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Citation	北海道大学農学部農場研究報告, 27, 63-68
Issue Date	1991-03-25
Doc URL	<a href="https://hdl.handle.net/2115/13409">https://hdl.handle.net/2115/13409</a>
Type	departmental bulletin paper
File Information	27_p63-68.pdf



# Aerial Crown-like Body Formation in Adult Plant of *Asparagus officinalis* L.

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(Received December 25, 1990)

## Introduction

Assimilation products of *Asparagus officinalis* L. are stored in crown and storage roots. This photosynthate induces the crown buds on some parts of the crown<sup>3,4</sup>. Since development of the crown and induction of the crown buds are important to growth of asparagus, it is necessary to investigate the factors on how the development of the crown and the induction of the crown bud take place. Unfortunately, because crowns are usually formed on a tip of growing rhizome, it is difficult to observe the developmental process of crown visually.

As mentioned above, at plant level, the crown formation was essential in rapid growth of asparagus plant. In *in vitro* propagation of asparagus, previous researches showed that rooting was more difficult than shooting<sup>1,2</sup>. This fact makes it difficult to regenerate an intact plantlet. However, easy rooting was expected from crown-like body induced in tissue culture. Therefore the crown-like body formation was necessary for plantlet regeneration in *in vitro* propagation of asparagus.

There were only a few studies subjected to the crown which was formed on above-ground nodes<sup>5,6</sup>. Understanding such formation of aerial crown-like body more detail will facilitate the way toward rapid means of vegetative propagation, and determine the physiological mechanism of its formation. Yang *et al.* reported that aerial crowns were formed at the node of basal portion in young seedlings and young plants propagated by tissue culture<sup>5</sup>.

The present work is conducted to investigate the induction of aerial crown-like body in the adult plants under natural condition.

## Materials and Methods

In the middle of October, 1990, formation of aerial crown-like body was investigated in 5-year-old plants of 6 cultivars (*Asparagus officinalis* L.) in Experimental Farm of Hokkaido University, Sapporo, Japan. Then, number of shoots developed from the aerial crown-like body was counted. For estimation of the aerial crown-like body-forming portion, the lowest order at the node forming the aerial crown-like body was checked in each plant.

For preliminary histological studies, aerial crown-like bodies obtained in the field were fixed in FAA (formalin : acetic acid : ethanol = 5 : 5 : 90), dehydrated by using ethanol-butanol series, and embedded in paraffin. The embedded tissues were cut into 12- $\mu$ m-thick sections, stained with

Delafield's hematoxylin, and observed under microscope.

### Results and Discussion

Many aerial crown-like bodies were formed on the node of adult plant in 6 cultivars investigated. The aerial crown-like body formation in a high frequency, 65% of observed plants, was found in cultivar 'Hidel', and 20-40% of observed plants in other cultivars formed aerial crown-like bodies (Table 1). However, further research is needed to define whether varietal difference in aerial crown-like body formation truly exists or not.

Aerial crown-like bodies could be found easily because they had yellow-colored shoots (Fig. 1-1, 2, 3). Almost all of them produced 1 or 2 shoots (Fig. 2). In addition, there was a variation in size of aerial crown-like body which ranged from 1 to 3 mm. Aerial crown-like body could be easily isolated from the nodes of stalks and lateral shoots, and it seemed to be the organ with established structure as individual plant (Fig. 1-4).

Aerial crown-like bodies were formed on the nodes at/above the 40 th node order on stalks and/or on the lateral shoots which were developed from the 20 th node or above on stalks (Fig. 3). In case of the aerial crown-like body formation on the lateral shoot, it was formed on the advanced node order of the lateral shoot developed on the 20 th-30 th nodes of stalk, but it could be observed on the lower node order if lateral shoots were developed from the 30 th node or above. These aerial crown-like bodies were formed on the portions at 70 to 120 cm above the ground.

From these observation, the aerial crown-like body seemed to be formed around the foliage growing thickly and at the portion exposed to sunshine. Some larger aerial crown-like bodies could be observed in other districts where the environmental conditions were different from those in Experimental Farm of Hokkaido University. This fact led to the assumption that environmental factors might influence the aerial crown-like body formation.

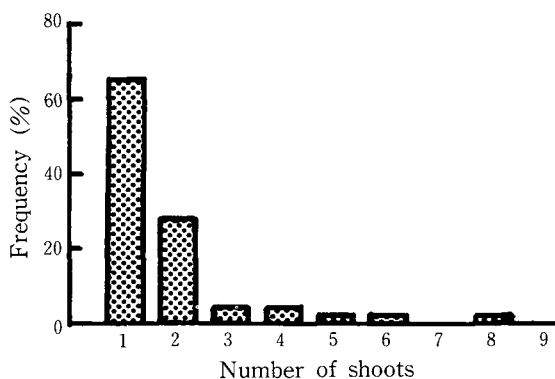
However, the previous reports interestingly showed that indole-3-acetic acid (IAA) induced crown formation at the basal portion of the young plants<sup>9)</sup>. It is necessary to carry out further work to give more informations related to the development, dormancy and other physiological, structural phenomena of the aerial crown-like body in nature.

By histological observation, it was clear that the aerial crown-like body was protected by a hard coat at the basal part, and induced some crown buds on its surface layer (Fig. 4-1). A large number of vascular bundles ran longitudinally and latitudinally inside the aerial crown-like body. Histologically there was a difference between the tissue around the crown buds and those of basal part (Fig. 4-2). Vigorously-dividing cells were observed in the former ; on the other hand, the tissue in the latter consisted of enlarged cells with thickened cell wall. This fact indicated that the activity of cell division was reduced. The histological characteristics of the aerial crown-like body resembled to that of subterranean crown.

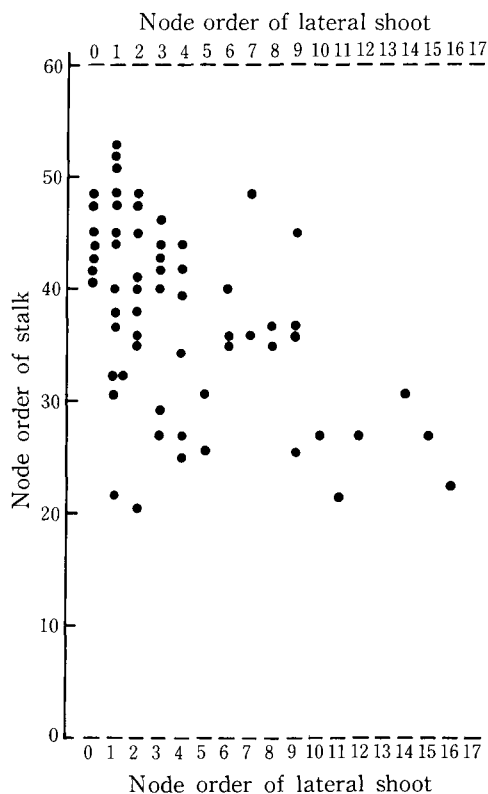
Conclusively, the essential conditions of the asparagus crown are that they can develop into rhizome, and continuously emerge a spear and a storage root, because an asparagus plant is perennial. Therefore, further experiments to prove the occurrence of the morphogenesis should be carried out through *in vitro* or *in vivo* cultures.

**Table 1.** Formation of aerial crown-like body in 6 cultivars of *Asparagus officinalis* L.

Cultivars	No. of plants observed	No. of plants with aerial crown-like body
Welcome	18	7
Marathon	20	4
Pole Tom	20	4
NJ Green	20	4
Hidel	20	13
MW500W	20	7



**Fig. 2.** Number of shoots developed from aerial crown-like body. One hundred and twenty seven aerial crown-like bodies were observed.



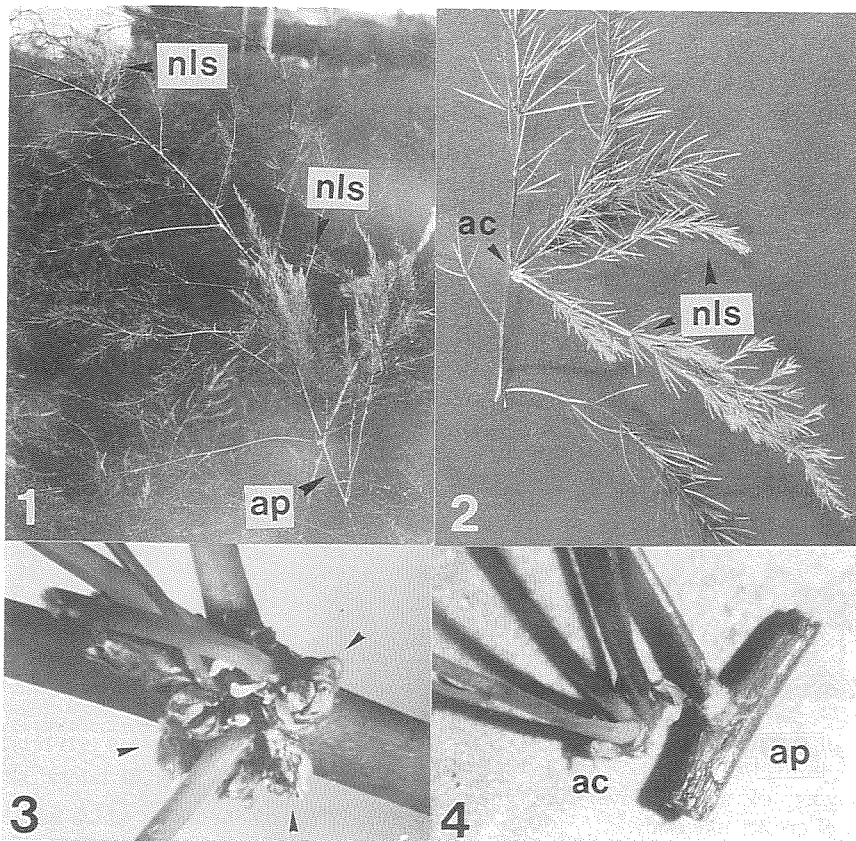
**Fig. 3.** Node order on which an aerial crown-like body attach. This observation was carried out using 61 stalks of cultivar 'Hidel' plants, and the symbol ● indicates the lowest node order on which aerial crown-like body attached in each stalk and lateral shoot.

**Summary**

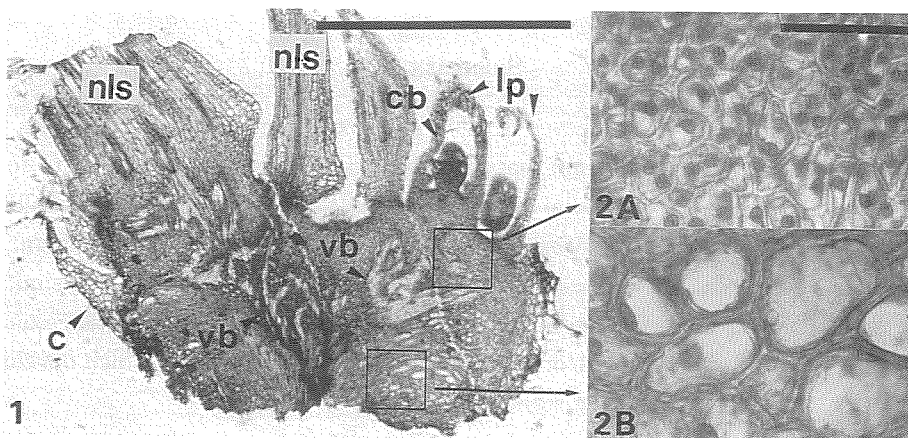
Aerial crown-like bodies were observed in adult plants of six cultivars of *Asparagus officinalis* L. under natural condition. It was found that in each cultivar there was an ability to form aerial crown-like body and the size of the aerial crown-like body varied. The aerial crown-like bodies had some buds on their surface layer, vascular bundles and storage tissues inside them, and were protected by hard coats. Generally, the structure of the aerial crown-like body was similar to that of a crown of rhizome. The formation of aerial crown-like body usually took place on the 40 th node or above along primary stalk and/or on the nodes of the lateral shoot which developed from the 20 th node or above of the primary stalk.

**Acknowledgment**

This work was supported in part by a Grant in Aid for Scientific Research (No. 01304022) from the Ministry of Education, Science and Culture, Japan.



**Fig. 1.** An aerial crown-like body formed in adult plant.  
 1, New lateral shoots(nls) developed from 5-year-old plants(ap) growing.  
 2, Aerial crown-like body(ac) formation on the node and new lateral shoot(nls) developing thereon. 3, External appearance of aerial crown-like body(arrow). 4, Aerial crown-like body isolated from adult plant(ap).



**Fig. 4.** Histological observation of aerial crown-like body.  
 1, Longitudinal section of aerial crown-like body. Crown bud(cb), leaf primordium(lp), vascular bundle(vb) and coat(c) were observed. Scale bar indicates 1 mm. 2, Difference between the tissue around crown bud(A) and that around basal part(B). Scale bar indicates 50  $\mu$ m.

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## アスパラガス成株の地上節におけるクラウン様体の形成

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(1990年12月25日受理)

### 摘 要

1990年10月中旬に北海道大学農学部附属農場に栽植してある5年生のアスパラガス (*Asparagus officinalis* L.) の地上部を調査したところ、いずれの品種にもクラウン様体の着生が認められた。この時期における調査では、クラウン様体は径1~3mmの大きさで、黄緑色のシュートを伸長させていた。クラウン様体は主茎の第40節位以上の節か、主茎の第20節位以上の節から発生している側枝の節部に着生していた。特に、主茎の第20~30節より発生した側枝では高節位に、主茎の第30節以上から発生している側枝では低節位に着生する傾向が認められた。組織学的観察により、クラウン様体の表面にはりん芽が、内部には維管束が存在した。また、下部の組織では細胞が肥大し、細胞壁も肥厚して貯蔵組織となっており、地下部に形成されるクラウンと同様の形態を示した。一般にクラウンは地下茎の先端部に形成されるため、肉眼的な観察が不可能であるが、その発育に関する諸要因を地上節に形成されるクラウン様体を通じて肉眼的に解析できる可能性が示唆された。