70 \quad (10)$$

These equations showed that there were no great differences between the two seasons in the relations between the assessment of street scenes and feeling of greenery. This means that, although the effect of the visual greenery ratio on the feeling about greenery were different by the seasons, the effect of the feeling about greenery in the assessment of residential street scenes are quite similar between the two seasons. As well as the equations (5) and (7), equation coefficients of the equation (8), (9) and (10) were lower than a previous result (Asakawa and Komatsu

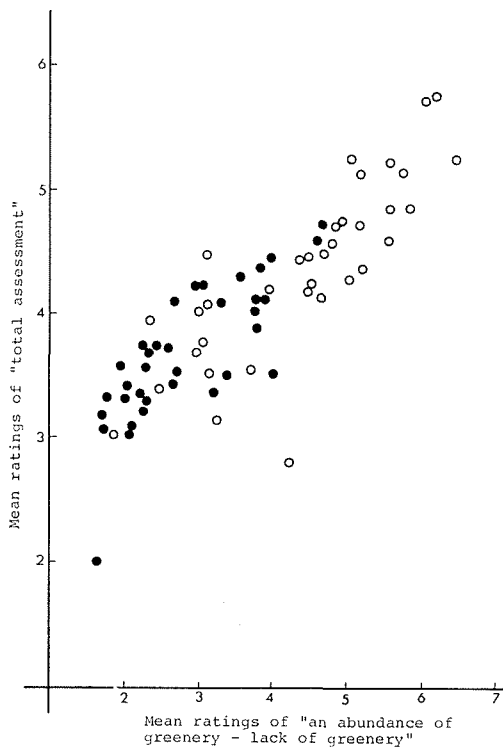


Figure 4. Relationship between mean ratings of the feeling of greenery and mean ratings of "total assessment".

Note; ● slides taken in early May, ○ slides taken in August.

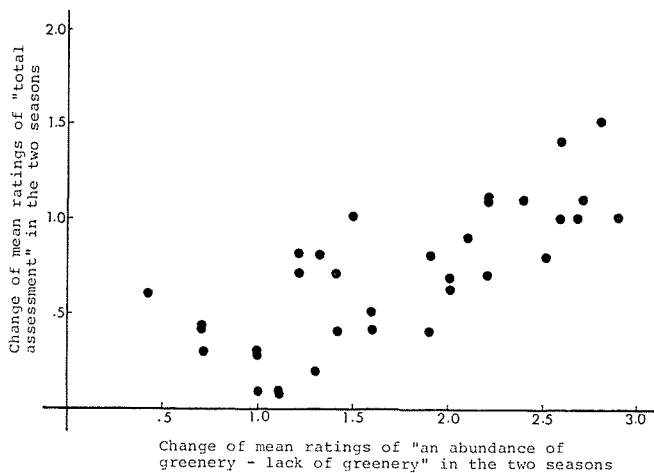


Figure 5. Relationship between change of the feeling of greenery and change of "total assessment".

1985). The reason is not so clear, but this may be due to sensibility of the total assessment. Then it is necessary to reconsider the scaling method and conditions of the experiment.

Next we examined the difference of the effect of visual greenery ratios on feeling about greenery by the seasons. Figure 5 shows the relation. In general, the greater difference of visual greenery ratio rendered a greater difference of the feeling about greenery. Using the differences of ratings of the total assessment between August and early May as the dependent variable and the difference of ratings of the greenery between August and early May as the independent variable, we can show the direct effect of greenery on the total assessment of street scenes as follows :

$$Y = 0.415 X - 0.025 \quad R^2 = 0.63$$

It is noteworthy that the equation coefficient was similar to the equation coefficient of the equation (10).

3. *Effect of the greenery on the image of street scenes*

Using the correlation coefficient based on the subjects, we showed the relations between the greenery that subjects felt and the adjective scales. As Table 1 shows, all the scales are significantly correlated to "an abundance of greenery — lack of greenery." The highest correlation was found between "an abundance of greenery — lack of greenery" and "good quality of greenery — poor quality of greenery." This means that the difference between quality and quantity of

Table 1. Correlation coefficients between "an abundance of greenery-lack of greenery" and "total assessment" and the other scales

Scale	The feeling of greenery			The total assessment		
	Both seasons	August	Early May	Both seasons	August	Early May
Friendly-Unfriendly	.47	.51	.31	.65	.63	.61
Warm-Cool	.55	.52	.42	.70	.67	.64
Diverse-Uniform	.47	.45	.42	.56	.54	.53
*Uruoigaaru-Sappukei	.75	.73	.65	.68	.66	.59
Unique-Common	.44	.42	.42	.52	.51	.49
Beautiful-Ugly	.62	.60	.48	.75	.75	.66
Good quality of greenery-Bad quality of greenery	.77	.73	.69	.66	.65	.56
Light-Dark	.51	.45	.42	.59	.57	.50
Harmony-Discord	.44	.44	.31	.62	.60	.56
Open-Closed	.26	.26	.18	.38	.41	.32
Quiet-Noisy	.32	.32	.20	.34	.35	.25
Calm-Disturbing	.29	.22	.22	.36	.34	.30
New-Old	.22	.14	.17	.30	.27	.28

There are some scales having no exactly fitting words in English.

*; Although it is difficult to translate this scale into English, "Lush-Bare or Tasteless" is part of the meaning.

greenery were not clearly felt by the subjects. Many scales especially “*uruoigaaru — sappukei*” (although it is difficult to translate into English, “*lush — bare or tasteless*”) and “*beautiful — ugly*” had high correlation coefficients. Some scales such as “*new-old*”, “*ordered — chaotic*” and “*calm — disturbing*” had lower correlation coefficients. Although it is difficult to compare these exactly, we found higher correlations in “*friendly — unfriendly*” and “*warm — cool*” than in a previous result (Asakawa 1984). It is suggested that these differences are due to the difference of the stimuli. In other words, we used slides in this study, and then, the meaning is visual but the meaning in the previous paper was social. In general, we can find higher correlation coefficients in August.

In order to clarify some systematic difference of response between the two seasons, the resulting 15×15 correlation matrix based on subjects was factor-analysed by the principle axis method and factors with eigenvalues greater than or equal to 1.0 were extracted. And the factors were rotated to a simple structure using the varimax criterion.

Factor loadings and communalities for the scales are shown in Table 2. There were some difference between the two seasons. May had three and August had two factors. An inspection of the loadings for the three factors reveals a relatively clean solution in that some scales had high loadings on only one factor. Factor 1 accounting for 18% of the total variance, can be labeled “*basic evaluation of residential area*”. Categories with high loading on this factor include “*warm —*

Table 2. Factor loadings

Scale	Both seasons				August			Early May			
	1	2	3	h^2	1	2	h^2	1	2	3	h^2
Friendly-Unfriendly	.78	.16	.18	.67	.73	.18	.57	.82	.10	.17	.71
Warm-Cool	.73	.21	.27	.65	.73	.16	.56	.72	.20	.27	.63
Diverse-Uniform	.63	.07	.28	.48	.65	.36	.68	.53	.06	.43	.47
*Uruoigaaru-Sappukei	.60	.23	.59	.76	.80	.27	.71	.49	.20	.64	.69
Unique-Common	.54	.11	.23	.36	.56	.12	.33	.47	.10	.35	.35
Beautiful-Ugly	.49	.54	.43	.72	.65	.53	.70	.41	.60	.34	.64
Good quality of greenery-Bad quality of greenery	.49	.33	.64	.76	.74	.36	.68	.34	.32	.66	.65
An abundance of greenery-Lack of greenery	.41	.21	.79	.84	.73	.24	.59	.19	.22	.81	.74
Light-Dark	.39	.59	.24	.56	.42	.60	.54	.29	.55	.26	.45
Harmony-Discord	.34	.57	.29	.52	.44	.59	.54	.34	.60	.14	.51
Open-Closed	.26	.53	.03	.35	.25	.52	.33	.20	.49	.08	.29
Quiet-Noisy	.19	.27	.28	.19	.32	.29	.19	.15	.25	.16	.11
Calm-Disturbing	.10	.73	.24	.59	.03	.76	.58	-.14	.73	.10	.56
New-Old	.05	.63	.07	.40	.04	.61	.37	-.04	.60	.08	.37
Variance %	23.0	18.1	14.5	56.0	32.0	18.8	50.8	18.1	17.7	15.4	51.2

*; See Table 1.

cool” and “friendly — unfriendly”. Factor 2, accounting for 18% of the total variance, might be described as “space attribute”. Categories with high loading in this factor were “calm — disturbing” and “new — old”. In the Factor 3, accounting for 15% of the total variance, “an abundance of greenery — lack of greenery” and “good quality of greenery — bad quality of greenery” were included. The result based on the two seasons was almost the same. However, Factor 2 as based on the ratings of slides in August was similar to Factor 2 as based on the ratings of slides in early May. Factor 1 of August was different from that of early May. Factor 1 was combined with Factors 1 and 3 of early May. In other words the greenery scales had high loadings on Factor 1. If we extracted Factor 3 to compare the structure, Factor 1 was separated into two, and a clear solution could not be obtained. We can suggest that the main reason is due to the higher correlation between greenery and other scales in August. Although the situation and kind of stimuli were different, Shinada *et al.* (1987) reported that there were not structural change in the image of vegetations by seasons, but we found a slight structural difference of factors in this case as noted already. But we could not extract a factor regarding temperature which Hirate (1985) showed in the case of winter. Using the factor scores of subjects as the independent variable and the ratings of “good street scene — bad street scene” as the dependent variable, the following equations were derived :

(Based on the two seasons)

$$Y = 0.925 F_1 + 0.614 F_2 + 0.406 F_3 + 3.829 \quad R^2 = 0.71$$

(Based on the early May)

$$Y = 0.815 F_1 + 0.579 F_2 + 0.389 F_3 + 3.355 \quad R^2 = 0.65$$

(Based on the August)

$$Y = 0.923 F_1 + 0.541 F_2 + 4.303 \quad R^2 = 0.68$$

F_1 ; Mean ratings of scores of Factor 1

F_2 ; Mean ratings of scores of Factor 2

F_3 ; Mean ratings of scores of Factor 3.

Then we can suggest that effect of greenery is more general in August than in early May.

Next, we roughly classified the slides using the three scales which had a high loading in the three factors based on the both seasons respectively and the total assessment.

Type A: Greater decreasing of the greenery decreased the other ratings and decreased the total assessment in early May.

Type B: Although a great decreasing in greenery, there were hardly any decreases in other scales because of good physical attributes.

Type C: There was little difference of the ratings in the two seasons because of little greenery.

Type D: Between the Type 1 and 2.

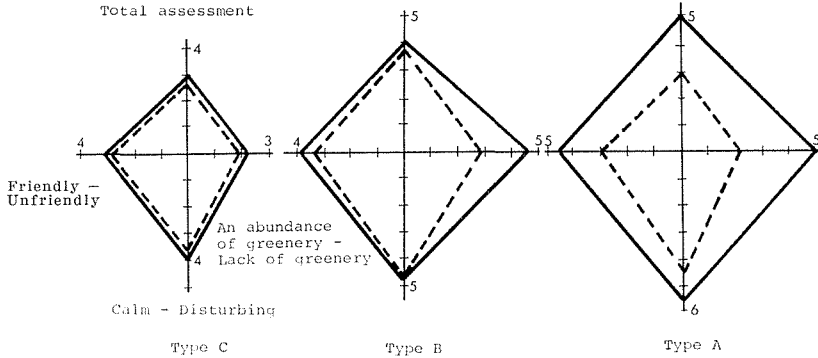


Figure 6. Examples of the three typical types of the street scenes.

Note; 1) This figure shows the mean ratings of the three scales which have high factor loadings respectively and the mean ratings of “total assessment”.
 2) --- slides taken in early May, — slides taken in August.

Table 3. Partial correlation of the variables according to the Quantification Theory 1 analysis

Variable	August		Early May	
	The total assessment	The feeling of greenery	The total assessment	The feeling of greenery
Street trees	.427	.396	.150	.201
Hedges	.150	.370	.333	.672
Trees and shrubs in housing lots	.656	.716	.519	.683
Ground cover vegetations	.366*	.184	.279*	.041
R	.766	.802	.629	.806

*: Negative effect.

The typical examples of Type A, B and C are shown in Figure 6.

Using the Quantification theory 1 developed by Hayashi, we examined the effect of vegetation types or planting position on the assessment of the street scenes and the feeling of greenery. The scores on which these analyses depend on were the mean scores or classifications for each of the characteristics of the photos. The mean ratings of the “an abundance of greenery — lack of greenery” and “good residential area — bad residential area” were used as the outside criteria. Then the number of slides were not sufficient in number to examine in detail, thus we showed only partial correlations.

As shown in Table 3, the trees in the housing lot category has the greatest influence on the rating of the feeling of greenery in both seasons. The ground cover vegetation which was mainly weeds has a weak effect on the feeling of the subjects about greenery. These results correspond to the previous paper (Asakawa and Komatsu 1985). It is noteworthy that the effect of the ground cover vegetation was negative in this result. A clear difference between the both seasons was relatively strong in hedges in early May which is shown in Figure 1. The hedges

had a relatively high greenery ratios in early May because of conifers. The reason of the lower partial correlations of street tree category in the case of early May were that most street trees are deciduous and we can only see conifers under the trees in a few cases.

Although further study is needed, the results showed that there were some differences of vegetation among seasons. As reported by Buhyoff (1979), seasonal bias in assessment test should be considered in further studies.

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