Final Evaluation Report

Your Details	
Full Name	Thaynara de Sousa Silva
Project Title	Evolution and conservation of the genus *Varronia* (Cordiaceae, Boraginales) in the Neotropics: The systematic elucidation for global application
Application ID	24813-1
Date of this Report	10 July 2022

1. Indicate the level of achievement of the project's original objectives and include any relevant comments on factors affecting this.

Objective	Not achieved	Partially achieved	Fully achieved	Comments
Taxonomic and nomenclatural elucidation in species of the genus *Varronia* for the correct delineation of taxa.				The taxonomic revision identified names of species from Brazil and other South American countries in need of nomenclatural updating and / or typification's. The circumscription, history and typification of names in *Varronia* is essential to facilitate the taxonomic identification and geographic distribution of species. Species names have been updated through publications in scientific journals: **Silva *et al*. 2019. Nomenclatural updates in *Varronia* from South America. [published]** This work presents two new combinations for species of *Varronia* from Colombia. This work has been published in the journal Harvard Papers in Botany, 2019 (in attached). **Silva & Melo. 2019. New synonym, new combination and typification's in *Varronia*. Phytotaxa [published]** This work presents one new combination (*V. serratifolia*) and a new synonym (*V. intonsa*). To promote nomenclatural stability, the historical of the names of widely distribute species is discussed and a lectotype is assigned to *V. globosa,* a lectotype and an epitype for *V. curassavica*. The names *V. hermanniifolia*, *C. hermanniifolia* var. *calycina*, *Cordia sessilifolia* var. *macrantha*, and *V. villicaulis* are also lectotypified. A neotype is designated to *V. paucidentata.*
Taxonomic and nomenclatural elucidation in species of				Updates and clarifications were made in the name of *Varronia* species, and information about habitat and

the genus *Varronia* for the correct delineation of taxa. To contribute for the knowledge of *Varronia* species in biodiversity hotspots				distribution of species. **Taxonomic revision of *Varronia* P. Browne (Cordiaceae, Boraginales) in Brazil.** This work presents details on habitat, distribution and conservation status of the genus *Varronia*. This work is being finalised (last editing adjustments) and will be submitted to the journal Systematic Botany. This is also the main contribution resulting from the PhD Thesis of the student Thaynara S. Silva. This work is being reviewed and finalised for publication. The taxonomic treatment will still be concluded with the presentation of distribution maps, addition of illustrations and materials examined (in the case of widely distributed species, such as *V. globosa*, *V. curassavica* and *V. polycephala*) and the inclusion of the conservation status of the species. We also make updates regarding the distribution and conservation status of the species to the Flora do Brasil Online 2020 database. Contribution to the expansion of scientific knowledge to the population. **Disponible in: http://floradobrasil.jbrj.gov.br/** **Flora of Brazil 2020. Taxon. [published]**
To discover new species and new records. To contribute for the knowledge of *Varronia* species in biodiversity hotspots.				New records and new species were discovered and published: **Silva & Melo. 2019. A New Species and a New Record of *Varronia*. [published]** **Silva & Melo. 2022. *Varronia minensis*, a new species from the Cerrado. [published]** Two new species were described and illustrated (*Varronia minensis* e *V. xinguana*). Both occur in highly threatened environments in Brazil: the Cerrado and Amazon biomes. *Varronia polystachya*, a species known only from Venezuela, was registered for the first time for Brazil. *V. polystachya* was evaluated as Endangered and *V. xinguana* is classified as Data Deficient (DD). *V. polystachya* and *V. xinguana*

				are endemic species of Amazonia region. In addition, new species and new records of the genus *Cordia*, a group more closely related to *Varronia*, were also found. The results are published in the following study: **Pedro-Silva *et al*. 2021. A new species of *Cordia* sect. *Gerascanthus* (Cordiaceae).** **Melo *et al*. 2021. New records in Brazil reveal a disjunct distribution for *C. wedelli*.** Due to the large amount of material collected and observed in herbaria, new species and new records are still under analysis and will be published soon. The assessment of the conservation status of all species studied is still being concluded, due to the large amount of data obtained in the field and in the herbaria.
To collect botanical material in natural environments in states of Brazil				Collections, photographs and habitat observations of 12 species of *Varronia* were made in areas of Restinga, Mata Atlântica, Caatinga and Cerrado in the states of Alagoas, Bahia, Minas Gerais, Pernambuco, Sergipe. These collections allowed the observation and updating of data on habitat and distribution of species.
To visit Brazilian herbaria to consult materials of *Cordia* and *Varronia* collected by other researchers in previous centuries.				Analyses of exsiccatae of the Brazilian herbaria to obtain morphological and distribution data. This information was used to produce the taxonomic descriptions of species of *Varronia*, to get distribution data and to evaluate the environments where they occur. From these data it will be possible to estimate the areas of occurrence of the species and their conservation status. Approximately 9000 dried specimens included in *Varronia* and *Cordia* sensu lato were examined originated from 35 herbaria: ALCB, ASE, BHCB, BHZB, CEN, CEPEC, CESJ, EAC, G, HACAM, HEPH, HRB, HST, HUEFS, HUESB, HURB, IBGE, IAN, IPA,

				INPA, JPB, K, MAC, MG, MOSS, P, PACA, PEUFR, QCA, QCNE, TEPB, UB, UFP, UFRN, and VIC.
To visit other herbaria of South America.				The study of specimens in South American herbaria allowed us to know other species that occur in other countries, besides Brazil. Data obtained from exsiccates contributed to the identification of new records and expansion of knowledge about the environments to which *Varronia* species are associated. In addition, the photograph of the specimens and data from the exsiccates (acquired during the visit) will contribute to the realisation of new studies on *Varronia* in South America, as well as to the realisation of the phylogenetic study of the group.
To visit European herbaria, where the largest collections of plants from South America are preserved.				Most of the types of the species of *Varronia* were studied. All the materials were also photographed in detail and are still being analysed. The list of visited herbaria is attached.
To describe the morphological characters of *Varronia*'s species from Brazil, preferred environments and conservation status.				The taxonomic descriptions, illustrations and photographs, comments of distribution and conservation status were produced for the species of *Varronia* from Brazilian territory. Thirty-five species were recognised for Brazil, of which 21 are endemic. An identification key, descriptions, comments regarding morphology and taxonomy, geographic distributions, and illustrations are provided. Eight new synonyms and 11 typification's of valid names are designated. New records for different Brazilian states were found for 10 species. **Taxonomic revision of *Varronia* P. Browne (Cordiaceae, Boraginales) in Brazil.** This work is being reviewed and finalised for publication. The first botanical illustrations with vegetative and reproductive characters were provided for the species *Varronia candolleana*,

				Varronia nivea, *Varronia setigera* and *Varronia striata*, complementing the information available for them and aiming to facilitate their recognition.
Anatomical analyses for the detection of diagnostic characters and understanding of strategies used in semi-arid environments.				The leaf anatomy of 10 *Varronia* species occurring in Brazil was investigated in order to detect diagnostic taxonomic characters for each of them. Leaves of 10 species collected were fixed in FAA, were dehydrated in ethyl series and embedded in resin. Sections of the petiole, vein, margin, apex and base were made using a rotary microtome, stained in toluidine blue and organised with water on slides. Slides for 10 species collected in the field were produced. Images were obtained using an Optical Microscope and Scanning Electron Microscopy (MEV) [images attached]. The leaf anatomy of the genus showed to be promising in the identification of diagnostic leaf characters at the species level and for the observation of characters that contribute to the understanding of the adaptations of these plants, especially in semi-arid environments. This work is being finalised for publication (manuscript is attached in archives). **Silva, Tolke and Melo. 2022. Anatomy_*Varronia*_preliminary results**
To contribute for the knowledge of *Varronia* species in biodiversity hotspots, as Atlantic Forest, Amazonia, Caatinga and Cerrado.				Field expeditions associated with the analysis of numerous exsiccates in herbaria made it possible to observe the frequency of *Varronia* species at forest edges, even in environments observed as already fragmented or under anthropic influence. This may suggest a strong adaptive character of the species of this group to the conditions of environmental disturbance, which may serve as an object for future ecological studies. In addition, the discovery of new species of *Varronia* in highly threatened biomes in Brazil (such as the Amazon

				and Cerrado) highlights the importance of conserving these environments, to avoid the extinction of species.
Molecular analyzes for phylogenetic study.				Due to the short time, to the collections period, visits to the herbaria and construction of taxonomic revision, it was not possible to obtain all the samples needed to initiate the molecular phylogeny of the genus *Varronia*. However, the study of *Varronia* species will continue. The set of data already obtained plus the realisation of new collections in other South American countries will serve as a basis for carrying out the Phylogeny of the group, as soon as possible.

2. Describe the three most important outcomes of your project.

a). Discovery of new species and new records of *Varronia* from Brazil and other countries in South America.

b). Resolution of nomenclatural problems and typification's in names of *Varronia* species, contributing to the correct delimitation of species and facilitating future identification of these species in ecological and/or taxonomic studies.

c). Field expeditions associated with the analysis of numerous exsiccates in herbaria made it possible to observe the frequency of *Varronia* species at forest edges, even in environments observed as already fragmented or under anthropic influence. This may suggest a strong adaptive character of the species of this group to the conditions of environmental disturbance, which may serve as an object for future ecological studies.

3. Explain any unforeseen difficulties that arose during the project and how these were tackled.

The taxonomic revision of *Varronia* species requires time and attention, since this genus is composed by ca. 130 species (35 occurs in Brazil). Of the 35 species recorded for Brazil (Flora of Brazil 2020), 15 were collected in the field during this study. In addition, more collections of botanical material need to be performed to obtain considerable number of samples for the molecular analysis.

Nomenclatural updates, typification's and clarification of the history of names in *Varronia* were the biggest challenge, as nomenclatural historical complexes were observed for accepted names and synonyms. The discussion and updating of commonly used names such as *V. mayoi* (suggested in this work as *V. nivea*) and *V. tarodaea* (suggested in this work as *V. candolleana*), exemplifies the importance of

revisional studies. The delimitation of lectotypes of accepted names and synonyms aimed to contribute to a better nomenclatural stability and delimitation of the species concept.

Due to the short time, to the collections period, visits to the herbaria and construction of taxonomic revision, it was not possible to obtain all the samples needed to initiate the molecular phylogeny of the genus *Varronia*. However, the study of *Varronia* species will continue. The set of data already obtained plus the realization of new collections in other South American countries will serve as a basis for carrying out the phylogeny of the group, as soon as possible.

For this, we aim carry out more field collections and to publish the taxonomic revision of *Varronia* by the end of 2022.

4. Describe the involvement of local communities and how they have benefitted from the project.

The work involves the formation of a PhD student (Thaynara de Sousa Silva) and a graduate student in Biological Sciences (Luan Pedro da Silva), contributing to the advancement of scientific knowledge in the Brazilian northeast, as well as to the training of this students in the development of works dealing with local flora.

The study of common species in the local flora, although sometimes neglected by Brazilian public bodies and local communities, is of extreme importance for the preservation of these and/or their sustainable use, noting that certain species urgently need more attention to their conservation.

In addition, the data obtained through this project contributed to the update (by our team) of Flora do Brasil Online 2020 (http://floradobrasil.jbrj.gov.br/). This database is updated by researchers from the botanical families. Since we work with *Varronia*, we have updated this database This database is updated by researchers from the botanical families. Since we work with *Varronia*, we have updated this database with the information obtained during the realisation of this project.

5. Are there any plans to continue this work?

Yes, the study of *Varronia* species will continue. The set of data already obtained plus the new collections in other South American countries will serve for carrying out the phylogeny of the group, as soon as possible.

6. How do you plan to share the results of your work with others?

The immediate results culminate in scientific publications.

Inedited data are provided about habitat, distribution, diagnostic characters and correct identification of the species of *Varronia*.

The results of Brazilian species are also available in the online database "Flora do Brasil Online". These publications provide the basis for the implementation of public conservation policies and for the utilization in other environments studies.

In addition, the results were also presented in National and International Congress (attached certificates).

7. Looking ahead, what do you feel are the important next steps?

- To conclude and publish the taxonomic revision of *Varronia*.
- To conclude and publish the anatomical study.
- To start molecular analyses and carry out of molecular phylogeny of *Varronia* including their origin and evolutionary history.

8. Did you use The Rufford Foundation logo in any materials produced in relation to this project? Did the Foundation receive any publicity during the course of your work?

The Rufford Foundation logo was used in presentation of conference in the XII Congreso LatinoAmericano de Botánica (October 21-28, 2018). The works presented were: "O gênero Varronia P. Browne (Cordiaceae, Boraginales) na América do Sul" and "O gênero Varronia P. Browne (Cordiaceae, Boraginales) no Nordeste brasileiro". The works are attached.

The Rufford Foundation was cited in acknowledgment in in all published articles (the works are attached).

9. Provide a full list of all the members of your team and their role in the project.

Thaynara de Sousa Silva – Substantial contribution in the concept and design of the study; Execution of collections, herborization and storage of the collected specimens; data analysis and interpretation of the results; Identification and description of specimens collected and viewed in herbarium; Contribution to manuscript preparation.

José Iranildo Miranda de Melo – Substantial contribution in the concept and design of the study; Contribution to data analysis and interpretation of the results; Contribution to manuscript preparation; Contribution to critical revision, adding intellectual content; Substantial contribution to identification and description of specimens collected and viewed in the herbaria visited.

Luan Pedro da Silva – Contribution to data collection; Contribution to data analysis; Contribution to the production of slides for anatomical and morphological analysis; Contribution to manuscript preparation; Contribution to critical revision.

Elizabeth Dantas Tölke – Contribution in the concept and design of the anatomical study; Contribution to the practical development of anatomical studies, mainly in

the methods used. Contribution to analysis of anatomical data and interpretation of the results; Contribution to critical revision, adding intellectual content.

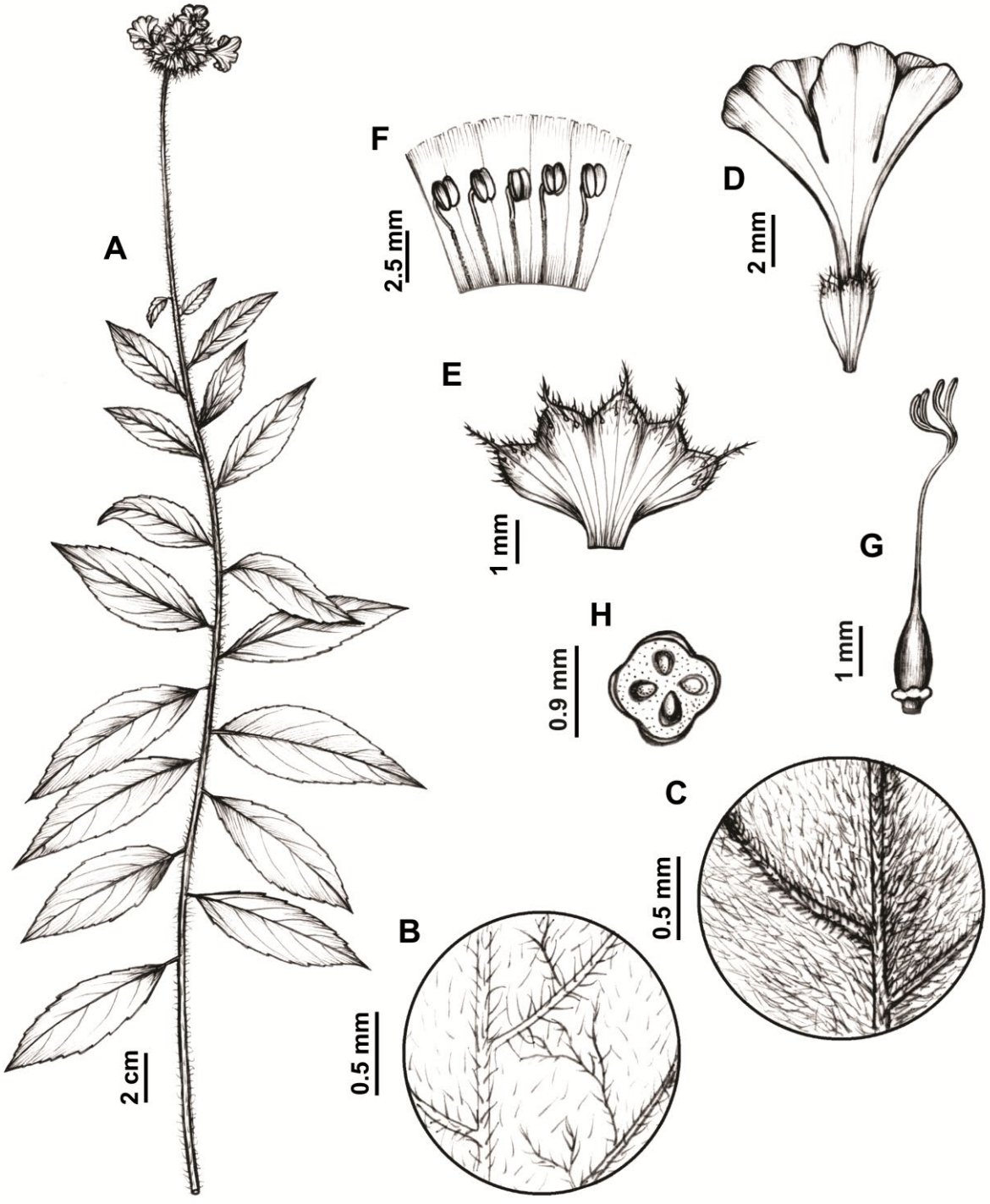
Ana Paula Stechhahn Lacchia – She granted the space of the plant anatomy, in the Botanic Laboratory (UEPB), to perform the anatomical analysis.

P.S.: The molecular analysis did not start; the participation of **Dr. Luis Gustavo Souza** has not yet been possible.

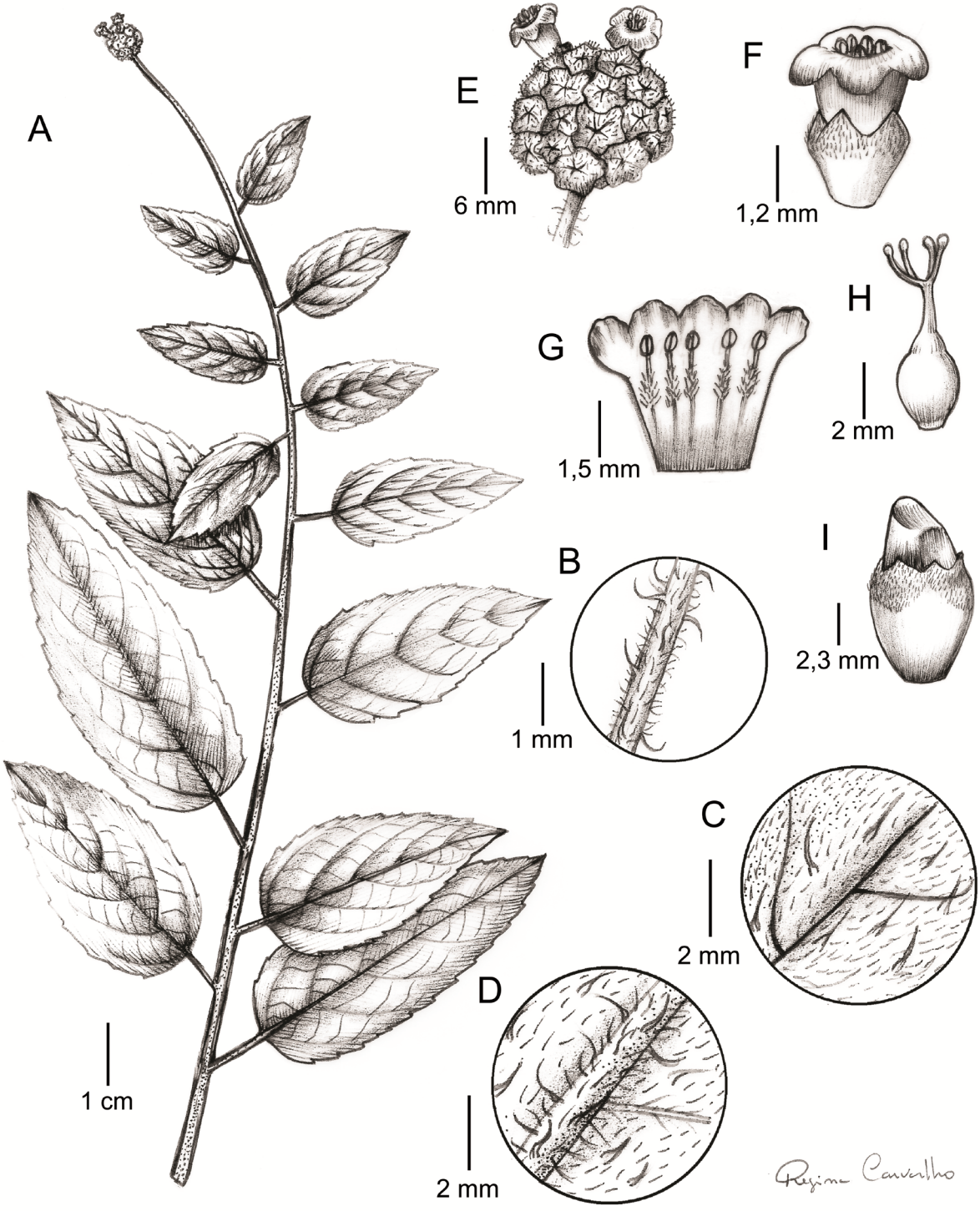
10. Any other comments?

We are extremely grateful to the foundation for all support for the knowledge and conservation of *Varronia* species.

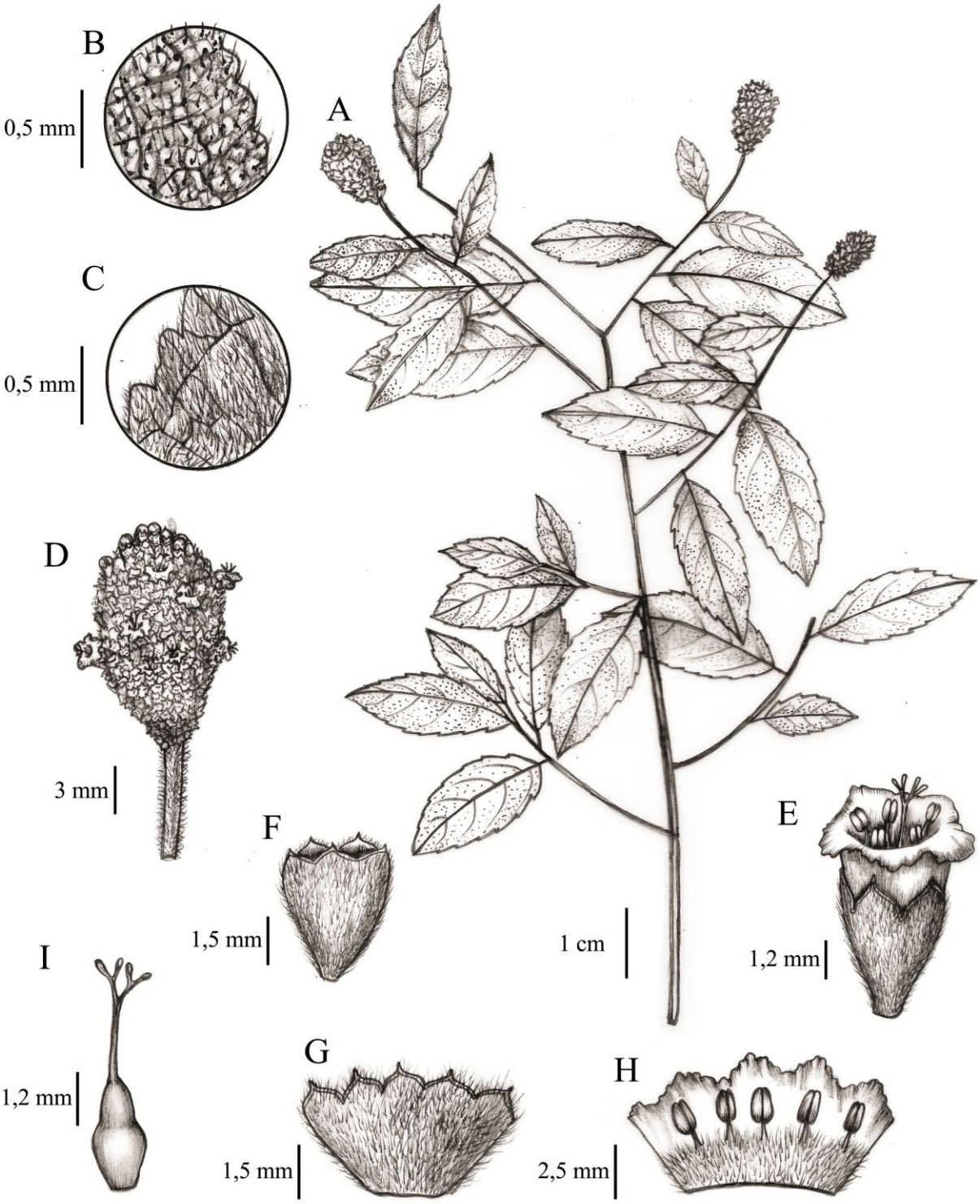
All the items and visits mentioned form the fieldwork, which culminated in the results presented, including the travels suggested in funding. The destination changes had to be made due to the time and amount of material in each locality. We understand that a basic eligibility criterion for Rufford is that the work is part of a postgraduate study (MSc or PhD), there needs to be a strong emphasis on fieldwork with clear conservation benefits. Thus, we understand that all the amounts used refer to the expenses incurred in all field activities (collections and herbaria). All values used are proven with receipts according to the fieldwork dates (collections and herbaria).



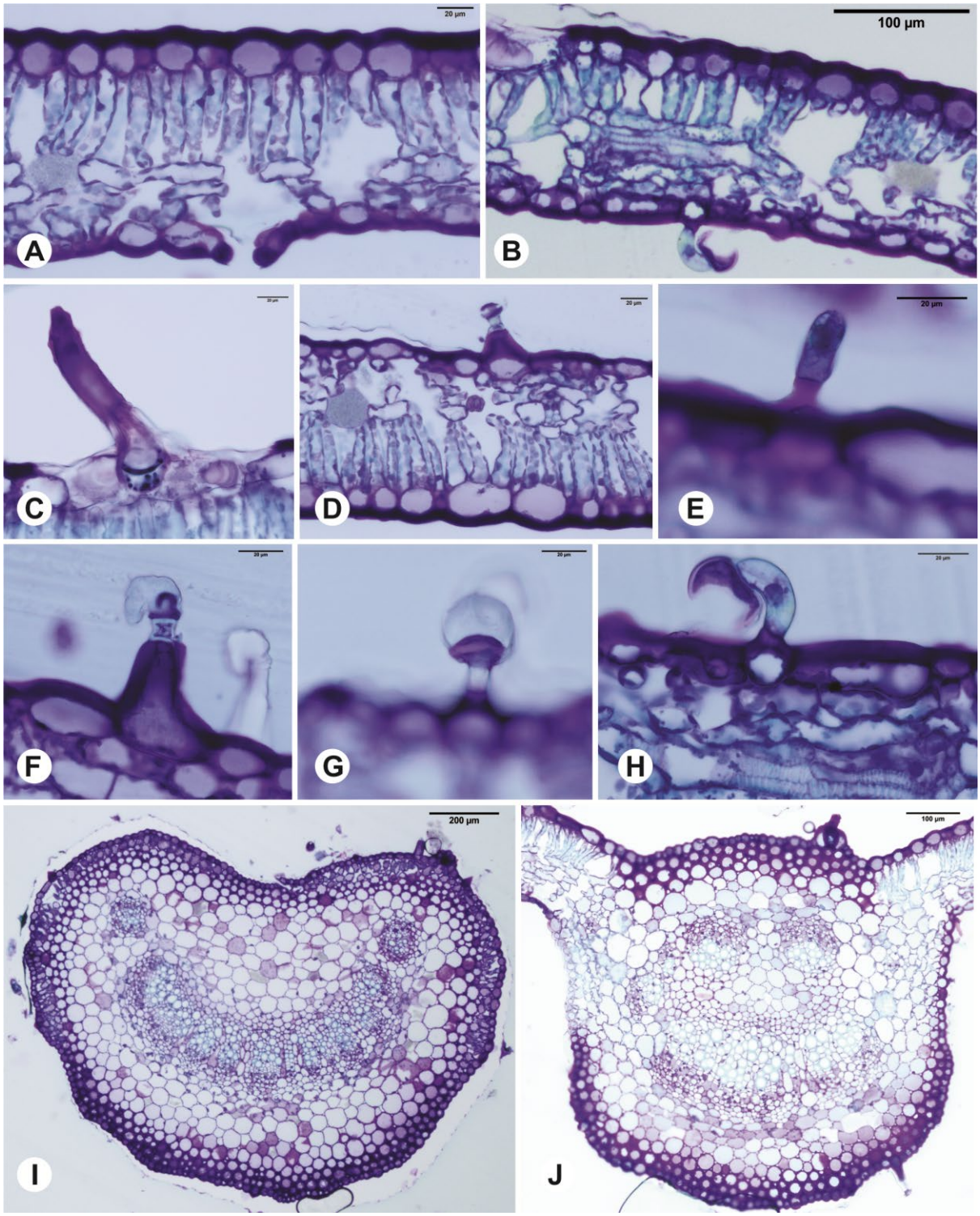
V. neowediana - First detailed illustration of its morphology



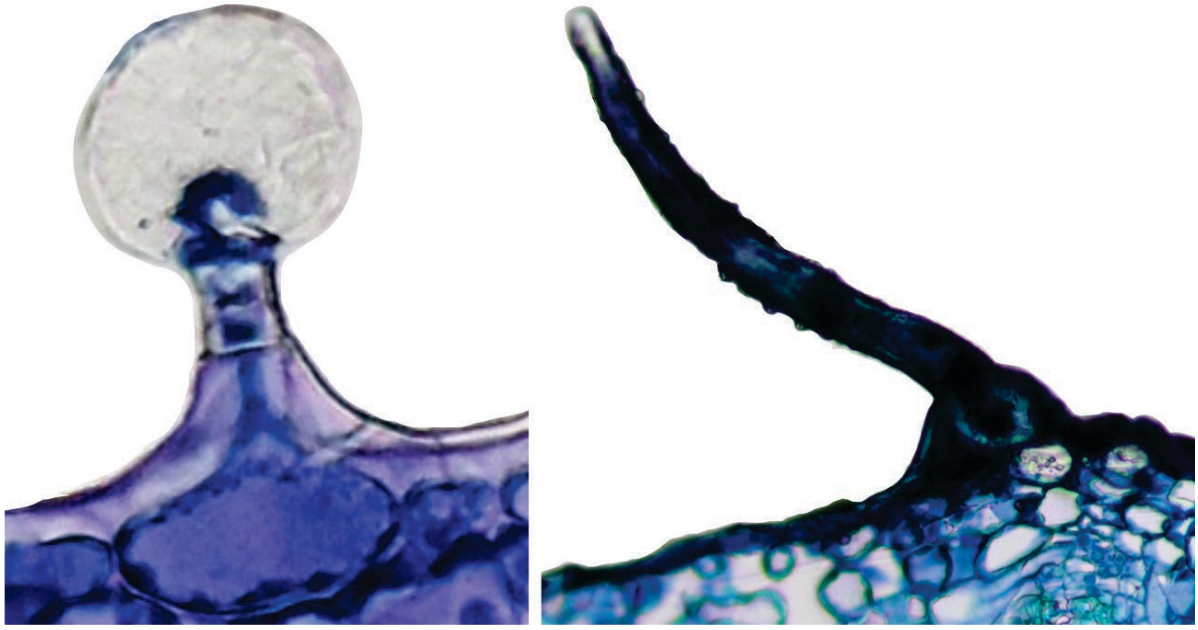
Varronia mariana, species recently described for Brazilian Flora. Drawing Regina Carvalho.



Varronia xinguana. Drawing Regina Carvalho.



Anatomy photograph - Visualization of the petiole anatomy in a species of Varronia.
© Thaynara Silva.



Anatomy photograph - Visualization of glandular and non-glandular trichome in a species of Varronia. © Elizabeth Tolke and Thaynara Silva.

Expedition collect Bahia - A caterpillar feeding a leaf of Varronia curassavica. © Thaynara Silva.

Expedition collect Bahia - An individual of V. curassavica with its leaves being feeding by caterpillars. © Thaynara Silva.

Expedition collect Bahia - V. leucocephala in a trasition area Caatinga-Cerrado in the South of Bahia state. © Thaynara Silva.

Expedition collect Bahia - V. multispicata in at the top of Serra da Jiboia, Bahia, Brazil. © Wesley Cordeiro.

Expedition collect Bahia, Brazil - Thaynara Silva beside a shrub of Varronia curassavica. © Thaynara Silva.

Expedition collect Bahia, Brazil - Varronia polycephala in Reserva do Una, South coast of Bahia state, Brazil. © Thaynara Silva.

Expedition collect Bahia, Brazil - Varronia polycephala in Reserva do Una, South coast of Bahia state, Brazil. © Wesley Cordeiro.

Expedition collect Minas Gerais - new species - V. minensis (2).

Expedition collect Minas Gerais - new species - V. minensis (2).

Expedition collect Minas Gerais - new species - V. minensis (3).

Expedition collect Minas Gerais - new species - V. minensis (4).

Expedition collect Minas Gerais - new species - V. minensis (5).

Expedition collect Minas Gerais - new species - V. minensis.

Expedition collect Minas Gerais - new species - V. minensis.

Expedition collect Sergipe, Brazil - Thaynara Silva with a specimen of Varronia johnstoniana. © Juliana Aureliano.

Expedition collect Sergipe, Brazil - V. johnstoniana, endemic species, being pollinated. © Juliana Aureliano.

Expedition collect Sergipe, Brazil - V. johnstoniana, endemic species, being pollinated. © Thaynara Silva.

Expedition collect Sergipe, Brazil - V. johnstoniana, endemic species. © Thaynara Silva.

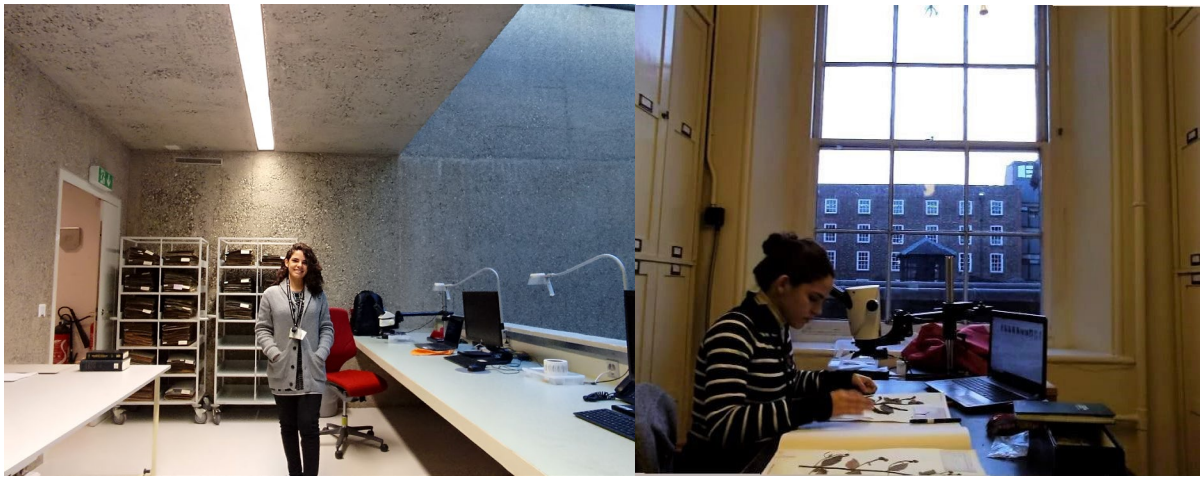
Inflorescence of a specie of Varronia in the south of Bahia state.

Varronia multispicata in Usina São José, Pernambuco, Brazil. © Thaynara Silva.

Thaynara S Silva and Luan Pedro Silva -Analysis of specimens of the genus Varronia_Herbarium QCNE_Quito.

Left: Visit to CEN herbarium in Brasilia, Federal District, Brazil. © Thaynara Silva. Right: Visit to MAC herbarium in Maceió, Alagoas, Brazil. © Thaynara Silva.


Visit to UB herbarium - analysing species of Varronia. © Thaynara Silva.



Left: Visit to G Herbarium - Thaynara Silva in G Herbarium for analyses of Varronia's collections. Right: Visit to K Herbarium - Thaynara Silva analysing specimens of Varronia at the Kew Herbarium.

Visit to Paris Herbarium - Collections Cordia e Varronia in P herbarium.

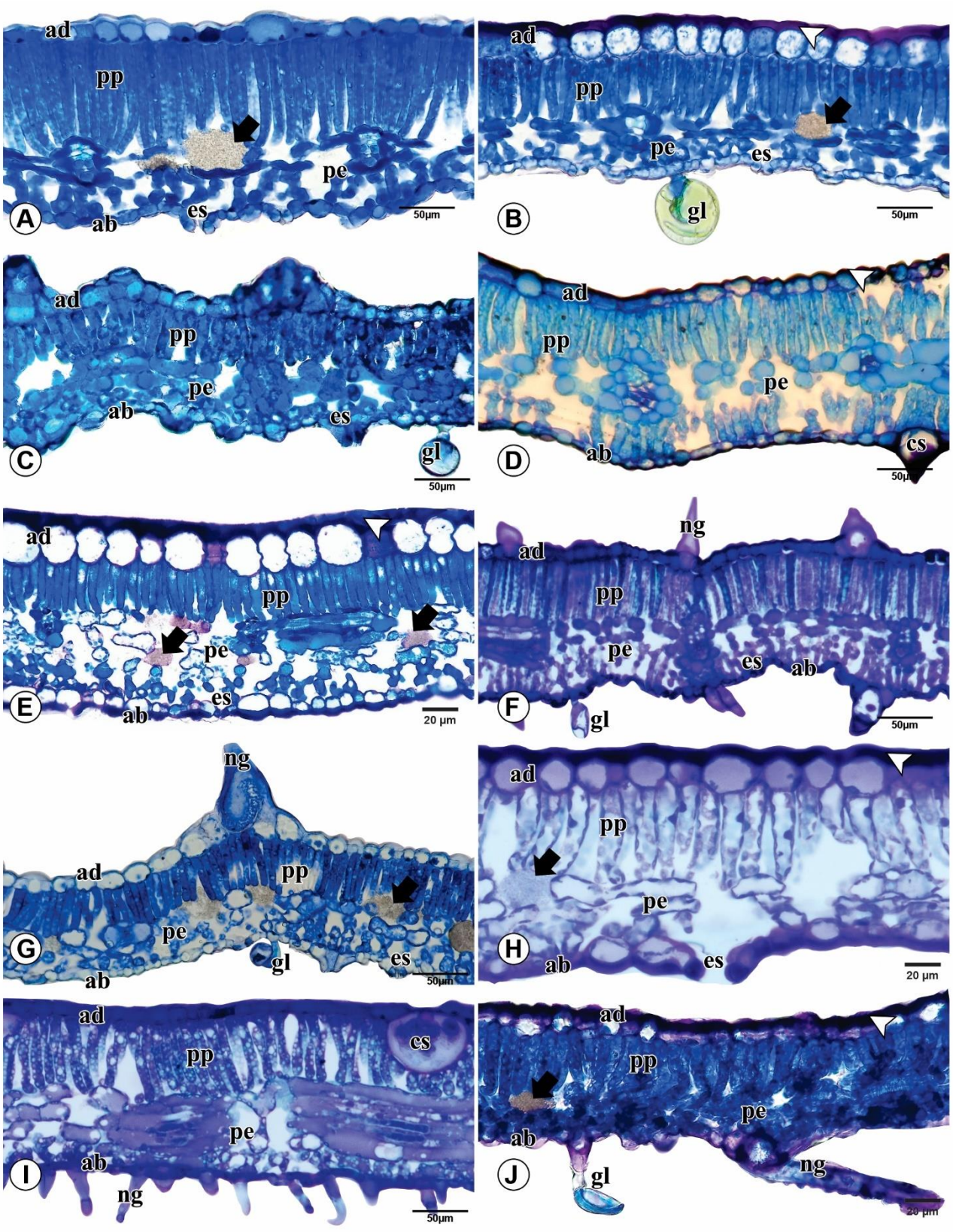


Fig. 1. Seção transversal da lâmina foliar em espécies de *Varronia*. A. *V. curassavica*. B. *V. dardani*. C. *V. glandulosa*. D. *V. globosa*. E. *V. johnstoniana*. F. *V. leucocephala*. G. *V. leucomalloides*. H. *V. mariana*. I. *V. polycephala*. J. *V. striata*. ab = epiderme abaxial; ad = epiderme adaxial; gl = tricoma glandular; es = estômato; pe = parênquima espojoso; pp = parênquima paliçádico; ng = tricoma não-glandular; setas pretas indicam idioblastos contendo areia cristalina; setas brancas indicam a cutícula.

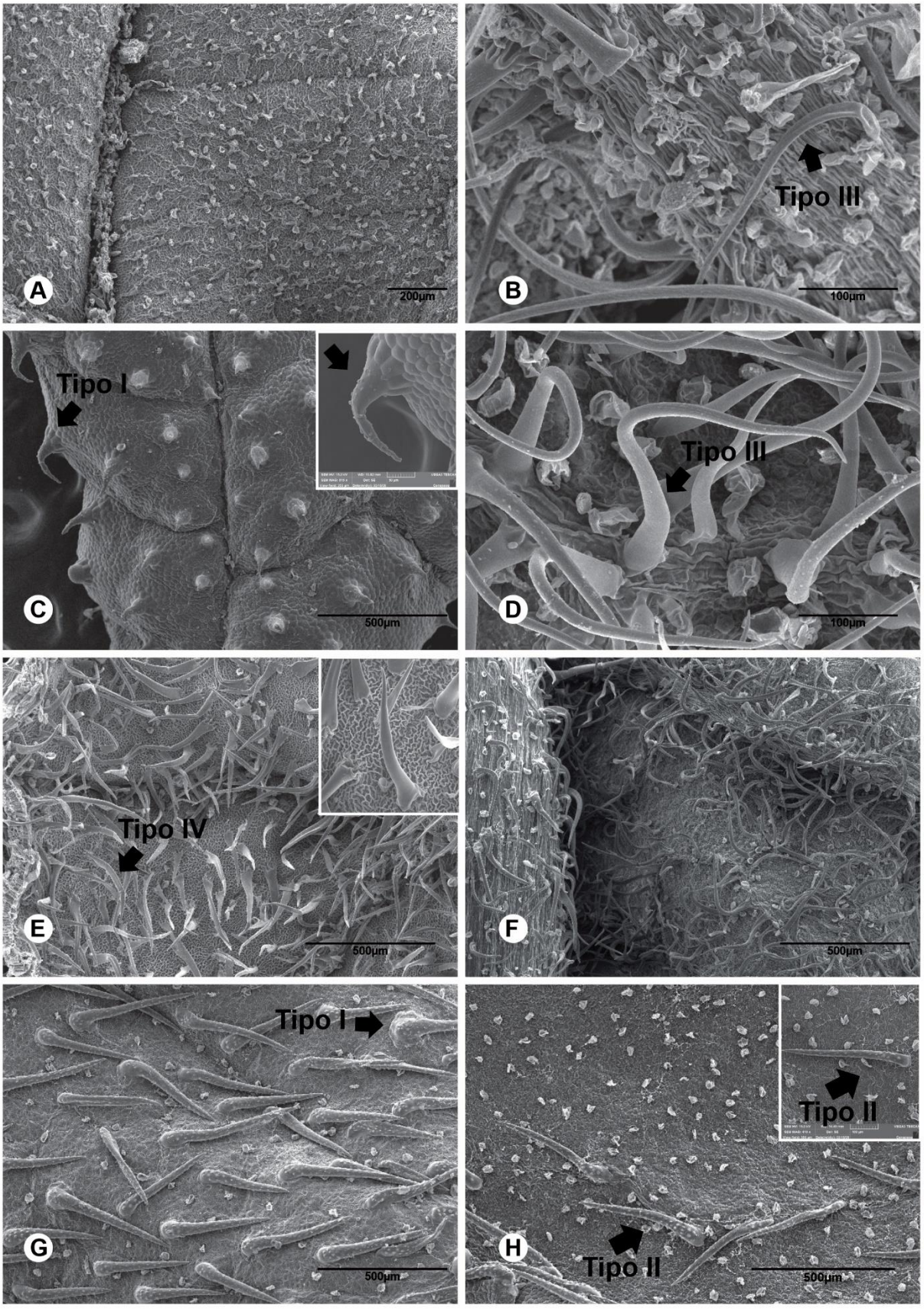


Fig. 2. Tricomas na face adaxial e abaxial da lâmina foliar, respectivamente, em espéciesde *Varronia*. A–B. *V. curassavica*. C–D. *V. dardani*. E–F. *V. glandulosa*. G–H. *V. johnstoniana*.

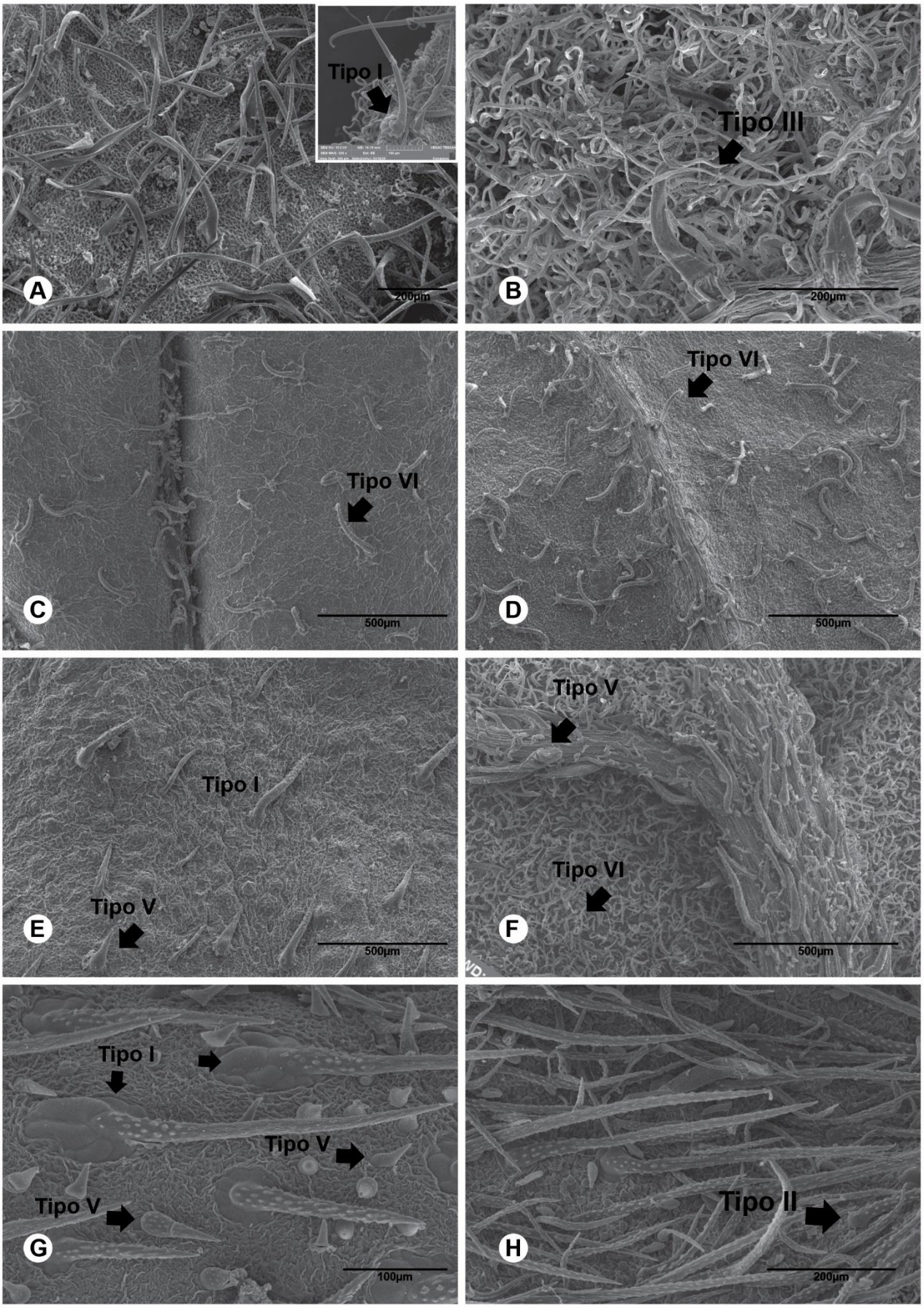


Fig. 3. Tricomas na face adaxial e abaxial da lâmina foliar, respectivamente, em espécies de *Varronia*. A–B. *V. leucomalloides*. C–D. *V. mariana*. E–F. *V. polycephala*. G–H. *V. striata*.

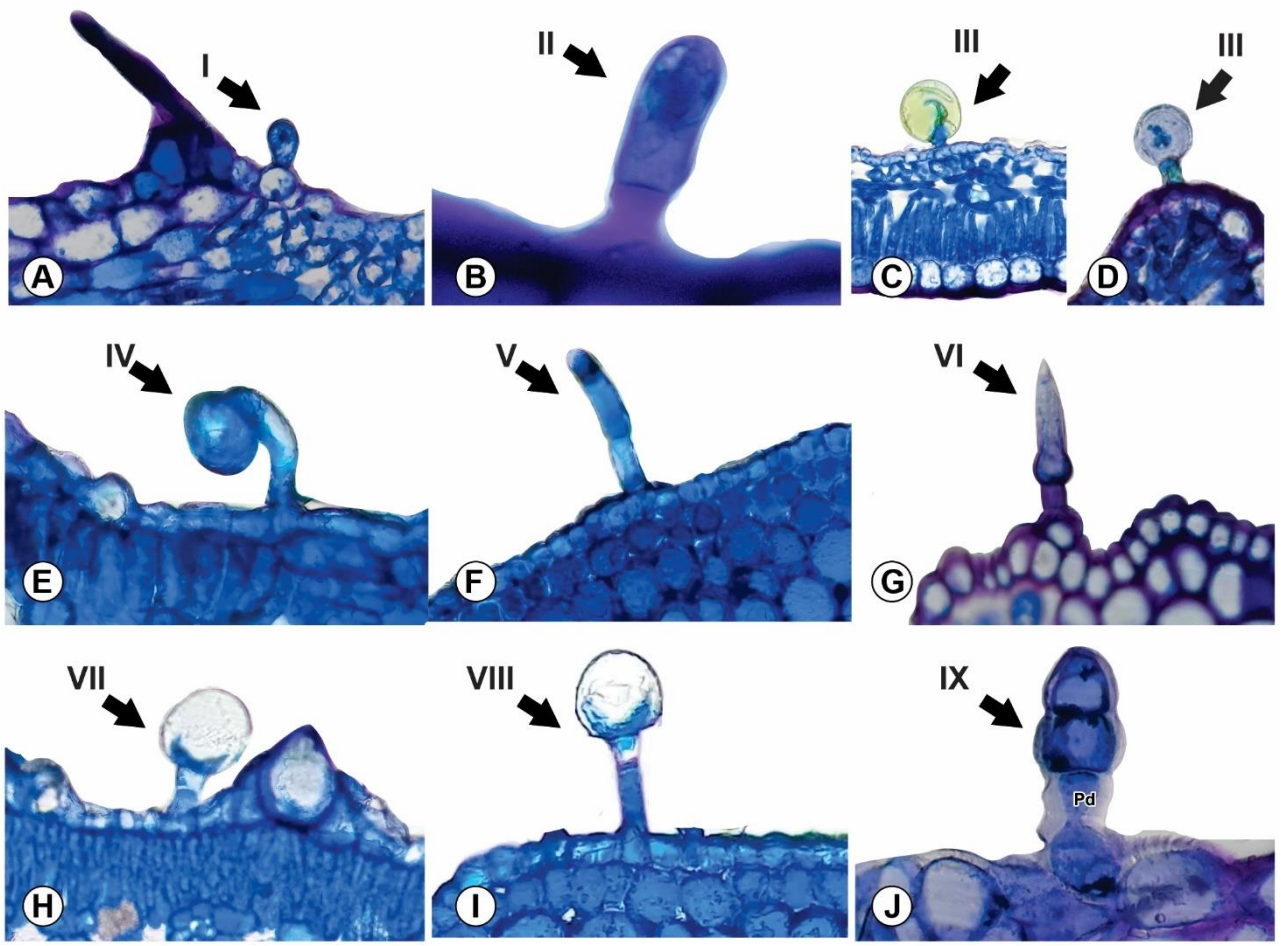


Fig. 4. Tipos de tricomas glandulares indicados pelas setas nas espécies de *Varronia*. A. Tipo I. B. Tipo II. C e D. Tipo III. E. Tipo IV. F. Tipo V. G. Tipo VI. H. Tipo VII. I. Tipo VIII. J. Tipo IX.

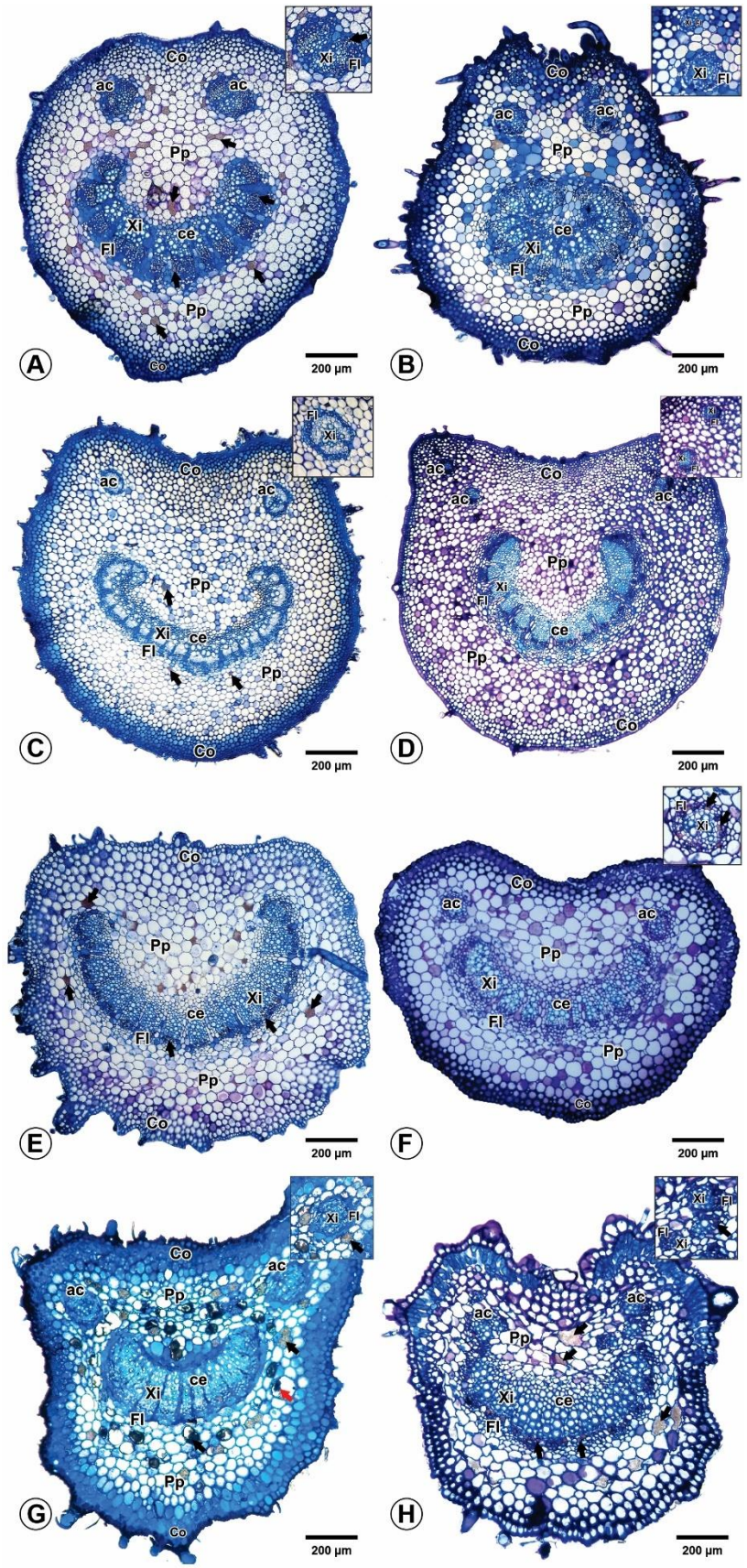


Fig. 5. Seção transversal do pecíolo com detalhe dos corpos laterais em espécies de *Varronia*. A. *V. curassavica*. B. *V. dardani*. C. *V. glandulosa*. D. *V. johnstoniana*. E. *V. leucomalloides*. F. *V. mariana*. G. *V. polycephala*. H. *V. striata*. ac = corpos vasculares acessórios; ce = corpo vascular central; Co = colênquima; Fl = floema; Pp = parênquima paliçádico; Xi = xilema; setas pretas = areia cristalina; seta vermelha = drusa.

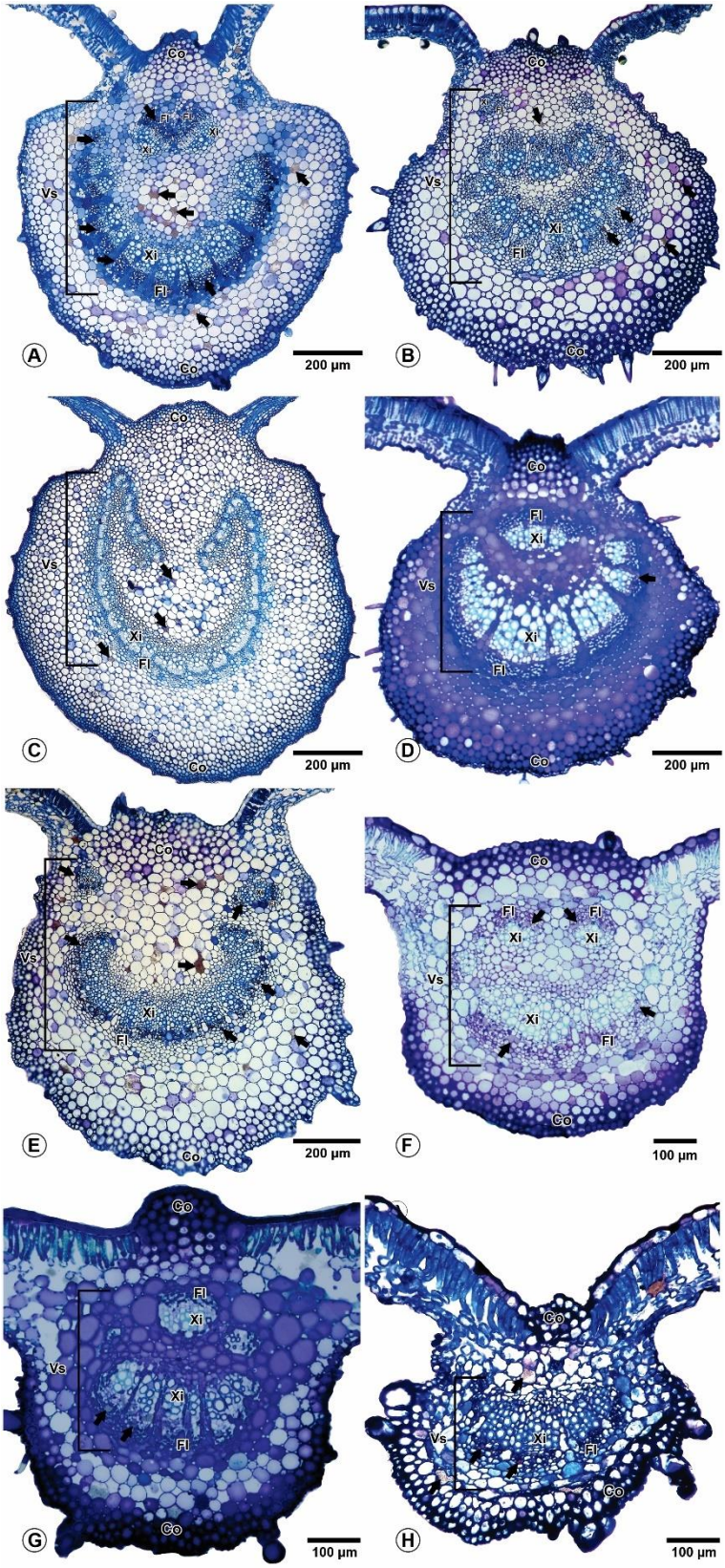


Fig. 6. Seção transversal da nervura sentral com detalhe do sistema vascular em espécies de *Varronia*. A. *V. curassavica*. B. *V. dardani*. C. *V. glandulosa*. D. *V. leucocephala*. E. *V. leucomalloides*. F. *V. mariana*. G. *V. polycephala*. H. *V. striata*. Co = colênquima; Fl = floema; Vs = sistema vascular; Xi = xilema; setas = areia cristalina.