ANATOMY AND RESOURCE OF THE STRIKING, SHORT-LIVED FLOWERS OF *Neomarica caerulea* (Ker Gawl.) Sprague

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ABSTRACT : Interactions between a flower and its visitors depend on the floral resource, which functions as an attractant. Floral resources are essential for the pollination of most angiosperms and might provide nourishment; their primary function is to attract and retain visitors. The genus *Neomarica* belongs to the tribe Trimezieae and is native to Central and South America. Current literature on *Neomarica* lacks data on their floral anatomy and the structure and histochemistry of sites responsible for producing floral resources. This study examined the floral anatomy of *Neomarica caerulea* (Ker Gawl.) Sprague to identify the resources available to visitors and their production sites using anatomical and histochemical techniques. The flowers are perfect, epigenous, trimerous, and have free tepals. The inner tepals contain polysaccharide-secreting unicellular trichomes, as confirmed through positive reactions to ruthenium red and periodic acid-Schiff reagent. The anthers are bithecate, tetrasporangiate, and dehisce through longitudinal slits. Pollen grains are released as monads during the two-cell microgametophyte stage. The gynoecium is syncarpous and tricarpellate, with a trilocular, multiovulate ovary that exhibits axile placentation. The ovules are anatropous and bitegmic, with a *Polygonum* type embryo sac. Our findings suggest that the floral resource is nectar, which is produced within trichomatous perigonal nectaries.

Keywords: glandular trichome; Iridaceae; neotropics; polysaccharide; structure; Trimezieae

ANATOMIA E RECURSOS DAS FLORES IMPRESSIONANTES E DE CURTA DURAÇÃO DE *Neomarica caerulea* (Ker Gawl.) Sprague

RESUMO: As interações entre uma flor e seus visitantes dependem do recurso floral, que funciona como um atrativo. Os recursos florais são essenciais para a polinização da maioria das angiospermas e podem fornecer nutrição; sua função primária é atrair e reter visitantes. O gênero Neomarica pertence à tribo Trimezieae e é nativo da América Central e do Sul. A literatura atual sobre Neomarica carece de dados sobre sua anatomia floral e a estrutura e histoquímica dos locais responsáveis pela produção de recursos florais. Este estudo examinou a anatomia floral de Neomarica caerulea (Ker Gawl.) Sprague para identificar os recursos disponíveis aos visitantes e seus locais de produção, utilizando técnicas anatômicas e histoquímicas. As flores são perfeitas, epígenas, trímeras e possuem tépalas livres. As tépalas internas contêm tricomas unicelulares secretores de polissacarídeos, conforme confirmado por reações positivas ao vermelho de rutênio e ao reagente de ácido periódico-Schiff. As anteras são bitecadas, tetrasporangiadas e se abrem por fendas longitudinais. Os grãos de pólen são liberados como mônadas durante o estágio de microgametófito bicelular. O gineceu é sincárpico e tricarpelar, com um ovário trilocular e multiovulado que apresenta placentação axilar. Os óvulos são anátropos e bitegumentados, com um saco embrionário do tipo Polygonum. Nossos resultados sugerem que o recurso floral é o néctar, produzido em nectários perigonais tricomatosos.

Palavras-chave: tricoma glandular; Iridaceae; neotrópicos; polissacarídeo; estrutura; Trimezieae

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INTRODUCTION

The interaction between a flower and its visitors relies on floral resources that act as attractants. Floral resources play a crucial role in the pollination of most angiosperms. Although these resources might provide nourishment, their primary purpose is to attract and retain visitors (Agostini *et al.,* 2014). Nutritional resources include pollen, nectar, lipids, and floral tissues, whereas non-nutritious resources consist of resins and fragrances.

Floral resources, such as nectar, are produced and secreted through specialized structures, supported by complex evolutionary and genetic processes that enable nectary development in specific plant parts (Ackerman *et al.,* 1994; Brandenburg *et al.,* 2012; Heiling *et al.,* 2018; Wang *et al.,* 2023; Pyke & Ren, 2023). In angiosperms, nectaries have evolved multiple times (Liao *et al.,* 2025). The shape, structure, and position of nectaries are crucial ecological features that help optimize the flower–pollinator interface (Tandon *et al.,* 2020; Liao *et al.,* 2025). Nectar composition varies widely with floral visitors, primarily comprising water, carbohydrates, amino acids, proteins, ions, antioxidants, lipids, terpenoids, and secondary compounds (Agostini *et al.,* 2014).

Floral oils are nonvolatile and of the most common alternatives to pollen and nectar that are used as rewards for flower-visiting insects (Simpson; Neff 1981). Elaiophores are floral glands that secrete nonvolatile oils. Their secretions facilitate specialized interactions between oil-producing flowers and a few species of oil-collecting bees (Possobom; Machado 2017). The oil produced by flowers usually contains lipophilic compounds, primarily hydroxy fatty acids and mono- or diglycerides, and may also include free fatty acids (Agostini *et al.,* 2014).

The Iridaceae family belongs to the order Asparagales (APG IV, 2016) and comprises seven subfamilies, 65 genera, and more than 2,000 species (Goldblatt *et al.,* 2008; Kamra *et al.,* 2023). It has a wide geographic distribution (Lovo *et al.,* 2018) and comprises numerous species that are commercially used for ornamental, food, and medicinal purposes (Kamra *et al.,* 2023). The flowers of Iridaceae species display a variety of colors, shapes, odors, and resources (Goldblatt and Manning, 2006), and they may provide pollen, nectar, or oils to pollinators (mainly pollen or nectar). In the Iridaceae, the septal nectary is plesiomorphic. Cases of suppression or complete loss of this nectary have been observed, and perigonal nectaries are hypothesized to have evolved from septal nectaries (Rudall *et al.,* 2003). Additionally, elaiophores have evolved multiple times within the Iridaceae (Renner & Schaefer, 2010).

In Africa, especially in the southern region, which is the largest center of diversity and endemism for Iridaceae, nectar-producing species seem to be more common (Goldblatt et al., 1995; Manning and Goldblatt, 2001; Goldblatt et al., 2008; Martins, 2019). Conversely, in the Neotropics, the literature highlights species that produce oil from elaiophores located in the tepals or stamen column (Chauveau et al., 2012; Goldblatt; Manning, 2006). However, Goldblatt and Manning (2006) highlighted the necessity for further research and evidence concerning species in the Neotropical region.

The Iridoideae subfamily is monophyletic and includes approximately 900 species, representing 40% of the Iridaceae. It comprises four tribes: Irideae, Sisyrinchieae, Trimezieae, and Tigrideae, all of which are primarily found in the Neotropics. Most members of the Iridoideae produce oil and possess elaiophores (Chauveau *et al.,* 2012; Chauveau, 2011; Goldblatt; Manning, 2006).

The tribe Trimezieae is native to the Americas, ranging from Central America to Argentina, and has a significant presence in Brazil (Lovo, 2018). It is comprised of five genera: *Trimezia* Salisb. ex Herb, *Pseudotrimezia* R.C.Foster, *Pseudiris* Chukr & A. Gil, *Deluciris* A. Gil & Lovo, and *Neomarica* Sprague (Chukr, 2003; Goldblatt *et al.,* 2008; Lovo, 2009; Chauveau *et al.,* 2012; Lovo *et al.,* 2018; Lovo *et al.,* 2021).

The genus *Neomarica* is native to Central and South America and includes 28 species found in Brazil across the Caatinga, Cerrado, Atlantic Forest, and Pampa phytogeographic domains (Gil; Hall 2025). These species are characterized by striking, short-lived flowers, with unequal tepals—the outer tepals are larger, spreading, decumbent, or rarely upright, and they are colored white, yellow, blue, or violet; the inner tepals are smaller, revolute, upright, and display white or bluish colors with blue, violet, or yellow markings (Chukr, 2003; Gil *et al.,* 2017). *N. caerulea* (Ker Gawl.) Sprague is a species endemic to Brazil, occurs in the Atlantic Forest, and is found in anthropic areas, rocky fields, rainforests, and rocky outcrops (Gil; Hall 2025).

Few studies have been conducted on *N. caerulea*, particularly concerning its systematic aspects (Chauveau, 2014) and cultivation (Júnior, 2003; De Paula, 2017). No data are available in existing literature on the floral anatomy of this species, structural or histochemical analyses of the production site, or the nature of the resources provided to pollinators. Based on the taxonomic information and phylogenetic placement, several authors have proposed possible identities for its floral resource, occasionally suggesting the presence of nectar-producing trichomes (Chauveau *et al.,* 2012; Kubitzki *et al.,* 1998; Gil *et al.,* 2019) or trichromatous elaiophores (Rudall *et al.,* 2003; Kubitzki *et al.,* 1998; Goldblatt & Manning, 2006). Indeed, an apparent inconsistency persists among previous studies about the type of structure and resources associated with *Neomarica*. Additionally, data on floral anatomy and reproductive biology that could provide insights into floral resources and visitors remain limited. Therefore, given this gap and the species' economic importance for ornamental use, we aimed to identify the resources provided by *N. caerulea* flowers and determine their production sites through anatomical and histochemical analyses.

MATERIAL AND METHODS

Flower buds and flowers were collected from mature *N. caerulea* individuals grown in the Horto Botânico at the Museu Nacional/Universidade Federal do Rio de Janeiro (22°54'48" S, 43°22'05" W) located in Quinta da Boa Vista, São Cristóvão, Rio de Janeiro (RJ, Brazil) (Fig. 1).

For anatomical studies, flower buds and flowers were fixed in 4% formaldehyde + 2.5% glutaraldehyde in 0.05M sodium phosphate buffer (pH 7.2) (GAHAN, 1984). All samples were dehydrated through an ethanol series and embedded in HistoResin (Leica, Wetzlar, Germany). Serial sections 1–3-µm thick were obtained with a glass knife on a Spencer 820 rotary microtome (American Optical, Vernon Hills, IL, USA) and stained with 0.05% Toluidine Blue O (GAHAN, 1984).

To identify the main classes of metabolites present in the cells, sections of embedded material were treated with: (a) Sudan IV for lipophilic compounds (JENSEN, 1962); (b) Lugol for starch (LANGERON, 1949); (c) potassium dichromate for phenolic compounds (GABE, 1968); (d) ruthenium red for acidic polysaccharides (LANGERON, 1949); (e) Fehling's reagent for sugars (Maclean and Ivemey-Cook, 1952); and (f) periodic acid and Schiff's (PAS) reagent for neutral polysaccharides (TABOGA; VILAMAIOR, 2013).

Analysis, measurements, and photographic documentation were performed using a Leica DM750 microscope equipped with a Leica ICC50 HD camera and LAS EZ software v.3.0.0. Micrographs were processed using Adobe Photoshop v.7.0.

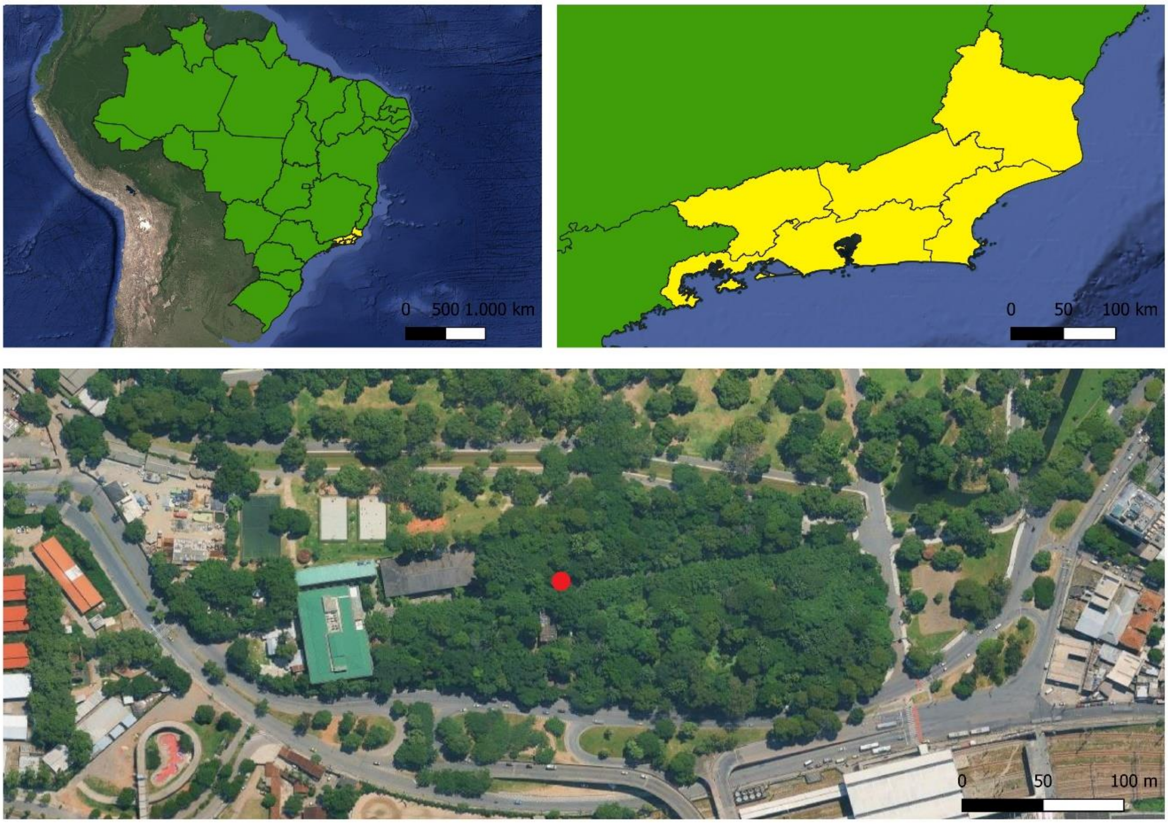

Figure 1: Study site. A, Map of Brazil, showing the location of the state of Rio de Janeiro; B, State of Rio de Janeiro; C, Collection site of *N. caerulea* (red dot) at the Horto Botânico, Quinta da Boa Vista, Rio de Janeiro city.

RESULTS

The flowers of *N. caerulea* are perfect, trimerous, epigenous, and homoclamydeous. The perigonium displays a range of shades, including blue, violet, and whitish tones. Some floral buds show outer tepals with a yellowish hue on the abaxial surface and white on the adaxial surface, which turn blue as they mature (Fig. 2A). The outer tepals are decumbent (Fig. 2A), elliptical, and have rusty-brown striations at their bases. The inner tepals are oblong, featuring rusty-brown strips at the proximal and median thirds, whereas the distal third is distinguished by a white central band with bluish striations (Fig. 2A–C). All the tepals are adorned with trichome regions; those on the inner tepals are particularly prominent in the median third. The androecium consists of three stamens alternately positioned with the inner tepals. Free filaments are located adjacent to the style. The bithecate anthers face the outer tepals and are juxtaposed to the style (Fig. 2C). The style diverges above the anther apex into three branches. Each style branch is winged, terminates in three papillose crests, and supports a transverse stigma.

Although this study did not investigate the reproductive biology of the species, field observations indicated that its flowers were visited by insects of the Hymenoptera (Fig. 2D, F) and Lepidoptera (Fig. 2E).

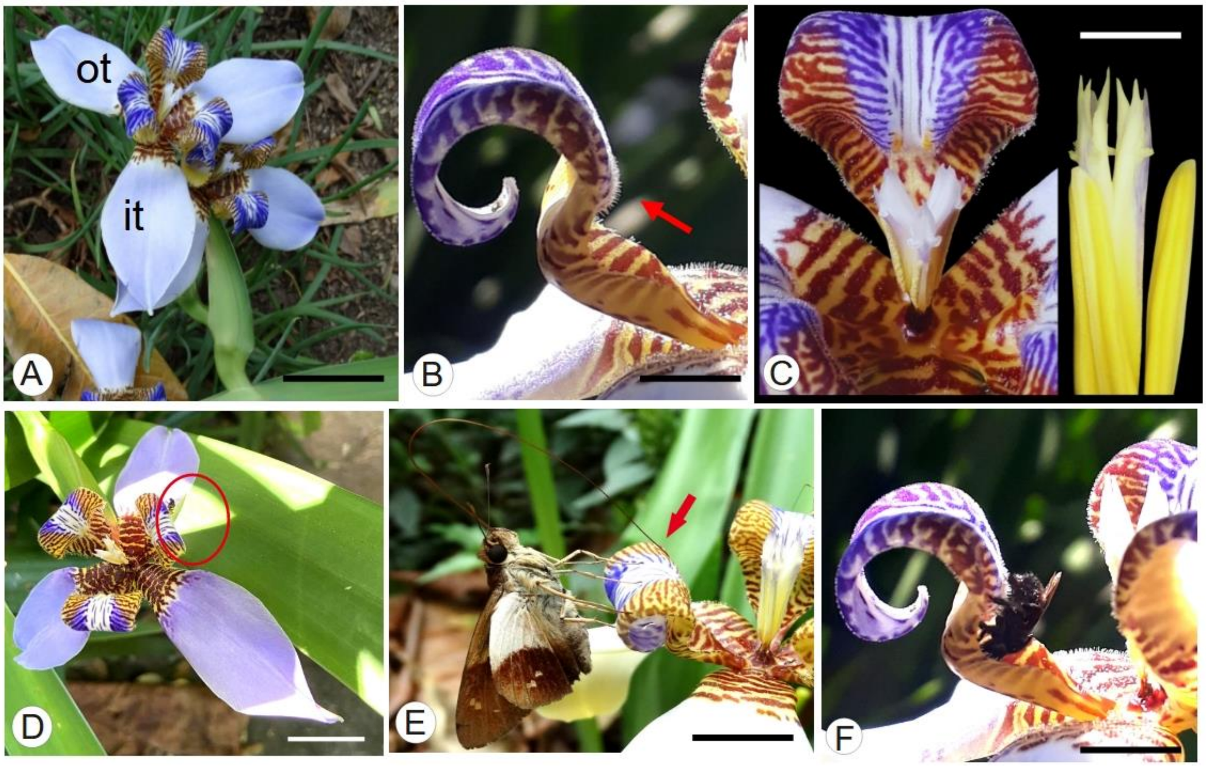

Figure 2: Flowers and flower visitors (D–F) of *N. caerulea*. A, General view showing the inner and decumbent outer tepals; B, Inner tepal showing the trichromatic region (green arrow); C, Inner tepal in the front view and details of the reproductive column (stamens and style branches); D and F, Hymenoptera (arrow); E, Lepidoptera (arrow). Photo (D, E) by Cristiana Koschnitzke. ot = outer tepal; it = inner tepal; sb = style branch; an = anther. Scale bars = 2 cm.

PERIGONIUM

The outer tepals are amphistomatic. When viewed in cross-section, they have a single-layered epidermis on both surfaces, with axially elongated cells on the abaxial surface and rectangular cells on the adaxial surface (Fig. 3A). The stomata are positioned slightly below the level of the ordinary epidermal cells (Fig. 3B). The mesophyll consists of 5–6 parenchyma layers, where collateral vascular bundles surrounded by a parenchyma sheath occur (Fig. 3C). The inner tepals have a one-layered epidermis on both surfaces. The epidermal cells are axially elongated and polarized with a centralized, conspicuous nucleus (Fig. 3D). Unicellular glandular trichomes are present on the adaxial surface. During early development, these trichomes have dense cytoplasm and a large, round nucleus occupying the proximal part of the cell. The distal part of the trichome is globose and positioned above the level of neighboring epidermal cells (Fig. 3D–E). As they develop, the trichomes elongate and develop thickened walls (Fig. 3F). The trichome contents positively reacted with ruthenium red (Fig. 3G; Table 1) and PAS reagent (Fig. 3H; Table 1), indicating the presence of acidic and neutral polysaccharides, and negatively with Sudan IV (Fig. 3I; Table 1), indicating the absence of lipophilic substances. The mesophyll consists of four parenchymatic layers in which the collateral vascular bundles are surrounded by a parenchymatic sheath (FIGURE 3D).

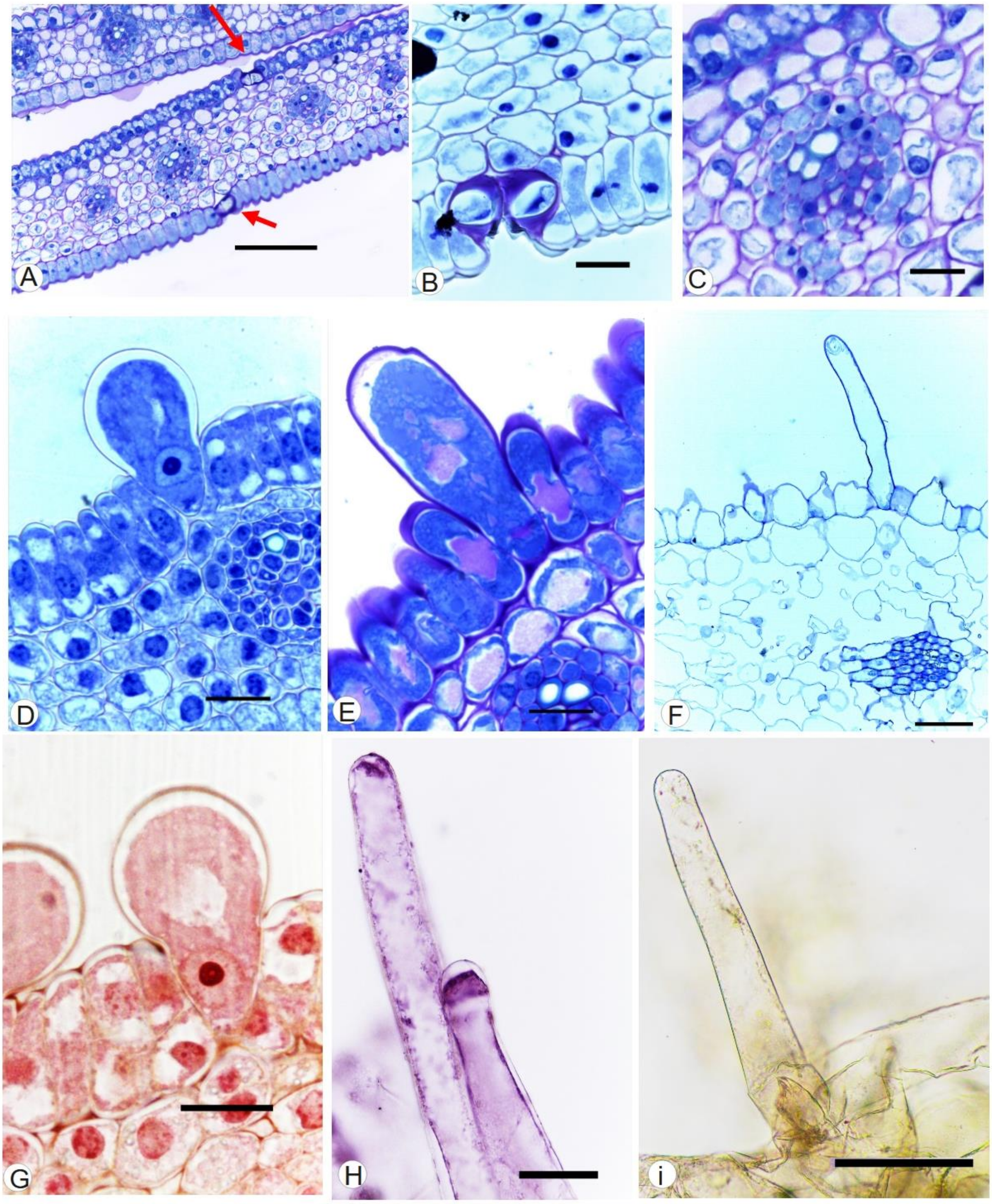

Figure 3. Cross-sections of the outer (A–C) and inner (D–I) tepals of *N. caerulea.* A, General view showing stomata (red arrows); B, Details of stomata on the abaxial surface; C, Vascular bundle surrounded by a parenchymatic sheath; D, Adaxial surface with secretory trichome in a young flower bud; E, Adaxial surface with secretory trichome in a pre-anthesis bud; F, Adaxial surface with secretory trichome in the flower; G, Young secretory trichome showing a positive reaction with ruthenium red for acidic polysaccharides; H, Mature secretory trichome with a positive periodic acid and Schiff's reaction indicating the presence of neutral polysaccharides; I, Mature secretory trichome with a negative response to Sudan IV, indicating the absence of lipids. Scale bars: 20 µm in B–E, G–I; 50 µm in F; 100 µm in A.

ANDROECIUM

The three stamens (Fig. 4A) have bithecate and tetrasporangiate anthers. When viewed in cross-section, the mature anther wall consists of the epidermis, endothecium, and two collapsed middle layers. In the anthers of pre-anthesis buds, tapetum remains are present (Fig. 4B), with pollen grains at the bicellular microgametophyte stage (Fig. 4D). The connective tissue is parenchymatic and contains a central vascular bundle (Fig. 4B, C). This region is covered by an epidermis with square or axially elongated cells and has stomata on the adaxial surface. Only the distal portion of the anther remains free (Fig. 4B). The median and proximal portions are shown next to the style: epidermal cells on the adaxial side of the anther contact those on the abaxial side of the style (FIGURE 4C).

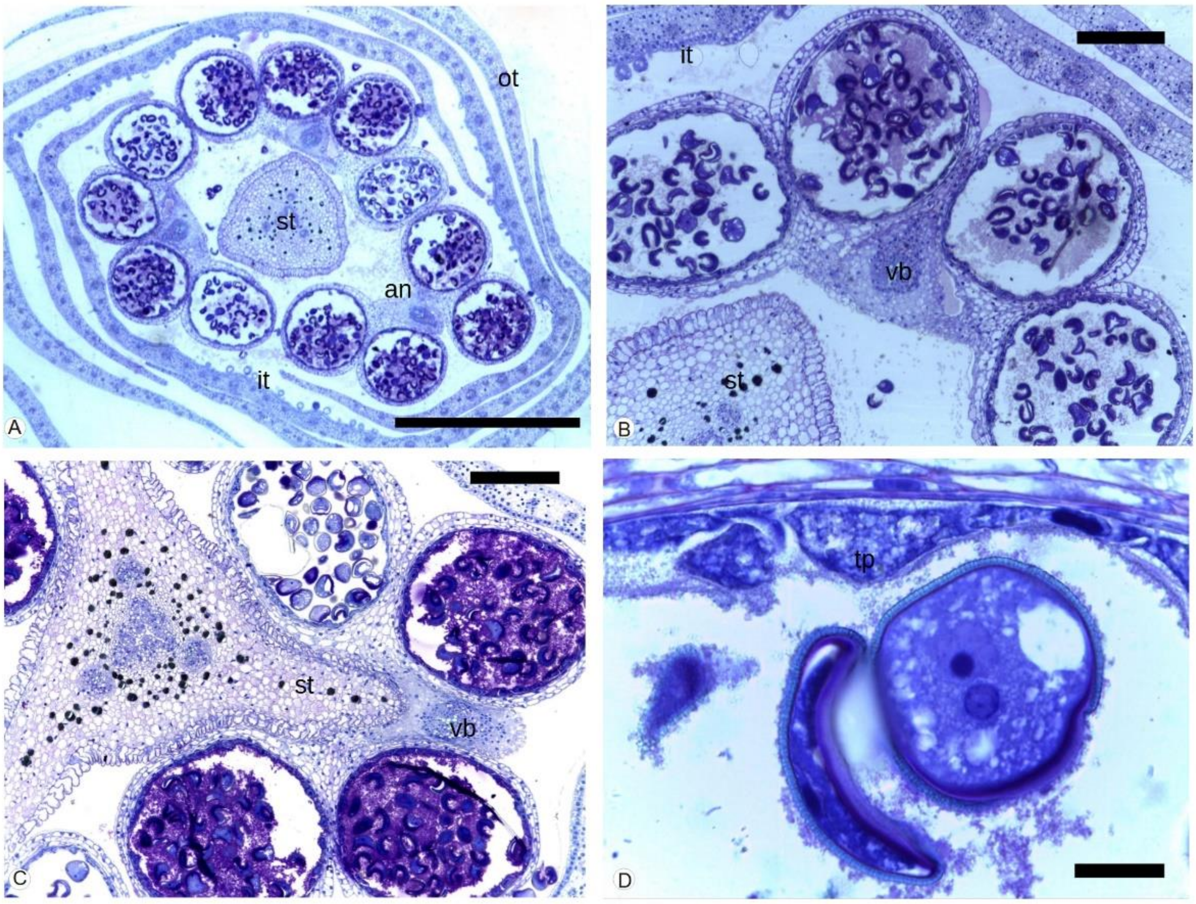

FIGURE 4. Anthers in *N. caerulea*, shown in cross-sections. A, General view of the three anthers; B, Anther in a pre-anthesis flower bud positioned away from the style; C, Anther in a pre-anthesis flower bud placed next to the style; D, Pollen grain in the bicellular gametophyte stage. an = anther; it = inner tepal; ot = outer tepal; st = stigma; tp = tapetum; vb = vascular bundle. Scale bars: 20 µm in D; 200 µm in B, C; 500 µm in A.

GINOECIUM

The ovary is inferior, tricarpellate, and trilocular, containing several ovules per locule (FIGURE 5A). The ovary wall, when viewed in cross-section, exhibits an outer epidermis composed of axially elongated cells filled with acidic polysaccharides and stomata (Fig. 5B; Table 1), accompanied by subsidiary cells containing starch grains (Fig. 5C; Table 1).

Additionally, the ovary wall contains parenchyma layers with idioblasts rich in phenolic compounds (Table 1) and an inner epidermis composed of square cells. The dorsal and ventral bundles of carpels are collateral (Fig. 5A) and surrounded by an amyliferous sheath (Table 1). Placentation is axile (Fig. 5A). The placentae have an epidermis with axially elongated, sometimes papillose, cells with a dense cytoplasm containing acidic polysaccharides and conspicuous nuclei (Fig. 5E; Table 1). In this region, cells in the subepidermal parenchyma layers contain starch grains (Fig. 5F; Table 1). Similar features of the epidermal and subepidermal layers are observed in the compitum region (Fig. 5D; Table 1). The ovules are anatropous, bitegmic, and have an inner integument longer than the outer integument. Only the inner integument forms the micropyle (Fig. 6A). Cells of the outer epidermis of the outer integument and inner epidermis of the inner integument contain phenolic compounds (Table 1). The embryo sac consists of seven cells—two synergid cells (Fig. 6B), an egg cell (Fig. 6C), a central cell (Fig. 6D), and three antipodal cells (Fig. 6E)—and eight nuclei. The two polar nuclei fuse before fertilization.

The style has a triangular outline (Fig. 7A), one-layered outer epidermis (Fig. 7B), parenchyma layers containing idioblasts with phenolic compounds (Table 1), and three vascular bundles arranged around the central stylar canal (Fig. 7A). The latter is surrounded by epidermal and subepidermal layers, with cells whose dense cytoplasm contains acidic polysaccharides (Fig. 7C; Table 1). The style branches into three winged sections above the apex of the anther. Each branch ends with three crests (Fig. 8A–C). These crests consist of an epidermis with tabular cells, layers of parenchyma, and a central vascular bundle (Fig. 8D). The distal part of the crest comprises a papillose adaxial epidermis with glandular trichomes, parenchyma layers containing cells with dense cytoplasm, and abaxial epidermis composed of square cells (Fig. 8E). The edges of the crest are elongated and ridge-like (Fig. 8F). The base of the crest is a transversely arranged stigmatic region.

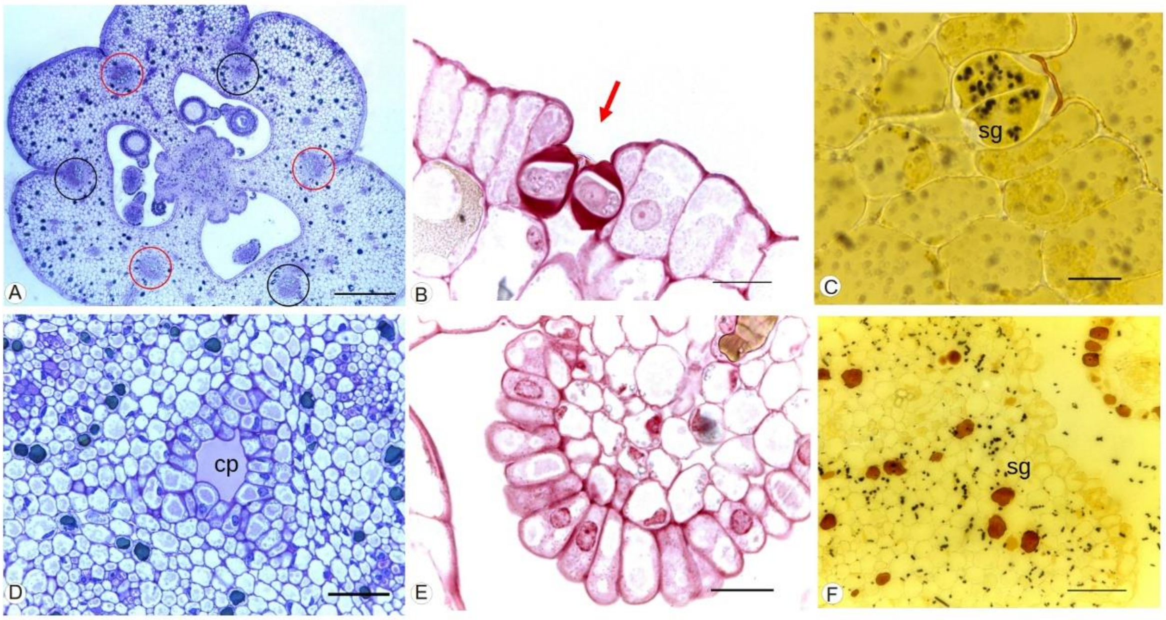

Figure 5. Ovary of *N. caerulea* in cross-section. A, General view showing the dorsal (black circle) and ventral (red circle) vascular bundles; B, Outer epidermis with stomata (arrow); C, Subsidiary cells under the Lugol test revealing starch grains; D, Compitum; E, Placenta epidermal and subepidermal cells showing a positive reaction with ruthenium red for acidic polysaccharides; F, Placenta subepidermal cells under the Lugol test showing starch grains. cp = compitum; sg = starch grains. Scale bars: 500 µm in A; 20 µm in B, C, E; 50 µm in D, F.

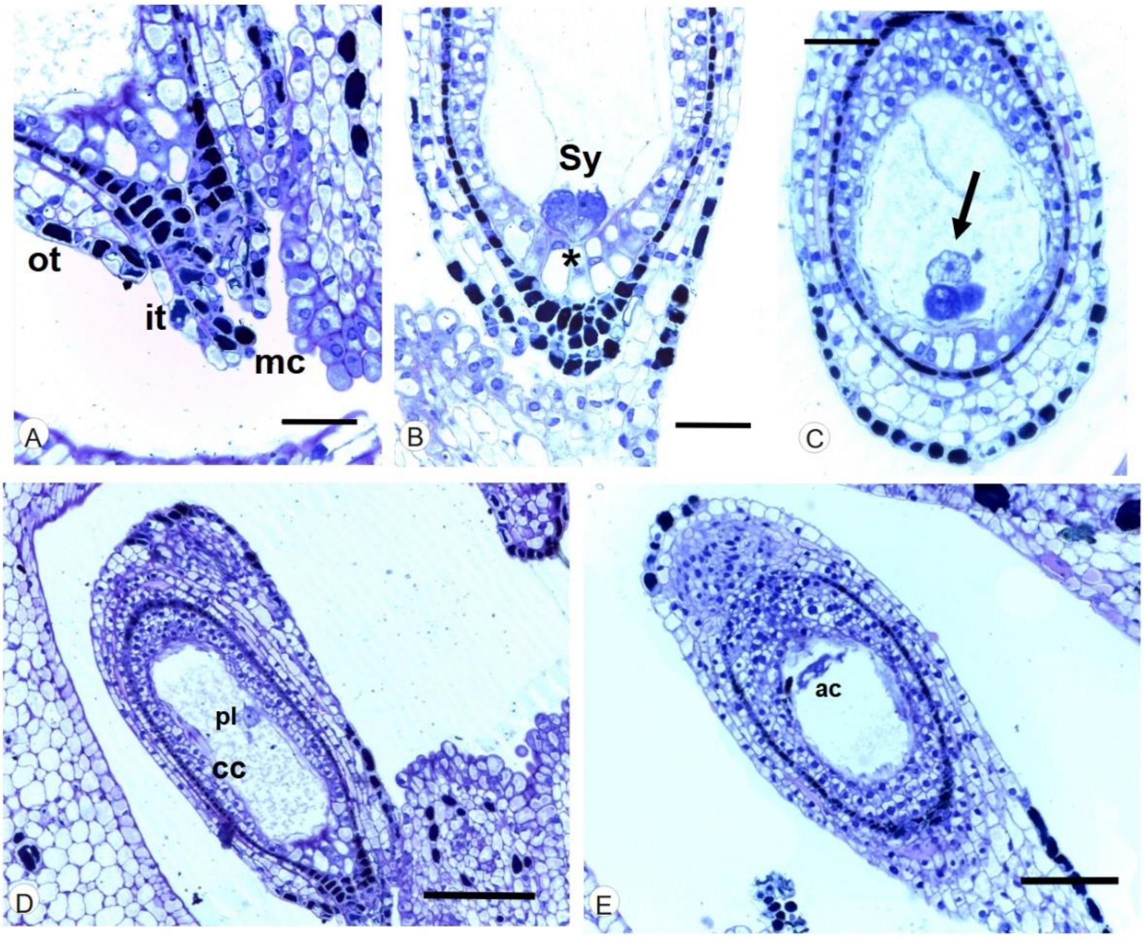

Figure 6. Ovules of *N. caerulea*, shown in longitudinal sections. A, Micropyle; B, Synergid cells; C, Egg apparatus: synergid cells (*) and egg cell (arrow); D, Central cell and polar nucleus; E, Antipodal cells. ac = antipodal cell; cc = central cell; eg = egg cell; it = inner integument; mc = micropyle; ot = outer integument; pl = polar nucleus; sy = synergid cell. Scale bars: 50 µm in A–C; 100 µm in D, E.

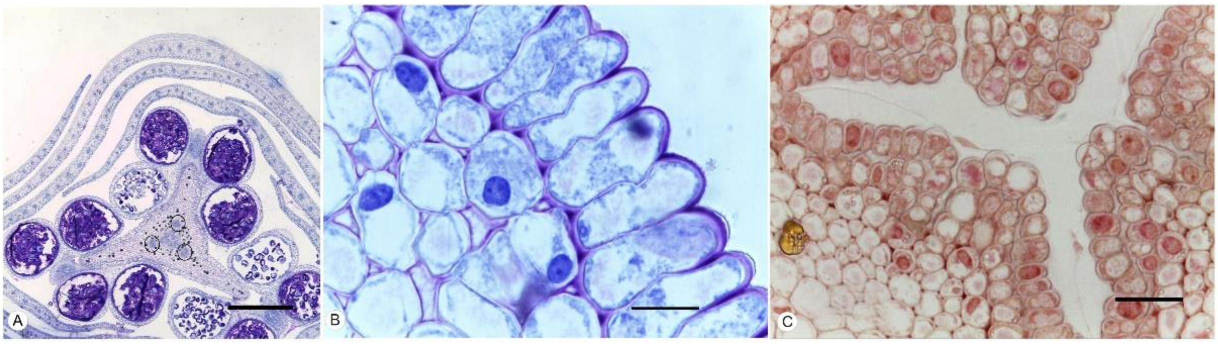

Figure 7. Style of *N. caerulea* in cross-section. A, Overview, showing the vascular bundles (circles); B, Outer epidermis; C, Stylar canal, epidermal, and subepidermal layers with a positive periodic acid and Schiff's reaction indicating the presence of neutral polysaccharides. Scale bars = 500 µm in A; 20 µm in B, C.

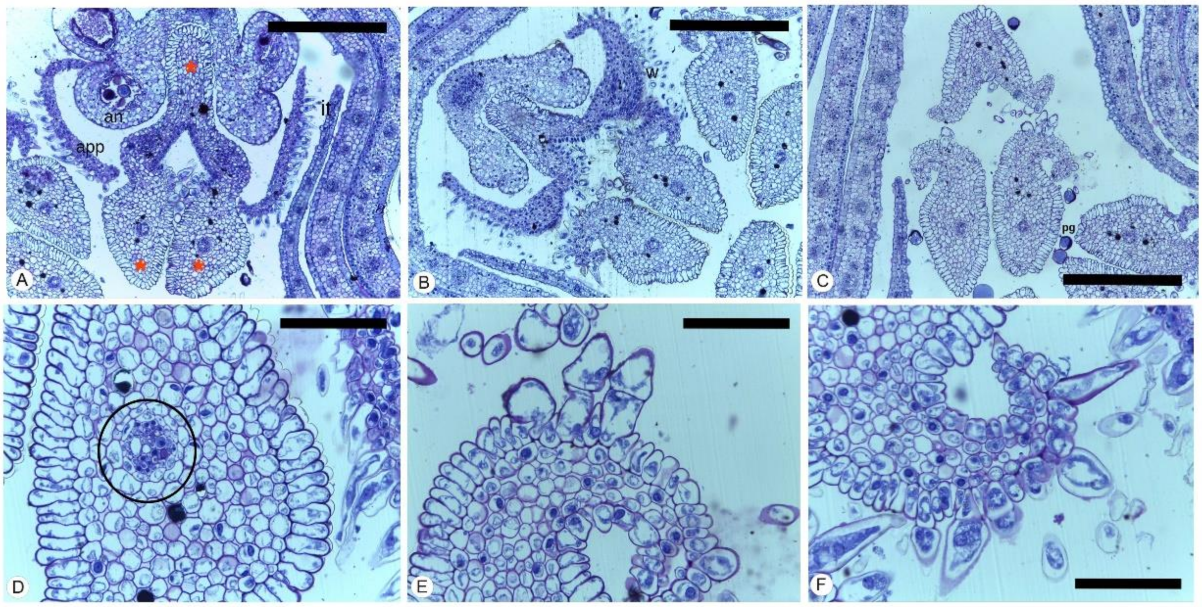

Figure 8. Style branches and crests of *N. caerulea* in cross-sections. A, Basal third in general view, * indicating one crest; B, Median third in general view; C, Apical third in general view; D, Crest showing the vascular bundle (circle); E and F, Adaxial surface and crest margin. an = anther; pg = pollen grain; ti = inner tepal; w = wing. Scale bars = 500 µm in A–C; 50 µm in D–F.

Table 1: Results of histochemical tests performed on the flower buds and flowers of *N. Caerulea.*

Reagent	**Compound tested**	**Color**	**Structure/region**									
			Trichomes of the adaxial surface of the inner tepals	Outer epidermis of the ovarian wall	Subsidiary cells of stomata of the outer epidermis of the ovary	Ovarian wall	Sheath of the dorsal and ventral bundles of the carpels	Epidermis of the stylar canal/compitum	Subepidermal layers of the stylar canal/compitum, epidermis of the placentae	Epidermis of the placenta	Subepidermal layers of the placenta	Integuments of the ovules
Periodic acid +Schiff's reagent	Neutral polysaccharides	Magenta	+									
Ruthenium red	Acidic polysaccharides	Pink to purple	+	+	+			+	+	+		
Potassium dichromate	Phenolic compounds	Brown	_			+						+
Lugol	Starch	Violet	_	_	+	+	+		+		+	
Sudan IV	Lipophilic substances	Orange-red	_									

+ = positive; − = negative

DISCUSSION

In this study, we examined the floral structures of *N. caerulea* using anatomical and histochemical analyses, with a particular focus on unicellular glandular trichomes on the adaxial surface of the inner tepals. The results showed that these trichomes synthesize polysaccharides that serve as resources for floral visitors.

Flowers of species within the Iridaceae family can provide pollinators with pollen, nectar, or oil. In Africa, studies show the presence of nectaries in several genera of the family, such as *Crocosmia*, *Babiana*, and *Moraea* (Goldblatt & Manning, 2006), and oil production remains rare in species from this continent. In this study, Goldblatt and Manning (2006) cited several oil-producing New World species and identified *Neomarica* as an oil producer, suggesting that the trichomes on its tepals are elaiophores. There is only one record in the literature for *Tritoniopsis parviflora* (Jacq.) G.J. Lewis, a species from the Western Cape, a province in South Africa, that secretes both floral oils in epithelial elaiophores and nectar in septal nectaries (Pastori, 2014).

In *Iris sibirica* L. (Iridoideae, Irideae), a wild-growing species primarily found in Central and Eastern Europe and the temperate zones of Asia, the nectary is located on the inner surface of the perianth tube. The nectary has a single-layered epidermis with papillae and several layers of glandular parenchyma. The nectary cells contain lipids and polysaccharides. The papillose epidermal cells of the nectary probably emit a scent that, together with visual attractants and nectar rewards, may significantly influence the pollination and reproductive success of this species (Konarska 2022).

Currently, research in the Neotropics has mainly focused on oil production from elaiophores in the stamen column and from trichomatous elaiophores in the tepals (Kubitzki et al., 1998; Chauveau et al., 2012; Lovo et al., 2021; Silva, 2021). However, knowledge of the floral resources of Neotropical Iridaceae species is limited, as is understanding of their pollination biology (Chauveau et al., 2012; Chauveau, 2014). Therefore, the available evidence suggests that floral resources within Iridaceae include nectar in African species and oil in Neotropical species.

Kubitzki *et al.* (1998) reported that trichomes of the inner tepals of Neotropical species produce nectar; however, they also indicated that tepals of the subfamily Iridoideae, including *Neomarica*, produce oil. Rudall *et al.* (2003) emphasized that most members of the Iridoideae subfamily lack septal nectaries; however, some possess perigonal nectaries or trichromatous elaiophores, and within the tribe Trimezieae, certain species exhibit trichromatous elaiophores in the tepal region.

According to Chauveau *et al.* (2012), tribes of the subfamily Iridoideae are mainly oil producers, and they had recorded the presence of trichromatous elaiophores on the adaxial surface of the inner tepals of some Trimezieae species. However, in the same publication, the authors stated that in the genus *Neomarica*, which is part of the tribe Trimezieae, this trichromatous region of tepals functions as a nectar-producing structure. The authors demonstrated that the ancestral trait in the Trimezieae is the presence of oil-producing trichomes, and they observed that the evolution of glandular structures within the Iridoideae was variable. They proposed that the minor differences observed in floral traits within the Trimezieae, including glandular structures, are likely associated with shifts in pollination mechanisms, speciation processes, and adaptive changes on American continents.

Valus (2018) described the anatomy and resources of flowers from various Iridaceae species, including *Trimezia spathata* (Klatt) Baker, which is classified within the Trimezieae, and highlighted oil as a floral resource. Silva (2021) used gas chromatography to analyze the extract from tepals of *N. northiana* (Schneev.) Sprague and detected limonene, a compound found in essential oils; however, the author did not directly examine tepal trichomes. These findings support the research of Chauveau *et al*. (2012), who had stated that New World Iridaceae flowers primarily produce oil (and pollen) as floral rewards for pollinators. Conversely, Gil *et al*. (2017; 2019) described the tepals of *Neomarica* as being distinct in shape and size, and that the inner tepals have nectar-secreting trichomes.

Lovo *et al*. (2021) provided a different perspective on the dominance of oil in Trimezieae species. The authors also noted that heterochrony-induced changes in floral morphology enabled the transition between ornate and plain flowers. Ornate flowers, such as those of *N. caerulea*, attract a broader range of pollinators, whereas plain flowers are more specialized for pollen-collecting bees. This shows that adaptive flexibility in floral morphology is directly linked to the diversity of pollination strategies. In this study, high sugar content was found in two ornate-flowered species, namely *Pseudotrimezia juncifolia* (Klatt) Lovo & A.Gil and *P. truncata* (Ravenna) Lovo & A.Gil, suggesting that these species produce oil in addition to nectar. The presence of oil was indirectly inferred from the observations of oil-collecting bees harvesting from the flowers. Although three species of the genus *Neomarica* were examined in the study, their floral resources were not confirmed.

This scenario highlights a lack of clarity in the scientific background and a research gap in floral anatomy and reproductive biology among Neotropical Iridaceae. Here, we demonstrated the presence of neutral and acidic polysaccharides in the unicellular glandular trichomes on the adaxial surface of the inner tepals of *N. caerulea* flowers. In contrast, the specific test for lipophilic substances was negative.

CONCLUSION

This study examined the floral structure of *N. caerulea*, focusing on the unicellular glandular trichomes on the adaxial surface of the inner tepals. These trichomes produce neutral and acidic polysaccharides, and during fieldwork, Hymenoptera and Lepidoptera visitors were observed collecting their secretions. Therefore, the floral resource is suggested to be nectar produced within the trichomatous perigonal nectary. Although these findings provide valuable data on the floral resource of *N. caerulea*, we emphasize the need for ultrastructural analysis of the trichomes on the inner tepals and further research on the reproductive biology of the species.

ACKNOWLEDGEMENTS

We thank Fundação Carlos Chagas Filho de Amparo à Pesquisa do Estado do Rio de Janeiro (FAPERJ, Brazil) for financial support of the project [E-26/111.207/2014 - APQ1]. We also thank Dr. Cristiana Koschnitzke for permission to use the images of the floral visitors (FIGUREs 2D and 2E).

FUNDING

This work was supported by Fundação Carlos Chagas Filho de Amparo à Pesquisa do Estado do Rio de Janeiro (FAPERJ, Brazil) [E-26/111.207/2014 - APQ1].

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

DATA STATEMENT

The data supporting this study are presented in the article.

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