Studies on Growth and Development of Bulbs in the Easter Lily (Lilium longiflorum Thunb.) : VII. Scale Position-Dependence of the Effect of the Hot Water Treatments on the Growth Behaviour of the Scale Bulblets

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VII. Scale Position-Dependence of the Effect of the Hot Water Treatments on the Growth Behaviour of the Scale Bulblets

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Introduction

In the previous paper, the authors[2] showed that the light scaling promoted the leaf emergence of the scale bulblets developed on the inner scales and that the dark scaling promoted that of those on the middle scales. It was also shown that the leaf of the scale bulblets on the inner scales emerged more rapidly when the parent bulbs had been soaked in the hot water (45°*C*) for 30 *min* than when not soaked. On the outer or the middle scales, however, there were quite few differences in the rate of the leaf emergence of the scale bulblets between the hot water treated lot and the untreated one.

Moreover, the types of leaf development (plant type) varied in accordance with the scale positions on the parent bulb. In general, quite few differences in the plant type were observed between the hot water treated lot and the untreated one. Some detailed observations on the inner scales, however, showed a tendency that the frequency occurrence of Epigeous Type Plants (ETPs) is greater in the former than in the latter, and that Hypogeous Type Plants (HTPs) are in reverse[1].

These results suggested that the effects of the hot water treatment on the parent bulb—which were subsequently observed on the growth behaviour of scale bulblets—would be dependent on the scale position of the parent scales on the parent bulb.

This experiment was, therefore, designed to clarify what kinds of differences would be observable on the growth behaviour of scale bulblets in accordance with the shifts in scale positions, when the parent bulb was hot water treated.

Materials and Methods

Easter lily cv. 'Hinomoto' bulbs (more than 22 *cm* in girth), produced in Okino-erabu Island, Kagoshima Pref., were obtained on July 15, 1976. They were stored in darkness at ca. 25°*C* until the beginning of the experiment. On Aug. 1, 1976, ten bulbs in each lot were soaked in 45°*C* water for 0 (control), 30 or 60 *min* prior to collecting scales from the different parts of the parent bulb.

The scales were collected and divided into 4 parts in the order from the outer to the inner part of the parent bulb. They were called 'Outer scale', 'Middle scale', 'Inner scale' and 'Innermost scale', respectively. The weight of the scale was more than 2 *g* for the

outer and the middle scales, 2~0.5 *g* for the inner scale or 0.5~0.2 *g* for the innermost scale, respectively.

These scales were planted horizontally ca. 2 *cm* below the soil surface (dark scaling) in wooden boxes (60×36×12 *cm*), filled with the mixture of sand and loam in equal volumes. They were cultured outdoors and watered without any nutrient as needed to maintain adequate moisture.

After the beginning of leaf emergence, the number of the leafed bulblets were counted every 6 or 7 days. The ratio of the leaf emergence was presented as percentage of the leafed bulblets to the scale bulblets developed. The experiment was terminated on Jan. 19, 1977, when the following items were examined: 1) Survival or death of the parent scale, 2) the number of scale bulblets developed on a parent scale, 3) size of the scale bulblet, and 4) type of the leaf development (plant type).

The situation of the parent scales (survival or death) was presented as followings by their appearance; 1) alive (perfectly alive), 2) partially alive (shrinked or partially dead) and 3) dead (completely decomposed).

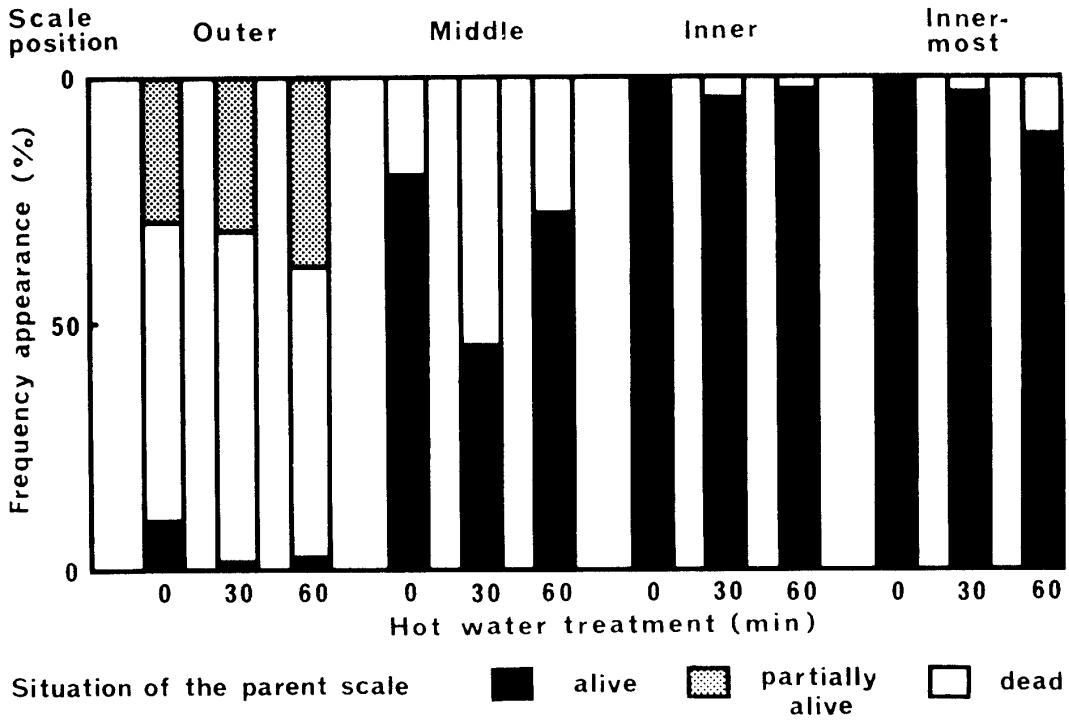

Fig. 1. Effect of the hot water treatment on the situation of the parent scale.

Table 1. Number of the parent scales used and of the scale bulblets developed

Scale position	Hot water treatment (*min*)								
	0 (control)			30			60		
	Parent scales	Scale bulblets	Average X±σ	Parent scales	Scale bulblets	Average X±σ	Parent scales	Scale bulblets	Average X±σ
Outer	150	228	1.52±0.64	155	304	1.97±0.76	163	291	1.78±0.79
Middle	178	257	1.44±0.56	132	261	1.99±0.51	129	281	2.21±0.63
Inner	60	62	1.05±0.28	87	140	1.61±0.58	66	107	1.62±0.63
Innermost	85	82	0.99±0.18	100	117	1.17±0.44	89	119	1.34±0.56

Results and Discussion

1. Survival or death of the parent scale

Irrespective of the hot water treatments the ratio of the scales alive was much greater in the inner or the innermost scales than in the middle or the outer scales. The dead scales were observed only on the outer scales (Fig. 1). This tendency was noted to be almost equal to the results already shown by the authors[2].

2. Number of scale bulblets developed on a parent scale

The inner the scale position became, the lesser the number of scale bulblets developed on a parent scale (Table 1). This is essentially the same as the results of the previous experiment[1]. There was also a tendency that the number of scale bulblets varied in accordance with the hot water treatments (Table 1).

The detailed observations on Fig. 2 showed that the hot water treatments increased the number of scale bulblets on a parent scale. That is, independent of scale positions,

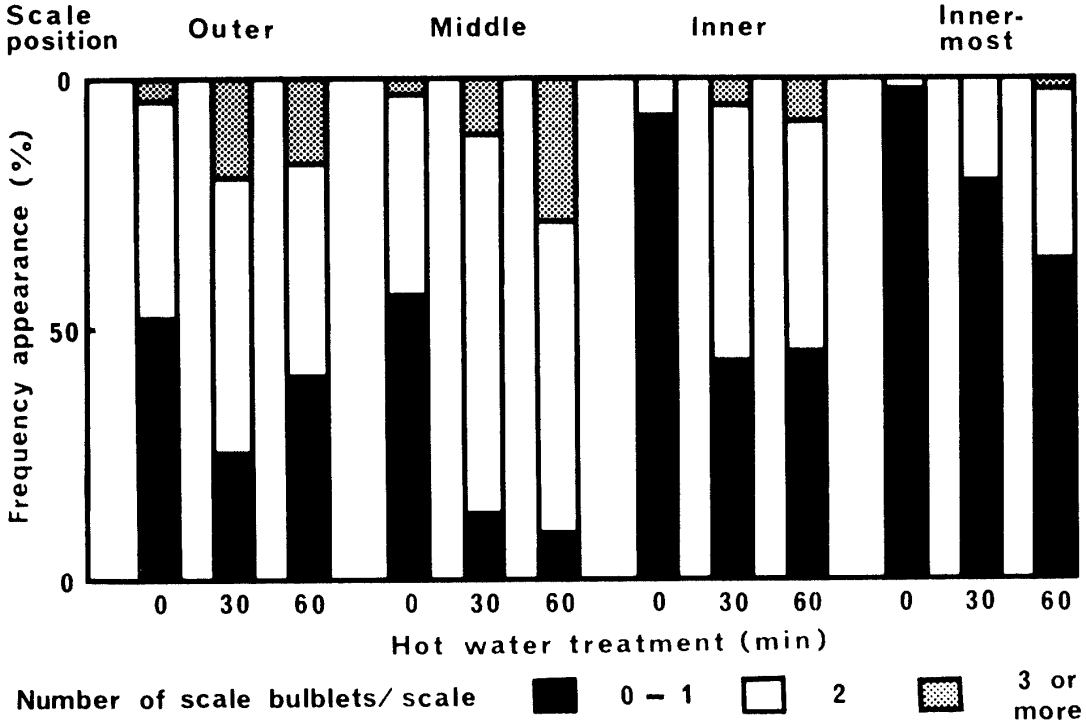

Fig. 2. Effect of the hot water treatment on the development of scale bulblets on a parent scale.

Table 2. Effect of the hot water treatment on the size of the scale bulblets (*mm* in diameter)

Scale position	Hot water treatment (*min*)		
	0 (control) $X \pm \sigma$	30 $X \pm \sigma$	60 $X \pm \sigma$
Outer	12.9±3.1	11.3±3.4	12.1±3.2
Middle	11.0±1.9	10.8±1.9	10.6±1.9
Inner	7.5±1.5	7.6±1.4	7.0±1.7
Innermost	5.2±1.6	5.1±1.5	4.6±1.0

Table 3. Relationship between the size of scale bulblets and their frequency appearance

Scale position	Hot water treatment (*min*)	Size of the scale bulblet in diameter (*mm*)					
		0	3	6	9	12	15
Outer	0	2.2	0.9	9.6	26.3	42.5	18.4
	30	3.3	7.9	11.9	35.0	33.7	8.2
	60	1.0	4.8	12.4	33.3	35.7	12.7
Middle	0	0.0	0.4	20.2	58.0	20.6	0.8
	30	0.0	0.8	2.3	14.5	65.9	16.5
	60	0.0	2.9	24.7	57.3	14.3	0.7
Inner	0	0.0	23.0	65.6	11.4	0.0	0.0
	30	0.7	18.6	72.9	7.8	0.0	0.0
	60	0.9	36.5	57.0	5.6	0.0	0.0
Innermost	0	13.2	63.9	22.9	0.0	0.0	0.0
	30	11.1	72.7	14.5	1.7	0.0	0.0
	60	10.2	86.4	3.4	0.0	0.0	0.0

N.B. Frequency appearance was presented as percentage of the number of scale bulblets in each class to the total number of scale bulblets developed on the lot.

the hot water treatments increased the ratios of the scales setting 2 or more scale bulblets. This increase in the number of scale bulblets by hot water treatment was also observed in the other experiment (unpublished data). The 60 *min* treatment induced higher ratios of the scales setting 2 or more scale bulblets than in the case of 30 *min* treatment (Fig. 2).

This increase in the ratio of 2 or more scale bulblets was more prominent on the scales from the middle or the inner parts of the parent bulb than those from the outer ones.

3. Size of the scale bulblet

Statistically significant difference was not observed on the bulblet diameter between the control and the hot water treated lots (Table 2). The detailed observations, however, showed a slight difference in the frequency appearance of the scale bulblet belonging to the different classes of size. That is, on the inner or the innermost scales, there is a tendency that the hot water treatments increase the ratio of the small bulblets (Table 3). As shown in the previous paper[1], the increase in the number of the scale bulblets per parent scale was followed by the decrease in size of the scale bulblets. It may be natural, therefore, that the frequency appearance of small sized bulblets was increased on the inner or the innermost scales in which the ratios of the parent scales setting 2 or more scale bulblets increased prominently (Fig. 2).

4. Type of leaf development (plant type)

In general, the percentage of ETPs was noted to be greatest on the middle scales and least on the innermost ones, and the reverse was the case in the percentage of HTPs (Fig. 3).

The detailed inspections indicated that the effect of the hot water treatment on the plant type was dependent on the scale position where the parent scales were collected. That is, on the outer or the middle scales, the ratio of plant types was not affected substantially by the hot water treatments. On the inner scales, hot water treatments

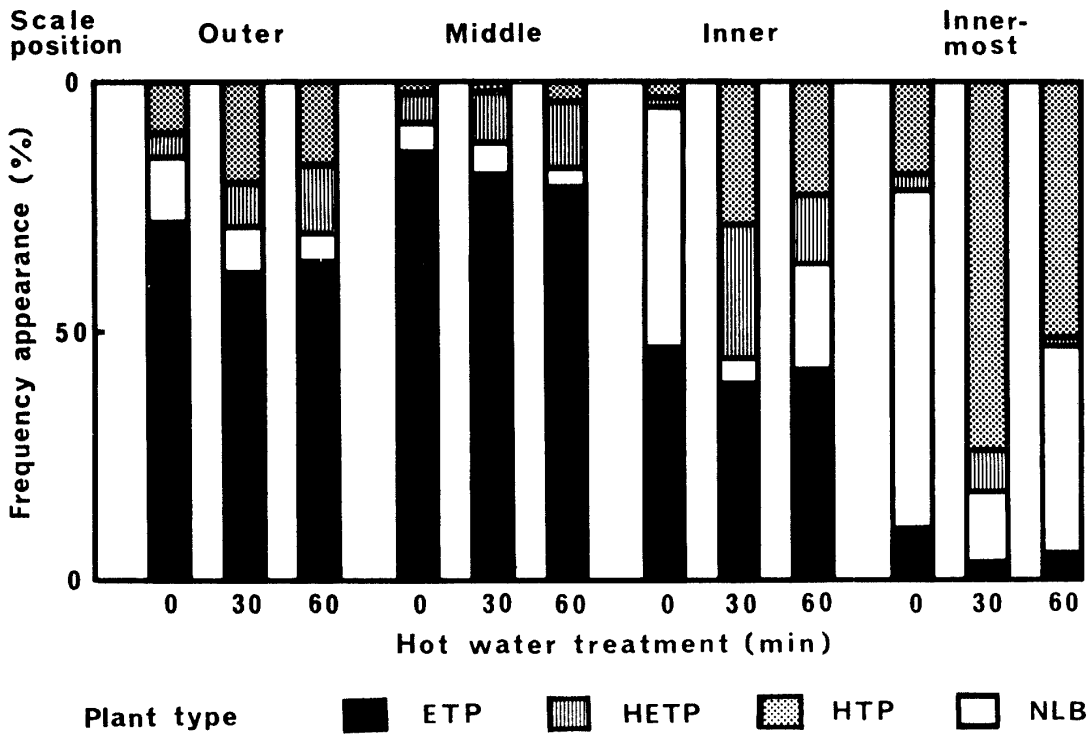

Fig. 3. Effect of the hot water treatment on the plant type of the scale bulblet.

increased both HTPs and Hypo-Epigeous Type Plants (HETPs) and decreased No Green Leaf Bulblets (NLBs). On the innermost scales, they increased HTPs and decreased NLBs. This increase in HTPs and decrease in NLBs were most prominent for the 30 *min* treated lot. The effect of the hot water treatments on the occurrence of HETPs was noted to be slight on the innermost scales. There was no tendency that ETPs are prominently increased or decreased by hot water treatments, independent of scale positions (Fig. 3).

Thus, the percentage of ETPs were not dependent on the hot water treatments, though that of ETPs in the control lot was slightly greater than in the hot water treated lots. Moreover, the percentage of HTPs including HETPs was increased and that of NLBs was contrarily decreased by the hot water treatments. These results suggested that the plant type was not to be affected by the hot water treatment, though the treatment might promote the leaf emergence of NLBs to HTPs. Whether this is the case or not is to be clarified, therefore, by the future examination which will be done when all the scale bulblets emerge their leaves.

5. Leaf emergence of the scale bulblet

The leaf emergence of the scale bulblet, developed on the middle scales, was more rapid than others, independent of the treatments (Fig. 4-A). This is essentially the same as the results of the previous experiment[1]. For the control and the 60 *min* lot, it was slowest on the innermost scales.

The difference between the rapidest lot and the slowest one in the leaf emergence was greatest on the untreated scales and least on the 30 *min* treated ones (Fig. 4-A). This fact is of great interest as the 30 *min* treatment was more effective on the leaf emergence of the scale bulblets from the inner or the innermost scales than the 60 *min* one was, for it is well-known that 45–60 *min* treatment is most effective in the case of lily forcing. Therefore, the more detailed experiments would be necessary on the effects of the

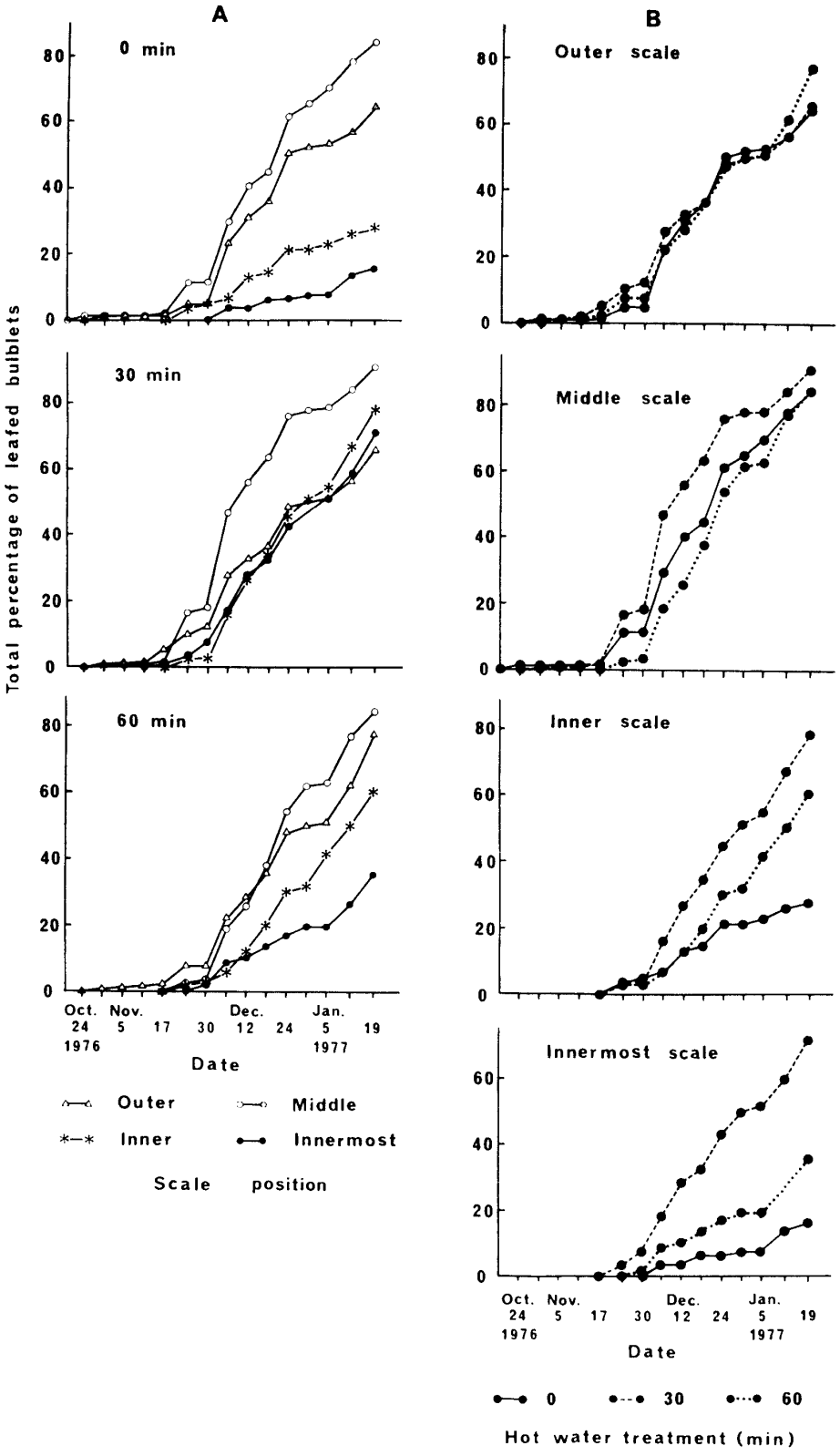

Fig. 4. Increasing of the leafed bulblets developed on the parent scales collected from the different parts of the parent bulb (A) and of those for the different hot water treatments (B).

duration of the hot water treatment on the leaf emergence of the scale bulblets.

On the outer scales, scale bulblets sprouted their leaves almost simultaneously, independent of the treatments (Fig. 4-B). On the other scales, the leaf emergence occurred most rapidly for the 30 *min* lots. On the middle scales, it was slowest when treated for 60 *min*, and on the inner or the innermost scales, for the 0 *min* (control) (Fig. 4-B).

As mentioned above, on the outer scales, there was no difference in the leaf emergence between the rapidest one and the slowest one. This difference became greater, as the scale position became inner until it reached greatest on the innermost scales (Fig. 5).

Wang and Roberts[4] reported that the detaching of daughter scales, which seem to correspond to the inner and the innermost scales in the present experiment, promoted the leaf emergence of the bulb, and observed that amounts of the growth inhibitors in these scales are greater than those of the mother scales, which seem to correspond to the outer and the middle scales. If the growth inhibitors in the scales detached from the parent bulb would act, in scaling, in the same manner as in the leaf emergence of the intact bulb, it leads us to the following consideration: Increase in the ratios of leaf emergence for the hot water treated lots indicates that the action or the amount of the growth inhibitors might have been decreased by the treatments as shown by Tsukamoto *et al.*[3]. Thus, the effects of the hot water treatment on the leaf emergence were more prominent on the scales of inner parts than those of the outers were.

Summary

This experiment was disigned to clarify the relationship between the effect of the hot water treatment on the growth behaviour of scale bulblets and the scale position on the parent bulb in the Easter lily cv. 'Hinomoto'.

Lily bulbs, more than 22 *cm* in girth, were soaked in 45°*C* water for 0 (control), 30 or 60 *min* prior to collecting scales from the different parts of the parent bulb on Aug. 1, 1976.

Lily was dark-scaled (underground) outdoors in wooden boxes filled with the mixture of sand and loam in equal volumes until the final examination on Jan. 19, 1977.

The hot water treatments increased the ratios of the scales setting 2 or more scale bulblets on a parent scale. This increase was more prominent on the scales from the inner or the middle parts of the parent bulb than on those from the outer parts.

Hypogeous Type Plants (HTPs) and Hypo-Epigeous Type Plants (HETPs) were increased and No Green Leaf Bulblets (NLBs) were decreased by the hot water treatments on the inner scales. On the innermost scales, HTPs were increased and NLBs were decreased by the treatments. The increase in HTPs and/or HETPs and the decrease in NLBs were most prominent for the 30 *min* hot water treated lot.

The difference between the rapidest leaf emergence and the slowest one was greatest for the 0 *min* (control) lot and was least for the 30 *min* lot.

On the outer scales, there was no difference in the rate of the leaf emergence in accordance with the duration of the hot water treatments. This difference was noted to be greatest on the innermost scales.

Acknowledgement

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