



## Floral trapping mechanisms in moth plant (*Araujia sericifera*) and the behavioural responses of flower-visiting insects in Southern France

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### Abstract

The moth plant, *Araujia sericifera* Brot. (Apocynaceae), is an invasive climbing vine known for a specialized floral mechanism that can trap the mouthparts of visiting insects. This study investigated floral morphology associated with proboscis entrapment and examined the diversity and behaviour of flower-visiting insects in residential areas of Saint-Barnabé, Marseille, southern France, during September–October 2026. Observations were conducted on two flowering vine clusters occupying approximately 40 and 80 ft<sup>2</sup>, respectively, from 7 September to 15 October 2026. Insect visitation, trapping events, escape responses, and pollinarium removal were recorded during 15 morning observation sessions. Fourteen insect species belonging to Lepidoptera, Hymenoptera, and Diptera were documented. The cabbage white butterfly, *Pieris rapae*, was the most frequently recorded lepidopteran visitor and was observed becoming trapped while attempting to obtain nectar. Floral dissection revealed a specialized gynostegium, narrow anther guide rails, and a corpusculum–pollinia complex associated with pollen attachment and transfer. Butterfly entrapment was attributed to the engagement of their proboscises within restricted floral guide channels, whereas stronger visitors, particularly the buff-tailed bumblebee (*Bombus terrestris*), violet carpenter bee (*Xylocopa violacea*), European honeybee (*Apis mellifera*) and hummingbird-hawk moth (*Macroglossum stellatarum*) successfully removed pollinaria during nectar feeding essential for pollination. The bumblebee showed particularly effective pollinarium removal under the observed conditions. The Asian hornet (*Vespa velutina*) frequently visited flowers and chased other insect visitors, although no pollinarium removal was detected following its visits. These observations illustrate contrasting outcomes of floral visitation, including potential pollen transfer, mechanical entrapment, and interference by predators. Further quantitative experiments are needed to verify the proposed force thresholds and determine the contribution of different visitors to successful pollination.

**Keywords:** *Araujia sericifera*, floral morphology, mechanical entrapment, pollinarium, proboscis, flower visitors, pollination, invasive plant

### Introduction

The moth plant, *Araujia sericifera* Brot., also known as the cruel vine, is a perennial climbing plant in the family Apocynaceae. It is native to tropical and subtropical South America, including Argentina, Brazil, Paraguay, Peru, and Uruguay, and has become established in many warm and temperate regions worldwide. Its reported range includes New Zealand, Australia, parts of Europe such as Portugal, Spain, Italy, Greece,

and Corsica in France, as well as western Asia, northern Iran, and parts of the United States, including California, Arizona, and Georgia (Coombs and Peter, 2010)<sup>[1]</sup>. The species is highly adaptable and spreads readily through its lightweight seeds, which bear silky tufts and can be dispersed over long distances by wind. It occurs along forest margins, tracks, coastal habitats, sand dunes, cliffs, residential fences and hedges, and in commercial orchards (Guyen *et al.*, 2026)<sup>[2]</sup>.





**Fig 1:** *Araujia sericifera*, moth plant growth stages and spread in urban areas of Marseille, France

*Araujia sericifera* is primarily cross-pollinated by insects, including moths, butterflies, and bees, although the plant is genetically self-compatible. Transfer of pollen between flowers on the same plant may therefore result in pollinator-mediated self-pollination, or geitonogamy. The flowers are bisexual and actinomorphic. Rather than relying on chemical toxicity to kill visiting insects, the plant's reputation as a "moth catcher" is associated with the mechanical properties of its floral structures (Stearns, 1887) [6]. The flowers emit a strong, sweet scent that attracts nectar-seeking insects. When a visitor inserts its proboscis into the narrow floral tube, the mouthparts may enter specialized guide channels associated with the pollen-bearing structures, known as pollinia. In some visitors, the proboscis becomes wedged in these narrow spaces, preventing withdrawal. Trapped insects may eventually die through exhaustion, starvation, or predation, while individuals that escape may carry pollinia to another flower (Stearns, 1887; Coombs and Peter, 2010; Maharaj *et al.*, 2024; Guven *et al.*, 2026) [1, 2, 3, 6], 6,1,4,2]. The floral trapping mechanism is associated with specialized structures characteristic of Apocynaceae. During

preliminary surveys conducted in Marseille, southern France, from 2024 to 2026, *A. sericifera* was observed growing extensively on fences and hedges in residential areas. Flowering plants, seed pods, and silk-tufted seeds were recorded (Fig.1, A–F). Mechanical uprooting is practiced for its control before seed dispersal (Fig. 1, G). Several insects, including *Aphis nerii*, *Myzus persicae*, *Aphis gossypii*, and *Spilostethus pandurus*, were observed damaging the foliage. Given the plant's reported ability to trap moths and other insects, the present investigation examined its floral trapping mechanism in relation to flower structure and the behaviour of visiting insects in residential fences and hedges in Marseille during the peak flowering period in September and October 2026.

### Materials and Methods

Two flowering clusters of *Araujia sericifera*, covering approximately 40 and 80 ft<sup>2</sup>, respectively, were selected on boundary walls and fences near schools and residential complexes in Saint-Barnabé, Sector 6, Marseille, France (Fig. 1, B). Observations were conducted from 7 September to 15 October 2026. The reported minimum temperatures in

Marseille during September and October were approximately 13–18°C, while maximum temperatures ranged from 21–27°C, representing moderate Mediterranean conditions (Data source: Predictwind-Marseille 12). Insect visitors, visitation frequency, trapping events, and successful escapes were recorded between 8:30 and 10:30 a.m. on three mornings per week. Fifteen observation sessions were completed during the study period. Flowers containing trapped insects, together with the insects themselves, were collected and maintained under ambient room conditions for measurements and examination of floral internal structures. Buff-tailed bumblebees, violet carpenter bees, and honeybees were also collected to examine the presence of pollinaria attached to their mouthparts or bodies. Asian hornets were collected to determine whether they carried pollinaria after visiting flowers. Between five and eight specimens from each insect category were placed in a deep freezer for euthanasia and subsequently examined for pollinarium attachment and other morphological features. Flowers were dissected to expose the arrangement of their internal reproductive structures, following the approach attributed to Stearns (1887) [6]. The floral geometry associated with proboscis entrapment in *Pieris rapae* was examined in detail. Five flowers visited by each insect species for more than 10 seconds were collected and inspected for pollinia displacement, which was treated as an indication of possible pollen removal or transfer. Figures and photographs were prepared and labelled using Adobe Illustrator and Nano Banana, with photographs captured using the 48-megapixel dual-fusion camera of an iPhone 17.

Results and Discussions

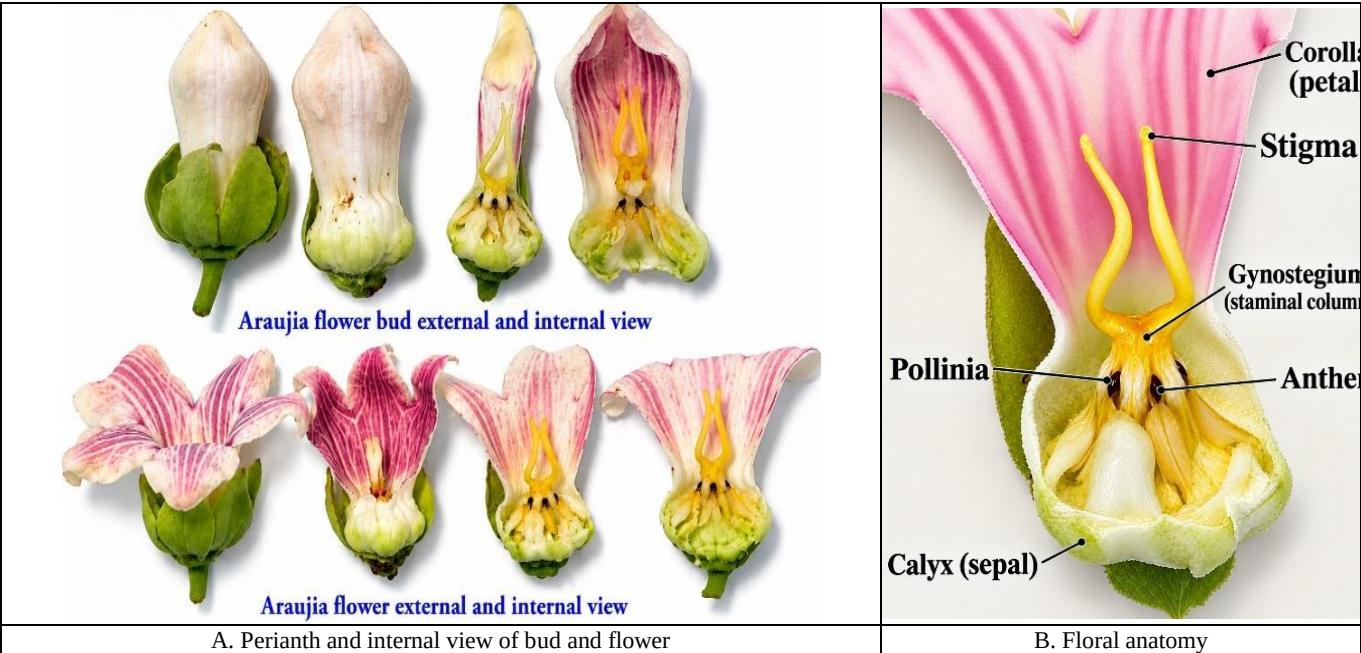
**Floral morphology:** *Araujia sericifera* belongs to Apocynaceae, a family that includes many milky-sapped plants, such as *Calotropis procera*

and *Oxystelma esculentum* in India (Singh, 2026) [5]. The species is also known as white bladder-flower, a name associated with the slightly inflated base of the flower, particularly in the unopened bud (Fig. 2, A). The corolla is trumpet- or funnel-shaped, with a flared opening and a tube that broadens into a bulbous region near its junction with the calyx.

The perianth consists of a calyx and corolla. The calyx comprises five relatively large, green, leaf-like sepals, often fused at the base, that are ovate and approximately 8–15 mm long. The corolla is funnel-shaped or cup-shaped, swollen near its base, and approximately 2 cm wide. It comprises five white, cream, pale-pink, or violet petals that are fused in their lower portion to form a tube approximately 12–16 mm long, terminating in five spreading lobes (Fig. 2, A).

Removal or longitudinal dissection of the corolla tube exposes the central reproductive complex, including the androecium and gynoecium, which are fused into a gynostegium (Fig. 2, B). The five stamens alternate with the corolla lobes. Their filaments are short, and the anthers are attached to the inner surface of the corolla tube (epipetalous). The anthers lie close to the stigma head and form the specialized central gynostegium. Pollen is aggregated into waxy masses called pollinia rather than being released as loose grains.

The pollinarium is the transferable pollen unit and functions somewhat like a small mechanical clip. Its corpusculum is a dark, hardened, gland-like structure positioned near the upper part of the gynostegium’s guide slit. The corpusculum attaches to an insect when an appropriate appendage enters or contacts the structure. Flexible connecting arms, referred to here as translators or retinacula, link the corpusculum to the pollinia. The pollinia are flattened, golden pollen masses containing numerous pollen grains and are positioned within the floral chambers until removed by a visitor (Fig. 2, D).



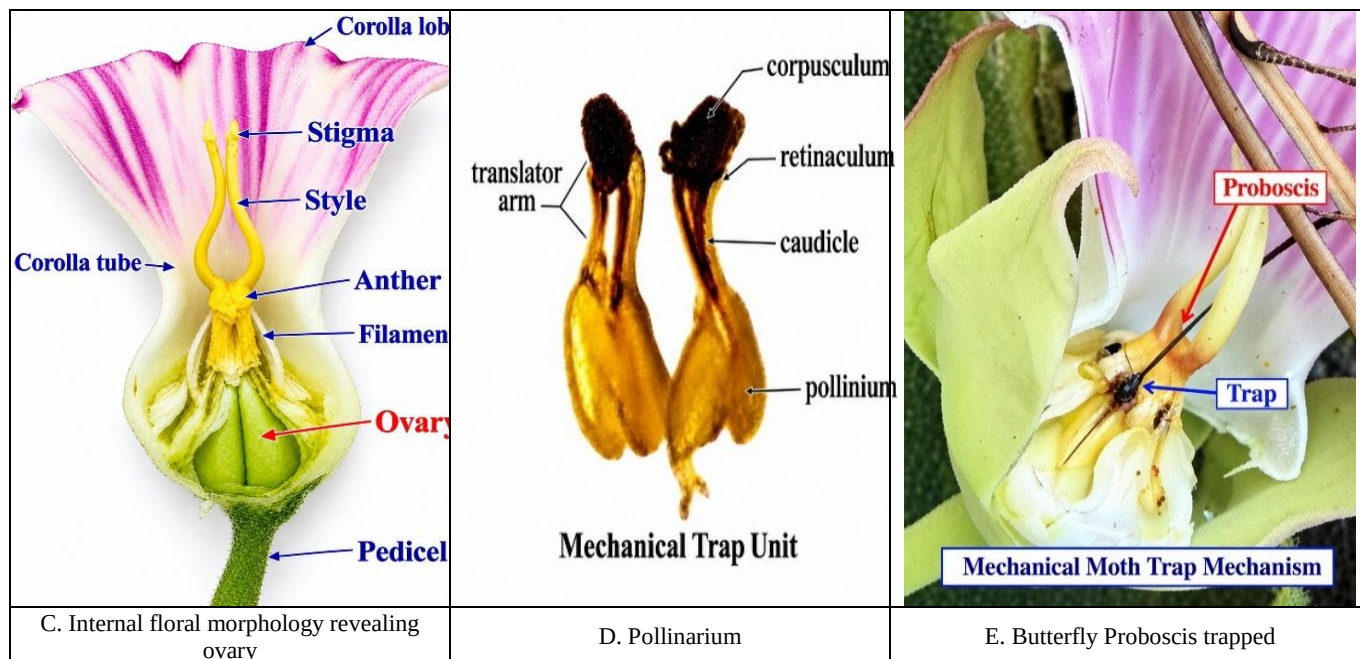
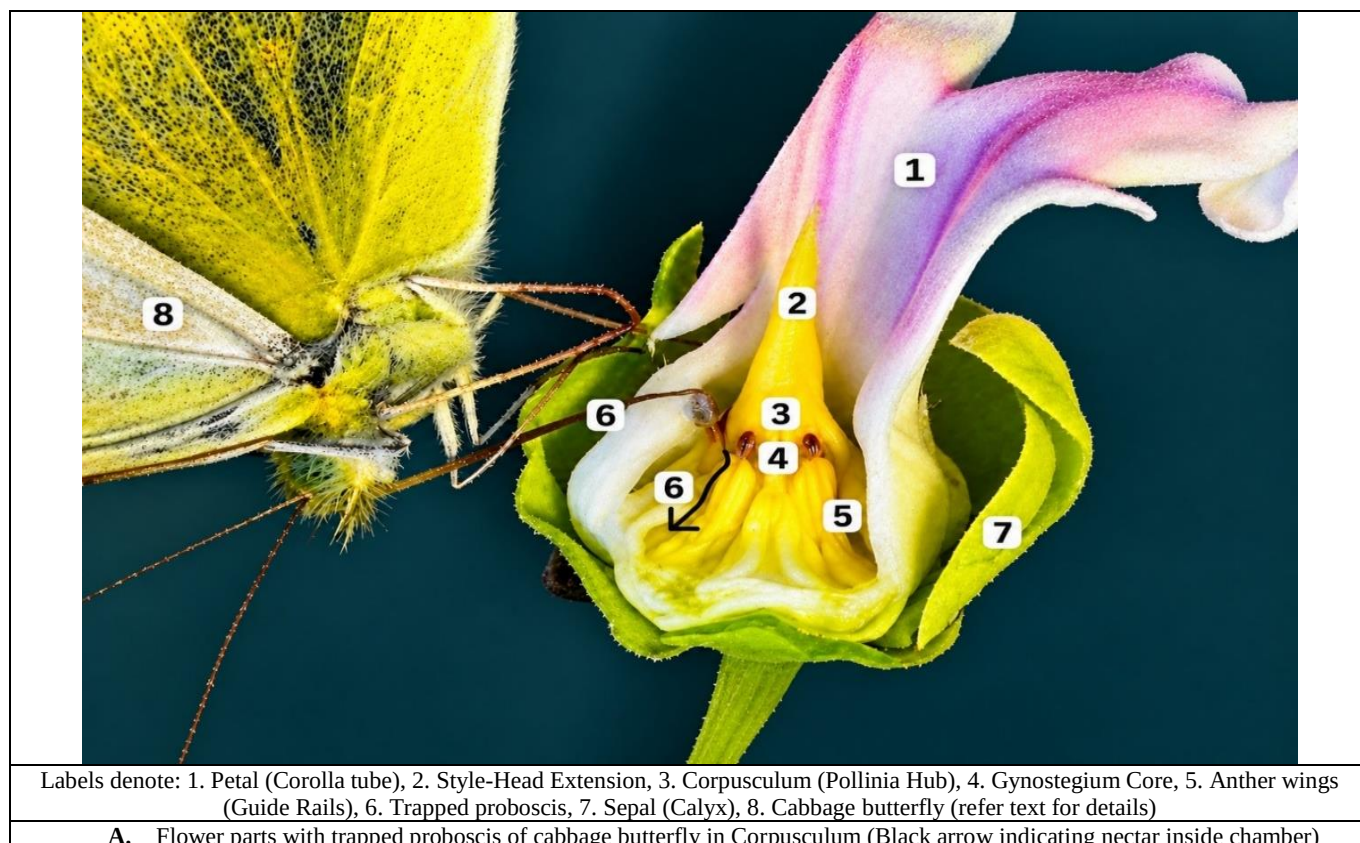


**Fig 2:** *Araujia sericifera* flower external and internal morphology and proboscis trapping site

The gynostegial corona comprises five distinct, backward-rolled, oblong or quadrate staminal segments attached near the base of the filament column. The gynoecium is bicarpellary: the two ovaries remain separate at the base, while their styles and stigma are united above (Fig. 2, C). The pistil thus comprises two superior ovaries associated with a shared style and a two-cleft extension of the style head (Fig. 2, C). Specialized nectaries are located within the stigmatic chambers,

which also serve as sites where pollinia may be deposited during visits by insects (Fig. 2, E). The stigma head is often enlarged into a drum-shaped structure.

Floral anatomy associated with proboscis entrapment in the cabbage white butterfly: A flower containing the trapped proboscis of a cabbage white butterfly was collected together with the insect and carefully dissected to identify the floral structures involved in the trapping event (Fig. 3, A).



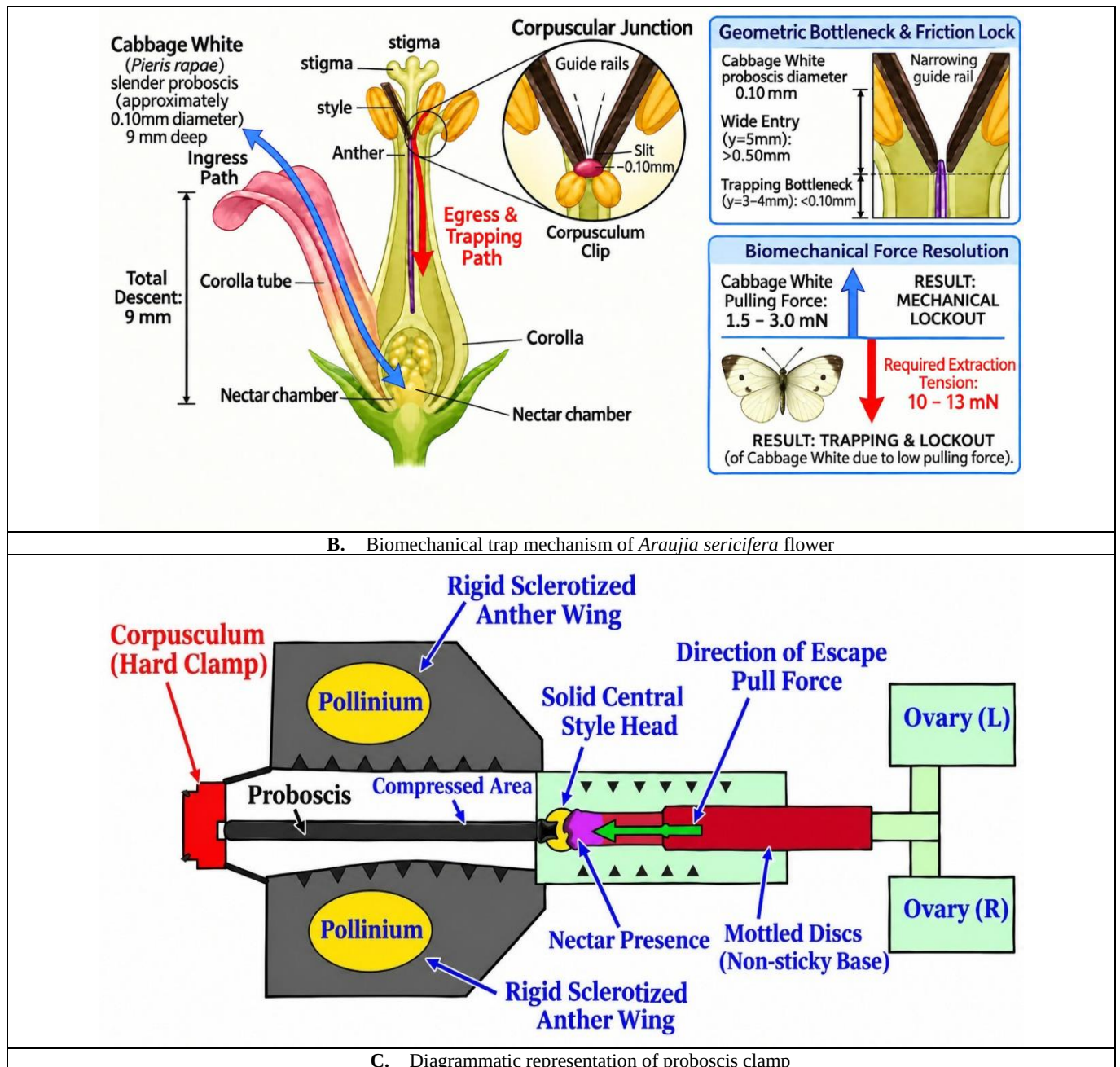


**Fig 3:** *Araujia sericifera* floral features role in trapping proboscis of *Pieris rapae*

The principal structures and their proposed functions are summarized in Table 1 as under.

**Table 1:** Principal anatomical features (Fig. 3A) and their functions in *Pieris rapae* entrapment

| Fig. ID | Floral structure              | Description and proposed function                                                                                                   |
|---------|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| 1       | Petals (corolla tube)         | The pale-pink to white upper floral covering that surrounds and protects the reproductive structures.                               |
| 2       | Style-head extension          | The prominent, yellow, cone-shaped projection extending upward from the central region.                                             |
| 3       | Corpusculum (pollinarium hub) | A small, dark structure near the top of the guide rails that functions as the attachment point for the pollen unit.                 |
| 4       | Gynostegium core              | The central column formed by the close association or fusion of the stamens and pistil.                                             |
| 5       | Anther wings (guide rails)    | Narrow, rigid edges bordering the guide slits; their geometry may restrict the movement of an entering proboscis.                   |
| 6       | Trapped proboscis             | The butterfly's tubular mouthpart, which extends into the narrowing channel while the insect attempts to reach nectar.              |
| 7       | Sepals (calyx)                | The green, cup-like outer structures supporting the base of the flower.                                                             |
| 8       | Cabbage white butterfly       | The visiting insect, <i>Pieris rapae</i> , positioned to the left of the figure, with its proboscis caught in the floral structure. |

In Fig. 3, A, a curved black arrow indicates the proboscis within the flower. The mouthpart had entered the narrowing

guide channel during nectar feeding. The cabbage white butterfly (*Pieris rapae*) remained attached to the flower by

its proboscis, illustrating the potential for mechanical entrapment in this floral system.

**Proposed biomechanical trapping and escape mechanism by pollinators:** During the observed trapping event, the cabbage white butterfly inserted its proboscis approximately 9 mm into the corolla tube. The inward-curving corona segments appeared to direct the mouthpart towards a narrow channel between the corona and central column. The resulting geometry may act as a one-way mechanical restraint: a slender proboscis can enter the channel but may become difficult to withdraw if it reaches a constricted section. The gynostegium itself remained intact during the observed interactions (Fig. 3, B). The observations suggested that stronger visitors, including large bumblebees and honeybees, could disengage the pollinarium mechanism without damaging the flower. The proposed process can be described in three stages. First, the rigid anther wings form narrow guide rails, with the corpusculum positioned near the upper end of the slit and connected to the pollinia. As an insect explores the flower for nectar, its mouthparts or other appendages may enter the guide channel. Second, during withdrawal, an appendage may engage the corpusculum. A sufficiently strong pull may detach the pollinarium and allow the insect to leave with the pollen unit attached. By contrast, a relatively weak or flexible proboscis may remain wedged between the guide structures.

Measurements presented in the study indicate that the guide channel was wider than 0.50 mm near the initial entry region, over an approximate depth of 5 mm, whereas the constricted region at 3–4 mm was reported to narrow to less than 0.10 mm. The proboscis thickness of *P. rapae* was recorded as approximately 0.10 mm. The manuscript estimates that a pull force of 10–13 mN would be required to release the trapped proboscis, compared with a calculated force of 1.5–3.0 mN for the cabbage white butterfly. These values theoretically provide a plausible proposed mechanical explanation for the observed entrapment, but the force estimates and channel dimensions require direct, replicated measurement before they can be considered experimentally validated.

The third stage involves escape mechanism resulting in pollen deposition. A pollinator carrying pollinia may visit another *A. sericifera* flower and insert the pollen unit into the appropriate floral guide structure. During withdrawal, the pollinia may become positioned within the stigmatic chamber, enabling pollen transfer. In the present observations, buff-tailed bumblebees were seen removing pollinaria during nectar feeding, and pollen units were subsequently found attached to their mouthparts (Fig. 4, 13). The results are consistent with the possibility that the same floral structures that impede some visitors facilitate pollen transfer by others. The mechanism should therefore be interpreted as a selective mechanical interaction rather than as evidence that all visiting insects are trapped or that every pollinarium removal results in successful fertilization.

The diagrammatic representation in Fig. 3, C illustrates the proposed entry path, constricted region, and withdrawal direction. The horizontal alignment of figure is in line with

natural inclination of majority of flowers. The flower may function as a restrictive clamp for some visitors but as a pollen-transfer mechanism for stronger insects capable of disengaging the pollinarium.

**Diversity and activity of flower-visiting insects:** Fourteen insect species were recorded visiting *A. sericifera* flowers during 15 morning observation sessions conducted between 7 September and 15 October 2026 (Fig. 4; Table 2). Eight species belonged to Lepidoptera, five to Hymenoptera, and one to Diptera. The recorded lepidopterans were the mallow skipper (*Carcharodus alceae*), cabbage white butterfly (*Pieris rapae*), red admiral (*Vanessa atalanta*), common zebra blue (*Leptotes pirithous*), painted lady (*Vanessa cardui*), clouded yellow (*Colias croceus*), long-tailed blue (*Lampides boeticus*), and hummingbird hawk-moth (*Macroglossum stellatarum*).

The lepidopteran visitors frequently approached and fed from the flowers, but the flowers they visited were often observed to retain their pollinia. Four species were recorded becoming trapped: the mallow skipper, cabbage white, red admiral, and painted lady, with reported trapping percentages of 25%, 33%, 10%, and 15%, respectively. The cabbage white was the most abundant recorded visitor, with 45 individuals noted, and was selected for closer examination of the trapping mechanism. Recorded proboscis lengths were approximately 10.5 mm in *P. rapae*, 13.0 mm in *V. cardui*, and 32.0 mm in *M. stellatarum*. These measurements alone did not explain whether a visitor became trapped or escaped; the observations suggested that mouthpart geometry and the ability to withdraw from the floral guide channel were also important. Notably, the hummingbird hawk-moth, having the longest measured proboscis, fed for more than 30 seconds on some occasions without becoming trapped and was successful in pulling off pollinia. This observation indicates that proboscis length may be a factor determining entrapment. Earlier reports cited in the source manuscript describe medium-sized nocturnal moths (proboscis length 10–15 mm) including *Heliothis*, *Plusia*, and *Agrotis*, becoming trapped frequently at night (Stearns, 1887; Coombs and Peter, 2010) [1, 6]. The present observations were restricted to daytime visitors and therefore do not provide a direct comparison with nocturnal visitation. In South Africa, day visitors were dominated by *Apis mellifera* (158) compared to about 1 to 2 moths of different families in the night indicating insignificant role of moths in pollination of *Araujia sericifera* (Coombs and Peter, 2010) [1, 1]. In present studies, in the morning observations not even a single moth trapped overnight could be reported indicating either the moth population in the vicinity was scarce or predators like some wall lizards, birds or predatory insects devoured over them soon after trapping.

Five hymenopteran insects including the violet carpenter bee (*Xylocopa violacea*), buff-tailed bumblebee (*Bombus terrestris*), European honeybee (*Apis mellifera*), four-striped digger bee (*Amegilla quadrifasciata*), and Asian hornet (*Vespa velutina*) were recorded on the flowers. Pollinaria were observed to be removed from flowers during visits by

the honeybee, carpenter bee, and bumblebee, suggesting that these insects may contribute to pollen transfer (Table 2). The reported tongue lengths of the carpenter bee and bumblebee were approximately 8.0 mm and 5.8 mm, respectively, shorter than those recorded for several lepidopterans. Nevertheless, these bees were able to remove pollen units within approximately 10–15 seconds of nectar feeding. Four pollinia were reportedly found on the mouthparts of a bumblebee within 30 seconds of feeding (Fig. 4, 13). Missing pollinia were also recorded in association with a carpenter bee collected after visiting a flower (Fig. 4, 14). In a separate observation, three flowers were offered to a

bumblebee and a carpenter bee in a plastic tube measuring 12 × 4 cm. After 60 minutes (subjecting perianth removal), bumblebee was found to remove all the pollinia, while the carpenter bee detached only one or two pollinia per flower (Fig. 4, 15). These observations suggest differences in pollinarium removal between the two-bee species under the conditions used, although the limited number of insects and flowers restricts the strength of this comparison. Although the European honeybee was considered a potential pollinator in South Africa (Coombs and Peter, 2010) <sup>[1]</sup>, but in present studies approximately 6% of the observed honeybees were found to struggle to free themselves from the floral structure.





13. *Bombus terrestris* with pollinia (Left Fig)

14. *Xylocopa violacea* with detached pollinia



15. In upper row most of the pollinaria (black dots) are present in presence of *Xylocopa violacea*, but in lower row most of them removed by *Bombus terrestris* within 60 minutes time

**Fig 4:** Insect visitors recorded on flowers of *Araujia sericifera*

The four-striped digger bee did not remove pollinia from the flowers it visited. The syrphid fly *Myathropa florea*, referred to as the Batman hoverfly, visited occasionally, but its observed contribution to pollinarium removal appeared limited.

The Asian hornet, *V. velutina*, was a frequent visitor and was observed chasing away other flower visitors, including larger butterflies, violet carpenter bees, and hummingbird hawk-moths. Although hornets approached flowers in a manner resembling that of nectar-feeding visitors, no pollinia were observed to be missing after their visits. A total of 60 hornet visits were recorded across the 15 observation sessions, more than twice the visit count reported for any other insect category. This behaviour is consistent with active prey-searching and interference with

flower visitation. Previous research has reported that *V. velutina* can reduce visitation by honeybees, smaller hymenopterans, bumblebees, and syrphid flies (Sandra and María, 2020) [4]. However, the present observations alone cannot establish the magnitude of any causal effect on pollination. To observe interspecific interactions, two *Vespa velutina* individuals were enclosed in a 12×4 cm plastic tube for 12 hours alongside a European honey bee, a violet carpenter bee, and a hummingbird-hawk moth. Throughout the confinement, all insects behaved normally, and no predatory activity was observed. This lack of aggression suggests that hornets may exert a deterrent effect on flowers rather than actively hunting insect visitors, though further investigation is required to decode these complex behavioral dynamics.

## Conclusion

The observations indicate that *A. sericifera* flowers support a diverse assemblage of insect visitors but that visits may have markedly different outcomes. The narrow guide structures associated with the gynostegium were implicated in the entrapment of some butterfly proboscises, particularly that of *P. rapae*. In contrast, bumblebees, carpenter bees, honeybees and hummingbird-hawk moth were observed removing pollinaria, suggesting a potential role in pollen transfer. The hummingbird hawk-moth's ability to feed without becoming trapped further indicates that entrapment cannot be explained by proboscis length alone. Frequent

visits and chasing behaviour by the Asian hornet may also influence the activity of other visitors, although its effects on pollination require further study. Because the study was based on two vine clusters and 15 morning observation sessions, the findings should be regarded as preliminary. Further work should quantify visitation rates, trapping and escape probabilities, pollinarium removal, pollen deposition, and the force required for extraction using replicated measurements. Such experiments would help distinguish observed associations from demonstrated mechanisms and clarify the relative pollination contribution of each insect species.

**Table 2:** Diversity of insect visitations, extent of entrapment, pollinia displacement and predatory activity

| S.No. | Insect                                       | Family      | Order       | Number visited | % trapped | Attribute Pollinator/ Robber/ Predator | Pollinia on body P/A | Pollinia missing on flower |
|-------|----------------------------------------------|-------------|-------------|----------------|-----------|----------------------------------------|----------------------|----------------------------|
| 1.    | <i>Carcharodus alceae</i> (Esper)            | Hesperiidae | Lepidoptera | 12             | 25        | Pollinator                             | Absent               | 0/5                        |
| 2.    | <i>Pieris rapae</i> (Linnaeus)               | Pieridae    | Lepidoptera | 45             | 33        | Pollinator                             | Absent               | 0/5                        |
| 3.    | <i>Vanessa atalanta</i> (Linnaeus)           | Nymphalidae | Lepidoptera | 10             | 10        | Pollinator                             | Absent               | 0/5                        |
| 4.    | <i>Leptotes pirithous</i> (Linnaeus)         | Lycaenidae  | Lepidoptera | 25             | 0.0       | Pollinator                             | Absent               | 0/5                        |
| 5.    | <i>Colias croceus</i> (Geoffroy)             | Pieridae    | Lepidoptera | 4              | 0.0       | Pollinator                             | Absent               | 0/5                        |
| 6.    | <i>Vanessa cardui</i> (Linnaeus)             | Nymphalidae | Lepidoptera | 20             | 15        | Pollinator                             | Absent               | 0/5                        |
| 7.    | <i>Macroglossum stellatarum</i> (Linnaeus)   | Sphingidae  | Lepidoptera | 8              | 0.0       | Pollinator                             | Absent               | 1/5                        |
| 8.    | <i>Lampides boeticus</i> (Linnaeus)          | Lycaenidae  | Lepidoptera | 3              | 0.0       | Pollinator                             | Absent               | 0/5                        |
| 9.    | <i>Apis mellifera</i> Linnaeus               | Apidae      | Hymenoptera | 30             | 6         | Pollinator                             | 1/insect             | 1/5                        |
| 10.   | <i>Amegilla quadrifasciata</i> (de Villiers) | Apidae      | Hymenoptera | 16             | 0.0       | Pollinator                             | Absent               | 0/5                        |
| 11.   | <i>Vespa velutina</i> Lepeletier             | Vespidae    | Hymenoptera | 60             | 0.0       | Predator                               | Absent               | 0/5                        |
| 12.   | <i>Bombus terrestris</i> (Linnaeus)          | Apidae      | Hymenoptera | 30             | 0.0       | Pollinator                             | 4/insect             | 2/5                        |
| 13.   | <i>Xylocopa violacea</i> (Linnaeus)          | Apidae      | Hymenoptera | 32             | 0.0       | Robber                                 | 1/insect             | 2/5                        |
| 14.   | <i>Myathropa florea</i> (Linnaeus)           | Syrphidae   | Diptera     | 3              | 0.0       | Pollinator                             | Absent               | 0/5                        |

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