カタクリの季節的消長と生育特性について

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Tatsuo FUKUDA*: The Phenology and Growth Characteristics of *Erythronium japonicum* DECNE. (Liliaceae)

福田達男*：カタクリの季節的消長と生育特性について

Erythronium japonicum DECNE. (Liliaceae) is a typical spring ephemeral, and its growing season is temporarily limited to the period from late February to early May before the closure of the forest canopy (KAWANO et al., 1978). Regarding the life history of *E. japonicum*, YOKOI (1976) estimated that this plant normally spends a nine to ten-year period in the non-flowering stage after germination. KAWANO et al. (1982) recently reported in detail on various aspects of the life history characteristics and survivorship of *E. japonicum*.

This paper is a report on the phenology and growth characteristics of *E. japonicum* based on continuous field observations.

The Study Site

Detailed studies of *E. japonicum* were conducted at Ohizumi (35°45′N, 139°36′E), Nerima-ku, Tokyo, a north-facing foothill of approximately 41m in elevation. The study site is called Shimizuyama. This area is covered by secondary broad-leaved deciduous forests, consisting of *Carpinus tschonoskii* MAXIM., *Quercus serrata* THUNB., *Q. acutissima* CARRUTH., *Styrax japonica* SIEB. et ZUCC. as the main associated species. The herbaceous layer is almost all covered by dwarf *Pleioblastus chino* MAKINO during the growing season of *E. japonicum*.

Methods

Air and soil temperature were measured from late February to early May in 1981, 1982, and 1983. Air temperature was measured at above 20cm from the ground with a recording thermometer. Soil temperature was also measured at the soil surface (just under the litter) and at the depth of 15cm at a weekly interval. Readings were taken at several sites (shaded and exposed) between 11 and 12 A. M.

Two 1×1m plots were established in the study site to observe the behavior of individuals in a natural and undisturbed population of *E. japonicum*. The exact locations each plant emerged were marked by white plates and the data of emergence was recorded for each individual plant. Then the number of individuals was counted by each of the following phenological categories at weekly intervals.

1) Emerging: tightly rolled leaves emerged from the litter
2) Yellowing: yellowing of the leaves
3) Dying: from progressive dissolution of leaf tissue to complete dying of all tissue

The study was carried out in spring (February to May) from 1981 to 1983.

Furthermore, shoot emergence of seeding could not be completely found in the plots at the emerging period. Therefore, the number of emerging plants was determined by subtracting seedling plants from the number of individuals.

Results

The phenology of *E. japonicum* observed during the three years was very similar. The spring growing season was very brief, extending only two months from late February to early May. Throughout the growing season, the mean air temperature ranged from below 0°C to 20°C, the maximum temperature rose to 25°C and the minimum temperature decreased to −5°C. The mean air temperature of the north-facing foothill covered by secondary broad-leaved deciduous forests was 1°C to 3°C lower than the mean standard temperature (the air temperature of level ground, i. e., Nakaarai Meteorological Station, Toyotama, Nerima-ku, Tokyo). However, there were a few days when the maximum temperature rose to 20°C, in the middle of March. When April came, the maximum temperature exceeded 20°C frequently. Soil temperature at 15cm depth was 4.5°C when the shoots emerged

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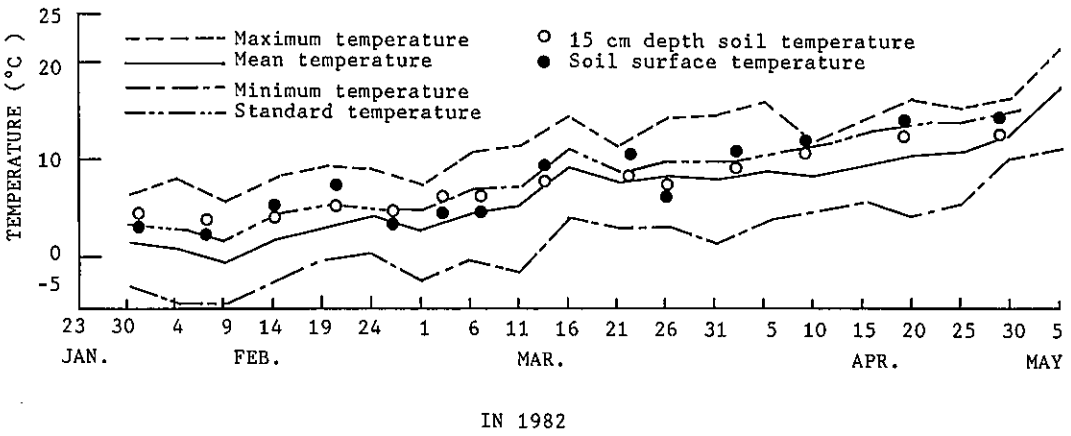

Fig. 1 Temperature changes at Shimizuyama. Soil surface and 15cm depth temperature measured between 11 and 12 A. M. Standard temperature illustrated from the data of Nakaarai Meterological Station. Mean to five days.

from the litter, and then continued to rise to 16°C until the dying of aerial structures of *E. japonicum*. Soil surface temperature ranged from 4°C to 16°C. When the aerial structures completely died in early May, soil surface temperature was higher than 15cm depth temperature.

The annual growth cycle of *E. japonicum* begins in September, when the roots protrude from the base of the primary bulb. In December, the shoots elongate from the bulb apex, and emerge from the litter in early spring the next year. MULLER (1978) indicated that the extent of shoot development of *E. americanum* at the beginning of the spring period was considerably influenced by the timing of snowmelt, and similarly indicated that *E. japosicum* was influenced by the timing of snowmelt at the Japan Sea side of Honshu. In the case of *E. japonicum* in Shimizuyama, it was influenced by the temperature. When the shoots emerged from the litter in the study site, soil surface and 15cm depth soil temperature were 4°C to 6°C and 4.5°C to 7°C between 11 and 12 A. M. each of the three years.

Table 1 shows the number of emerged individuals and percentage of seedling, non-flowering, and flowering plants of *E. japonicum* in two plots. The total number of individuals emerged in the two plots, counted 237 individuals in 1981, 251 individuals in 1982, and 255 individuals in 1983. However, when they grew to the flowering stage each year (early April), the number of individuals decreased to 200 individuals in 1981, 217 individuals in 1982, and 235 individuals in 1983. It was the period of the processing stage to maturity for *E. japonicum*. I could not observe the dying plants caused by senescence. The cause of the decrease is still unknown. The percentage of seedling, non-flowering, and flowering plants indicated the same tendency in the three years.

Figure 2. shows the transition of the emerging and dying plants in the two plots in the three years. In 1981, the shoots emerged from February 20 to March 24, 31 days; emerged at the same time as the preceding year and lasted until late March, 41 days, and emerged from March 4 to April 5, 36 days in 1983. The population reached 50% emerging in two to three weeks from the first emerging; reached 100% emerging in five to six weeks. Immediately following emerging, shoot elongation was accelerated and continued while

Table 1 Percentage of seedling, non-flowering, and flowering plants of *Erythronium japonicum*, investigated in early April 1981, 1982, and 1983. Data represent the percentage of all individuals in two 1×1m plots.

Year	No. of individuals	Percentage of seedling	non-flowering individuals	flowering individuals
1981	200(237)	4	64	29
1982	217(251)	13	62	25
1983	235(255)	19	59	22

( ) Total number of emerged individuals in the growth period.

the leaves rapidly unfurl. Anthesis was concentrated in early April of each year. The leaves began to yellow in the middle of April, then progressed to the dying of leaf tissue, and reached 80 to 90% dying two weeks after they first began to die. By early May, all of the *E. japonicum* had completely died in the study site.

The transition of emerging of *E. japonicum* showed little difference each year. The period of emerging was six to seven weeks, longer than the period of dying, which was concentrated in two to three weeks.

On the other hand, the comparison of emerging and dying between the non-flowering and flowering plant showed definite difference through three years. The flowering plant began to emerge from the litter one to two weeks later than the non-flowering plant. In addition, I observed that some flowering plants emerged at anthesis of *E. japonicum* outside the plots (Fig. 3). Thus the flowering plant emerged later than the non-flowering plant, which reached 100% emerging in a short period, and the leaves rapidly unfurled. They were nearly all flowered in two to three weeks from emerging.

Figure 4 shows the growth period per individual in a plot by recording the date of marked individuals which were emerging and dying in 1981 and 1982, respectively. In 1981, 11 non-flowering plants were first noted on March 5. This group began to die in late April and completely died by May. The growth period per individual of this group was 45 to 58 days (average 53.0 days). From the first recording, the second week counted 31 individuals (1 flowering plant), 45 to 53 days (47.4 days). The third week counted 40 individuals (9 flowering plants), 39 to 46 days (43.7 days) and the last week of emerging counted 41 individuals (19 flowering plants), 32 to 39 days (38.5 days). In 1982, the emerging period was two weeks longer than in 1981, but the growth period per individual in several groups showed the same tendency as the preceding year. Each decreased 67.0, 56.5, 44.6, 42.8, 35.6, and 31.8 average days from the first week to the sixth week in a growth period.

Thus, there was a difference in growth period per individual between the individuals which

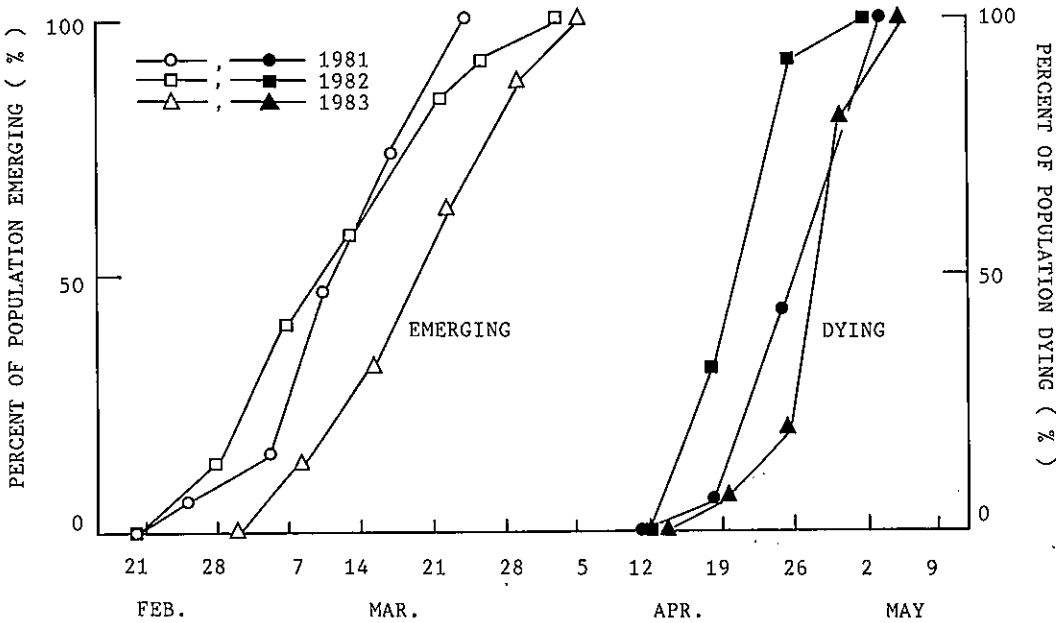

Fig. 2　Transition of the emerging and dying of *Erythronium japonicum* in 1981, 1982, and 1983. Each symbol is the mean of two $1m^2$ plots at the study site and represents the percentage of the total number of individuals.

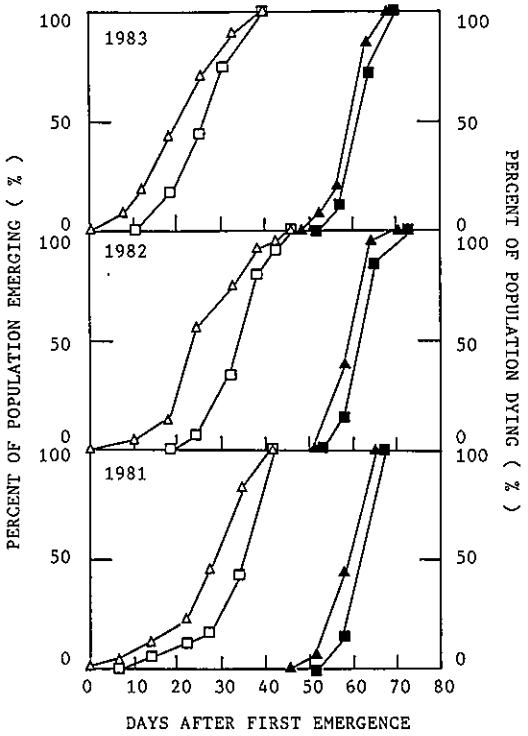

Fig. 3 Comparison of emerging and dying between the flowering and non-flowering plants in 1981, 1982, and 1983. Each symbol represents the percentage of the total number of flowering and non-flowering plants which occurred in two 1×1m plots.
—△—, —▲—: non-flowering plant,
—□—, —■—: flowering plant.

emerged early and those which emerged late. The individuals which emerged early show a tendency for an increased growth period. The growth period of individuals which emerged first was about twice as long as those which emerged last. The cause of this difference was that the dying was concentrated in a short period, while the emerging was long. YOKOI (1976) reported that the normal growth period seems to require 45 days, but in unusual conditions the growth period may be shortened to less than 30 days. My observations generally agree with YOKOI's (1976).

Discussion

The species like *Erythronium* which occurs on the floor of a secondary deciduous forest in early spring was influenced by the temperature and solar radiation, and also closely correlated with the forest canopy (VÉGINU, 1965; CALDWELL, 1969; MULLER, 1978; KAWANO et al., 1978). The general phenological responses of *E. japonicum* were found to be well correlated with temperature and solar radiation, in accordance with VÉGINU et al. (1965). Especially in the three years, dying began to accelerate in the middle of April, and reached 100% dying in two to three weeks. At that time the canopy began to develop and maximum temperature exceeded 20°C frequently.

The growth period of *E. japonicum* was known

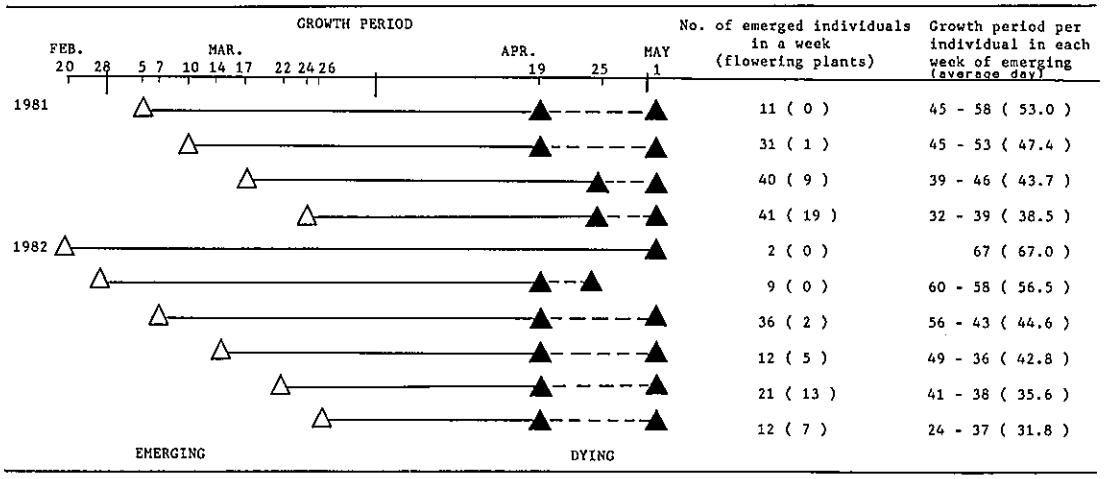

Fig. 4 Growth period per individual of the population in 1981 and 1982. The growth period per individual repersents the period from emergence to dying of emerged individuals in a 1m² plot at a weekly interval. One-year seedling plants subtracted in the emerged individuals.
▲: Investigated day of dying, △: Investigated day of emerging.

to be very short (YOKOI, 1976). In this study, we clarified the difference in the growth period between individauls which emerged early and those which emerged late. The growth period of individuals which emerged first was about twice as long as those which emerged last. Many flowering plants were included among individuals which emerged later (also indicates that the flowering plants emerged later than the non-flowering plants in Fig. 4). However, KAWANO et al. (1982) reported that flowering in this species continues for at least several years after the initial sexual maturity. From the marked individuals we observed that the flowering plants are continuous the next year in spite of their growth period being about 40 days. Assimilation characteristic of *E. japonicum* indicated typical "Sunleaf" plant and exhibited broad photosynthetic optimum over a wide thermal range from 5°C to 20°C (KAWANO et al., 1978). In early spring, adequate sunlight reached the floor of the forest and air temperature rose to 15°C in daytime (whereas decreased 0°C at night). It seems that assimilation was achieved sufficiently in daytime. In spite of such a short growth period, *E. japonicum* finished the assimilation to accumulate energy for the next year.

Acknowledgements——The author wishes to thank Prof. S. NAKAMURA Tokyo University of Agriculture and Y. SUZUKI for their useful suggestions, and to I. SATO and T. YAGISAWA for their kind assistance of field observation. I am very grateful to Prof. S. KAWANO, Kyoto University for critical reading of the manuscript.

References

CALDWELL, M. L. 1969. *Erythronium*: Comparative phenology of alpine and deciduous forest species in relation to environment. American Midland Naturalist 82: 543-558.

KAWANO, S., H. TAKASU and Y. NAGAI. 1978. The productive and reproductive biology of flowering plants. IV. Assimilation behavior of some temperate woodland herbs. J. Coll. Lib. Arts, Toyama Univ. 11: 33-60.

——, A. HIRATSUKA and K. HAYASHI. 1982. Life history characteristics and survivorship of *Erythronium japonicum*. The productive and reproductive biology of flowering plants V. Oikos 38: 129-149.

MULLER, R. N. 1978. The phenology, growth and ecosystem dynamics of *Erythronuium americanum* in the northern hardward forest. Ecological Monographs 48: 1-20.

VÉZINA, P. E. and M. M. GRANDTNER. 1965. Phenological observation of spring geophytes in Quebec. Ecology 46: 869-872.

YOKOI, Y. 1976. Growth and reproduction in higher plants II. Analytical study of growth and reproduction of *Erythronium japonicum*. Bot. Mag. Tokyo 89: 15-31.

摘　要

カタクリの季節的消長と生育特性を明らかにするため，1981年から1983年にかけて東京都練馬区大泉の清水山憩いの森にあるカタクリ群落に1×1m調査区を2ケ所設け，調査区内の萌芽個体を全て個体識別し，萌芽から枯死に至るまで追跡調査した。同時にカタクリ生育期間中の地上20cm気温と地表面温度，地下15cm地温を測定した。

カタクリの生育期間は2月下旬から5月上旬にかけての約2ケ月間で，その期間の平均気温は0°C以下から20°Cまで上昇し，最高気温は25°C，最低気温は−5°Cであった。これを平地の平均気温と比較すると1°Cから3°C低かった。しかし，3月中旬になると20°Cを越える日があり，4月になると20°Cを越える日が多くなった。また，萌芽時期の地表面温度は4°Cで枯死する時期には16°Cまで上昇し，地下15cm地温は4.5°Cから16°Cまで上昇した。また，1981年では2月20日から萌芽を開始し3月24日までつづき，萌芽期間は31日間であった。1982年では前年とほぼ同時期に萌芽し3月下旬まで続き，萌芽期間は41日間であった。1983年では3月4日から4月5日まで続き，萌芽期間は36日間であった。萌芽の推移は，最初の萌芽から2〜3週間で50%の個体が萌芽し，5〜6週間で100%が萌芽した。萌芽につづき葉を展開しながら急速に伸長した。開花期は各年ともに4月上旬に集中し，4月中旬には葉の黄化が開始するとともに枯死しはじめ，最初の枯死から2週間後には80〜90%が枯死し，5月上旬には全ての個体が枯死した。このように萌芽期間が5〜6週間と長いのに対して，枯死する期間は2〜3週間と短期間であった。一方，有花個体と無花個体の萌芽と枯死の推移を比較すると，有花個体は無花個体より1〜2週間おくれて萌芽するが，短期間で100%萌芽し，萌芽から2〜3週間で開花に至った。

1×1mの調査区を構成する各カタクリの生育期間を調べた結果，1981年では最初に3月5日に11

個体の萌芽が確認された。これらの各個体の生育期間は45から58日間で，平均生育期間は53.0日間であった。第2週目には31個体（有花個体1個体）が萌芽し，生育期間が45から53日間で，平均生育期間が47.4日間であった。第3週目は40個体（有花個体9個体）が萌芽し生育期間39から46日間で，平均生育期間が43.7日間であった。萌芽期間の最後の週では，41個体（有花個体19個体）が萌芽し，生育期間が32から39日間で，平均生育期間が38.5日間であった。1982年では，萌芽期間が前年より2週間長かったが，各個体の生育期間は同様の傾向を示し，平均生育期間は第1週から第6週まで，67.0，56.5，44.6，42.8，35.6，31.8日間と短かくなった。このように群落を構成する個体の生育期間は，おそく萌芽した個体ほどその生育期間が短かくなる傾向を示した。特に，有花個体は無花個体よりおそく萌芽し，生育期間が短かくなる傾向を示した。

以上のように，カタクリの生育期間は短かく，また，萌芽時期により生育期間に大きな差がでることが明らかになった。しかし，開花状況をみると，毎年ほぼ同数の開花数がみられ，なかでも40日と短い生育期間の有花個体が翌年も開花することが観察された。このことはカタクリが短かい生育期間にもかかわらず，早春の落葉樹林の林床という環境に適応し，種の維持のための効率のよいエネルギー生産をしていることを意味すると思われる。

(Received Nov. 9, 1986)

○ **フナシホタルブクロ（新品種）**（米澤信道）Nobumichi YONEZAWA: A New Form of *Campanula punctata* LAM.

ホタルブクロの花冠は，内側に紅紫色の斑点が多少ともあるが，筆者は1985年7月，福井県の景勝地三国海岸で，白花で斑点の全くないものを発見した。

フナシホタルブクロ
（1986年6月27日自宅植栽中のものを撮影）

ホタルブクロは，花色，葉形，毛の多少など変異に富むことが知られているが，三国海岸一帯に分布するホタルブクロは，白花ばかりで，萼や茎葉に毛が少なく，広葉の傾向が強く，とくに，葉の表面は無毛で光沢が著しい。本品種は，これらの集団の中で発見した一型である。写真は，持ち帰り自宅で植栽したものが今年開花したもので，斑点の有無は遺伝的であることが確認できた。なお，本品種を含め，三国海岸一帯のホタルブクロは，多くの個体で茎に虫瘿を持つのがめだったことを付記しておく。

最後に，本品種の採取に際して，成安女子高校の野村健治先生に同行，協力頂いており，深く感謝の意を表します。

Campanula punctata LAM. form. **impunctata** YONEZAWA, form. nov.

Corollae albae impunctatae.

Nom. Jap. Funashi-hotaru-bukuro (nov.)

Hab. Honshu. Pref. Fukui: Mikunikaigan, Mikuni-machi, Sakai-gun, alt. ca. 3m (N. YONEZAWA; July 7, 1985; Holotype in KANA no. 117390).

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○ **谷口森俊　三重県の海藻相**（三重県の植物相その1）　自己出版。昭和62年発行。B5版，33頁。領価500円（送料170円を含めて）。内容は三重県全沿岸の海藻群落の分布，組成，分類，季節的消長，目録，文献である。入手御希望の方は谷口森俊氏（〒514-11　久居市鳥木町413-2，振替口座名古屋2-56390）に申しこまれると送本される。（里見信生）