

運用掃描電子顯微鏡記錄花粉和孢子

香港是彈丸之地，卻孕育著逾 2,000 種原生植物，植物多樣性相當高。花粉和孢子是植物繁殖周期中的關鍵元素，而多樣的傳粉媒介，如昆蟲、風、水等，在植物繁衍中扮演著重要角色。當解釋植物的繁殖方法時，研究花粉和孢子亦是一個與人類有著密切關係的跨學科課題，這類別研究一般稱為孢粉學。對某些人，花粉或是致敏原；對另一些人，花粉則是人類的補品，如蜂花粉、松花粉等。孢粉學的應用及相關研究領域廣泛，包括人體過敏反應、蜂蜜孢粉學、生態學與演化、古孢粉學及法證科學等，因此花粉和孢子的記錄和鑒定是奠定孢粉學研究的基礎。譬如說，蕨類植物中海金沙的繁衍孢子是中醫臨床上常用的中藥之一。因此，花粉和孢子是植物繁殖後代的重要結構，也可能是人類能利用的天然資源。

被子植物和裸子植物均利用花粉繁衍下一代，花粉粒是源自雄配子體，用於種子植物的有性繁殖。而孢子是蕨類植物等陸生植物用於繁殖的結構，孢子會發育成為配子體，用於繁殖。同屬的花粉和孢子擁有獨特形態結構，其結構特徵有助分辨相似的植物品種，因此，記錄這些植物品種的結構特徵，可鑒定植物的品種及其親緣關係。

常見的花粉和孢子形態研究方法包括使用光學顯微鏡 (LM)、掃描電子顯微鏡 (SEM) 和投射電子顯微鏡 (TEM)。此外，花粉和孢子樣本也有不同的處理方法，本館現時使用的方法是以掃描電子顯微鏡記錄已脫水的花粉和孢子形態。野外採集後，花粉和孢子 (樣本) 會先從新鮮的憑證標本上取下，然後貯存於標本紙封袋中。其他水分含量較高的植物部分，如花瓣或花萼，會先被移除以防止真菌滋生。紙封袋隨後會被放置在除濕器或低於攝氏 40 度的乾燥機內風乾 3 天或以上。已乾燥的樣本由導電碳膠帶黏在金屬樣本台上，在拍照影像前會放入 Edwards Sputter Coater S150B 鍍上金及鉑。鍍上金屬的樣本會被轉移至 Thermo Scientific Prisma E Scanning Electron Microscope 掃描成像。掃描電子顯微鏡的基本原理是在真空環境中把電子束射在樣本上，過程中產生的背向散射電子 (信號) 會被偵測器接收，最後重組成灰階影像。每個樣本均會拍攝多張影像，以選擇高質素且多角度的影像。



在本冊中，我們新增了「掃描電子顯微鏡圖像」單元，展示了花粉和孢子的影像，選取一些關鍵結構作註解，並加入相關的形態描述。此新增的部分旨在為花粉和孢子提供新的資訊，雖然現在已有一些公開的花粉和孢子資料庫，例如 PalDat 和 Australasian Pollen and Spore Atlas，然而，香港植物的花粉和孢子的研究記錄有限，特別是稀有及瀕危植物，故本館希望能為花粉和孢子研究作出一份貢獻；而本書所展示這些大眾難得一見、嶄新的植物結構影像，亦能增加讀者對大自然的興趣。

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香港中文大學出版社：具有版權的資料

Documentation of Pollen and Spores by Scanning Electron Microscopy

Although Hong Kong is small, it supports over 2,000 types of native plants, making it impressively diverse in flora. Pollen and spores are critical elements in the reproductive cycle of plants, and various pollinators such as insects, wind, and water play important roles in plant propagation. When explaining the methods of plant reproduction, the study of pollen and spores is also considered a multidisciplinary science that is closely connected with human beings and is categorized under the field of palynology. For some people, pollen is an allergen, while for others, pollen serves as a human health product, such as bee pollen and pine pollen powder. Applications of palynology and related fields of studies are extensive, including allergies in the human body, melissopalynology, ecology and evolution, paleopalynology, forensic science, etc. Hence, documentation and authentication of pollen and spores are part of the fundamental work for palynology. For example, the spores produced by fern plants, such as **Lygodii Spora** (Haijinsha), are commonly used in clinical Chinese medicine. Therefore, pollen and spores are integral to the reproduction of plant offsprings and are natural resources we may utilize.

Pollen, which angiosperms and gymnosperms utilize to facilitate reproduction, are endosporic male gametophytes, which engage in the sexual reproduction of seed plants. Spores are reproductive structures that will develop into gametophytes in terrestrial plants, including ferns. The morphological characteristics of pollen and spores of the same genus can be distinctive, and certain characteristics can also be used to differentiate related species. Therefore, having a record of these characteristics can be one of the pieces of evidence to facilitate the classification and authentication of plants.

There are several common ways to study pollen and spore morphology: light microscopy (LM), scanning electron microscopy (SEM), and transmission electronmicroscopy (TEM). And there are different protocols of pre-treatment for the pollen and spore samples. Our Herbarium is currently focusing on the use of SEM to document the morphology of dehydrated pollen and spores. After field collection, pollen and spores are collected from fresh samples of voucher specimens (samples). Samples are stored in archival grade capsules; other floral parts high in moisture, such as petals



or the calyx, are removed in advance to prevent fungal growth. The capsules are then transferred to a dehumidifier or oven below 40°C and dried for at least three days. After that, dried samples are adhered to metal stubs with conductive adhesive carbon tape. The stubs are put inside Edwards Sputter Coater S150B for coating with gold and palladium before images are taken. Finally, the coated samples are transferred to a Thermo Scientific Prisma E Scanning Electron Microscope for SEM imaging. The basic principle of SEM is that by shooting electron beams inside a vacuum chamber onto the coated samples, backscattered electrons (signals) are generated and received by the detectors. Reconstituted, grayscale images are then generated. Multiple images are taken for each sample so that high-quality images of the pollen or spores from different angles of view can be selected.

In this volume, we have added a section on ‘Scanning Electron Microscope Images,’ in which images of pollen and spores are displayed, with key morphological structures and characteristics selected for annotation. There are open resources of pollen and spore databases, such as PalDat and the Australasian Pollen and Spore Atlas. However, there are limited studies and documentation of pollen and spores on Hong Kong flora, especially for rare and endangered plants. Our Herbarium, therefore, hopes to take this opportunity to fill in the missing pieces. With the new section added, this book aims to provide new information on pollen and spores. We hope that these rarely seen and innovative images of plant structures will be of interest to readers and allow for greater appreciation of nature.

Hiu-Yan Wong & Man-Ching Li
Shiu-Ying Hu Herbarium Research Coordinator

本圖鑑的編排

How This Book Is Organised

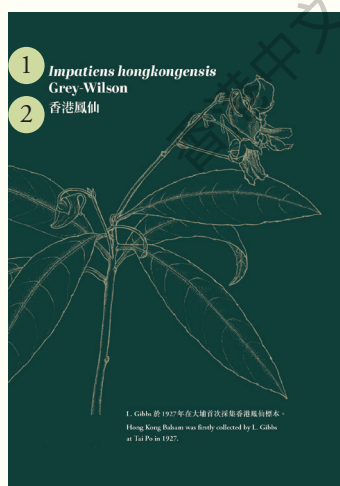
植物分類系統 Plant Classification System

本圖鑑所收載的蕨類植物和被子植物，分別採用秦仁昌分類系統和被子植物系統發育及演化組 IV (APG IV) 的分類系統排列。文中亦有收錄《中國植物誌》英文版 (*Flora of China*) 及《香港植物誌》的植物拉丁名稱。

The ferns and angiosperms included in this book comply with the Ching Ren Chang System and Angiosperm Phylogeny Group IV (APG IV) systems of classification respectively. The scientific names adopted in the *Flora of China* and the *Flora of Hong Kong* are also documented.

編排結構 The Structure

I. 首頁 Opening Page



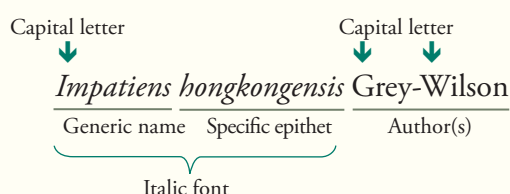
1 學名

Scientific Name

根據《國際藻類、真菌及植物命名法規》，標準的植物學名由拉丁文組成：

學名 = 屬名 + 種加詞 + 命名者

The standard scientific names of plants follow the *International Code of Nomenclature for Algae, Fungi, and Plants*, and are constructed from Latin as follows:
Scientific name = Generic name + Specific epithet + Author(s)



2 中文名稱 Chinese Name

植物的常用中文名稱
The common Chinese names of the plants

II. 植物簡介 Introduction of Plant Species



3 植物基本資料 Basic information of plants

4 繪圖編號 (根據植物繪圖師的繪畫次序而編定) Illustration number (complying with the drawing sequence of the botanical illustrators)

5 內文描述 Description

6 在《中國植物誌》(英文版)與《香港植物誌》的名稱 Names in *Flora of China* and *Flora of Hong Kong*

7 參考文獻 References

III. 胡秀英教授採集的標本 Specimens Collected by Professor Shiu-Ying Hu



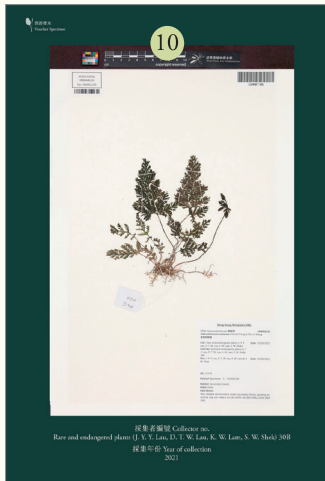
8 採集者編號 Collector number

9 採集年份 Year of collection

有些物種並沒有胡教授採集的標本，會以憑證標本的詳細特徵替代。

Some species do not contain specimens collected by Dr Hu, the details of the voucher specimen will be shown instead.

IV. 憑證標本 Voucher Specimen



10 展示科學繪圖主要對照的植物標本

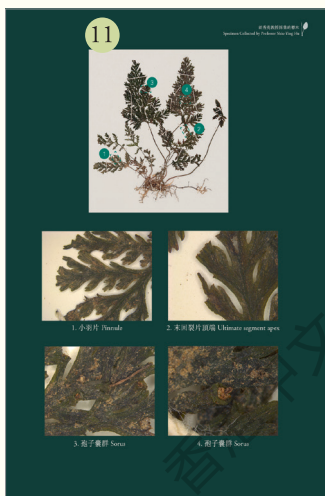
Showing the voucher specimen used to draw the scientific illustration

憑證標本

一種為了驗證和作永久參考而被採集或挑選的植物個體或種群標本，用於植物的生態、基因、化學或藥理研究，並被引用在科學文章中。

Voucher Specimen

This is a kind of plant specimen that is specially collected / selected as a verifiable and permanent reference of a plant individual or population, which is used for analysis of the plant's ecology, DNA, chemicals or pharmacology, and is cited in scientific articles.

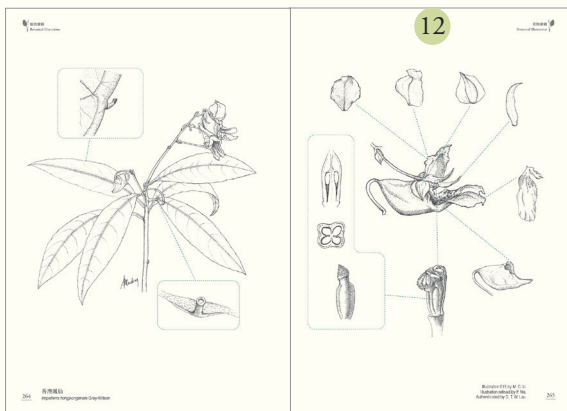


11 展示憑證標本的詳細特徵*

Showing the details of floral parts on the voucher specimen

* 僅展示於沒有「胡秀英教授採集的標本」的品種
Only in the species without 'Specimens Collected by Professor Shiu-Ying Hu'

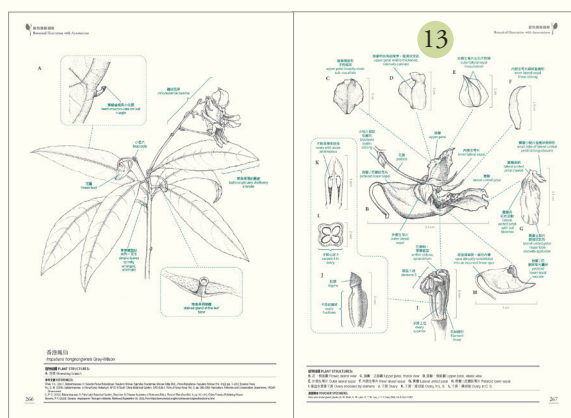
V. 植物繪圖 Botanical Illustration



12 展示植物結構

Showing the plant structures

VI. 植物繪圖圖解 Botanical Illustration with Annotations



13 展示「植物繪圖圖解」、「植物結構」、「參考文獻」及「憑證標本」

Showing 'Botanical Illustration with Annotations', 'Plant Structures', 'References' and 'Voucher Specimens'

植物的展示面向 Orientation of plant view

本圖鑑主要的展示面向為「正面觀」和「側面觀」，示意圖如下：

This illustrated book mainly shows the plant's frontal view and lateral view, as indicated here:



正面觀 Frontal view

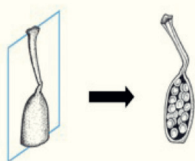


側面觀 Lateral view

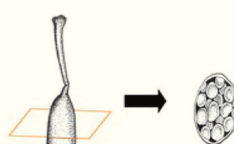
植物的解剖面向 Plant dissection

本圖鑑主要的解剖面向為「縱切面」及「橫切面」，以下是垂直或水平剖開雌蕊展示胚珠排列的示意圖：

This illustrated book mainly shows the longitudinal section and cross-section of dissection. The following diagram demonstrates the vertical and horizontal dissection of a pistil to show the arrangement of ovules:



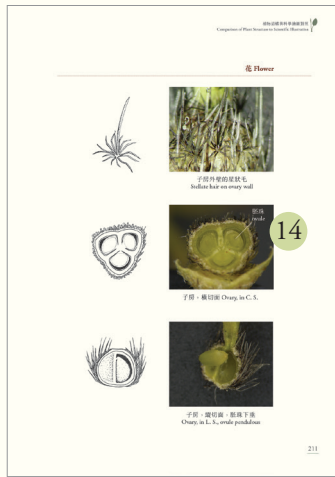
縱切面 Longitudinal section



橫切面 Cross-section

V. 植物結構與科學繪圖對照

Comparison of Plant Structure to Scientific Illustration



- 14 展示所引用的植物結構以作科學繪圖之用
Showing the plant structure used for each scientific illustration

解剖

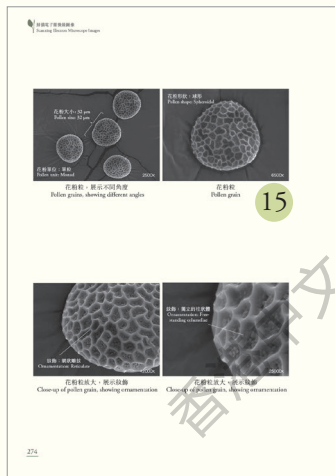
這是理解植物結構學的其中一個重要步驟，例如胚珠的著生點。

Dissection

This is one of the essential steps for understanding plant anatomy, e.g. the attachment point of ovules.

VIII. 掃描電子顯微鏡圖像

Scanning Electron Microscope (SEM) Images



- 15 書中 20 個植物品種裡，展示當中大部分植物的花粉和孢子的孢粉學特徵

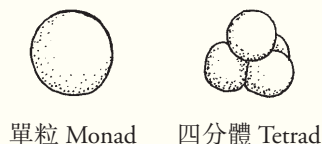
Revealing the palynological features on spores and pollen of the majority of the 20 illustrated species.

掃描電子顯微鏡可以顯示在高倍放大率下的花粉粒和孢子圖像，超越解剖顯微鏡的放大率。SEM 圖像的編排為：從不同角度的整體視圖，到顯示花粉粒與孢子紋飾和 / 或特殊特徵的近距影像。此外，亦記錄了與花粉粒和孢子相關的結構，包括蘭科植物的花粉塊和蕨類植物的孢子囊。

SEM can show the image of pollen grains and spores under high magnification, which exceeds the capacity of a dissecting microscope. The SEM photos are arranged as follows: from the overall view at different angles, to close-ups of certain areas that reveal the ornamentation and / or special features on pollen grains and spores. Associated structures of pollen grains and spores, including pollinaria of orchids and sporangia of ferns, are also documented.

花粉單位 Pollen Unit

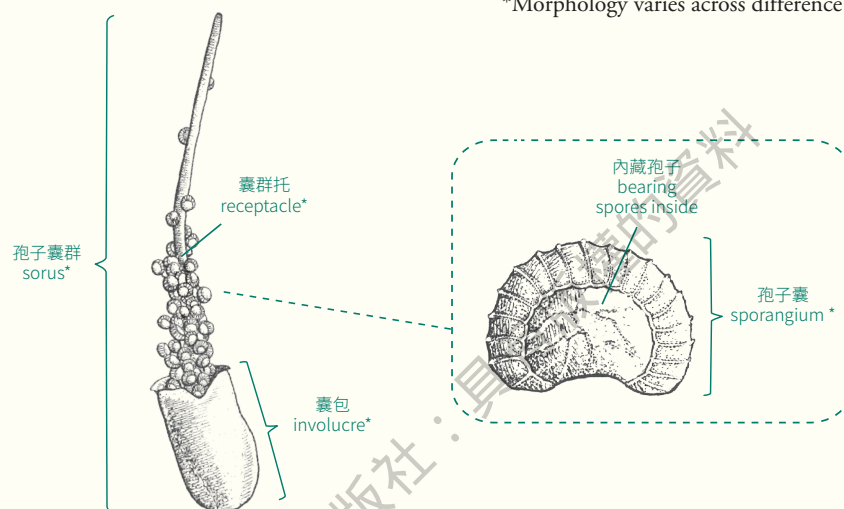
書中收錄的品種，大部分的花粉及孢子皆為單粒，亦有四分體的狀態。
Most species recorded in this book have monad pollen or spore, with some other forms like tetrad.



相關結構 Associated Structures

*不同品種有不同的形態

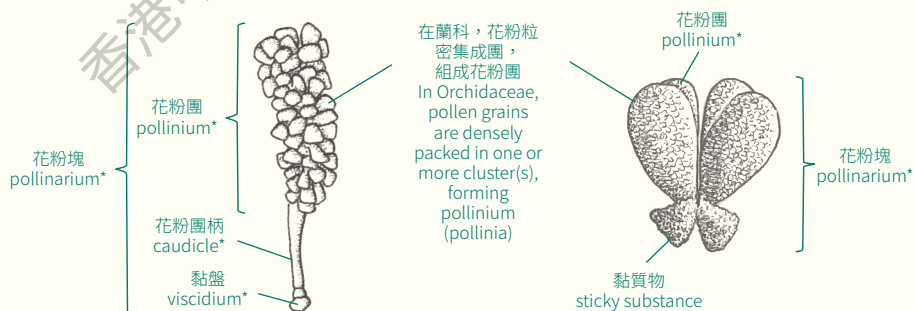
*Morphology varies across difference species



1：蕨類的孢子囊群及孢子囊 Sorus and sporangium of ferns

例子：華南長筒蕨

Example: *Abrodictyum obscurum* var. *siamense* (Christ) K. Iwats.



2：蘭科的花粉塊 Pollinaria of orchids

例子：細裂玉鳳花 (左)、流蘇貝母蘭 (右)

Examples: *Habenaria leptoloba* Benth. (left), *Coelogyne fimbriata* Lindl. (right)

李敏貞、王曉欣

Man-Ching Li & Hiu-Yan Wong