

*Sporocarp Initiation in *Salvinia natans* at Relative Low Temperature*

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(Received Dec. 26, 1963)

Though plant growth has been known to be retarded at relative low temperature, it is evident in certain short day plants that the low temperature is sometimes effective in initiation of flowers.

ROBERTS and STRUCKMEYER⁽⁴⁾ have observed that a tobacco variety, Maryland Monmouth, developed flowers under long day condition when the plants were cultured at relative low temperatures. MURAOKA, ÔHORI and SASAKI⁽²⁾, using the same species, reported that floral development was accelerated at 15°C, while its maximum growth was attained at 25°C. From these results, they suggested that the temperature below 20°C may be suitable for the floral initiation. Recently, OGAWA and the other workers^(1,3,7) have observed the positive effect of the low temperature to initiate the flower of *Pharbitis* plants. The author in a laboratory with uncontrolled temperature became aware of the fact that *Salvinia natans* forms sporocarps under a continuous illumination when average room-temperature went down below 20°C.

This report is concerned in the sporocarp initiation at relative low temperature, and a relation between photoperiodic and thermoperiodic processes is discussed.

Materials and Methods

Salvinia natans was cultured by supplying a modified Knop's solution under continuous illumination. On detailed experimental conditions, our previous report⁽⁵⁾ is to be referred to.

To obtain relative low temperature (LT), the inside of an ice-box was kept at about 7°C, and was continuously illuminated with white light-fluorescent lumps. The test plants were set in room temperature (25–30°C) except for the duration exposed to the low temperature.

Experimental Results

Experiment 1. The effect of continuous relative low temperature on sporocarp initiation under continuous illumination.

The plants were continuously exposed to LT under the continuous illumination to determine the effects of temperature on sporocarp initiation.

Seven groups of the plant were treated with LT for 1, 2, 3, 8, 12, 16 days or more respectively. The leaves of the plants exposed to LT for 8 days became more or less yellowish, and the plants were found in their under-growth. Plants which were treated for 12, 16 days or more were perished in process of LT treatment. So, the last three groups were left out of consideration.

Table 1. Sporocarp initiation in *Salvinia natans* under continuous low temperature (ca. 7°C).

days exposed to low temperature	number of sporocarp	percentage of induced plants
1	1	33 %
2	1.6	71
3	2	86
8	(can not initiate for a sluggish growth)	

The results obtained here are shown in table 1. It was found that *Salvinia natans* can be induced to reproductive state by only 1 day treatment with LT. Longer duration of LT treatment was resulted in the increase of the number of sporocarp and induced plants, but the duration more than 8 days inhibited exceedingly the growth of the test plants and killed their leaves. All of the initiated sporocarps were confined to their primordial stage.

Experiment 2. The effect of various thermoperiods on sporocarp initiation under continuous illumination.

The plants were subjected to the thermoperiod for 3 days, which being consisted of various hours of LT and relative high temperature (25–30°C).

The designed experiments and the results obtained from them are shown in table 2. The number of sporocarp was less in 8 hours than in 4 hours of LT, but it could not be determined safely to have a significant difference in 5% error level. Such difference was shown among the groups which were exposed to LT for more than 8 hours. When the period of LT was longer than 16 hours, the number of sporocarp primordia was decreased. From these results, it was concluded that LT induced an ability of the sporocarp initiation at only 4 hours, and that the ability was maximal at 16 hours of LT.

Table 2. The effects of thermoperiod on sporocarp formation in *Salvinia natans*.

hours exposed to high temperature	hours exposed to low temperature	number of sporocarp	percentage of induced plants
20	4	1.2	80 %
16	8	0.8	60
12	12	2	100
8	16	3.4	100
4	20	1.7	60

Sporocarps were found to be of primordial level at 4 or 8 hour exposure of LT, and they developed progressively with the lengthened period of LT. In the case of 20 hour exposure, however, the development was not so higher than that of 16 hours of LT.

Experiment 3. A relation between photoperiodic and thermoperiodic processes in sporocarp initiation.

In our previous report⁽⁶⁾ with *Salvinia natans*, it has been reported that a short-light interruption in a long dark period made invalid the sporocarp-forming stimulus while the induced state did remain. The experiments as shown in table 3 were undertaken to investigate the natures of photoperiodic and thermoperiodic processes.

As an inductive day-length 8 hour photoperiod was applied, and in thermoperiodism 16 hour low temperature was given. To counteract the photoinductive effects, the photoinduced plants were light-interrupted for 10 minutes at the middle of 16 hour dark period.

Table 3. Experiments on a relation between photoperiodism and thermoperiodism.

treatment	number of sporocarp	percentage of induced plants
2 photoperiods	1	60 %
3 photoperiods	3.2	80
1 thermoperiod	0.2	20
1 thermoperiod after 2 light-interrupted photoperiods	2	60
1 photoperiod after 2 light-interrupted photoperiods	2.6	80

Difference in the number of sporocarp between 2 and 3 photoperiods was shown in the number of the sporocarps initiated on the plants which were given 1 photoperiod after 2 light-interrupted photoperiods. More sporocarps were produced on the plants exposed to 1 thermoperiod after 2 light-interrupted photoperiods than that exposed to 1 thermoperiod alone without the photoperiod, and even more was found in the plants exposed to 1 photoperiod after 2 light-interrupted photoperiods. The number of the plants developed the sporocarps was practically parallel to the number of sporocarp on the plants.

Discussion

It has been reported by a few workers^(2,4) that relative low temperature has an effect to induce flowers. Recently, such effect was observed in *Pharbitis nil*^(1,3,7). *Salvinia* plant, which was used as material at present study, was also found to turn from vegetative to reproductive phase under a relative low temperature.

Though continuous LT for 1 day could initiate sporocarps, their number was relative small, and increased gradually with increasing duration of LT. In the case of thermoperiod, longer period of LT, generally, tended to

increase the number of sporocarp and the percentage of induced plants. In comparison with inductive photoperiod, the thermoperiodism was rather ineffective than the photoperiodism to induce and develop the sporocarp. It was not determined whether such differences between two periodisms were caused by the difference of sporocarp-producing activity or by some disturbances of normal metabolism of the plants under LT. Since the plants showed a sluggish growth and a withering of leaves when they were exposed to LT for more than 8 days, the differences, probably, seem to be caused by the latter case. KIMURA and TAKIMOTO⁽¹⁾ have also assumed that the reduced flowering response of *Pharbitis* plants maintained at relative LT is due to the poor development of the growing point.

In the previous report⁽⁶⁾, it was presumed that the light-interruption in the dark period may not prevent the activation of a specific metabolic processes for the formation of the photoinductive stimulus. In the present data, this conjecture was found to be admissible. So, it is suggested that the effect of photoperiodic or thermoperiodic treatment after 2 light-interrupted photoperiods may be differentiated only by the kind of third period following the inhibitory 2 periods. This difference in experimental data was slight in the number of sporocarp, but the effect of 2 light-interrupted photoperiods prior to 1 thermoperiod was fairly deviated from that of 1 thermoperiod alone.

These facts may suggest the possibility that the metabolic processes activated photoperiodically can replace the processes for the thermoperiodic sporocarp formation. At present, however, it was not determined whether the thermoperiodic processes contained whole or a part of the photoperiodic one.

Summary

1. *Salvinia natans*, cultured under a continuous illumination, was investigated concerning the effect of relative low temperature (ca. 7°C) of different durations or of different periodisms in 24 hour cycle on sporocarp formation.
2. On continuous low temperature, the duration of only one day was enough to initiate the sporocarps.
3. In thermoperiodic treatment, the number of sporocarp was increased with lengthening period of the low temperature to 16 hours, but was decreased by 20 hour exposure.
4. One thermoperiod after two light-interrupted photoperiods had a greater effect to initiate the sporocarps than one thermoperiod alone.
5. It is suggested that *Salvinia natans* can initiate sporocarps at the low temperature, and that the physiological processes involved here are conjectured to have some parts similar to that under photoperiod.

References

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The author wishes to express his hearty gratitude to Prof. K. NAKAYAMA for his kind help and constant encouragement in the course of this study.