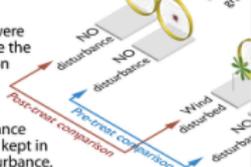




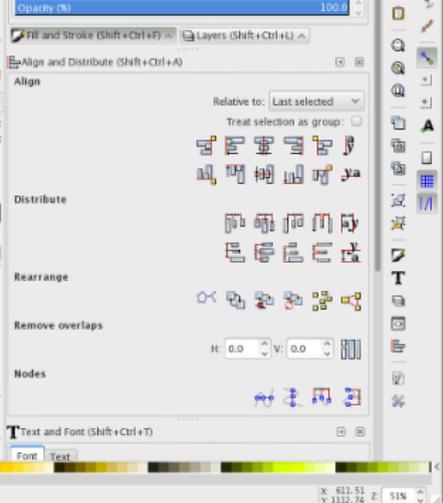
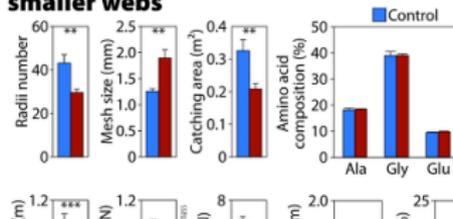
response to wind disturbance.

Some spiders' silks and webs were collected and measured before the wind-disturbance manipulation to serve as control.

In experimental group, half spiders received wind disturbance for 6D and the other half were kept in same setting but without disturbance.



### 5) Wind disturbance induced stronger silk smaller webs



# 教你做海報一次就上手！ 學術海報的要領與實務

廖鎮磐 <[andrew.43@gmail.com](mailto:andrew.43@gmail.com)>

2016年11月25日於國立中興大學

# 大綱

- ① 學術海報的特性
- ② 平面設計要領
- ③ 製作流程與工具
- ④ 印刷
- ⑤ 解說
- ⑥ 我的作品

# 大綱

- 1 學術海報的特性
- 2 平面設計要領
- 3 製作流程與工具
- 4 印刷
- 5 解說
- 6 我的作品

# 與口頭或書面報告的不同之處

- 不長篇大論；不以詳述細節為優先目的
- (傳統上) 缺少動態影音內容呈現
- 特定的解說時間與閱者直接口頭互動
- 容易找到同行、「知音」



# 適合以海報呈現的情況

- 大會中口頭報告名額擠不進去
- 研究尚未完成；只有方法或初步結果
- 主題冷門；內容偏向技術層面
- 主要成果以口頭報告呈現；額外補充內容切割至海報
- 有難以克服的口頭障礙

# 設計與呈現重點

- 以圖、表、標題文字、清單為重點
- 內容高度精簡；版面寸土寸金
- 即使不能口頭解說也要讓閱者能明白前因後果
- 視覺設計上需要能吸引眼球

## The effects of wind on microstructures of MA silks

produced by *Cyclosa mulmeinensis*

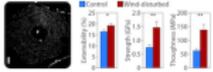


Chen-Pan Liao  
Dep. Life Science  
Tinghai Lu, Taiwan  
andrew.430@gmail.com

Chung-Lin Wu  
Industrial Technology  
Research Institute  
Taiwan

### 1) The effect of wind on spider silk/web

- Reduced catching area & web mesh spacing
- Higher tensile properties of MA silk without adjusting amino acid compositions.
- How spider achieves such adjustments is unclear.

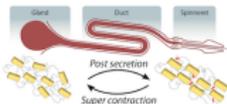


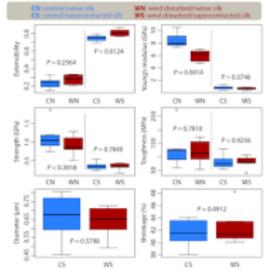
### 4) Preliminary results

- Currently the sample size is still small of two treatment ( $n_{\text{control}} = 6$ ,  $n_{\text{wind}} = 7$ ). Most of tensile properties of supercontracted silks were not significantly different, except for extensibility. However, due to non-significant results between native silks, the hypothesis still remains unclear.
- Shrinkage of supercontracted silks has been considered as an indicator of molecular-chain orientation, in which higher shrinkage percentage is associated with highly aligned crystal structures inside and high tensile properties.

### 2) The post secretion processing & supercontraction of MA silk

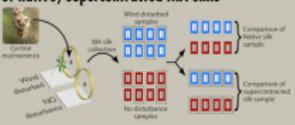
- Post secretion processing — Ion exchange, protein alignment, H<sub>2</sub>O removing and H-bond formation occur through duct to alter tensile properties of MA silk.
- Supercontraction — MA silk shrinks significantly after absorbing water and then transforms into a rubber-like form, a reversed process of post spinning process.





### 3) Comparing mechanical properties of native/supercontracted MA silks

- Hypothesis — Spiders may produce stronger MA silk through post secretion processing
- By comparing native and supercontracted silks from different treatments, we can estimate whether spiders adjust silks properties through post secretion process.
- Predictions — Native MA silks from wind disturbed and no wind disturbance treatments differ in mechanical properties, but those of supercontracted silks from two treatments will be no differ.



• Future works — FTIR & X-ray diffraction for protein secondary structure composition and crystal size/alignment.

# 海報的門檻與遺珠

- 較高程度的平面設計技巧
- 印刷需要數小時；可能出錯但無法即時更正
- 印刷成本較高（台灣：數百元；歐美：數千元）
- 有些與會者的閱覽意願較低
- 口頭解說時環境吵雜

# 科學海報設計原則

- 最高原則** 以快速、有效、清楚地傳遞訊息
- 佈局簡潔** 排列整齊；一目了然；不是路邊房仲廣告
- 內容簡單** 一看就大概清楚研究主軸與結論
- 什麼都大** 1.5 公尺遠能看清楚所有內容
- 視覺美感** 視覺上的力求清晰、簡單並保持品位

# 大綱

- 1 學術海報的特性
- 2 平面設計要領**
- 3 製作流程與工具
- 4 印刷
- 5 解說
- 6 我的作品

## 平面設計四要素 (C.R.A.P.)

對比 (contrast)

重複 (repetition)

對齊 (alignment)

相近 (proximity)

# 對比

- 字體、字重、顏色、面積之差異
- 產生層次感、強調重點、吸引眼球

## Title

### 1. Subtitle

- Lorem ipsum dolor sit amet, consectetur adipiscing elit. Aenean commodo ligula eget dolor. Aenean massa.
- Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Donec quam felis, ultricies nec, pellentesque eu, pretium quis, sem. Nulla consequat massa quis enim.

### 2. Subtitle

- 1) Lorem ipsum dolor sit amet, consectetur adipiscing elit. Aenean commodo ligula eget dolor. Aenean massa.
- 2) Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Donec quam felis, ultricies nec.



## Title

### 1. Subtitle

- Lorem ipsum dolor sit amet, consectetur adipiscing elit. Aenean commodo ligula eget dolor. Aenean massa.
- Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Donec quam felis, ultricies nec, pellentesque eu, pretium quis, sem. Nulla consequat massa quis enim.

### 2. Subtitle

- 1) Lorem ipsum dolor sit amet, consectetur adipiscing elit. Aenean commodo ligula eget dolor. Aenean massa.
- 2) Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Donec quam felis, ultricies nec.



# 重覆

- 字體、字型、線條的顏色、粗細
- 相同層級的物件有相同的外觀；產生秩序感

## Title

### 1. Subtitle

- Lorem ipsum dolor sit amet, consectetur adipiscing elit. Aenean commodo ligula eget dolor. Aenean massa.
- Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Donec quam felis, ultricies nec, pellentesque eu, pretium quis, sem. Nulla consequat massa quis enim.

### 2. Subtitle

- 1) Lorem ipsum dolor sit amet, consectetur adipiscing elit. Aenean commodo ligula eget dolor. Aenean massa.
- 2) Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Donec quam felis, ultricies nec.



## Title

### 1. Subtitle

- Lorem ipsum dolor sit amet, consectetur adipiscing elit. Aenean commodo ligula eget dolor. Aenean massa.
- Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Donec quam felis, ultricies nec, pellentesque eu, pretium quis, sem. Nulla consequat massa quis enim.

### 2. Subtitle

- 1) Lorem ipsum dolor sit amet, consectetur adipiscing elit. Aenean commodo ligula eget dolor. Aenean massa.
- 2) Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Donec quam felis, ultricies nec.



# 對齊

- 強調各種物件的左側邊界
- 引導視覺流動方向

## Title

1. Subtitle

- Lorem ipsum dolor sit amet, consectetur adipiscing elit. Aenean commodo ligula eget dolor. Aenean massa.
- Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Donec quam felis, ultricies nec, pellentesque eu, pretium quis, sem. Nulla consequat massa quis enim.

2. Subtitle

- 1) Lorem ipsum dolor sit amet, consectetur adipiscing elit. Aenean commodo ligula eget dolor. Aenean massa.
- 2) Cum sociis natoque penatibus et magnis dis parturient montes.



## Title

1. Subtitle

- Lorem ipsum dolor sit amet, consectetur adipiscing elit. Aenean commodo ligula eget dolor. Aenean massa.
- Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Donec quam felis, ultricies nec, pellentesque eu, pretium quis, sem. Nulla consequat massa quis enim.

2. Subtitle

- 1) Lorem ipsum dolor sit amet, consectetur adipiscing elit. Aenean commodo ligula eget dolor. Aenean massa.
- 2) Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Donec quam felis, ultricies nec.



# 相近

- 主題、物件類型相關的物件放在一起
- 建立邏輯

## Title

### 1. Cat

- Lorem ipsum dolor sit amet, consectetur adipiscing elit. Aenean commodo ligula eget dolor. Aenean massa.

### 2. Dog

- 1) Lorem ipsum dolor sit amet, consectetur adipiscing elit. Aenean commodo ligula eget dolor. Aenean massa.
- 2) Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Donec quam felis, ultricies nec.



## Title

### 1. Cat

- Lorem ipsum dolor sit amet, consectetur adipiscing elit. Aenean commodo ligula eget dolor. Aenean massa.



### 2. Dog

- 1) Lorem ipsum dolor sit amet, consectetur adipiscing elit. Aenean commodo ligula eget dolor. Aenean massa.
- 2) Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Donec quam felis, ultricies nec.



# 字的襯線

無襯線字體

Arial

Myriad Pro

Candara

思源黑體

蘋方體

圓體

微軟正黑體

有襯線字體（內文避免使用）

Times New Roman

Minion Pro

Cambria

宋體

新細明體

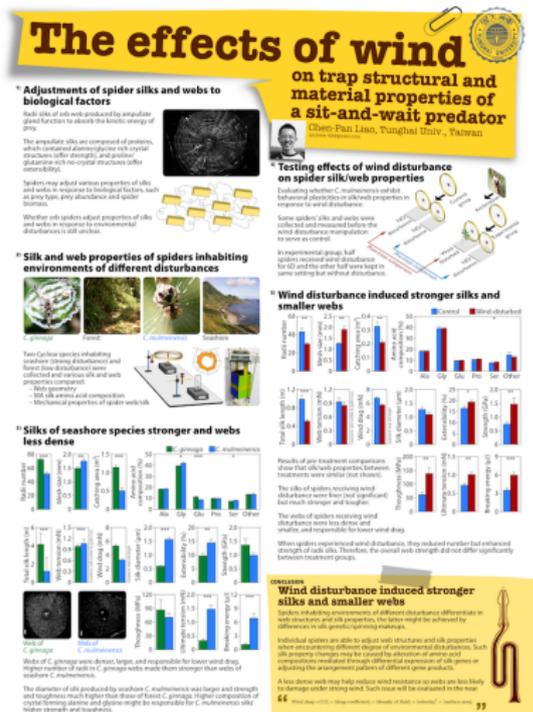
標楷體 (?)

# 大綱

- 1 學術海報的特性
- 2 平面設計要領
- 3 製作流程與工具**
- 4 印刷
- 5 解說
- 6 我的作品

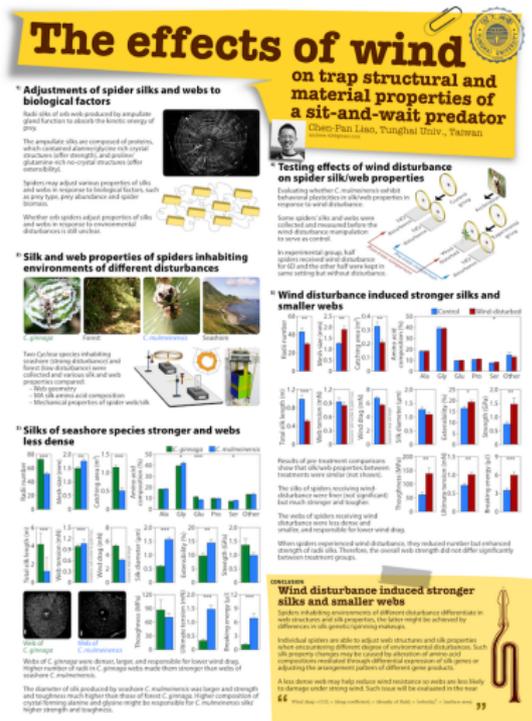
# 組成要素

- 以**區塊**為設計單元
- 一個區塊負責一個主題（次標題、大綱）
- 可存在「**結論**」區塊
- 海報應強調**圖、表與標題**
- 內文的角色傾向輔助說明



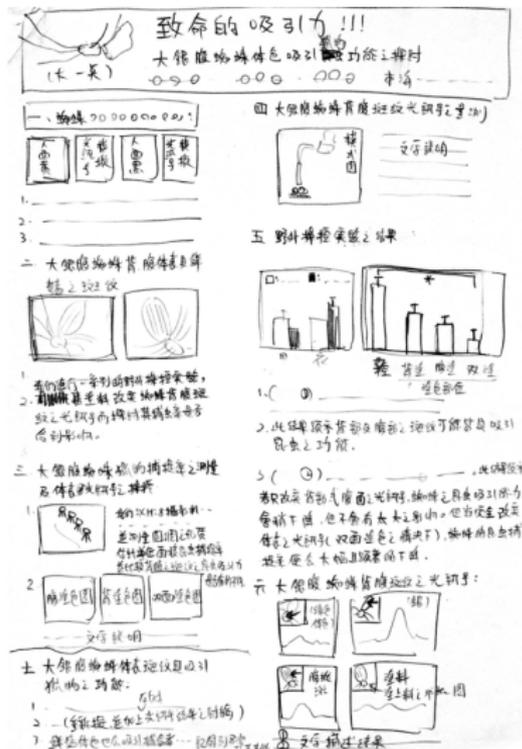
# 各要素的面積比例分配

- 大標題 (10–20%)
- 次標題 (10–15%)
- 圖、表 (40–50%)
- 與清單式內文 (20%)
- 空白 (至少 10% ; 千萬別塞滿滿)



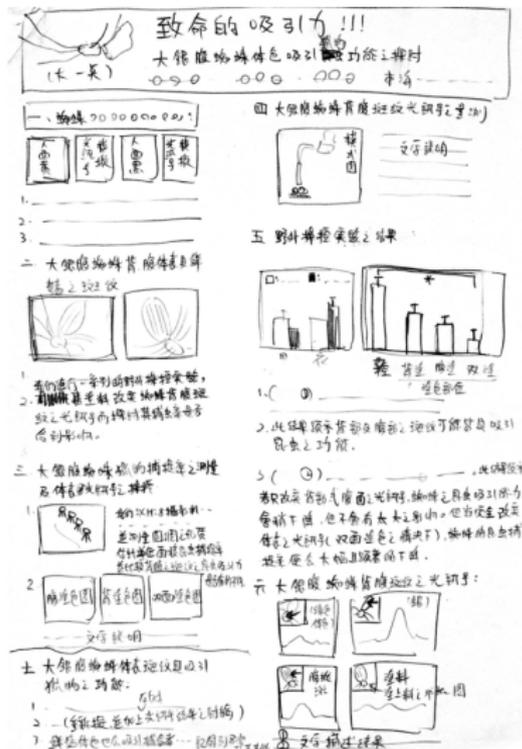
# 動工前準備：手繪草稿

- 查詢海報尺寸規定
- 框出大標題、次標題、圖片、表格、文字方塊、空白的區域
- 寫上大標題和次標題的文字
- 請別人看看草稿並輔助解說，聽取意見



# 動工前準備：手繪草稿

- 單欄、二欄、三欄，還是混合設計？
- 一定要放的方法與結果的圖、表是哪些？
- 如果只看次標題是否容易看懂有邏輯？
- 是否有非常搶眼的照片可呈現以吸引眼球？



# 製作軟體

- 簡報軟體：PowerPoint、Libreoffice
  - 容易使用；所見即所得
  - 數學式排版相對容易
  - 視覺創作空間較小
- 專業向量繪圖排版軟體：InDesign、Illustrator、CorelDRAW、GNU Inkscape
  - 使用門檻高；所見即所得
  - 沒有內建數學式排版
  - 視覺創作空間大；色彩控制精準
- 泛 T<sub>E</sub>X 系統
  - 非所見即所得
  - 大量數學式排版容易

# 大標題區塊

## The effects of wind

on trap structural and  
material properties of  
a sit-and-wait predator



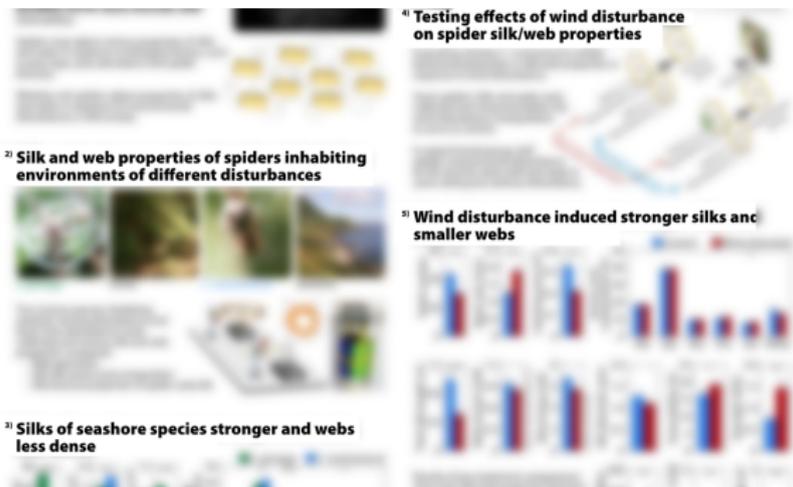
Chen-Pan Liao, Tunghai Univ., Taiwan

andrew.43@gmail.com



- 大標題：高對比色彩與字型，可適度製作視覺效果，字非常大（如字高 10 公分）
- 作者（們）姓名（標示解說者）、學校單位國家、校徽、電子信箱、個人照

# 次標題



- 以數字或字母為首進行篇號
- 直接簡明扼要地寫上有意義的句子，而不只是「前言」、「方法」、「結果」
- 高對比色彩與字型；字較大（如字高 3 公分）

# 內文

- 中度舒適易閱讀的**無襯線字體**；字稍大（字高大於 0.8 公分）
- **置左對齊**，避免置中或置右對齊；西文環境若文寬度太小則避免左右對齊
- 適合以**清單**的型式呈現
- 可成為輔助圖、表之文字說明

Radii silks of orb web produced by ampullate gland function to absorb the kinetic energy of prey.

The ampullate silks are composed of proteins, which contained alanine/glycine rich crystal structures (offer strength), and proline/ glutamine-rich no-crystal structures (offer extensibility).

Spiders may adjust various properties of silks and webs in response to biological factors, such as prey type, prey abundance and spider biomass.

Whether orb spiders adjust properties of silks and webs in response to environmental disturbances is still unclear.

# 內文字體選擇

- 中、西文字體個別設定且風格相近
- 選用無襯線字體中西字體；中文通常叫「黑體字」或「圓體字」
- 選用「真斜體」西文字體
- 避免使用「可愛」、「書寫」、「筆刷」、「粉筆」、「趣味」風格的藝術字體

## 二種西文斜體 (italic 與 slanted)

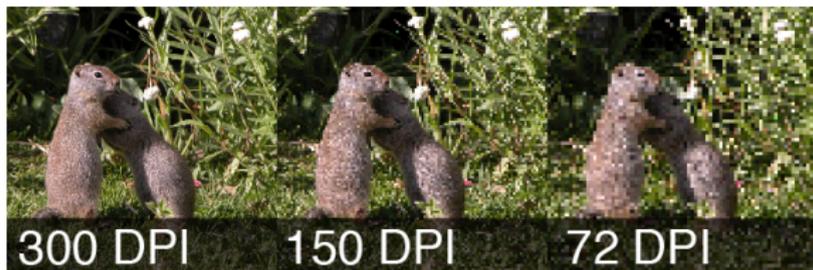
Upright ABCDEabcde12345

Italic *ABCDEabcde12345*

Slanted *ABCDEabcde12345*

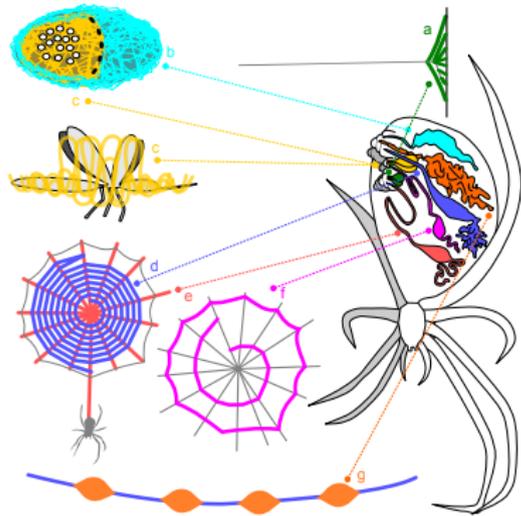
# 點陣圖圖片

- 由像素 (pixel) 結成，如照片
- 解析度至少 150 ppi (pixel per inch)，300 ppi 更好  
例如：輸出照片寬為 30 公分，則該圖至少需  $30 / 2.54 \times 150 = 1771$  個像素寬。
- 常見格式為 JPEG、PNG、TIFF
- 注意失真問題



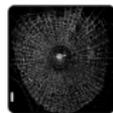
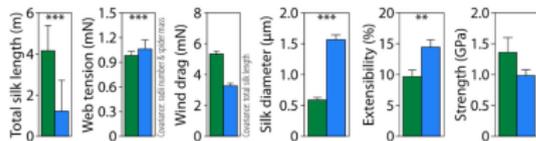
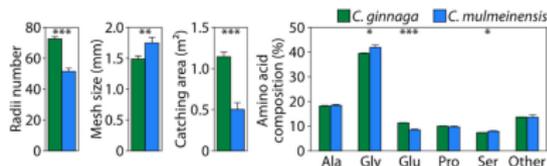
# 向量圖圖片

- 實由文字、線條結成，如統計圖、流程圖、示意圖
- 常見格式為 EPS、SVG，或是直接在 Office 中製作的圖表
- 向量圖就用向量圖，別預先轉成點陣圖
- 小心使用半透明、漸層、網點

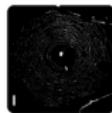


# 良好的統計結果圖片設計

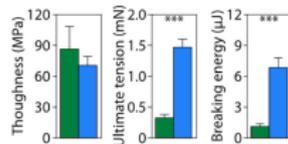
- 明確標示座標軸名稱、數值單位、圖例
- 避免冗餘的線條、文字；儘可能保持簡單
- 文字精煉，不要像正式文章般完整
- 使用色盲有善色 (colorblind friendly color)



Web of *C. ginnaga*



Web of *C. mulmeinensis*



Webs of *C. ginnaga* were denser, larger, and responsible for lower wind drag. Higher number of radii in *C. ginnaga* webs made them stronger than webs of seashore *C. mulmeinensis*.

The diameter of silk produced by seashore *C. mulmeinensis* was larger and strength and toughness much higher than those of forest *C. ginnaga*. Higher composition of crystal forming alanine and glycine might be responsible for *C. mulmeinensis* silks' higher strength and toughness.

# 以 PowerPoint 製作海報

- 1 開啟新檔，無背景，刪去所有預設物件
- 2 設定海報尺寸；若數值過大無法輸入則等比例縮小
- 3 拉出參考線大致規畫內邊界與區塊間距
- 4 可自動換行的文字方塊置入文字
- 5 從檔案、其它 Office 物件插入貼上圖表
- 6 可插入攜帶特定網址的 QRcode 讓閱者自行觀看影音多媒體補充資料

# 給新手的小提醒

- 利用「項目符號及篇號」來建構你的條列式文字段落
- 善用格點、尺規、對齊、等距分布
- 定義各物件格式，方便統一不同物件的樣式
- 如果沒有偏好，採用白底黑字
- 把海報做得比大會規定的小張一點點
- 避免把需要長時間討論的內容放在海報最下方

# 小心！別弄巧成拙

- 能清楚地傳遞研究內容永遠是第一優先要求
- 半透明、漸層、陰影、文字特效、照片邊框之類的功能小心使用；常常更糟更俗
- 不要用一張照片放大當成淡淡的全幅背景，真的很俗而且解析度很差
- 美感來自於秩序，而不是花花綠綠
- 留白空間不要小氣
- 有經驗者也需要數日後才大致完成海報，畫圖和精簡文字非常耗時，請及早準備並保持耐心

# 小結

- 海報由大標題及各區塊組成
- 大標題、圖、表為主，精簡內文
- 軟體操作需要經驗，請提早準備
- 不庸俗

# 大綱

- ① 學術海報的特性
- ② 平面設計要領
- ③ 製作流程與工具
- ④ 印刷**
- ⑤ 解說
- ⑥ 我的作品

# 送印的檔案格式

- PowerPoint 原始檔案（注意字體嵌入與點陣圖解析度下降的問題）
- 轉存成 PDF；儘可能採用 PDF/A 或標準
- 許多印刷廠也接受 CorelDraw/Adobe Illustrator/InDesign 原檔，但注意字體嵌入、物件連結、出血、平面化等細節

# 字體嵌入問題

- 印刷廠的電腦可能沒有安裝你使用的字體
- Windows 版 PowerPoint 在另存新檔時有 (很難找的) 選項可以嵌入字體
- 若轉存為 PDF 檔案則會嵌入字體

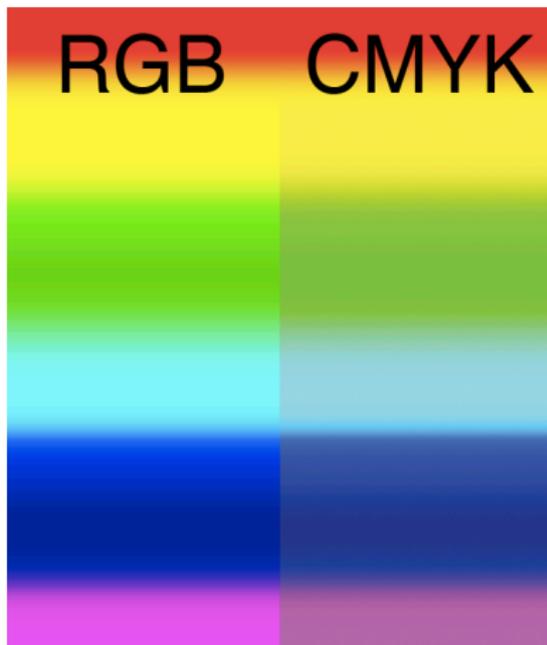
# 點陣圖解析度問題

- 簡單檢查方法：在軟體中放大檢視 2 倍實際輸出大小，看看馬賽克是不是很明顯
- PowerPoint 另存新檔時有選項可強迫關閉壓縮圖片功能（預設是關閉）
- 一定要在印刷廠的電腦再仔細檢查過

# 顏色失真問題

為什麼輸出的顏色和螢幕上看到的不太一樣？

- 螢幕是 RGB，印表機是 CMYK；不能完全轉換
- 小心使用看起來太亮或具有螢光感的顏色
- 專業軟體可模擬或直接使用 CMYK



# 廠商、選紙、裁切、加膜、計價

- 印刷廠的品質參差不齊，請多打聽
- 台灣通常以  $30 \times 30 \text{ cm}^2$  為計價單位
- 加膜可防墨暈開與簡單防水
- 亮面紙、膜容易反光
- 明確指定裁切方式（特別是有出血）
- 若不能帶大海報，可改用帆布但品質不精細
- 一定要在印刷廠的電腦再仔細檢查過
- 不要在最後一天才送印否則無法補救

# 小結

- 配合廠商** 印刷前先與印刷廠溝通，了解送印檔案格式、價格、裁切等細節
- 現場檢查** 一定要在印刷廠的電腦再仔細檢查；留意點陣圖解析度、字體、佈局等是否有異
- 提早送印** 不要在最後一天輸出

# 大綱

- 1 學術海報的特性
- 2 平面設計要領
- 3 製作流程與工具
- 4 印刷
- 5 解說**
- 6 我的作品

# 閱者的邏輯

- 1 海報很醜不想看
- 2 先看大標題、次標題、圖
- 3 感覺有點有趣了從頭開始仔細看
- 4 想了解更多，想和作者聊聊



# 不同閱者的需求

- 走馬看花型** 除非視覺設計有吸引力，否則閱讀時間不超過 10 秒。
- 相關研究型** 除非能馬上看懂主要方法與重要結果，否則看完標題大綱就走了。
- 同行深入型** 對所有細節感到興趣、想照相或領取複本、希望與作者直接口頭討論。

# 解說準備與過程

- 練習解說** 事先熟練 1 及 3 分鐘解說內容
- 提早看海報** 事先看完其它海報
- 開水喉糖** 解說時段很擠很吵時間又長，記得準備開水和喉糖
- 主動解說** 有人接近時勇敢、主動、愉快地尋問是否需要解說
- 附本** 可印出黑白 A4 小大副本（如 50 張）供人取閱
- 認識同行** 非常可能會認識同行並有深刻交流

# 小結

- 吸引眼球** 大多數閱者需要視覺上有吸引力才會佇足
- 練習講稿** 針對不同領域的閱者提供不同長度與深度的解說
- 誠懇熱情** 解說時保持誠懇與熱情，並準備開水

# 總複習

- 最高原則 清楚快速有效地傳遞訊息
- 內容設計 簡潔、邏輯、夠大、美感
- 平面設計 對比、重複、對齊、相近
- 內容比例 圖表 > 大標題 = 次標題 > 內文
- 口頭解說 練習講稿、熱情與誠懇

# 大綱

- ① 學術海報的特性
- ② 平面設計要領
- ③ 製作流程與工具
- ④ 印刷
- ⑤ 解說
- ⑥ 我的作品**

# 風干擾對於蜘蛛絲性質及蜘蛛網結構之影響

## 1. 圓網蜘蛛因生物因子調整其網及絲特性

- 蜘蛛網的構造複雜，蜘蛛對蜘蛛網的調整，其中蜘蛛絲的性質是蜘蛛調整蜘蛛網的重要可變因。
- 蜘蛛絲的性質與蜘蛛的生理狀態有關，大腸菌生長在蜘蛛絲上的 *glpX* 與 *MetJ* 以及聚胺 *glutamine* 及 *proline* 之 *N*-terminal 區域的比率，與蜘蛛之生理狀態有關，蜘蛛的生理狀態與蜘蛛絲的性質有關。
- 蜘蛛的生理狀態與蜘蛛絲的性質有關，蜘蛛的生理狀態與蜘蛛絲的性質有關。



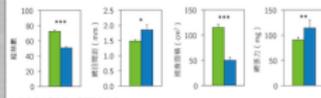
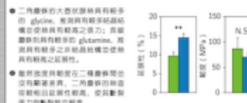
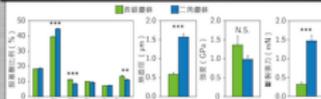
## 2. 比較不同強風干擾程度之塵蛛絲及網性質



- 以次角二角蜘蛛為例的圓網蜘蛛 (*Gelae hahnleini*) 具有較強的網及絲特性。
- 蜘蛛絲的性質與蜘蛛的生理狀態有關。
- 蜘蛛絲的性質與蜘蛛的生理狀態有關。
- 蜘蛛絲的性質與蜘蛛的生理狀態有關。
- 蜘蛛絲的性質與蜘蛛的生理狀態有關。

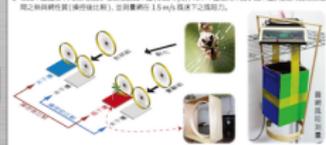


## 3. 二角塵蛛具有較強的絲與網且網較稀疏

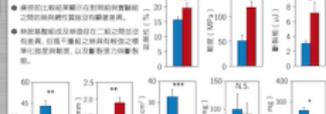
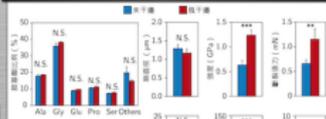


## 4. 攔控風速以測試風對絲與網之影響

- 攔控風速以測試風對絲與網之影響。
- 攔控風速以測試風對絲與網之影響。
- 攔控風速以測試風對絲與網之影響。



## 5. 強風下產的絲較強結的網較疏但較堅固



## 6. 蜘蛛在不同風干攔程度之樓地可調節絲及網性質

- 蜘蛛在不同風干攔程度之樓地可調節絲及網性質。
- 蜘蛛在不同風干攔程度之樓地可調節絲及網性質。
- 蜘蛛在不同風干攔程度之樓地可調節絲及網性質。

# The effects of wind

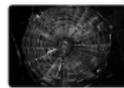
## on trap structural and material properties of a sit-and-wait predator

Chen-Pan Liao, Tungshai Univ., Taiwan

### Adjustments of spider silks and webs to biological factors

Radii silks of orb webs produced by araneid goblin spider to absorb the kinetic energy of prey.

The ampullate silks are composed of proteins, which contained alanine-glycine with crystal structures (silk strength), and proline-glutamine-rich-crystal structures (silk elasticity).



Spiders may adjust webs properties of silks and webs in response to biological factors, such as prey type, prey abundance and spider biomass.

Whether orb spiders adjust properties of silks and webs to environmental disturbances is still unclear.

### Silk and web properties of spiders inhabiting environments of different disturbances

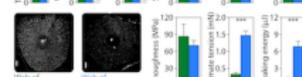
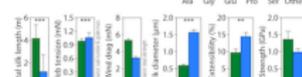
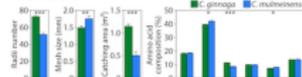


Two *C. ginnagei* species inhabiting seashore (strong disturbance) and forest (low disturbance) were collected and various silk and web properties compared.

Web geometry

Mechanical properties of spider web/silk

### Silks of seashore species stronger and webs less dense



Web of *C. ginnagei* were denser, larger, and responsible for lower wind drag. Higher number of radii in *C. ginnagei* webs made them stronger than webs of seashore *C. mahmensis*.

The diameter of silk produced by *C. mahmensis* was larger and strength and toughness much higher than those of forest *C. ginnagei*. Higher composition of crystal forming alanine and glycine might be responsible for *C. mahmensis*'s higher strength and toughness.

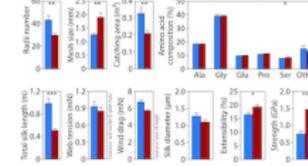
### Testing effects of wind disturbance on spider silk/web properties

Evaluating whether *C. mahmensis* exhibit behavioral plasticities in silk/web properties in response to wind disturbance.

Some spiders silk and webs were collected and measured for the wind-disturbance manipulation to serve as control.



### Wind disturbance induced stronger silks and smaller webs



Results of pre-treatment comparisons show that silk/web properties between treatments were similar (not shown).

The silks of spiders receiving wind disturbance were finer (not significant) but much stronger and tougher.

The webs of spiders receiving wind disturbance were less dense and smaller, and responsible for lower wind drag.

When spiders experienced wind disturbances, they reduced number but enhanced strength of web silks. Therefore, the overall web strength did not significantly between treatment groups.

### CONCLUSION

#### Wind disturbance induced stronger silks and smaller webs

Spiders inhabiting environments of different disturbance differentiate in web structures and silk properties. The latter might be achieved by differences in silk genetic/splicing mechanisms.

Individual spiders are able to adjust web structures and silk properties when they experience different degree of environmental disturbance. Such silk property changes may be caused by alteration of amino acid composition mediated through differential expression of silk genes or adjusting the arrangement pattern of different gene products.

A less dense web may help reduce wind resistance so webs are less likely to damage under strong wind. Such issue will be evaluated in the near future.

# 風干擾對於蜘蛛絲性質及蜘蛛網結構之影響

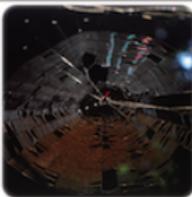
東海大學

TUNGSHAI UNIVERSITY

廖鎮磐 東海大學生命科學系

## 1. 圓網蜘蛛因生物因子調整其網及絲特性

- 圓網主要由骨架絲、輻射狀絲和黏絲所組成，其中輻射狀絲主要之功能為支撐圓網並吸收獵物或物理性干擾之動能。
- 圓網中的輻射狀絲主要由大亞胺酸絲組成。大亞胺酸絲主要由富含 alanine 及 glycine 的 MaSp1 蛋白及富含 glutamine 及 proline 之 MaSp2 蛋白所組成。當絲中此二種絲蛋白比例不同時，其物理性質也會有所不同。
- 過去研究指出，蜘蛛絲及網之特性並非固定，而是隨獵物種類、獵物數量、蜘蛛重量而不同。然而，非生物因子（如路徑、強度、紫外線等環境因子）是否影響蜘蛛絲及網性質尚不清楚。



## 2. 比較不同強風干擾棲地之塵蛛絲及網性質



二角塵蛛



濱海性棲地

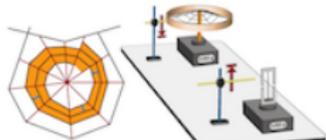


長銀塵蛛



森林性棲地

- 我收集二種棲於濱海的二角塵蛛 (*Cyclosa mulmeinensis*) 及森林的長銀塵蛛 (*C. ginnoga*)，並比較其絲及網性質：
- 絲及網之物理性質：網張力、絲強度及韌度
- 網型質：黏絲數、網目大小及網面積
- 大亞胺酸絲之胺基酸組成

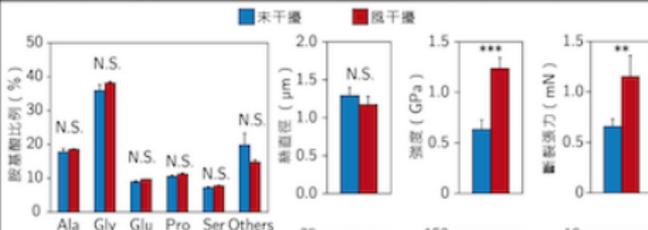


## 4. 操控風速以測試風對絲與網之影響

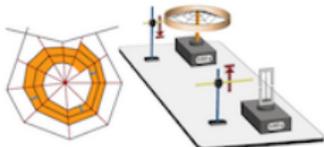
- 將二角塵蛛飼養於實驗室並操控其風干擾程度，再測量其絲與網之性質。
- 在對照組與實驗組中，某些個體在操控之前先測量其絲與網之性質並在二組間比較（操控前比較），以作為分組已隨機化之依據。
- 在風干擾處理中，蜘蛛被給予七日之強風干擾 (1.25 m/s)，而未干擾組則未給予風干擾。之後再比較二組間之絲與網性質（操控後比較），並測量網在 1.5 m/s 風速下之風阻。



## 5. 強風下產的絲較強結的網較疏但較堅固

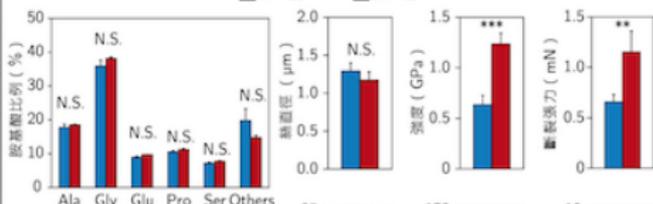


- 我收集二種棲息於濱海的二角塵蛛 (*Cyclosa muhlenensis*) 及森林的長銀塵蛛 (*C. ginnaga*)，並比較其絲及網性質：
- 絲及網之物理性質：網張力、網強度及韌度
- 網型質：縱絲數、網目大小及網面積
- 大亞狀腺絲之胺基酸組成

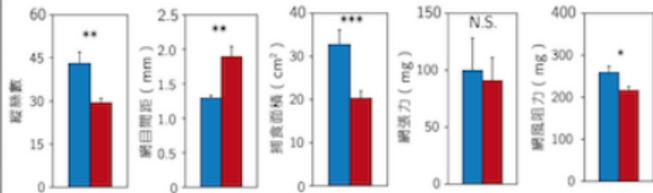


● 未干擾

● 風干擾

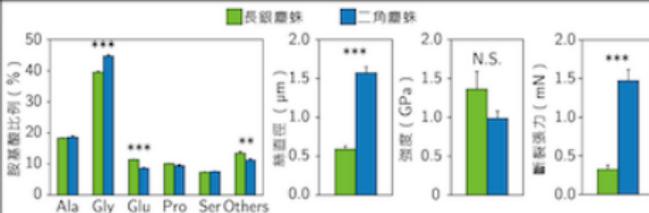


- 操控前比較結果顯示在對照組與實驗組之間的絲與網性質皆沒有顯著差異。
- 絲胺基酸組成及絲直徑在二組之間並沒有差異，但風干擾組之絲具有較強之標準化強度與韌度，以及斷裂強力和斷裂能。

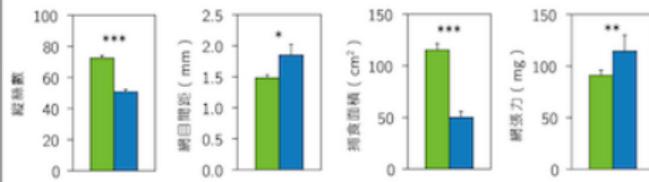


- 風干擾處理組之囊網具有較小之網面積及較之絲密度，且其網風阻也較小。
- 即使風干擾處理組之囊網具有較少之縱絲，但其網張力仍達到未干擾處理組之相似程度，表示其具有較大之單位縱絲張力。

### 3. 二角塵蛛具有較強的絲與網且網較稀疏



- 二角塵蛛的大亞狀腺絲具有較多的 glycine，推測具有較多結晶結構並使絲具有較高之張力；長銀塵蛛則具有較多的 glutamine，推測具有較多之非結晶結構並使絲具有較高之延展性。
- 雖然強度與韌度在二種塵蛛間並沒有顯著差異，二角塵蛛的絲直徑較粗且延展性較高，使其斷裂強力和斷裂能亦較高。



- 二角塵蛛具有較小且較稀疏的網。
- 二角塵蛛的囊網縱使具有較少的縱絲數，但仍具有較強的網張力。

### 6. 蜘蛛在不同風干擾程度之棲地可調節絲及網性質

- 兩種棲息於不同程度風干擾地區之蜘蛛可能因遭受不同之天擇壓力而演化出具有不同基因組成之絲及不同結構之網。
- 二角塵蛛在接受不同風干擾程度時，具有調整絲特性及網性質之可塑性，此生理及行為之調整與減少風阻並降低網被風破壞有關。
- 由於不同處理組之二角塵蛛其絲之胺基酸組成無顯著差異，顯示在遭受強風時，蜘蛛不是藉由調整絲基因之表現，而是調控絲蛋白排列之方式來改變絲之物理特性。
- 本研究所發現之絲基因多樣性及絲物性可塑性有助於設計適當方法產生具不同物性之人工轉殖蜘蛛絲。



# The effects of wind



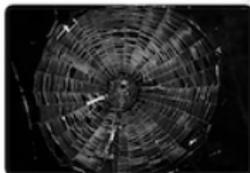
## 1) Adjustments of spider silks and webs to biological factors

Radii silks of orb web produced by ampullate gland function to absorb the kinetic energy of prey.

The ampullate silks are composed of proteins, which contained alanine/glycine rich crystal structures (offer strength), and proline/ glutamine-rich no-crystal structures (offer extensibility).

Spiders may adjust various properties of silks and webs in response to biological factors, such as prey type, prey abundance and spider biomass.

Whether orb spiders adjust properties of silks and webs in response to environmental disturbances is still unclear.



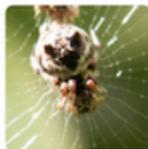
## 2) Silk and web properties of spiders inhabiting environments of different disturbances



*C. ginnaga*



Forest



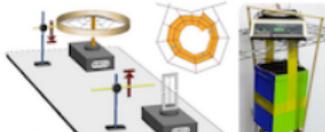
*C. mulmeinensis*



Seashore

Two *Cyclosa* species inhabiting seashore (strong disturbance) and forest (low disturbance) were collected and various silk and web properties compared:

- Web geometry
- MA silk amino acid composition



## on trap structural and material properties of a sit-and-wait predator



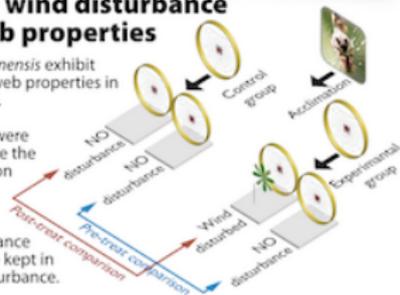
Chen-Pan Liao, Tunghai Univ., Taiwan  
andrew.43@gmail.com

## 4) Testing effects of wind disturbance on spider silk/web properties

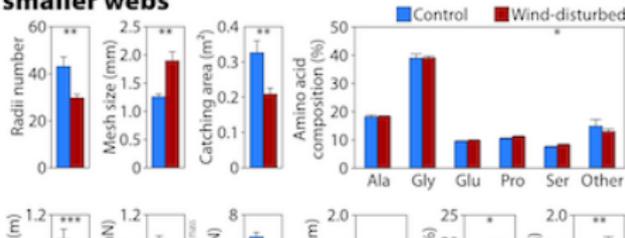
Evaluating whether *C. mulmeinensis* exhibit behavioral plasticities in silk/web properties in response to wind disturbance.

Some spiders' silks and webs were collected and measured before the wind-disturbance manipulation to serve as control.

In experimental group, half spiders received wind disturbance for 6D and the other half were kept in same setting but without disturbance.



## 5) Wind disturbance induced stronger silks and smaller webs





*C. ginnaga*

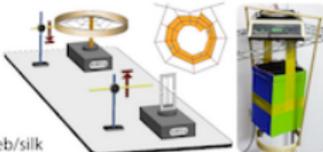
Forest

*C. mulmeinensis*

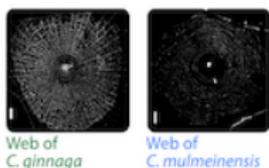
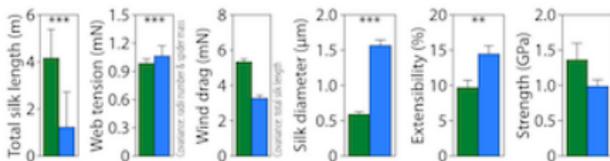
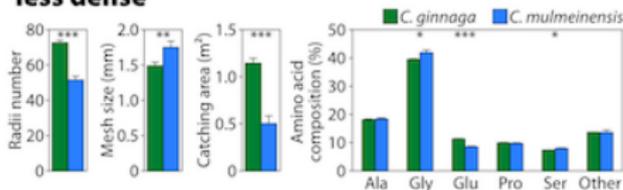
Seashore

Two *Cyclosa* species inhabiting seashore (strong disturbance) and forest (low disturbance) were collected and various silk and web properties compared:

- Web geometry
- MA silk amino acid composition
- Mechanical properties of spider web/silk



### 3) Silks of seashore species stronger and webs less dense

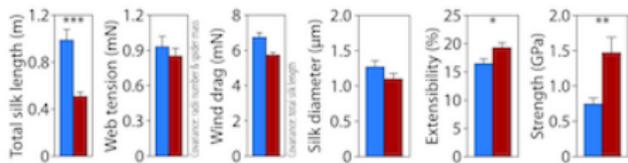
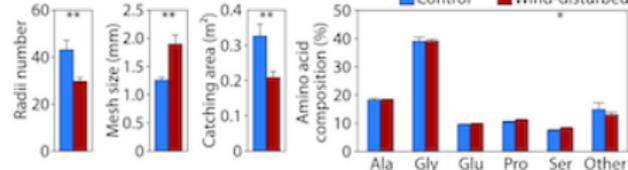


Web of *C. ginnaga*

Web of *C. mulmeinensis*

Webs of *C. ginnaga* were denser, larger, and responsible for lower wind drag. Higher number of radii in *C. ginnaga* webs made them stronger than webs of seashore *C. mulmeinensis*.

The diameter of silk produced by seashore *C. mulmeinensis* was larger and strength and toughness much higher than those of forest *C. ginnaga*. Higher composition of crystal forming alanine and glycine might be responsible for *C. mulmeinensis* silks' higher strength and toughness.

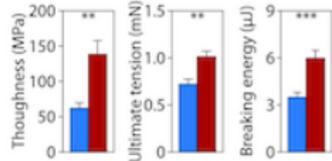


Results of pre-treatment comparisons show that silk/web properties between treatments were similar (not shown).

The silks of spiders receiving wind-disturbance were finer (not significant) but much stronger and tougher.

The webs of spiders receiving wind disturbance were less dense and smaller, and responsible for lower wind drag.

When spiders experienced wind disturbance, they reduced number but enhanced strength of radii silks. Therefore, the overall web strength did not differ significantly between treatment groups.



#### CONCLUSION

### Wind disturbance induced stronger silks and smaller webs

Spiders inhabiting environments of different disturbance differentiate in web structures and silk properties, the latter might be achieved by differences in silk genetic/spinning makeups.

Individual spiders are able to adjust web structures and silk properties when encountering different degree of environmental disturbances. Such silk property changes may be caused by alteration of amino acid compositions mediated through differential expression of silk genes or adjusting the arrangement pattern of different gene products.

A less dense web may help reduce wind resistance so webs are less likely to damage under strong wind. Such issue will be evaluated in the near

“ Wind drag = (1/2) × (drag coefficient) × (density of fluid) × (velocity)<sup>2</sup> × (surface area) ”





下載低解析  
度附本：

[http://  
imgur.com/  
57PeNU0](http://imgur.com/57PeNU0)

感謝聆聽  
敬請指教