

Studies on *Delphinium* hybrids. IV Flower bud differentiation  
and development in *Delphinium hybridum* cv 'Blue Bird'

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Summary

Flower bud differentiation and development were studied in *Delphinium hybridum* cv 'Blue Bird'. Seeds were sown on November 11, 1983, and plants were grown in a vinyl film house. Floret primordia were observed on March 17, 1988 ( 128 days after sowing ), sepals on March 31, petals and stamens on April 7, pistils on April 14, and ovules, pollen tetrads and pollens on April 28. Flowers opened on May 12 ( 184 days ).

Introduction

*Delphinium hybridum* cultivars are very attractive plants. They are known as gorgeous garden flowers and also fine cut flowers. Most popular of these are the Giant Pacific Court series. They produce cylindrical spires of densely arranged blue, lavender, puple or white flowers. They attain heights of 100 to 200 cm

Their commercial importance as cut flowers is increasing these days in Japan. The beneficial features of this series are that they are grown up from seeds and treated as annuals, and also that they respond

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well to forcing. For commercial use they are sown in fall, and grown in heated or nonheated houses<sup>(1)</sup>. Flowers are cut from winter to early summer.

This morphological study was undertaken to obtain information on the flower bud initiation and development of the Giant Pacific Court series.

### Material and Method

Seeds of *Delphinium hybridum* cv 'Blue Bird' were sown on November 11, 1983 in a greenhouse of Keisen Jogakuen Junior College at Isehara, Kanagawa. The seedlings were transplanted to vinyl pots (7.5 cm across) on December 13. They were planted in a vinyl film house, which had no heating, on February 18, 1984. 5 plants were collected at weekly intervals from January 7 to May 12. Plants were stored in FAA solution. Flower bud differentiation and development were observed and pictures were drawn.

### Results and Discussion

#### Plant structure

The plant height was about 150 cm. Inflorescence (about 100 cm) had 50 to 70 florets (Fig. 1). About 16 leaves were presented below the first floret. Florets consisted of a pedicel, 2 bracteoles, 13 sepals, 9 petals, about 25 stamens and 3 to 7 pistils. One of the sepals and also one of the petals formed a spur (Fig. 2).

### Floret development

The developmental stages of the florets were determined as follows :

- Stage I. Florets undifferentiated. Floret primordia have not been observed in the axil of leaves. The axially vegetative buds are so small as to be hardly distinguishable (Fig. 3).
- Stage II. Floret primordium formation. Oval floret primordia are observed when bracts are removed. Florets differentiate in acropetal order ( Fig. 4 and 7 ).
- Stage III. Bracteole formation. Two bracteoles appear at the lateral sides of the floret primordium ( Fig. 5 and 8 ).
- Stage IV. Sepal formation. Several sepals can be distinguished at the front view of the floret ( Fig. 6 and 9 ).
- Stage V. Petal formation. Petals appear inside the circles of sepals. It is impossible to structurally distinguish petals from sepals at this stage. The primordia appearing next to the 13th sepal can be determined as petals ( Fig. 10 ).
- Stage VI. Stamen formation. Several circles of stamens appear inside the petals. The completion of stamen formation can be recognized by the transformation of the apical end of florets from dome-like to flat. The flat apical end looks like a tableland surrounded by stamens ( Fig. 11 ).
- Stage VII. Stile formation. Three or four corners of the apical end rise forming stile primordia ( Fig. 12 and 13 ).
- Stage VIII. Ovule formation. Stiles develop into long conical structures. The ventral side of the stile is flat and a slit, which is the suture of the carpel edges, runs from the top to the bottom. The faced edges do not unite completely. Ovule primordia differentiate in two rows in the ovary. They make lines along the slit ( Fig. 14 ).

Stage IX. Pollen tetrad formation. Pollen tetrads were observed later than ovule differentiation ( Fig. 15 ).

Stage X. Pollen formation. Pollen mother cells, tetrads and pollen grains can be observed in one pollen sack. It means the time pollens remain in tetrads is very short ( Fig. 15 ).

Stage XI. Flowering ( Fig. 16 ).

The floret primordia were observed on March 17 ( 128 days after sowing ), sepals on March 31, petals and stamens on April 7, pistils on April 14, ovules, pollen tetrads and pollens on April 28, and the flowers opened on May 12 ( 184 days )(Table 1).

#### Plant development

Plants grew very slowly until the middle of March, then they started rapid growth ( Fig.17). Floret primordia differentiated on exactly the same days. This fact may suggest that floret differentiation was a sort of trigger of plant growth. Plant growth continued until flowering. The growth during the last two weeks was surprisingly rapid. This was mainly due to the elongation of inflorescence. The day inflorescence started rapid growth coincided with the day of pollen and ovule differentiation.

#### Literature cited

- 1) Murakami, M. and Nagano, K. 1980. Studies on Delphinium hybrids. II Cultivation of the Giant Pacific series. Bull. of Keisen Jogakuen Jr. College. No. 13 : 123 - 130.

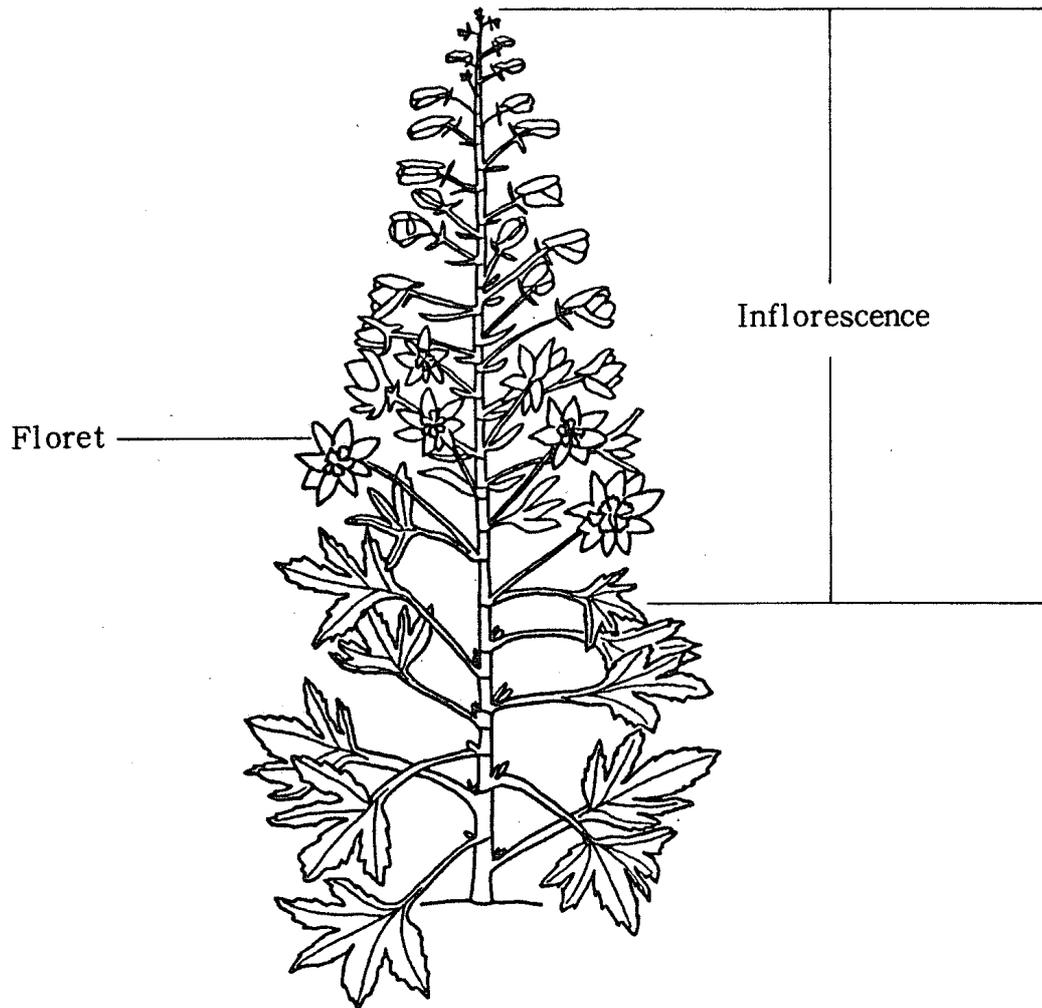


Fig. 1. Plant structure of *Delphinium hybridum* cv 'Blue Bird'.

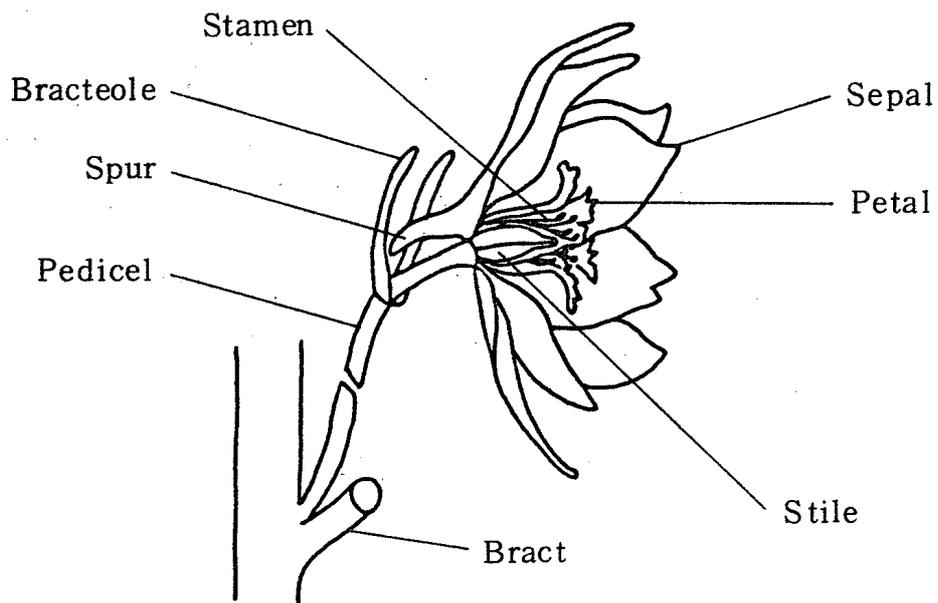


Fig. 2. Flower structure of *Delphinium hybridum* cv 'Blue Bird'.

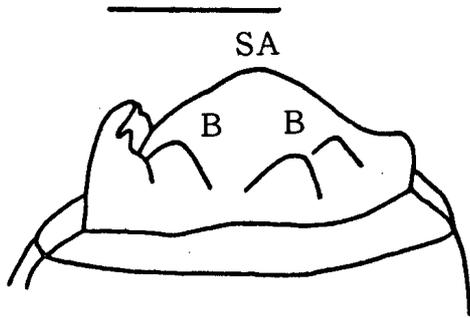


Fig. 3. Shoot apical region with bracts. Floral primordia have not been differentiated. SA, shoot apex ; B, bract. Bar = 0.5 mm in Fig. 3-6

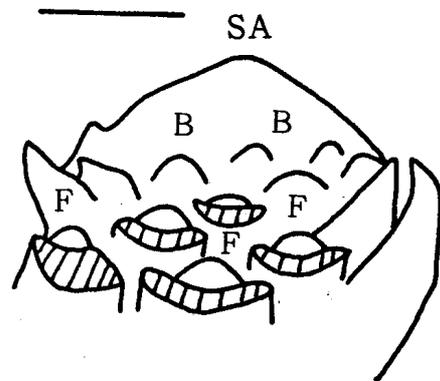


Fig. 4. Inflorescence with floret primordia. Some bracts are removed. F, floret primodium.

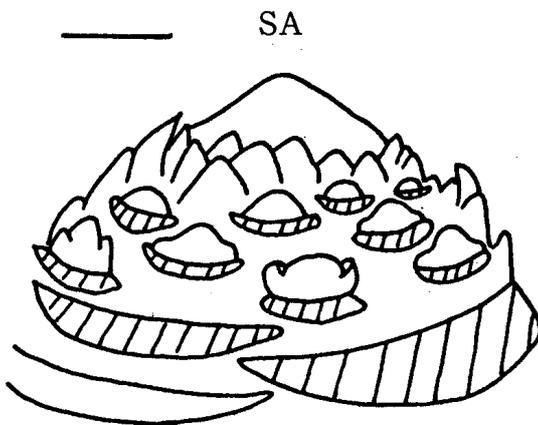


Fig. 5. Inflorescence with florets having bracteoles.



Fig. 6. Inflorescence with florets having sepals.

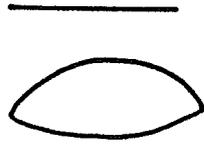


Fig. 7. Floret primordium.  
Bar = 0.2 mm in  
Fig. 7-12.

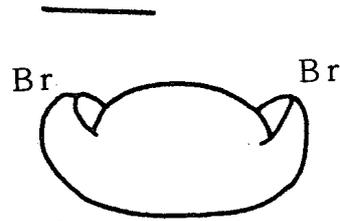


Fig. 8. Floret with bracteoles.  
Br, bracteole.

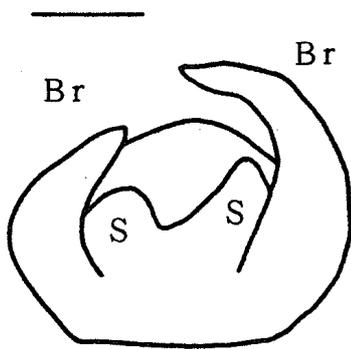


Fig. 9. Floret showing sepal  
differentiation. S, sepal.

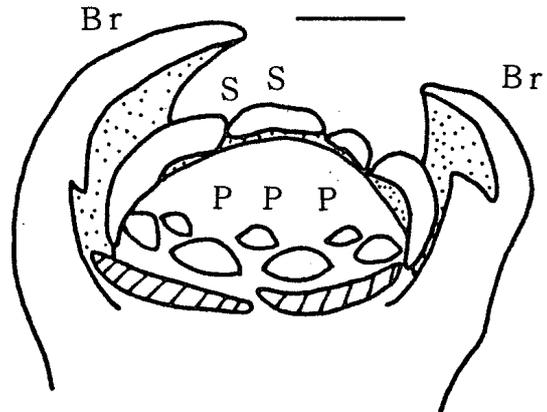


Fig. 10. Floret showing petal  
differentiation. P, petal.

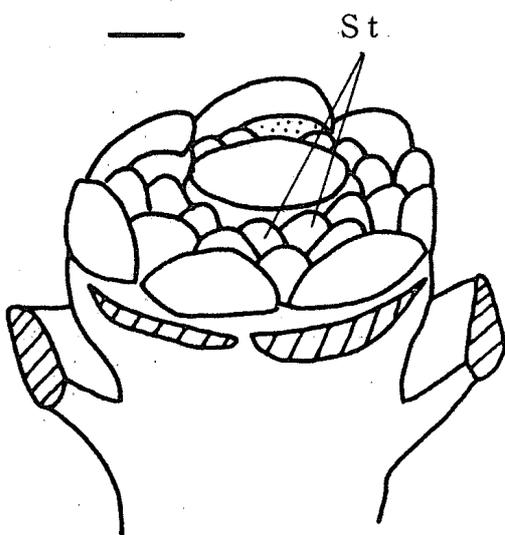


Fig. 11. Floret showing stamen  
differentiation and flat  
apex. St, stamen.

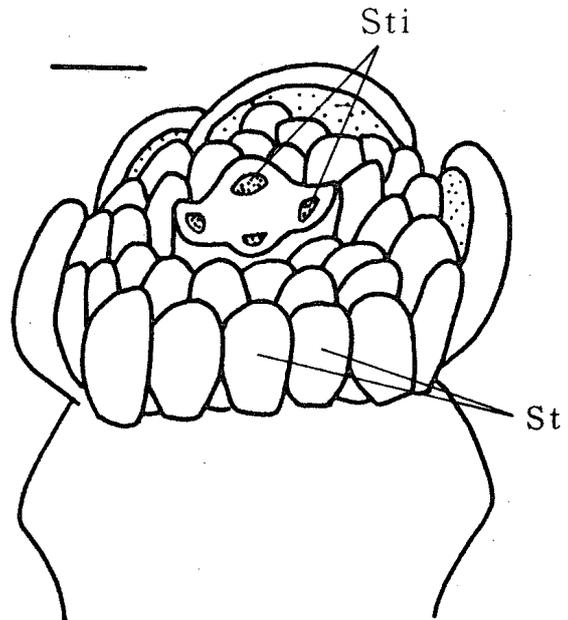


Fig. 12. Floret showing stile  
differentiation. Sti,  
stile.

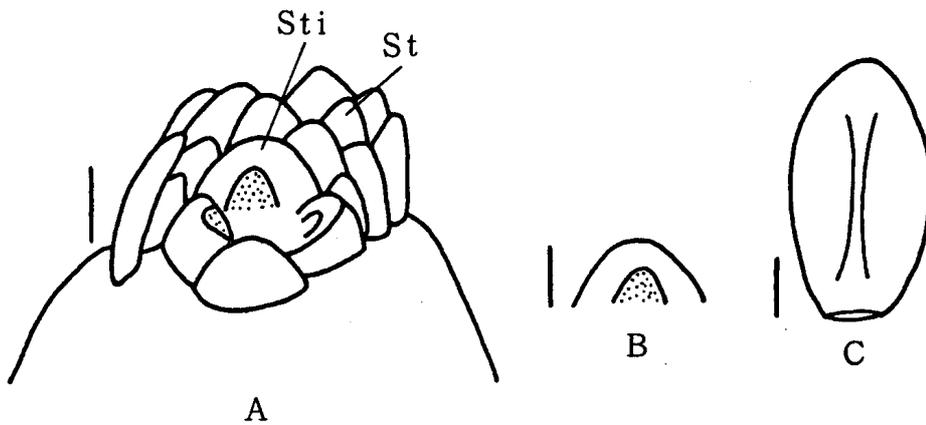


Fig. 13. Floret with stiles and stamens. A : stiles and stamens. B : ventral view of a stile. C : ventral view of a stamen.  
Bar = 0. 2 mm.

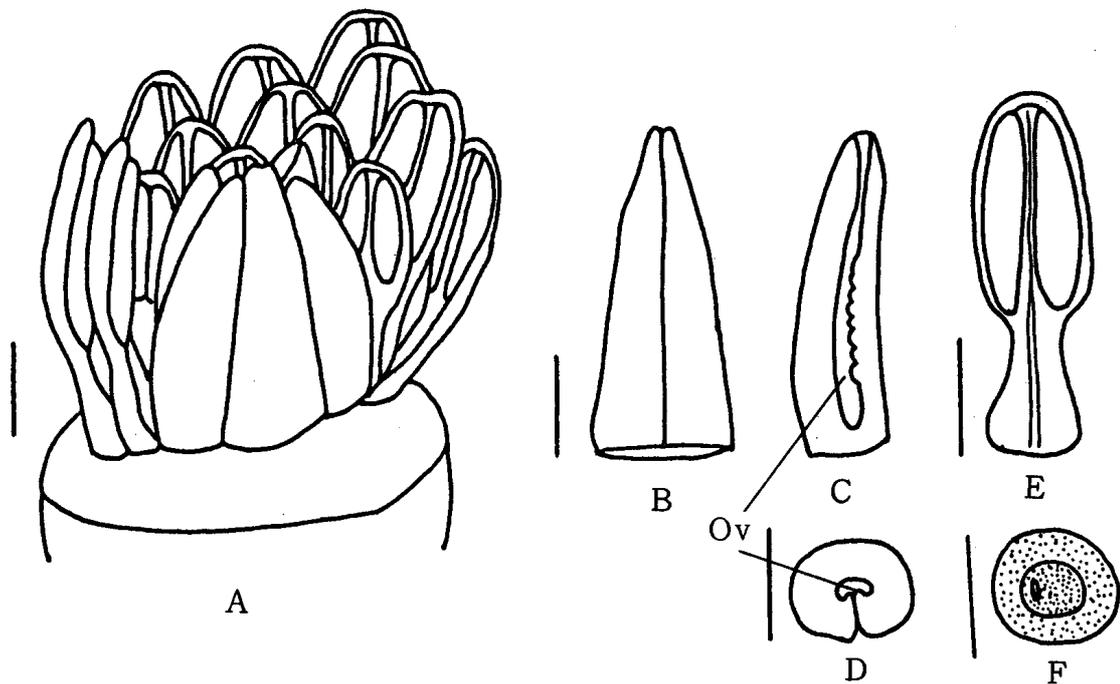


Fig. 14. Floret showing ovule differentiation. A : stiles and stamens. B : ventral view of a stile. C : stile vertically cut showing ovule differentiation. D : stile transversely cut. E : ventral view of a stamen. F : pollen mother cell. Ov, ovule. Bar = 0. 03 mm in F ; 0. 5 mm in others.

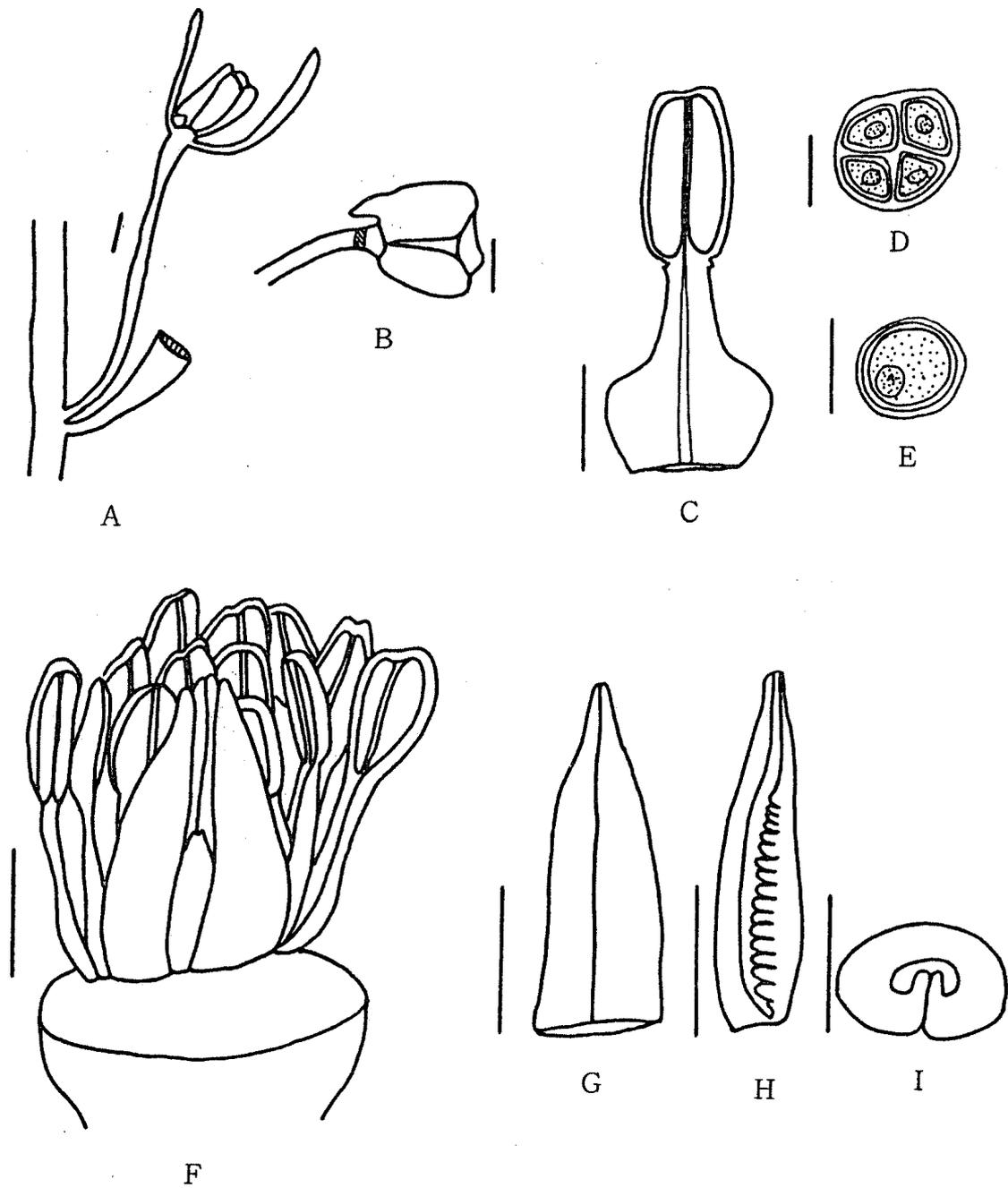


Fig. 15. Floret at pollen formation stage. A : floret attached to flower stalk. B : flower bud. Bracteoles are removed. C : ventral view of a stamen. D : pollen tetrad. E : pollen grain. F : stiles and stamens. G : ventral view of a stile. H : stile vertically cut along slit showing ovules. I : stile transversely cut. Bar = 0.02 mm in D, E ; 2 mm in others.

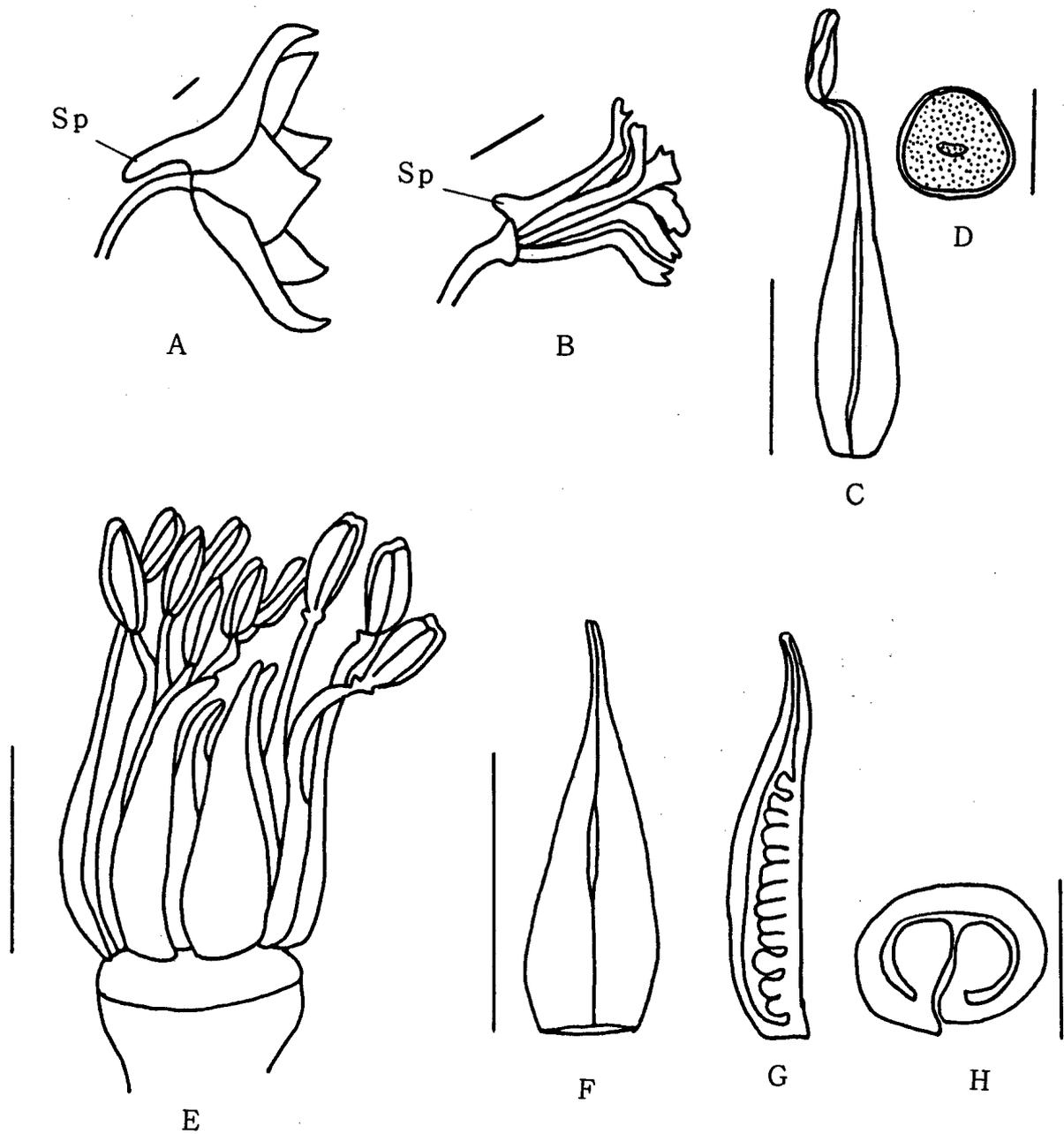


Fig. 16. Floret at flowering stage. A : intact floret. B : side view of petals. Dorsal petal possesses a spur. C : stamen. D : matured pollen grain. E : stiles and stamens. F : ventral view of a stile. G : stile vertically cut along slit showing ovules. H : stile transversely cut. Sp, spur. Bar = 0.03 mm in D ; 1 mm in H ; 5 mm in others.

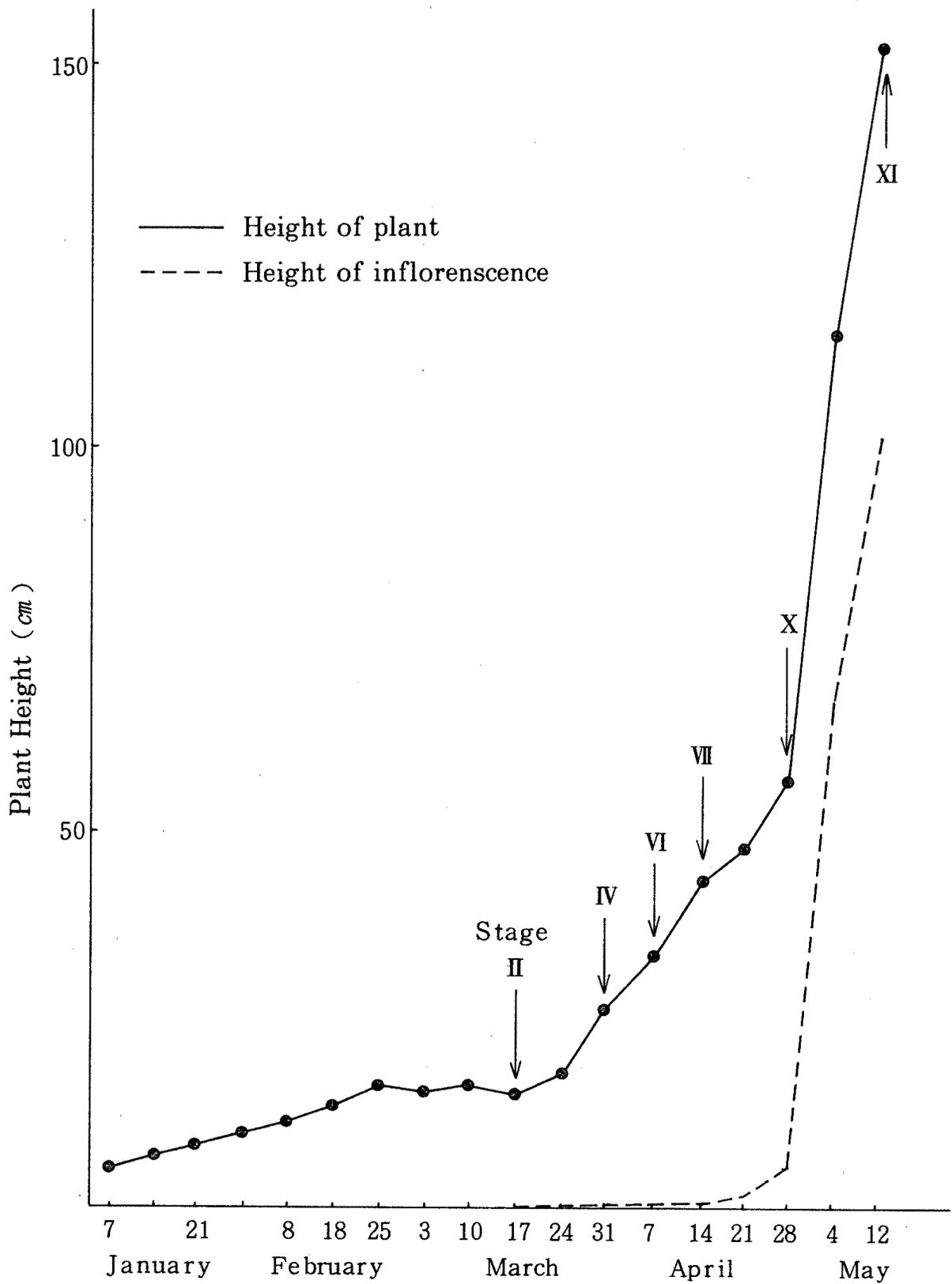


Fig. 17. Plant development and the developmental stages of the first floret in *Delphinium hybridum* cv 'Blue Bird'.

Table 1. Developmental stages of florets in *Delphinium hybridum* cv 'Blue Bird'

| Developmental stages<br>of the first floret | Date examined |    |    |    |    |       |    |    |    |     |    |
|---|---------------|----|----|----|----|-------|----|----|----|-----|----|
|   | March         |    |    |    |    | April |    |    |    | May |    |
|   | 3             | 10 | 17 | 24 | 31 | 7     | 14 | 21 | 28 | 6   | 12 |
| I   | 5             | 5  | 3  | 1  |    |       |    |    |    |     |    |
| II  |               |    | 2  | 3  | 1  |       |    |    |    |     |    |
| III   |               |    |    | 1  | 2  |       | 1  |    |    |     |    |
| IV  |               |    |    |    | 2  | 2     | 1  |    |    |     |    |
| V   |               |    |    |    |    | 1     | 1  |    |    |     |    |
| VI  |               |    |    |    |    | 2     |    |    |    |     |    |
| VII   |               |    |    |    |    |       | 2  | 5  |    |     |    |
| VIII  |               |    |    |    |    |       |    |    | 1  |     |    |
| IX  |               |    |    |    |    |       |    |    | 1  |     |    |
| X   |               |    |    |    |    |       |    |    | 3  | 5   | 2  |
| XI  |               |    |    |    |    |       |    |    |    |     | 3  |

Stage I : Floret undifferentiated.

Stage II : Floret primordia formation.

Stage III : Bracteole differentiation. Stage IV : Sepal formation.

Stage V : Petal formation. Stage VI : Stamen formation.

Stage VII : Style formation. Stage VIII : Ovule formation.

Stage IX : Pollen tetrad formation. Stage X : Pollen formation.

Stage XI : Flowering.