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Revisão Taxonômica e Anatomia Foliar de *Lychnocephalus* Mart. ex DC.

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2021

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Revisão Taxonômica e Anatomia Foliar de *Lychnocephalus* Mart. ex DC.

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“Para tudo há um tempo, para cada coisa há um momento debaixo do céu”

Eclesiastes 3:1

RESUMO

Lychnocephalus Mart. ex DC. é um pequeno gênero da subtribo Lychnophorinae (Asteraceae, Vernonieae) recentemente restabelecido, e anteriormente considerado um sinônimo de *Lychnophora* Mart.. Na última classificação realizada, o gênero apresentava quatro espécies, endêmicas da Cadeia do Espinhaço, *Lychnocephalus humillimus, L. mellobarretoi*, *L. sellovii* e *L. tomentosus*. Apesar do recente restabelecimento do gênero e esclarecimento de sua delimitação, os limites de algumas espécies permaneciam duvidosos, além disso, algumas espécies ainda não haviam sido validamente publicadas. Nesse contexto, era necessário uma reavaliação dos conceitos das espécies descritas bem como da distribuição geográfica das mesmas. Considerando os aspectos apresentados objetivou-se realizar uma revisão taxonômica integrativa do gênero *Lychnocephalus*, complementando os dados morfológicos e geográficos com o estudo da anatomia foliar das espécies. Foram realizadas expedições na Serra do Cipó, estado de Minas Gerais na porção Sul da Cadeia do Espinhaço, além de coletas de folhas para o estudo anatômico. A análise morfológica foi realizada através do estudo dos tipos nomenclaturais, exemplares depositados em herbários, além dos novos materiais botânicos coletados durante as expedições de campo. Foram revistos os nomes publicados para o gênero e espécies. No estudo da anatomia foliar das espécies foram analisados aspectos tanto referentes à arquitetura quanto ao mesofilo das folhas. No presente estudo, são reconhecidas oito espécies de *Lychnocephalus* (*L. canus*, *L. cipoensis*, *L. grazielae*, *L. humillimus*, *L. jolyanus*, *L. mellobarretoi*, *L. sellovii* e *L. tomentosus*), sendo seis delas restritas à Serra do Cipó e proximidades e duas amplamente distribuídas ao longo da Cadeia do Espinhaço. Em relação à anatomia, foram observadas características que incluem um novo tipo de tricoma não glandular, diferenças na disposição de fibras esclerenquimáticas que circundam os feixes vasculares, nervuras intermediárias entre as nervuras principais e traqueídes terminais localizados nas vênulas das espécies, que corrobora com a taxonomia de *Lychnocephalus*.

Palavras-chave: Asteraceae; Campos rupestres; Cadeia do Espinhaço; Lychnophorinae; Sistemática integrativa; Taxonomia.

ABSTRACT

Lychnocephalus Mart. ex DC. is a small genus of the subtribe Lychnophorinae (Asteraceae, Vernonieae) recently reestabished, and considered a synonym for *Lychnophora* Mart. In the last classification carried out, the genus had four species, endemic to Espinhaço Range: *Lychnocephalus humillimus*, *L mellobarretoi*, *L. sellovii* and *L. tomentosus*. Despite the recent reestablishment of the genus and clarification of its delimitation, the limits of some species remained doubtful, furthermore, some species that have not yet been clarified. In this context, it was necessary to reassess the concepts of the specific species as well as their geographic distribution. Basic aspects the objective was to carry out an integrative taxonomic revision of the genus *Lychnocephalus*, complementing the morphological and geographic data with the study of the leaf anatomy of the species. Expeditions were carried out in the Serra do Cipó, state of Minas Gerais in the southern portion of the Espinhaço Range, in addition to leaf collections for the anatomical study. A morphological analysis was carried out through the study of nomenclatural types, specimens deposited in herbariums, in addition to the new botanical materials collected during field expeditions. Published names for the genus and species have been revised. No study of the leaf anatomy of the species has been compensated for either the architecture or the mesophyll of the leaves. In the present study, eight species *Lychnocephalus* are recognized (*L. canus*, *L. cipoensis*, *L. grazielae*, *L. humillimus*, *L. jolyanus*, *L. mellobarretoi*, *L. sellovii* and *L. tomentosus*), six of which are restricted to Serra Cipó and proximities and two widely distributed along the Espinhaço Range. Regarding anatomy, characteristics were observed that include a new type of non-glandular trichome, differences in the arrangement of sclerenchymatic fibers that surround the vascular bundles, intermediate veins between the main veins and terminal tracheids treated in the venules of the species, which corroborate with the species. taxonomy of Lychnocephalus.

Key-words: Asteraceae; Campos Rupestres; Espinhaço Range; Lychnophorinae; Integrative Sistematics; Taxonomy.

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1 INTRODUÇÃO

Asteraceae é considerada umas das maiores famílias de angiospermas, com aproximadamente 25.000-35.000 espécies e cerca de 1.600-1.700 gêneros, distribuídas em todo o mundo, com exceção da Antártida (FUNK et al. 2009; MANDEL et al. 2019), ocorrendo principalmente em campos abertos, em vegetações montanhosas e, com menor frequência, em florestas úmidas (JEFFREY 2007).

A família apresenta como principais caracteres diagnósticos a presença de flores arranjadas em um receptáculo e circundadas por um conjunto de brácteas (capítulo), anteras sinânteras e presença de cipselas geralmente com pápus (FUNK et al. 2009). Estudos de Asteraceae que integram aspectos morfológicos, mas também citogenéticos, anatômicos, ontogenéticos, ecológicos, fitoquímicos e moleculares vem aumentando bastante (FUNK et al. 2009), contribuindo significativamente para um melhor conhecimento da família, sendo reconhecidas atualmente 16 subfamílias e 50 tribos. (FUNK et al. 2009; PANERO et al*.* 2014; SUSANNA et al*.* 2020).

Vernonieae Cass., uma das tribos de Asteraceae compreende entre 1.200 e 1.500 espécies distribuídas em aproximadamente 135 gêneros, apresentando como principais centros de diversidade a África tropical, Madagascar, Brasil e a América do Norte (KEELEY & ROBINSON 2009; KEELEY ET AL. 2021). Lychnophorinae é uma subtribo de Vernoniae que atualmente compreende 19 gêneros e cerca de 123 espécies ocorrendo predominantemente nos campos rupestres do Planalto Central Brasileiro (LOEUILLE et al. 2019; BRINGEL JR. et al. 2019; CÂNDIDO & LOEUILLE 2020; GOMES & LOEUILLE 2021 (ver apêndice 1)). A subtribo é monofilética apresentando como sinapomorfia fitoquímica a presença do composto heliangolido nas partes aéreas (LOEUILLE et al. 2015a). Além disso, outras características morfológicas que auxiliam no reconhecimento da subtribo são: plantas geralmente lenhosas, estilete sem nódulo basal , tricomas 3-5 ramificados, presença de bainhas foliares, sincefalia frequente e pápus paleáceo decíduo a caduco (LOEUILLE et al. 2015b; LOEUILLE et al. 2019).

Lychnocephalus Mart. ex. DC. é um pequeno gênero de Lychnophorinae, da Cadeia do Espinhaço, Minas Gerais, ocorrendo nos campos rupestres, com a maioria das suas espécies endêmicas da Serra do Cipó. O gênero foi validamente descrito por Candolle em 1836 e transferido para *Lychnophora* por Schultz-Bipontinus em 1863, sendo recentemente restabelecido por Loeuille et al. (2019) com base em evidencias filogenéticas utilizando dados morfológicos e moleculares (LOEUILLE et al. 2015b).

Na dissertação de doutorado realizado por Semir (1991) que consiste na revisão do gênero *Lychnophora*, no qual *Lychnocephalus* ainda estava incluso, são descritas oito espécies, sendo quatro delas novas (*L.* “cipoensis” sp. ined., *L.* “grazielae” sp. ined, *L. “joliana”* sp. ined., *L. “sessilis”* sp. ined), porém o trabalho foi parcialmente publicado no Livro “Arnicas êndemicas da Serra do Cipó", em 2011, sem incluir a descrição dessas novas espécies. Na classificação mais recente, o gênero apresentava quatro espécies: *Lychnocephalus humillimus* (Sch.Bip.) Loeuille, Semir & Pirani; *L. mellobarretoi* (Barroso) Loeuille, Semir & Pirani; *L. sellovii* (Sch.Bip.) Loeuille, Semir & Pirani e *L. tomentosus* Mart. ex Candolle (LOEUILLE et al. 2019).

Lychnocephalus caracteriza-se por compreender em sua maioria, espécies arbustivas ou arvoretas robustas, às vezes candelabriformes, a subarbustos; folhas dispostas de forma laxa ou moderadamente imbricadas ao longo dos ramos, bainha semiamplexicaule ou amplexicaule e capítulos organizados em sincéfalos de terceira ordem (i.e., capítulos terciários). Uma das caraterísticas que têm se mostrado útil na identificação de algumas espécies do gênero é o padrão de venação denominado paralelódromo que, que consiste na presença de nervuras principais paralelas que partem da bainha foliar das folhas (SEMIR 1991; LOEUILLE et al. 2019).

Os avanços nos estudos filogenéticos envolvendo *Lychnocephalus* esclareceram as relações do gênero com o restante das Lychnophorinae, principalmente com *Lychnophora*. No entanto, uma revisão taxonômica do gênero faz-se necessária devido ao grande número de coletas dessas espécies realizadas desde o último tratamento realizado pelo Semir (1991). Além disso, as espécies apresentam uma ampla variação em relação à morfologia, necessitando, deste modo, de uma reavaliação das características morfológicas usadas para distinguir as espécies.

O **capítulo 1** trata da Revisão Taxonômica de *Lychnocephalus*, onde foi revisto todos os nomes válidos para o gênero, bem como a inclusão de quatro novas espécies, sendo uma delas descrita aqui. Nesse trabalho contém o histórico da classificação do gênero, descrições e comentários morfológicos, ilustrações, pranchas de fotos, chave de identificação e mapas de distribuição para todas as espécies

O **capítulo 2** consiste na utilização da anatomia vegetal como subsídio à taxonomia de *Lychnocephalus*. Nesse capítulo são abordados tanto aspectos referentes à arquitetura foliar,quanto a anatomia interna de todas as espécies do gênero, com o objetivo de encontrar caracteres que possam ser úteis na diferenciação de espécies relacionadas, entre elas *Lychnocephalus sellovii* e a nova espécie descrita *L. canus*, as quais são morfologimaente semelhantes.

Além disso, é adicionado no apêndice o **artigo submetido e aceito** pela revista Systematic Botany, que descreve três novas espécies de *Lychnocephalus* endêmicas da Serra do Cipó.

2 FUNDAMENDAÇÃO TEÓRICA

2.1 *Lychnocephalus* Mart. ex DC., um breve histórico do gênero

Lychnocephalus Mart. ex DC. é um pequeno gênero de Asteraceae (Vernoniae, Lychnophorinae), recentemente restabelecido com base em dados morfológicos e moleculares (LOEUILLE et al. 2019). O gênero apresenta espécies endêmicas e pouco coletadas, sendo classificadas pelo Livro Vermelho da Flora do Brasil entre vulneráveis a criticamente em perigo de extinção (FERNANDEZ et al. 2020).

Com base em um material coletado por Martius, o gênero foi estabelecido por Candolle em 1836, juntamente com os gêneros *Blanchetia* DC., *Chronopappus* DC. e *Haplostephium* Mart. ex DC. (=*Lychnophora* Mart.). Schultz-Bipontinus (1863), em sua revisão de *Lychnophora*, sinonimizou *Lychnocephalus* em *Lychnophora*, e descreveu duas novas espécies: *L. humillima* e *L sellovii*. A classificação realizada por Schultz-Bipontinus, que consistia no agrupamento das espécies de *Lychnocephalus* dentro do grupo infragênerico *Homalophyllum*, foi a que mais se assemelhou com a atual classificação do gênero, excluindo apenas *Lychnophora albertinoides* Gardner; ele agrupou os táxons de acordo com características que incluíam a presença de folhas planas sem margens revolutas e frequentemente com nervuras longitudinais na face abaxial. Posteriormente, Baker (1873), na *Flora Brasiliensis*, manteve a sinonimização realizada por Schultz-Bipontinus, entretanto, não posicionou as espécies no mesmo subgênero.

Em 1922, Krascheninnikov descreveu uma nova espécie do grupo: *Lychnophora saxosa*, morfologicamente relacionada com *L. sellovii*. Barroso (1956) descreveu outra nova espécie : *L. mellobarretoi* , distribuída na Serra do Cipó. Em 1981, Coile e Jones, ao revisarem o gênero *Lychnophora*, sinonimizaram *L. mellobarretoi* em *L. humillima.* King (1986) ao realizar estudos fitoquímicos com base nas espécies de *Lychnophora* estabelecidas na revisão de Coile e Jones (1981), concordou com a sinonimização de *Lychnocephalus* em *Lychnophora* por apresentarem composição semelhante de flavonóides.

Semir (1991) realizou, no seu doutorado, uma nova revisão de *Lychnophora*, descrevendo 68 espécies para o gênero, 57 espécies a mais em relação a revisão de Coile e Jones (1981). O gênero foi dividido em seis seções: *L.* sect. *Lychnophora*, *L.* sect. *Lychnophoriopsis*, L. sect. *Lychnophorioides*, *L.* sect. *Lychnocephaliopsis*, *L.*

sect. *Sphaeranthus* (= *Paralychnophora*) e *L.* sect. *Chronopappus* (= *Chronopappus*). Nesse estudo não publicado, novas espécies são descritas além de ajustes relacionados às modificações realizadas na revisão anterior. Na seção *L.* sect. *Lychnocephaliopsis*, Semir restabeleceu *L. mellobarreto*i, sinonimizou *L. saxosa* em *L. sellovii* e descreveu quatro novas espécies: *L. cipoensis* sp. ined., *L. grazielae* sp. ined., *L. joliana* sp. ined. e *L. sessilis* sp. ined. Em 2011, Semir et al., publicaram esse trabalho, incluíndo informações fitóquímicas das espécies. No entanto, nenhuma espécie nova foi publicada neste trabalho, entre elas os táxons descritos em *L.* sect. *Lychnocephaliopsis*.

Posteriormennte, estudos filogenéticos realizados por Loeuille et al. (2015b) com base em dados morfológicos e moleculares, mostraram a polifilia de *Lychnophora* em três clados distintos, com boa sustentação estatística. As espécies classificadas em *Lychnophora* sect. *Lychnocephaliopsis*, formaram um clado bem sustentado na denominada Aliança *Prestelia* (Figura 1).

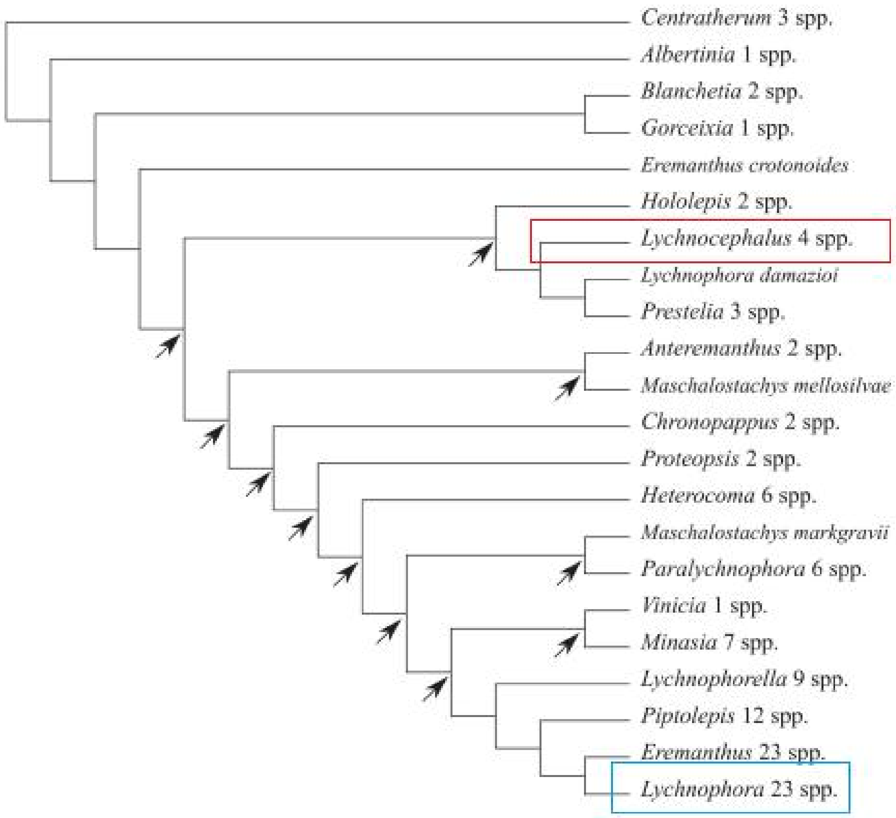


Figura 1 - Árvore mostrando as relações filogenéticas entre as Lychnophorinae, em destaque, o desmembramento de *Lychnocephalus* (quadro vermelho), das demais espécies de *Lychnophora* (quadro azul), as setas pretas indicam clados com sustenção >50% na análise de parcimônia. (Extraído e alterado de Loeuille et al. 2015b).

Ao realizarem a sinopse da subtribo Lychnophorinae em 2019, Loeuille et al. com base nos resultados obtidos em 2015, restabelecem o gênero *Lychnocephalus.* No entanto, das oito espécies descritas por Semir em 1991, apenas quatro são validamente publicadas (*L. humillimus, L. mellobarretoi, L. tomentosus* e *L. sellovii*).

Desse modo, apesar das contribuições de vários pesquisadores no melhor entendimento tanto de *Lychnophora* quanto de *Lychnocephalus*, há a necessidade de uma revisão para este último tanto para sanar os possíveis problemas de circunscrição dos táxons, além da publicação das novas espécies descritas por Semir (1991) e atualização de termos morfológicos que foram adotados em Lychnophorinae e que precisam ser atualizados em *Lychnocephalus* para uma melhor compreensão da morfologia do gênero.

2.2 A Taxonomia na elaboração de hipóteses científicas

Segundo a definição de Stuessy (2009), a taxonomia é o ramo da Biologia que objetiva explorar, descrever, nomear e classificar todos os organismos, diferentemente da Sistemática, que estaria relacionada no estudo das relações evolutivas entre organismos. Entretanto, o conceito de taxonomia ainda é amplamente discutido, e muitos autores consideram esse ramo da biologia como um sinônimo da Sistemática (STACE 1989; MICHÁN et al. 2008; STUESSY 2009) ou uma subdisciplina dentro desta (SIMPSON 1961).

Apesar da divergência de opiniões entre autores no conceito de taxonomia, é notável a importância desta para a ciência, tanto na descrição de padrões morfológicos, quanto para o desenvolvimento e teste de hipóteses de delimitação de espécie, aprimorando, dessa forma, idéias e descrições existentes através de novos dados (THOMSON et al. 2018).

De acordo com Nixon & Wheeler (1990) cada descrição de espécie é uma hipótese científica por ser uma descrição descontínua de combinações únicas de caracteres. Seguindo esse pensamento, Wheeler (2004) afirma que espécies são hipóteses por representarem uma generalização a partir da qual observações posteriores podem ser previstas; sendo que ao realizar essas observações a hipótese pode ser corroborada ou refutada. Além disso, a hipótese de uma espécie contribui para classificações preditivas que auxiliam nosso entendimento sobre diversidade biótica por meio de revisões sistemáticas e avaliações de homologia (CARVALHO et al. 2013).

No entanto, nos últimos anos tem-se observado o acentuado declínio em financiamentos na denominada taxonomia descritiva, atribuindo-se maior importância e altos investimentos às análises filogenéticas moleculares (WHEELER 2004). Segundo o relatório publicado pela House of Lords (2002) os financiamentos foram destinados em grande parte para análises filogenéticas em vez da taxonomia descritiva. Somado a isso, infelizmente a taxonomia ainda é vista por muitos como um ramo da ciência meramente descritivo, onde as espécies são entidades estáticas que não evoluem (CARVALHO et al. 2008).

Com a atual crise da biodiversidade, onde muitas espécies podem ter sido extintas antes mesmo de serem descritas, e onde uma provável extinção em massa pode occorer, devido principalmente à ações antrópicas (KOLBERT 2014; BRAZ 2015) é cada vez mais exigido dos taxonomistas a descrição ininterrupta de novas espécies (CARVALHO et al. 2013). A conseqüência disso pode acarretar em hipóteses de espécies incorretas, que comprometerão a confiabilidade de informação sistemática (CARVALHO et al. 2008).

Enquanto há o acúmulo de novas espécies descritas, muitos grupos permanecem com problemas taxonômicos não resolvidos. Thomson et al. (2018) citam a importância das revisões taxonômicas, sendo estas significativamente importantes para a taxonomia, por analisar e atualizar o conhecimento sobre um grupo taxonômico e propor classificações alternativas promovendo dessa forma novos conhecimentos. Wheeler (2004) também menciona a relevância das revisões e monografias para a taxonomia, de forma que estas representam um importante veículo para o teste de hipóteses de espécies.

2.3 Endemismo

2.3.1 Definições e importância na conservação de espécies

A biogeografia é o ramo da biologia onde se busca entender a distribuição de organimos no espaço e no tempo e quais são os padrões dessa distribuição (BROWN & LOMOLINO 2006). Através dos estudos biogeográficos é possível descrever gradientes de diversidade, delimitar áreas de endemismo, identificar áreas ancestrais e tentar descobrir as relações entre elas (CASAGRANDA & DE GROSSO 2013)

O termo endemismo é amplamente conhecido e muito utilizado em biogeografia, o qual designa táxons que são restritos a uma determinada região geográfica do mundo (MORRONE 2008). O termo data de há mais de 200 anos, tendo como principal precursor os estudos de Candolle onde o conceito de endemismo foi utilizado pela primeira vez, sendo compreendido devido às grandes explorações dos continentes, onde houve a descoberta de novos táxons que eram distribuídos em regiões restritas (CASAGRANDA & DE GROSSO 2013).

A partir de então, o termo tornou-se amplamente utilizado, tornando o entendimento principal de endemismo muitas vezes confuso e distorcido, principalmente, no sentindo semântico do termo, onde a distribuição das espécies estaria mais relacionada a limites geopolíticos ao invés de limites ecológicos (LINDER 2001). Termos como neoendemismo, paleoendemismo, endemismo edáfico foram e ainda são utilizados atualmente, podendo ser classificados de acordo com a distribuição, solos e origem geológica (Figura 2) (FERREIRA & BOLDRINI, 2011).

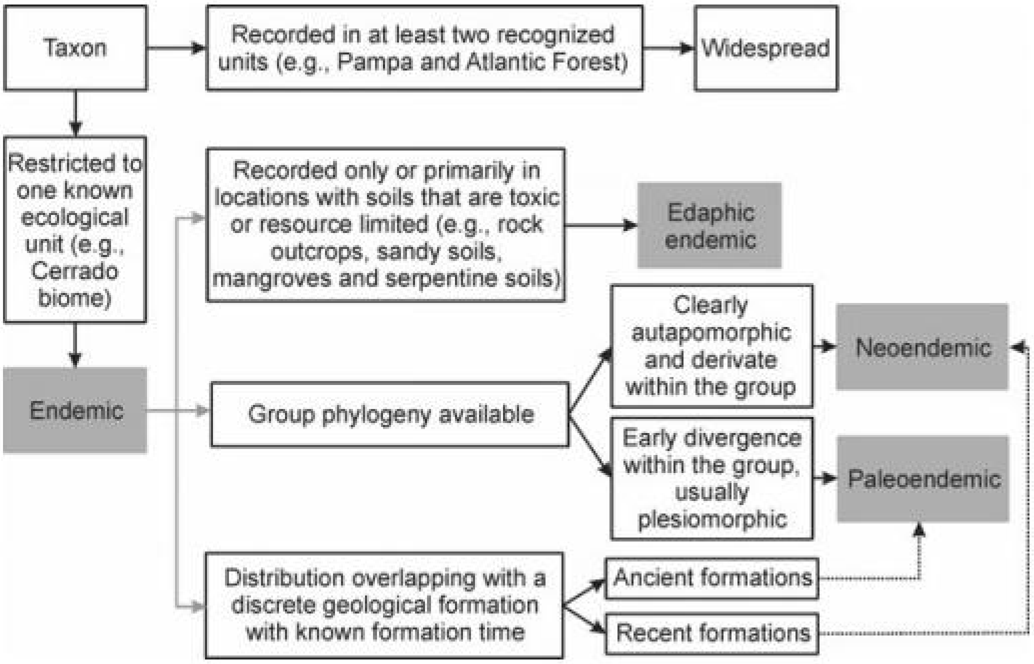


Figura 2 - Passos para a classificação do tipo de endemismo de um táxon (Extraído de Ferreira e Bodrini 2011).

A compreensão do padrão de distribução de um grupo de organismos pode auxiliar na desenvolvimento de estratégias de conservação para a preservação de espécies (LAMOREUX et al. 2006). O endemismo, assim como riqueza e probabilidade de extinção de espécies, tem papel fundamental na determinação de áreas de alta prioridade de conservação (MYERS et al. 2000; ORME et al. 2005), visto que, espécies que apresentam distruibição geográfica restrita estão mais suceptíveis à extinção que espécies com ampla distribuição geográfica (ORME et al. 2005; FERREIRA & BOLDRINI 2011).

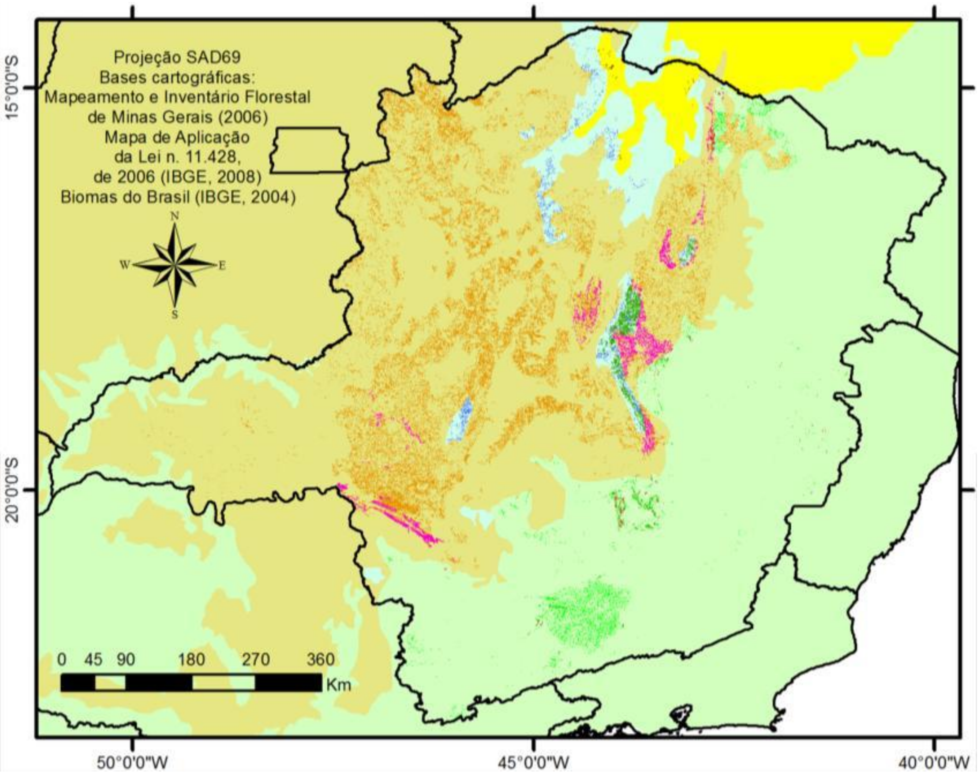
Trabalhos com o objetivo de determinar áreas com altos níveis de biodiversidade, e dessa forma detectar e definir áreas de conservação vem sendo realizados. Um termo definido por Myers (2000), amplamente aceito e frequentemente utilizado, é "*hotspots*" de biodiversidade que consiste em áreas onde há altos níveis de biodiversidade. No trabalho realizado por Myers et al. (2000), os autores sugerem 25 *hotspots* de biodiversidade, dois deles no Brasil (Cerrado e Floresta Atlântica), os quais apresentaram 1,5% e 2,7%, respectivamente, do total de plantas endêmicas conhecidas no mundo.

No entanto, é conhecida a dificuldade, tanto em termos financeiros quanto no planejamento de projetos que possam abranger áreas com altos níveis de biodiversidade tão extensas (CAÑADAS et al. 2014). Devido a necessidade da conservação desses *hotsposts*, um estudo mais refinado de áreas com alta diversidade dentro desses *hotposts* maiores vem sendo realizados, com o intuíto de estudar *hotsposts* menores dentro de *hotsposts* maiores e determinar áreas de conservação que possam proteger pelo menos parte da biodiversidade (FENU et al. 2010; GRANT & SAMWAYS 2011)

2.3.2 Microendemismo de espécies nos campos rupestres e importância para a conservação

Os campos rupestres são caracterizados por apresentarem vegetação predominantemente herbáceo-arbustiva geralmente associada a afloramentos rochosos que occorem, geralmente, em altitudes com mais de 900 metros (SILVEIRA et al. 2016). Atribui-se aos campos rupestres uma consideravel diversidade de táxons e um alto nível de endemismo. Várias espécies de Asteraceae, Bromeliaceae, Cactaceae, Eriocaulaceae, Melastomataceae, Orchidaceae, Velloziaceae e Xyridaceae são endêmicas dos campos rupestres (GIULIETTI et al. 1987, 1997; HARLEY 1995; STANNARD 1995; ZAPPI et al. 2003; CONCEIÇÃO et al. 2005, CONCEIÇÃO; PIRANI 2007)

Segundo Vasconcelos (2014), os ambientes campestres montanos do domínio Cerrado, não associado a Floresta Atlântica, equivalem a 80% do total de campos de altitude no estado de Minas Gerais, desse total, 70% sendo campos limpos e apenas 10% correspondendo aos campos rupestres (Figura 3).



	Contexto Ecológico	Campos Rupestres	Campos Limpos
Floresta	🟩	🟥	🟩
Disjunção associada à Floresta Atlântica no Cerrado	🟦	🟩	🟦
Cerrado	🟨	🟪	🟧
Caatinga	🟨		🟫

Figura 3 - Campos (limpos e rupestres) em Minas Gerais, por contexto de dominío fitogeográfico (Cerrado, Caatinga e Mata Atlântica), destacando ainda os ecossistemas associados à Mata Atlântica. (Extraído e adaptado de Vasconcelos 2014).

Ao estudar quatro áreas distintas de campos rupestres, Conceição e Pirani (2007) mostraram variação na composição florística dessas quatro áreas, onde havia exclusividade de ocorrências de espécies em cada uma delas. Desse modo, por consistir em um mosaico de fitofisionomias, os campos rupestres podem apresentar grande diversidade de espécies, mas composições florísticas distintas em suas diferentes regiões. Isso pode ser preocupante em relação à conservação dessas áreas, visto que, muitas espécies raras e endêmicas podem estar distribuídas em regiões não protegidas. Por isso são necessárias medidas conservacionistas que possam abranger uma maior área possível dos campos rupestres e não somente a pequenas áreas pontuais (RAPINI et al. 2008).

Um evento frequentemente observado na Cadeia do Espinhaço é a grande quantidade de espécies microêndemicas (SEMIR 1991; ECHTERNACHT 2015; STAUDT 2017; MARQUES et al. 2018), as quais podem apresentar distribuição de populações restritas a determinadas localidades (RAPINI 2008). As causas dessa diversidade e endemismo restrito pode estar relacionada à variedade de ambientes originados pelo conjunto de diferentes tipos de solos, rochas, elevações, inclinações, alta exposição à luz e microclimas (MORAN 1995; SALINO & ALMEIDA 2008). Essa variedade de ambientes, relacionada às condições climáticas e geológicas extremas, tornam o ambiente limitado e exige que as espécies sejam adaptadas a viver nessas condições adversas, isso estaria atrelado a diversidade de organismos desse ecossistema (TILMAN 1994).

O microendemismo de espécies torna-se preocupante do ponto de vista conservacional, devido a maior susceptibilidade de extinção por eventos locais. (ECHTERNACHT 2015). Nos campos rupestres isso torna-se preocupante devido às frequentes queimadas, monoculturas e turismo (RAPINI et al. 2008). Segundo dados do CNCFlora (2020), das 578 espécies endêmicas dos campos rupestres, cerca de 10% estão criticamente em perigo, 40% estão em perigo e 13% estão vulneráveis. O gênero *Lychnocephalus* têm todas suas espécies sob algum risco, desde vulnerável à criticamente ameaçadas (FERNANDEZ et al. 2020).

2.4 Estudos anatômicos como subsídio à taxonomia

2.4.1 Importância da anatomia vegetal em Asteraceae

Um marco para os estudos anatômicos atrelados à taxonomia de Dicotiledôneas consitiu na publicação do livro “Anatomy of Dicotiledons” de C.R.

Metcalfe e L. Chalk em 1950, que consistia em uma síntese dos conhecimentos anatômicos até o século XX.

A grande diversidade e ampla distribuição da família Asteraceae é frequentemente relacionada à plasticidade morfológica de suas espécies, principalmente, em relação à estrututa vegetativa interna (CRONQUIST 1991; MELO-DE-PINNA 2004). Para entender a diversidade morfológica da família e suas implicações ecológicas e adaptativas, estudos anatômicos vem sendo realizados tanto para estruturas vegetativas (e.g., OMER & MOSELEY JR. 1981; CARLQUIST 1997; GRIGORE & CONSTANTIN 2006; VILHALVA & APPEZZATO-DA-GLÓRIA 2006; ESPINDOLA JUNIOR et al. 2009; ROSSATO & KOLB 2010; DÓRIA et al. 2018) quanto para reprodutivas (e.g., SULBORSKA 2011; HARATYM & WERYSZKO-CHMIELEWSKA 2012, MARQUES et al. 2018; MARZINEK & OIVEIRA 2019).

Estudos anatômicos auxiliam na compreensão de adaptações das espécies através do reconhecimento das estruturas que possibilitam o seu desenvolvimento em diferentes tipos de ambientes. Criptas estomáticas na superfície abaxial de folhas estão frequentemente associadas à adaptação à ambientes xerofíticos (BOMBO et al. 2012; LUSA et al. 2018). Estruturas secretoras também fornecem mecanismos de proteção ao secretar diferentes compostos tóxicos que auxiliam tanto na defesa contra herbivoria como também podem estar relacionadas à proteção a condições adversas do ambiente (BOMBO et al. 2014; DA SILVA et al. 2014, FILARTIGA et al. 2016).

Estudos envolvendo a diversidade de tricomas, também vem sendo frequentemente realizados, sua impotância ecológica é essencial na proteção das estruturas contra as altas temperaturas, alta luminosidade, patógenos, perda de água e contra a herbivoria (WAGNER et al 2014). Além disso, a grande variedade de tricomas em Asteraceae, têm auxiliado na diferenciação de diferentes gêneros, um exemplo foi um estudo realizado por Castro et al. (1997) que diferenciou espécies de Asteraceae da Reserva Biológica de Mogi-Guaçu, São Paulo utilizando estruturas secretoras. Nesse estudo, foram descritos dez tipos diferentes de tricomas secretores, sendo oito deles exclusivos de oito gêneros diferentes.

2.3.2 Estudos Anatômicos em Lychnophorinae

Na subtribo Lychnophorinae, estudos anatômicos contribuíram significativamente para um melhor entendimento de estruturas vegetativas. Luque et al. (1999), ao realizarem o estudo da anatomia foliar de algumas espécies do gênero *Lychnophora* Mart., onde estavam classificadas as espécies do atual gênero *Lychnocephalu*s, *Paralychnophora* e *Chronopappus*, mostraram diferenças na estratificação da epiderme, variedade nos tipos de tricomas, espessura da cutícula, entre outras. Entretanto, por ser um estudo envolvendo um "gênero" relativamente grande em número de espécies, não foram realizadas análises de todas elas.

Posteriormente, Luque e Menezes (2003), realizaram novos estudos anatômicos de *Lychnophora*, envolvendo a estrutura primária dos ramos. Após as análises as autoras puderam observar que, apesar de estudos afirmarem que espécies de regiões xerofíticas apresentam casca mais desenvolvida que atuam na proteção contra a desecação, em *Lychnophora* as cascas são pouco desenvolvidas, sendo a medula a responsável pela maior proporção dos ramos. As autoras supõem que em *Lychnophora,* a proteção relacionada aos fatores limitantes de ambientes xerofíticos provalvelmente seja realizada pela grande quantidade de tricomas presentes nos ramos das espécies do gênero.

Com o objetivo de descobrir quais caracteres poderiam ser considerados funcionais em Lychnophorinae e que espécies compartilhariam tais caracteres apresentando respostas semelhantes a fatores ambientais, Lusa et al. (2014) realizaram uma analise multivariada utilizando tanto dados qualitativos quanto quantitativos para avaliar as possíveis implicações adaptativas desses caracteres no agrupamento de espécies do grupo. Após análises estatísticas, tanto caracteres morfológicos quanto caracteres anatômicos mostraram ser funcionais na subtribo, sendo eles o tipo de hábito, a presença de folhas sobrepostas, a presença de esclereídeos e criptas na folhas, a presença de cloroplastos na epiderme foliar e a distribuição de estômatos na folhas. Além disso, tais características foram úteis na identificação de grupos funcionais de espécies relacionados à distintas condições ambientais dos campos rupestres.

Outro estudo realizado por Lusa *et al* (2018), consistiu na reconstrução de estados ancestrais de caracteres anatômicos sobre a hipótese filogenética de Lychnophorinae (LOEUILLE et al. 2015b). Utilizando esses dados, foram observadas prováveis sinapomorfias tanto para a subtribo quanto para alguns gêneros e clados.

Os autores sugerem a presença de uma nervura central volumosa em relação ao mesofilo como provável sinapomorfia para Lychnophorinae, e acrescentam que alguns caracteres podem significativamente ter influenciado no sucesso da subtribo no domínio Cerrado, entre eles a presença de muitos tricomas, cloroplastos na epiderme e esclereídes nos ramos, além de cutícula espessa e presença de esclereídes no mesófilo das folhas. Além disso, foi observado um conjunto de características anatômicas compartilhadas por cada um dos clados de Lychnophorinae que incluem nervura central volumosa, indumento muito conspícuo sobre o caule e como sinapomorfia exclusiva a presença de esclereídes com diferentes formas e tamanhos no córtex caulinar.

Em relação a estudos envolvendo tricomas de Lychnophorinae, vale ressaltar o trabalho de Wagner et al. (2014), onde foram caracterizados os tricomas não glandulares da subtribo. No total, foram descritos 18 tipos diferentes de tricomas, podendo ser ramificados ou não ramificados. Nesse contexto, autores destacam a utilidade dos tricomas como complemento na diferenciação de espécies relacionadas morfologicamente e sua importância ecológica para as espécies de Lychnophorinae. Nesse estudo, *Lychnocephalus* mostrou uma grande diversidade de tipos de tricomas, onde foram registrados para o gênero cinco subtipos de tricomas diferentes.

Apesar de haver um número considerável de trabalhos anatômicos envolvendo Lychnophorinae, nenhum deles aborda com detalhes aspectos sobre anatomia dos padrões nervação presentes nas espécies da subtribo, que variam muito, até em um mesmo gênero, como por exemplo, *Lychnocephalus.* Nesse caso, vê-se a necessidade de estudos que abordem essas características, tanto para avaliar sua utilidade na taxonomia do grupo quanto para verificar suas possíveis relações evolutivas e adaptativas. Vale ressaltar ainda, a carência de trabalhos com estruturas reprodutivas da subtribo, que têm se mostrado tão informativos para outros grupos de Asteraceae

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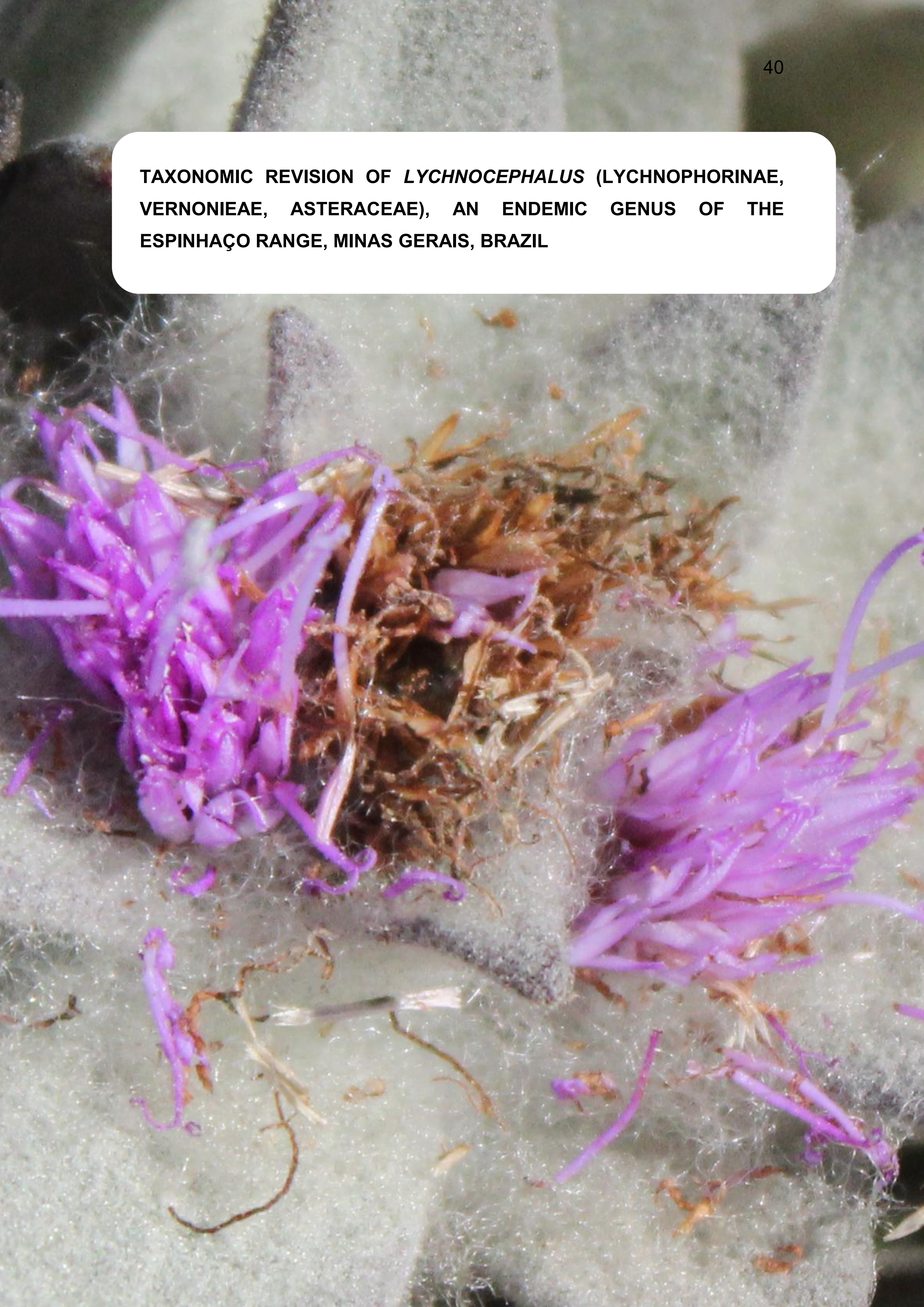
TAXONOMIC REVISION OF *LYCHNOCEPHALUS* (LYCHNOPHORINAE, VERNONIEAE, ASTERACEAE), AN ENDEMIC GENUS OF THE ESPINHAÇO RANGE, MINAS GERAIS, BRAZIL



Taxonomic Revision of *Lychnocephalus* (Lychnophorinae, Vernonieae, Asteraceae), an endemic genus of the Espinhaço Range, Minas Gerais, Brazil[1]

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Abstract

Lychnocephalus, as circumscribed here, contains eight species, occuring in the *campos rupestres* of the Espinhaço mountain range in Minas Gerais state, Brazil. The following species are revised in the current treatment, *L. cipoensis*, *L. grazielae*, *L. humillimus*, *L. mellobarretoi*, *L. jolyanus*, *L. sellovii*, *L. tomentosus* and a new species, *L. canus*, is described and discussed. Taxonomic comments, preliminary conservation status, distribution maps, illustrations and an identification key of all described species are provided.

Kew words: Compositae, *campos rupestres*, taxonomy, *Lychnophora.*

Introduction

Lychnocephalus Mart. ex Candolle (1836: 83) belongs to the subtribe Lychnophorinae (Vernonieae, Asteraceae). This subtribe is composed of shrubs or treelets (rarely herbs) frequently displaying the following combination of characters: indumentum composed of 3-5 armed trichomes, leaf sheath, syncephaly (secondary heads), paleaceous and deciduous to caducous pappus (Loeuille *et al.* 2019). Currently, this monophyletic subtribe comprises 123 species that are mainly distributed in the cerrado and *campos rupestres* (rock outcrops grassland) of the Brazilian Central Plateau (Loeuille *et al.* 2019; Bringel Jr. *et al.* 2019; Cândido & Loeuille 2020, Gomes & Loeuille 2021 (see appendix 1)).

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[1] Manuscrito seguindo as normas da revista Phytotaxa

Lychnocephalus is characterized by its species ranging from decumbent subshrubs to candelabriform treelets, displaying third-order syncephalium and caducous pappus with twisted inner series. It was established by Candolle in 1836 based on the materials collected by Martius on his expedition in the *campos rupestres* of Minas Gerais state, being later synonymized in *Lychnophora* Martius (1822: 148) by Schultz-Bipontinus (1863). For a long time, the genus remained classified as a synonym of *Lychnophora*, mainly due to the limited number of collections and field information. Phylogenetic studies in Lychnophorinae based on morphological and molecular data have helped to clarify the phylogenetic relationships between *Lychnophora* species, the genus emerging as a polyphyletic group and diverging into three well-supported clades (Loeuille *et al.* 2015). One of these clades was composed of *Lychnophora* species with flat leaves and leaf sheath, corresponding to the Candolle's concept of *Lychnocephalus*, which was re-established later (Loeuille *et al.* 2019).

Field exploration (Barroso 1956) and revisional works of *Lychnophora* by Schultz-Bipontinus (1863), Coile and Jones (1981), Semir (1991, unpublished), Gomes and Loeuille (2021) (see appendix 1) have brought new species to *Lychnocephalus*, based on the variation of habit, venation, inflorescence and pappus characteristics but also some hasty synonymizations (Coile and Jones 1981) have blurred the species circumscriptions.

Lychnocephalus is endemic to the *campos rupestres* of the Espinhaço Meridional Range in Minas Gerais state. The *campos rupestres* consist of a grouping of different types of vegetation, associated with pré-Cambrian infertile soils, quartzite, metarenite or ironstone outcrops (Fernandes *et al.* 2020). Eight species are here recognized in the genus, including a newly described species, *L. canus*.

Material and Methods

This work is based on the analysis of 265 herbarium specimens housed at the following herbaria: BHCB, BHZB, CTES, ESA, G, HUFU, INPA, K, L, LB, LE, M, MBM, MO, NY, P, RB, SP, SPF, UB, US, VIC (acronyms according to Thiers 2011, continuously updated). Specimens cited seen by either one or both authors are indicated by "!", "*e*!" stands for type specimens where only digital images were seen. Information on distribution, habitat and phenology were obtained through labels of herbarium specimens and field observations. The terminology used for the characterization of leaves and venation followed Hickey (1979), for indumentum Harris & Harris (2001), for the types of trichomes Wagner *et al.* (2014), for structure of the syncephalium Harris (1995, 1999), for pappus and receptacle Small (1919).

Conservation status of the species provided here follows the criteria established by IUCN (2020); in addition, GeoCat (Bachman *et al.* 2011) was used to calculate and estimate both the Extent of Occurrence (EOO) and the Area of Occupancy (AOO) (cell size of 2 km^2). The distribution map was produced in Quantum GIS v. 3.8.1. (QGIS Development Team 2015), based on geographic coordinates of analysed specimens.

Taxonomic History

In 1836 Candolle established *Lychnocephalus*, describing a unique species: *Lychnocephalus tomentosus* Mart. ex DC. (1836: 83), characterized by the presence of petiolate leaves, heads with eight florets and inner series pappus with twisted setae. The genus was classified within the ‘Subtribo Vernonieae, Divisio Euvernonieae, Subdivisio Albertinieae’. Later, Schultz-Bipontinus (1863) transferred *Lychnocephalus* to *Lychnophora* when publishing the first taxonomic revision of the genus. *L. tomentosus* was placed in the monotypic *Lychnophora* subg. *Lychnocephalus* Schultz-Bipontinus (1863: 369). He also described two new species: *L. humillima* Schultz-Bipontinus (1863: 371) and *L. sellovii* Schultz-Bipontinus (1863: 372), respectively placed in *L*. subg. *Lychnocephaliopsis* Schultz-Bipontinus (1863: 370) and *L.* subg. *Oleariopsis* Schultz-Bipontinus (1863: 372).

Baker (1873), in Martius 'Flora Brasiliensis', maintained *Lychnocephalus* as a synonym of *Lychnophora*, but does not group the three species in the same subgenus. Due to its reduced outer pappus series, *L. humillima* was placed alone in *L.* subg*. Lychnocephaliopsis*. *L. sellovii* and *L. tomentosa* (Mart. ex DC.) Schultz-Bipontinus (1863: 369) were placed in *L.* subg*. Lychnophora* (as '*Eulychnophora*'). During the 20th century, new species, now belonging to *Lychnocephalus*, collected in the Serra do Cipó have been described in *Lychnophora*: *L. saxosa* (Krascheninnikov 1922: 160), a species morphologically similar to *L. sellovii*, and *L. mellobarretoi* Barroso (1956: 261), which was classified within the subgenus *Lychnocephaliopsis*, due to the reduced size of the pappus.

In their revision of *Lychnophora*, Coile & Jones (1981) have followed the generic circumscription of Schultz-Bipontinus (1863) and Baker (1873). They synonymized *L. mellobarretoi* under *L. humillima* and considered *L. saxosa* as a doubtful species. A decade after, based on an extensive field work, Semir (1991) produced a taxonomic revision of *Lychnophora* in its Ph.D. dissertation (unpublished). *L. humillima*, *L. mellobarretoi*, *L. sellovii* and *L. tomentosus* are placed together in *L.* subg. *Lychnocephaliopsis*, along with four new species from Serra do Cipó (three of them validly published in Gomes & Loeuille (2021) (see appendix 1). Posteriorly, based on preliminary phylogenetic results, Semir *et al.* (2011) published only part of the 1991's Ph.D. dissertation, corresponding to the revision of *Lychnophora* subg. *Lychnophora* (i.e., *Lychnophora* s.str.).

Based on the results from phylogenetic analyses that clearly point to a polyphyletic *Lychnophora* s.l. and a well-supported clade corresponding to *Lychnophora* subg. *Lychnocephaliopsis*, Loeuille *et al.* (2019) re-established *Lychnocephalus*, recognizing a total of four species. In 2021, Gomes & Loeuille validly published three new species described by Semir (1991) (see appendix 1).

Morphology

Despite being a small genus, the species of *Lychnocephalus* can display a variety of habits from subshrubs, shrubs to treelets. Only *L. humillimu*s (Sch.Bip.) Loeuille *et al.* (2019: 53) has a subshrub habit, individuals do not exceed 30 cm tall with flexible, delicate and decumbent branches close to the ground (Fig. 1G). According to Loeuille *et al.* (2019), the subshrub habit is uncommon in the subtribe Lychnophorinae. *L. grazielae* Semir ex Gomes & Loeuille (see appendix 1) and *L. mellobarretoi* (G.M. Barroso) Loeuille *et al.* (2019: 53) have a shrubby habit (Fig. 1E, 6C). This habit can also be observed, occasionally, in some individuals of *L. cipoensis* Semir ex Gomes & Loeuille (2021) (see appendix 1), *L. sellovii* (Sch.Bip.) Loeuille *et al.* (2019: 55) and *L. tomentosus*. These three species can also exhibit a candelabriform treelet habit, which is characterized by presenting a defined main trunk from which flexuous branches depart, giving to the individuals a candelabriform aspect. This is a common habit in other species of Lychnophorinae, especially in *Lychnophora* (Loeuille *et al.* 2019). In *L canus* Gomes & Loeuille, *L. cipoensis*, *L. mellobarretoi*, *L. sellovii* and *L. tomentosus*, the trunk is usually short (Fig. 1A, 1C, 6E, 6G) but in *L. jolyanus* Semir ex Gomes & Loeuille (2021) (see appendix) this trunk can reach five meters high (Fig. 6A).

The branches of *Lychnocephalus* species vary widely among taxa, consisting of an important characteristic for distinguishing closely related species. The branches are always cylindrical, however, they vary in relation to their length, diameter and degree of branching. The branches' indumentum is densely tomentose to densely lanulose in most species (*L. cipoensis*, *L. grazielae*, *L. humillimus*, *L. mellobarretoi*, *L. tomentosus*), whereas in *L canus*, *L. jolyanus* and *L. sellovii* the branches are densely lanate. In all species, the most basal portion of these branches tends to become glabrous when aged and in woodier individuals (Fig. 6E) these regions become tessellated (Fig. 1C). In *L. grazielae* and *L. mellobarretoi*, it is possible to observe longitudinal ribs distributed along the branches (Fig. 4H, 7A). In *L. tomentosus*, the fragments of the leaf sheath give the branches a knotty appearance (Fig. 9A). Leaf scars are linear, very impressed in the branches (Fig. 5I). Regarding the degree of branching, they can be poorly branched (*L. canus*, *L. humillimus*, *L. jolyanus*, *L. tomentosus*, and *L. sellovii*)(Fig. 1A, 1G, 6A, 6E, 6G) to moderately branched (*L. cipoensis*, *L. grazielae*, and *L. mellobarretoi*)(Fig. 1C, 1E, 6C). In *L. jolyanus* this poorly branching is quite evident, with the side-branches always restricted to the apical part of the plant (Fig. 6A). The thickness of the branches can vary from very delicate (ca. 3 mm in diameter) in *L. grazielae*, *L. humillimus* and *L. mellobarretoi* (Fig. 4H, 5A, 7A) to very robust (up to 2.3 cm in diameter) in *L. canus*, *L. jolyanus* and *L. sellovii* (Fig. 2A, 5I, 7I). In *L. sellovii* and *L. tomentosus* there are some geographical variation in the diameter of these branches. By example, some populations of *L. tomentosus* from the National Park of the Sempre Vivas (Diamantina Plateau, Minas Gerais state) display more delicate branches than observed in the rest of the species distribution.

Leaves of *Lychnocephalus* species present a great morphological variety in shape, type of venation, presence or absence of petiole and indumentum type. Leaf blades range from oblong, lanceolate, elliptic, obovate, ovate to linear (Fig. 2B, 4B, 4I, 5B, 5J, 7B, 7J, 9B). The margins are slightly revolute or flat and the apex varies from acute, obtuse, attenuate and sometimes rounded. All species of the genus have alternate leaves spirally arranged, laxly imbricate (*L. humillimus*, *L. grazielae*, *L. mellobarretoi*, *L. tomentosus*) to moderately imbricate (*L. canus, L. cipoensis, L. jolyanus*, *L. sellovii*). Leaves are sessile (*L. canus*, *L. cipoensis*, *L. grazielae*, *L. humillimus*, *L. jolyanus*, *L. sellovii.*)(Fig. 2B, 4B, 4I, 5B, 5J, 7J) or petiolate (*L. mellobarretoi* and *L. tomentosus*)(Fig. 7B, 9B). In some populations of *L. tomentosus* the petiole is very short and somewhat enlarged, giving the leaves a sessile aspect, however, it is only a morphological variation in some individuals from the Diamantina Plateau and Northeastern Serra do Cipó. The leaf sheath display several characteristics that are useful for distinguishing *Lychnocephalus* species. The sheath are always well-developed, amplexicaul (Fig. 7J) or semiamplexicaul (Fig. 4I). It was observed, in the field, that the sheaths of the older leaves of *L. canus* and *L. sellovii* present vinaceous color (Fig. 1A), acquiring a darker shade when dry. In *L. canus*, *L. jolyanus* and *L. sellovii* the sheath adaxial face is glabrous, and in *L. canus* and *L. sellovii* it sometimes present a tuff of trichomes in its upper portion (Fig. 2C). In other species, the adaxial surface is always glabrous and the abaxial surface vary between tomentose, lanulose or lanate. Venation is another valuable character to set apart the species, however, the high density of trichomes on the abaxial surface often difficults an accurate characterization. The veins on the adaxial surface are poorly impressed, with the midrib being visible most of the time. On the abaxial surface, the species have prominent midribs (*L. canus*, *L. cipoensis, L. jolyanus and L. sellovii*) or impressed (*L. grazielae, L humillimus, L. mellobarretoi and L. tomentosus*). An eucamptodromous pattern is found in *L. humillimus*, *L. grazielae*, *L. mellobarretoi* and *L. tomentosus* (Fig. 7B 9B), whereas a mixed pattern parallelodromous-cladrodomous is observed in *L. canus*, *L. cipoensis*, *L. jolyanus* and *L. sellovii* (Fig. 2B, 4B, 5K, 7J). This last pattern is characterized by presenting parallel main veins that emerge from the leaf sheath. It was often mentioned as parallelodromous (Semir 1991, Loeuille et al 2019), an uncommon venation pattern in Asteraceae. However, anatomical studies (Gomes *et al.* in prep.) have described a secondary pattern veins between these primary parallel veins. These secondary veins are often obscured by the dense amount of trichomes on abaxial surface.

The indumentum on the abaxial surface vary from densely tomentose, lanulose or densely lanate, with colour ranging from ochreous, dirty white or withish. In *Lychnocephalus canus*, the young leaves, bracts and syncephalia present a unique greyish-white lanate indumentum (Fig. 1B). The adaxial surface of young leaves is usually sparsely to densely lanulose, becoming glabrescent. However, in anatomical studies involving the species *L. canus*, *L. cipoensis*, *L. jolyanus* and *L. sellovii* (Gomes *et al.* in prep.), in addition to tector trichomes, two different types of glandular trichomes were found, a capitate trichome, consisting of a bisseriate base, with a short peduncle and a bicellular head, located in depressions of the adaxial epidermis. This type of trichome has also been observed in some species of *Lychnophora* and *Maschalostachys* Loeuille & Roque (2017: 38) by Luque *et al.* 1999 (*L. rosmarinifolia* Martius (1822: 155), *L. salicifolia* Martius (1822: 148) *M. markgrafii* (Barroso) Loeuille & Roque (2017: 38), *M. mellosilvae* Loeuille & Roque (2017: 42)). The other type of glandular trichomes is multicellular, without bicellular head, located in the abaxial epidermis of all species, but only in *L. canus*, *L. cipoensis*, *L jolyanus* and *L. sellovii*. Wagner *et al.* (2014) observed a great diversity of trichomes in *Lychnocephalus* (*L. humillimus*, *L. mellobarretoi*, *L. sellovii* and *L. tomentosus*). The indumentum is composed of three types of trichomes (except in *L. tomentosus* with only one type). The most common type (B1) is the branched, spurred trichome, with one long arm and diminutive side arms at the base (absent only from *L. humillimus*). Unbranched, long, thin trichomes (type A1) were observed in *L. humillimus* and *L. mellobarretoi*, simple stellate trichomes in *L. humillimus* and *L. mellobarretoi*, and 3–5-armed trichomes in *L. mellobarretoi* and *L. sellovii*. The T-shaped trichomes with arms diagonal to stalk (type C3) was found only in *L. tomentosus*

The heads of *Lychnocephalus* are organized in a complex structure that comprises the set of heads first arranged upon a receptacle and surrounded by secondary involucre and (second-order syncephalia), and then several syncephalia are aggregated into a third-order syncephalium (Fig. 2D, 6D). In addition, the heads are characterized by a low number of florets (Harris 1995, Harris 1999). In Vernonieae third-order syncephalia are only found in *Lychnocephalus* and in some individuals of *Paralychnophora glaziouana* Loeuille in Loeuille *et al.* (2012: 290) (Loeuille *et al.* 2019). In *Lychnocephalus*, the third-order syncephalium is composed by the aggregation of three to seven second-order syncephalia and is surrounded by an involucre of small tertiary leaf-like bracts. Each second-order syncephalium is composed by five to 16 heads, surrounded by a secondary involucre, with lanate indumentum between heads. In *L. canus* this indumentum is greyish-white and ochreous, whitish or dirty white in the other species. Dispersed among the heads, there are small wide lanceolate to deltoid subinvolucral bracts, with their upper half leaf-like, and lower-half scarious. Involucres of *Lychnocephalus* vary from cylindrical (Fig. 4E) to campanulate (Fig. 2G). Species with a smaller number (4–8) of florets per head, have cylindrical involucre (*L. cipoensis*, *L. grazielae*, *L. jolyanus, L. mellobarretoi*), whereas the ones with a larger number (10–15) have a campanulate involucre (*L. canus, L. humillimus*, *L. sellovii*, *L. tomentosus*). The phyllaries are 2–4-

seriate, weakly imbricate and vary in shape, size and indumentum between species. The phyllaries of *L. humillimus*, *L. mellobarretoi* and *L. tomentosus* are slightly concave with a densely lanate apex (Fig. 5F, 7F, 9F), whereas in the other species the phyllaries are straight, glabrous to glabrescent with a glandular apex (Fig. 2H, 7N). The apex of the phyllaries varies from obtuse to rounded (*L. cipoensis*, *L. grazielae*, *L. humillimus*, *L. mellobarretoi*, *L. tomentosus*) (Fig. 5F, 7F, 9G) or acute (*L. canus*, *L. jolyanus*, *L. sellovii*) (Fig. 2H, 7N). Unfrequently, some specimens of *L. cipoensis* have some phyllaries with truncate apices. The receptacle is flat, glabrous and varies from areolate or frimbillate.

The florets have actinomorphic corolla, deeply 5-lobed, rarely 6-lobed (some individuals of *L. grazielae*), with lobes smaller than the corolla tube. The corollas are glabrous and sparsely glandular punctate, with glandular trichomes concentrated in the lobes (Fig. 2I). Only *L. mellobarretoi* and *L. tomentosus* have pubescent corolla lobe apex (Fig. 7G, 9G). Floret colour varies from pale lilac to purple (Fig. 1B, 1D, 1F, 1H, 6D, 6F, 6H) with the exception of *L. jolyanus* which have most florets with white corollas (Fig. 6B), an unusual charater in the subtribe Lychnophorinae (Loeuille *et al.* 2019).

All species have calcarate anthers with acute apical appendages and strongly sagittate bases (Fig. 2K). The styles are usually purple (white to pale lilac in *L. jolyanus*), without basal node, glabrous, except for the pubescence of about 1.2–1.5 mm below the style arms (Fig. 2J). Style arms have acute apices. In *L. canus* and *L. jolyanus* the styles are remarkably long for the tribe and can reach up to 2.5 cm (Fig. 1B, 6B).

The cypselae of *Lychnocephalus* species are glabrous and glandular-punctate, 10-ribbed, generally cylindrical, rarely prismatic or obconic (Fig. 2L, 4G, 4N, 5H, 5O, 7H, 7P, 9H). In some capitula of *L. jolyanus* cypselae are connate in pair, from the base to the top. This same characteristic was observed by Semir (1991) in some cypselae of *L. grazielae*[2] and in some species of *Lychnophora* (*L. pinaster* Martius (1822: 152) and *L. rosmarinifolia* Martius (1822: 155)). This characteristic is uncommon in Vernonieae, and it might be related to the reduction and fusion processes involved in the development of syncephaly. Something similar was found in the ovaries of *Dipterocypsela succulenta* Blake (1945: 36) (Asteraceae,

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[2] Not observed in the material examined in this taxonomic revision

Vernonieae), where a connection between two to three ovaries was also observed. It would be interesting to carry out ontogenetic studies to gain a better understanding of this phenomenon.

The pappus in most species is biseriate (Fig. 1L, 1M), except in *L. grazielae* (Fig. 4N) and *L. humillimus* (Fig. 5H) where the outer series is frequently absent, and when present is vestigial (less than 0.1 mm). In *L. mellobarretoi* the outer series is also reduced (less than 1 mm) (Fig. 7H), however to a lesser degree, and is never absent. The other species' cypselae have an outer pappus series measuring up to 3 mm. Similar gradual reduction series have been observed in *Piptolepis* (Marques *et al.* in prep.) and further anatomical and ontogenetic studies are necessary to understand the pappus evolution in *Lychnocephalus.* The pappus setae are paleaceous, with the inner series moderately to strongly twisted, barbellate and narrowed apices. The outer pappus series, when present, is always persistent and the inner series always caducous. Pappus colour is usually stramineous, rarely whitish in some individuals of *L. jolyanus.*

Secondary Metabolites

Lusa *et al.* (2016b), in a phytochemical study carried out with several species of Lychnophorinae, registered different types of secondary metabolites in *Lychnocephalus tomentosus*. Lipophilic substances, terpenoids, sesquiterpene lactones, phenolic compounds and flavonoids were found in leaves whereas in branches only lipophilic substances and terpenoids were detected (Lusa *et al.* 2016a). Bohlmann *et al.* (1980), when analysing phytochemical aspects of the Vernoniae tribe, found similar compounds in *L. sellovii* that included classes of terpenoids and sesquiterpenes.

Phylogenetic Relationships

According to the phylogeny performed for Lychnophorinae (Loeuille *et al.* 2015), *Lychnocephalus* emerged within the *Prestelia* Alliance clade, being the sister group of *Prestelia* Schultz-Bipontinus (1864: 73). Despite the fact that all species of *Lychnocephalus* are in a well supported clade, the internal relationships are completely unresolved.

Taxonomic Treatment

Lychnocephalus Mart. ex Candolle (1836: 83). Type:—*Lychnocephalus tomentosus* Mart. ex DC.

Treelets, shrubs or subshrubs, frequently candelabriform; stems poorly to moderately branched; branches cylindrical, delicate to robust, flexuous or not, densely tomentose to densely lanate, indumentum composed of usually unbranched, auriculate and 3- to 5-armed trichomes, stellate, T-shaped or Y-shaped trichomes, linear leave scars. Leaves alternate, simple, sessile or petiolate, with a semi-amplexicaul to amplexicaul leaf sheath, spreading or ascending, weakly to moderately imbricate, sometimes crowded at apices; blade coriaceous, discolorous to strongly discolorous, margin entire to slightly sinuous, flat or revolute, indumentum densely tomentose, lanulose or lanose, ochreous, greyish-white, dirty white or whitish, venation eucamptodromous or mixed parallelodromous-cladodromous. Inflorescence an axillary or terminal, pedunculate or sessile, solitary or grouped of 2–3 syncephalia (third order); third order syncephalium hemispherical to spherical, surrounded by leaf-like tertiary bracts, composed of 3–7 second order syncephalia; second order syncephalium spherical, surrounded by leaf like secondary bracts. Capitula 8–150, sessile, homogamous, discoid, fused for 1/4 of their length, interspersed by subinvolucral bracts, upper half leaf-like, lower half scarious, flat or concave. Involucre cylindrical or campanulate, phyllaries 2–4-seriate, brown, weakly imbricate, persistent, outer series shorter than inner series or subequal, apex acute, obtuse, rounded or sometimes truncated, glabrous or wirh apex densely lanate, glandular-punctate, flat or slightly concave; receptacle flat, areolate or fimbrillate. Florets 4–15 per capitulum, bisexual, fertile; corolla actinomorphic, deeply 5–(–6)-lobed, purple, pale lilac or white, glabrous, sparsely glandular-puncate, tube longer than limb, corolla lobes lanceolate, apex acute, glabrescent or pubescent towards apex, glandular; anthers calcarate, apical appendages triangular, acute, anther base strongly sagittate; style shaft glabrous throughout except for pubescent beneath style arms, style base glabrous, lacking a basal node, style arms with acute apex, pubescent outside throughout, with nectariferous disc. Cypselae cylindrical, prismatic or obconical, 10-ribbed, glabrous, glandular-punctate; carpopodium inconspicuous; pappus bi- or rarely uniseriate, paleaceous, whitish to stramineous, outer series shorter than inner series, sometimes vestigial, persistent, straight, apex acute to erose, inner series caducous, twisted, barbellate, apex narrowed.

Chromosome number: n = 19 (*L. cipoensis*, *L. grazielae*, *L. mellobarretoi*, *L. sellovii*, *L. tomentosa*), n = 18 (*L. jolyanus*) (Mansanares et al. 2002, 2007).

Lychnocephalus is distributed in *campos rupestres* of the Serra do Cipó in the southern portion of the Espinhaço Range and in the Diamantina Plateau, central portion of the Espinhaço Range, Minas Gerais state, Brazil.

Diagnostic Key For species of *Lychnocephalus* (modified from Gomes & Loeuille 2021) (see appendix 1)

1. Leaf blade narrow oblong; pappus usually uniseriate, if biseriate then outer series vestigial 2
- Leaf blade elliptic, lanceolate, linear, obovate or wide oblong; pappus biseriate, outer series not vestigial 3

2. Decumbent subshrubs; inflorescence sessile, 10–15 florets per capitulum .... *L. humillimus*
- Erect shrubs; inflorescence pedunculate, 6–8 florets per capitulum .... *L. grazielae*

3. Leaf petiolate, venation eucamptodromous; corolla lobes pubescent 4
- Leaf sessile, mixed venation pattern parallelodromous-cladodromous; corolla lobes glabrescent 5

4. Stem stout; third-order syncephalium spherical; 12–15 florets per capitulum; outer pappus not strongly reduced (longer than 1 mm) .... *L. tomentosus*
- Stem slender; third-order syncephalium hemispherical; 4–6 florets per capitulum; outer pappus strongly reduced (shorter than 0.5 mm) .... *L. mellobarretoi*

5. Shrubs or treelets moderately branched, stem densely lanulose; phyllary apex obtuse or rounded .... *L. cipoensis*
- Treelets poorly branched, stem densely lanate; phyllary apex acute (rarely obtuse) 6

6. Secondary veins of the abaxial surface concealed by indumentum; corolla shorter than 1.8 cm .... *L. sellovii*
- Secondary veins of the abaxial surface not concealed by indumentum; corolla longer than 1.8 cm 7

7. Leaf blade wide lanceolate to oblong, apex acute ; indumentum of leaves, bracts and synchephalia withish; involucre cylindrical, 4–7 florets per capitulum..*L. jolyanus*

- Leaf blade narrow lanceolate, apex attenuate; indumentum of leaves, bracts and synchephalia greyish-white; involucre campanulate, 10–15 florets per capitulum...*L. canus*

1. ***Lychnocephalus canus*** Gomes & Loeuille, ***sp.nov.*** Type:—BRAZIL. Minas Gerais: Santana do Riacho, Lapinha da Serra, subida para o Pico do Breu, 19°06'57"S, 43°40' 10"W, 1146 m, 23 July 2019, *F.M.B. Gomes et al. 8* (holotype: UFP!, isotypes: RB!, K!) (Fig.1 A-B, 2).

Species *Lychnocephali sellovio* habitu, foliis anguste lanceolatis, sed foliorum apicibus attenuatis (non acutis), juvenium foliorum, syncephaliorum et bractearum indumento cano (non albido), subinvolucralibus bracteis majoribus (1.2–2 cm, non 0.9–1.1 cm), corollis majoribus (1.8–2.2 cm, non 1.3–1.6 cm), stylis longioribus (2–2.4 cm, non 1.1-1.8 cm) differt.

Treelet, candelabriform, 0.8–1.5 m tall; poorly branched. Stems 1.2–2.1 cm diam, robust, greyish-white to dirty white, densely lanate, glabrescent, surface tessellate. Leaves sessile, weakly imbricate; leaf sheath amplexicaul, 0.7–1.3 × 0.9–1.3 cm, green or greyish-white, sometimes, vinaceous, abaxial surface densely lanate to glabrous, adaxial surface glabrous; blade narrow lanceolate, 4.5–9.5 × 1.3–2.3 cm, strongly discolorous, mixed venation pattern parallelodromous-cladodromous, primary veins very prominent abaxially, secondary veins not concealed by indumentum, abaxial surface whitish, lanulose, adaxial surface greyish-white to dark-green, lanate, glabrous with age, margin entire, slightly revolute, apex attenuate, base attenuate. Third-order syncephalium 2–3.1 cm tall, 2.9–3.5 cm diam, composed of 4–6 second-order syncephalia, spherical, solitary, terminal, densely covered with greyish-white indumentum, pedunculate, peduncle 3.5–9.1 cm long, glabrous with age; tertiary bracts 4.5–6 × 0.9–1.3 cm, lanceolate; secondary bracts 3.5–4.5 × 0.9–1.2 cm, narrow lanceolate. Capitula 40–70, subinvolucral bracts, 1.2–2 × 0.4–0.6 cm, elliptic to lanceolate; involucre campanulate, 1.4–1.6 cm tall × 1.1–1.2 cm diam.; phyllaries 2-seriate; outer series phyllaries shorter than inner series, lanceolate, apex acute, glabrous, margin entire, outer phyllaries 12–13 × 1.8–2.3 mm, inner phyllaries 14.2–16 × 1.7–2.4 mm; receptacle areolate. Florets 10–15 per capitulum, corolla deeply 5–lobed, purple, 1.8–2 cm long, corolla tube 1.2–1.5 cm × 0.8–1.1 mm, corolla lobes 4–4.5 × 0.5–1 mm, glabrescent; anthers 5–6 × 0.3–0.5 mm, purple; style shaft 2.0–2.4 cm long, purple, glabrous throughout except for pubescent upper 1.5–1.8 mm beneath style arms, style arms 1.7–2.2 mm long. Cypselae cylindrical, 3.5–5 × 0.5–1.5 mm, brown; pappus setae biseriate, stramineous, outer series 2.5–3 mm long, apex erose, inner series 12–13 cm long.

Distribution and habitat:—Brazil (Minas Gerais). *Campo rupestre*. This new species is found in the northewestern portion of the Serra do Cipó, which is located in the southern portion of the Espinhaço Range, growing between rocky outcrops and sandy soils at altitudes between 992–1,406 m. (Fig.3)

Phenology:— Found with florets and fruits from March to July.

Etymology:— The specific epithet *canus* means greyish-white and refers to the indumentum of younger leaves, syncephalia and bracts.

Informal Conservation status:—The new species was found only north-west Serra do Cipó. Although the area of occurrence of the species is within the Environmental Protection Area (EPA) Morro da Pedreira, and Private Natural Heritage Reserve (PNHRs) Ermo dos Gerais and Brumas do Espinhaço, the place is widely used for tourist activities including trails, cycling, archaeological sites, activities in waterfalls and lakes and camps (where campfires are often used), it is also reported river pollution, garbage left on the ground by tourists and unauthorized collections of botanical specimens (Gontijo 2003). In addition, the site changes due to agricultural activities, construction of dams and unrestrained human occupation (Silveira et al. 2016). According to analyses carried out in GeoCat, the species was classified as Endangered (EN), EOO = 182,044 km^2; AOO = 20,000 km^2, according to the criteria established by IUNC Red List B2ab (i, ii, iii, iv, v) + D.

Taxonomic Notes:—This new species is similar to *L. sellovii* by their habit (poorly branched candelabriform treelets), but it differs by the leaves with attenuate apices (vs. acute), indumentum from the young leaves, bracts and syncephalia greyish-white (vs. dirty white), longer subinvolucral bracts (1.2–2 vs. 0.9–1.1 cm), longer florets (1.8–2 vs. 1.3–1.6 cm), longer style (2–2.4 cm vs. 1.1–1.8 cm). In addition, the leaf secondary veins are generally not covered by indumentum (vs. completely concealed) and penducle become glabrous with age (vs. densely lanate).

L. canus is also morphologically related to *L. jolyanus* by leaf secondary veins not covered by indumentum, but the new species has usually a smaller habit (0.8–1.5 vs. 0.5–5 m) and narrow lanceolate leaves (vs. lanceolate to wide oblong), attenuate leaf apex (vs. acute), syncephalium densely covered by greyish-white indumentum (vs. glabrous to lanulose) and heads with 10–15 florets (vs. 4–7).

Additional specimens examined (paratypes):—BRAZIL. Minas Gerais: Santana de Pirapama, Serra do Cipó, acesso pela fazenda Inhame, campo com Vellozia, 19°00’39”S, 43°75’62”W, 992 m, 19 March 2011, *W. Milliken et al. 4288* (SPF); Santana do Riacho, estrada Santana do Riacho-Lapinha, encosta oeste da Serra do Cipó, 19°04’S, 43°42’W, ca. 1090 m, 4 March 1998, *A. Rapini et al. 595* (SPF); ibid., Morro do Breu, subida para a cachoeira, 19°06’57”S, 43°40’17”W, 27 September 2002, *K. Yamamoto et al. 196* (UEC); ibid., Lapinha, elevações imediatamente a norte de Lapinha, nas nascentes do Córrego do Boqueirão, trilha para o alto do paredão, 19°06’05”S, 43°40’36”W, 1406 m, 22 April 2006, *Loeuille et al. 23* (SPF); ibid., PNHR Brumas do Espinhaço e Ermos dos Gerais, 19 April 2012, *J. Ordones et al. 1993* (BHZB, HUFU); ibid, EPA Morro da Pedreira, Lapinha da Serra, subida para o Pico do Breu, depois da segunda cachoeira, 19°07’03”S, 43°41’57”W, 1166 m, 19 November 2013, *M. Monge et al. 2259* (UEC); ibid., PNHR Brumas do Espinhaço, estrada para a sede, a aproximadamente 400 m da porteira, 19°03’53”S, 43°42’25”W, 1174 m, 3 July 2015, *F.L. Contro et al. 159* (HUFU); ibid., trilha para o Pico do Breu, 19°05’40’’S, 43°38’42’’W, 1309 m, 16 June 2017, *G.M. Antar & L.J. Sauthier 1669* (RB, SPF).

2. ***Lychnocephalus cipoensis*** Semir ex F.M.B. Gomes & Loeuille (2021). Type:—BRAZIL. Minas Gerais: Santana do Riacho, Serra do Cipó, 26 km ao Sul de Conceição do Mato Dentro, km 123 (Córrego Três Pontinhas), 19°11’S, 43°32’W, 1250 m, 27 October 1988, *R.M. Harley et al. 25416* (holotype: BHCB! [BHCB025575]; isotypes: SPF! [SPF70391], UEC! [UEC120823], US! [US01636391]) (Fig. 1C-D, 4A-G).

Shrub or treelet, candelabriform, 0.4–1.1 m tall, rarely up to 1.7 m; moderately branched. Stems 0.7–1.4 cm diam., robust, brownish, densely lanulose, glabrescent, surface tessellate. Leaves sessile, weakly imbricate, frequently crowded at branch apices; leaf sheath amplexicaul, 4.3–7.2 × 0.9–8.1 mm, ochreous, abaxial surface lanulose, adaxial surface glabrous; blade lanceolate to elliptic, 2.7–5.1 × 0.7–1.7 cm, mixed venation pattern parallelodromous-cladodromous, primary veins poorly prominent adaxially, secondary veins covered by indumentum, abaxial surface ochreous, densely lanulose, adaxial surface dark-green (ferrugineous when dry), lanulose, glabrescent, margin entire, slightly revolute, apex obtuse, rarely rounded, base attenuate. Third order syncephalium 2–2.8 cm tall, 3.2–4.6 cm diam., composed of 3–4 second-order syncephalia, spherical, frequently in pairs or solitary, terminal, sparsely by lanulose indumentum, pedunculate, peduncle 2.2–16.1 cm long, lanulose, tertiary bracts 2–3.1(–4) × 0.8–1.2 cm, lanceolate; secondary bracts 1.1–1.4 × 0.5–0.9 cm, wide lanceolate. Capitula 40–60, subinvolucral bracts, 0.7–0.9 × 0.5–0.8 cm, deltoid; involucre cylindrical, 7.8–8.5 cm tall, 0.4–0.6 cm diam.; phyllaries 3 or 4 seriate, outer series shorter than inner series, oblong to spathulate, apex obtuse to rounded or truncate, sometimes erose, glabrous, margin entire, outer phyllaries 5.6–6.1 × 1.4–2.3 mm, inner phyllaries 7.8–8.5 × 1.6–2.1 mm; receptacle areolate. Florets 6–8 per capitulum, corolla deeply 5-lobed, purple to pale lilac, 0.8–1.0 cm long, corolla tube 5.5–7 × 0.4–1.1 mm, corolla lobes 2.8–3.3 × 0.4–0.7 mm, glabrous; anthers 2.9–4.1 × 0.1–0.2 mm purple or pale lilac; style shaft 8–12 mm long, purple, glabrous throughout except for pubescent upper ca. 1.2–1.5 mm beneath style arms, style arms 1.4–2 mm long. Cypselae cylindrical, 1.7–3.5 × 0.5–1 mm, brown; pappus setae biseriate, stramineous, outer series 0.9–2.2 mm long, apex erose, inner series 6.9–7.5 mm long.

Distribution and Habitat:—Brazil (Minas Gerais, Serra do Cipó). *Campo rupestre*; occurring between rock outcrops and sandy grasslands, with some populations found close to rivers, at altitude between 1,110–1,380 m (Fig. 3).

Phenology:—Flowering and fruiting occur between February and July.

Etymology:—The epithet *cipoensis* was originally attributed by Semir (1991), and refers to the microendemism of the species to Serra do Cipó.

Informal Conservation Status:—*L. cipoensis* was categorized as Endangered (EN), according to criteria B2a, B2b i, ii, iii, iv (Gomes & Loeuille 2021) (see appendix 1).

Taxonomic Notes:—*Lychnocephalus cipoensis* is easily recognized by its habit (moderately branched treelets) and its heads with cylindrical involucre and 6–8 florets. This species is morphologically related to *L. canus*, *L. sellovii* and *L. jolyanus* for having sessile leaves with parallel primary veins and secondary veins cladrodomous. However, *L. cipoensis* differs from the morphologically closely related species *L. sellovii* by shorter leaf blades (2.7–5.1 vs. 4.5–12.8 cm), leaf lanceolate to elliptic (vs. narrow lanceolate to linear), indumentum of branches and leaves densely lanulose (vs. lanate to densely lanate), involucre shape (cylindrical vs. campanulate). Another species morphologically related to *L. cipoensis* is *L. jolyanus*, however that species differs by the habit (moderately branched shrubs or treelets rarely exceeding 1.1 m vs. poorly branched trees, with 0.5–5 m), phyllaries with obtuse to rounded or truncate (vs. acute apex) and purple to pale lilac (vs. usually white florets (rarely pale lilac)).

Additional specimens examined:—BRAZIL. Minas Gerais: Serra do Cipó, Km 137, 1300 m, 7 December 1949, *A.P. Duarte 2181* (RB, UEC); ibid., 1963, *M. Magalhães & C. Shimoya s.n.* (VIC 3769); ibid., Km 137 antigo, próximo a antiga estrada para o Serro, 12 August 1971, *A.P. Duarte 13525* (RB, UEC); ibid., along road ca. 5 km NE of Chapéu do Sol, 15 January 1981, *R.M. King & L.E. Bishop 8479* (UB, US); ibid., 16 km E. of Chapéu do Sol, 16 January 1981, *R.M. King & L.E. Bishop 8495* (UB, US), ibid., Rodovia MG 010, km 119, 6 May 1997, *W. Vichneswskis 425* (UEC). Jaboticatubas, Serra do Cipó, 25 Km ao Norte, 18 January 1972, *G. Hatschbach et al. 28832* (MBM); ibid., km 139, ao longo da rodovia Lagoa Santa-Conceição do Mato Dentro-Diamantina, 1290 m, 17 April 1972, *A.B. Joly et al. 1884* (UEC); ibid., Serra do Cipó, km 126, 31 November 1978, *J. Semir 8653* [x2] (NY, UEC). Morro do Pilar, Parque Nacional da Serra do Cipó, Alto do Palácio, 19°15'S, 43°32'W, 20 December 2008*, D. Dias 135* (BHCB). Santana do Riacho, Alto do Palácio, Km 138, ao longo da Rodovia Belo Horizonte-Conceição do Mato Dentro, 15 November 1984, *R.M. Harley et al. CFCR 6056* (K,SPF); ibid., Serra do Cipó, campo rupestre, 19 May 1990, *A. Inácia s.n.* (BHCB18183); ibid., Serra do Cipó, Retiro Alto do Palácio, 25 Km NE de Cardeal Mota, caminho a Conceição do Mato Dentro, campo rupestre, 1380 m, 12 February 1991, *M.M. Arbo et al. 4945* (SPF); ibid., Serra do Cipó, km 125 da Rodovia Belo Horizonte-Conceição do Mato Dentro, elevação em frente à estátua do Velho Juca, ca. 1320-1370 m, 7 December 1991, *J.R. Pirani et al. CFSC 12844* (SPF); ibid., Serra do Cipó, encosta pedregosa e arenosa, antigo Km 140, 4 April 1994, *J. Semir & E. Martins 35228* (UEC); ibid., em frente à Fazenda Palácio, na entrada da trilha que vai para a cachoeira na região de Congonhas, à 300 m da estrada, campo rupestre 19°17'29"S, 43°33'44"W, 8 February 1998, *V.N. Vacarelli et al. 3* (UEC); ibid., lado direito da estátua do

Juquinha, km 118, 19°15’30”S, 43°33’06”W, 8 February 1998, *V.N. Vacarelli et al. 5* (UEC); ibid., Serra do Cipó, lado direito da estátua do Juquinha, Km 118, campo rupestre, 19°15’30”S, 43°33’06”W, 8 February 1998, *V.N. Vacarelli et al. 7* (UEC); ibid., à 500 m da estátua do Juquinha, campo rupestre 19°15’30”S, 43°33’06”W, 9 February 1998, *V.N. Vacarelli et al. 8* (UEC); ibid., 9 February 1998, *V.N. Vacarelli et al. 9* (UEC); ibid., região do Congonhas, campo rupestre, 19°18’55”S, 43°32’42”W, 11 February 1998, *V.N. Vacarelli et al. 16* (UEC); ibid., Distrito Cardeal Mota, 1 km acima da estátua do Juquinha em direção a Serra, 05-08 May 1998, *M.E. Mansanares & L.Y.S. Aona 09* (UEC); ibid., 05-08 May 1998, *M.E. Mansanares & L.Y.S. Aona 10* (UEC); ibid., 1 km acima da estátua do Juquinha, 07 October 1998, *M.E. Mansanares et al. 16* (UEC); ibid., em afloramento rochoso do lado oposto da estrada da estátua do Juquinha, 16 December 1998, *F. Feres et al. 98* (UEC); ibid., Parque Nacional da Serra do Cipó, campo rupestre próximo a estátua do Juquinha, 22 November 2000, *L.S. Kinoshita & M.E. Mansanares 174* (UEC); ibid., campo rupestre próximo a estátua do Juquinha, 22 November 2000, *L.S. Kinoshita & M.E. Mansanares 181* (UEC); ibid., Estrada entre Fazenda Palácio e estátua do Juca, 22 November 2000, *L.S. Kinoshita & K. Matsumoto 548* (UEC); ibid., EPA Morro da Pedreira, entrada para Congonhas, km 112, ao lado da estrada em direção à Conceição do Mato Dentro, 19°17.281’S, 43°3405’W, 27 February 2002, *M.E. Mansanares et al. 204* (UEC); ibid, Serra do Cipó, estrada entre Belo Horizonte e Conceição do Mato Dentro, próximo a bifurcação para Morro do Pilar, campo rupestre, 11 January 2006, *A.P. Savassi-Coutinho et al 967* (CTES, ESA, K, RB); ibid., Serra do Cipó, Alto do Palácio, Estrada Lagoa Santa-Conceição do Mato Dentro, MG010, 17,4 Km ao norte da ponte sobre o Rio Vacaria, elevação em frente à estátua do Velho Juca, 19°14’40”S, 43°33’2”W, 21 April 2006, *B. Loeuille et al. 13* (SPF); ibid., EPA Morro da Pedreira, Rodovia Belo Horizonte-Conceição do Mato Dentro (MG 010), Km 118 atual (antigo 125), elevação a leste da estátua do Velho Juca, campo limpo, campo sujo, brejo e capão da mata, 19°15’28”S, 43°33’27.3”W, 1332 m, 12 July 2009, *B. Loeuille et al. 497* (K, SPF); ibid., Serra do Cipó, EPA Morro da Pedreira, Rodovia Belo Horizonte-Conceição do Mato Dentro (MG010), Km 129, Alto do Palácio, topo das elevações com escarpas voltadas para o vale do Córrego Palácio, campo limpo de cimeira, campo rupestre e afloramentos rochosos, 19°15’S, 43°32’W, ca. 1250-1300 m, 17 February 2011, *J.R. Pirani et al. 6252* (SPF); ibid., Parque Nacional da Serra do Cipó, Trilha do Travessão, Campo Rupestre, solo arenoso, 19°19’51.9”S, 43°31’28”W, 1100 m, 4 July 2012, *G.M. Antar et al. 53* (SPF); ibid, Serra do Cipó, Trilha do Travessão, 19°19.24’S, 43°31.43’W, 1243 m, 14 August 2013, *G.C.T. Ceccantini et al. 3916* (SPF); ibid., Serra do Cipó, Trilha atrás do Velho Juquinha, campo rupestre, 19°15’46.9”S, 49°33’30.5”W, 9 November 2013, *B. Loeuille et al. 871* (RB, SPF); ibid, Alto do Palácio, depois da estátua do Juquinha, 19°15'26"S, 43°33'26"W, 21 July 2019, 1313 m, *F.M.B. Gomes et al. 2* (UFP, RB, K); ibid., trilha para o Salitreiro, 19°15'38"S, 4332'19"W, 1385 m, 22 July 2019, *F.M.B. Gomes et al. 4* (UFP, RB, K)

3. *Lychnocephalus grazielae* Semir ex F.M.B. Gomes & Loeuille (2021) Type:—BRAZIL. Minas Gerais: Santana do Riacho, Cardeal Mota, trilha para o Salitreiro, campo rupestre, 19°16’42.1”S, 43°32’03.3”W, 1450 m, 1 September 2011, *B. Loeuille et al. 537* (holotype: UFP!; isotype: SPF! [SPF214797]) (Fig. 1E-F, 4H-N).

Shrub, 0.3−1 m tall, erect; moderately branched. Stems 3.7−4.1 mm diam., flexuous, delicate, ochraceous, densely lanulose, longitudinally striated. Leaves sessile, laxly disposed; leaf sheath semi-amplexicaul, 4−6 × 3−5 mm, ochreous, abaxial surface lanulose, adaxial surface glabrous; blade narrow oblong, 3.1−4.8 × 0.7−1.2 cm, strongly discolorous, venation eucamptodromous, primary vein prominent, secondary veins no covered by indumentum, abaxial surface ochreous, lanulose to tomentose, adaxial surface dark green or dark brown, glabrous, scrobiculate, tomentose to lanulose when younger, glabrescent, margin entire, slightly revolute, apex obtuse, base attenuate. Third-order syncephalium 1.7–2.8 cm tall, 1.8–3.5 cm diam, composed of 3 second-order syncephalia, hemispherical, solitary, terminal, sparsely covered by lanulose indumentum, pedunculate, peduncle 8.2–22.5 cm long, lanulose; tertiary bracts 2.2–3.5 × 0.4–0.9 cm, oblong; secondary bracts 1.5-1.9 × 0.9–1.1 cm, lanceolate to deltoid. Capitula 10-15, subinvolucral bracts, 0.9–1.4 × 0.4–0.6 cm, deltoid; involucre cylindrical, 1.2–1.3 cm tall, 0.5–0.6 cm diam.; phyllaries 2 or 3 seriate, subequal, oblong, apex obtuse to rounded, sometimes erose, glabrous, margin entire, outer phyllaries 6.8–9.1 × 1.3–1.8 mm, inner phyllaries 7.1–9.3 × 1.8–2 mm; receptacle fimbrillate. Florets 6−7(−8) per capitulum, corolla deeply 5(−6)-lobed, purple, 0.9−1.2 cm long, corolla tube 6.2−7.3 × 0.9−1.2 mm, corolla lobes 3.2−5.2 × 0.5−0.7 mm, glabrescent; anthers 3.1−4.9 × 0.1−0.2 mm, purple; style shaft 8–11 mm long, purple, glabrous throughout except for pubescent upper ca. 1.2−1.5 mm beneath style arms, style arms 1.2−3.2 mm long. Cypselae cylindrical, 2.5−3 × 0.8−1 mm, brown; pappus setae biseriate or uniseriate outer series, vestigial when present, stramineous, inner series 6.9−8.1 mm long.

Distribution and habitat:—Brazil (Minas Gerais, Serra do Cipó). *Campo rupestre. Lychnocephalus grazielae* occurs in western portion of the Serra do Cipó. This species grows in rock outcrops or sandy soils, at elevation between 1,200−1,450 m (Fig. 3).

Phenology:—Specimens with florets and fruits were collected in April, June and September.

Etymology:—The epithet honnors Dr. Graziela Maciel Barroso (1912–2003), an important Brazilian botanist who contributed to the studies of Brazilian flora, especially of Asteraceae and Myrtaceae families.

Informal conservation Status:—*L. grazielae* was classified as Critically Endangered (CR), according to criteria B1ab (i, ii, iii, iv, v) + B2ab (i, ii, iii, iv, v). (Gomes & Loeuille 2021) (see appendix 1).

Taxonomic Notes:—This species is characterized by being an erect shrub with flexuous branches, corolla lobes glabrescent and pappus setae biseriate or uniseriate. The outer series, when present, is vestigial. It is morphologically related to *L. humillimus* by its narrow oblong leaves and hemispherical syncephalia. However, *L. grazielae* is easily differentiated from that species by its habit (erect shrub vs. decumbent subshrub) and by its pedunculate syncephalia (vs. sessile syncephalia) and phyllary apex glabrous (vs. densely lanate).

Another species that resembles morphologically to *L. grazielae*, is *L. mellobarretoi*. Both species have a similar habit (erect shrub) with delicate and flexuous branches as well as a 2 or 3-seriate involucre. But *L. grazielae* differs mainly by its sessile leaves (vs. petiolate) and glabrescent corolla lobes (vs. pubescent).

Additional specimens examined:—BRAZIL. Minas Gerais: Morro do Pilar, PARNA Serra do Cipó, Trilha do vale do córrego do Salitreiro, 19°16’37”S, 43°28’24”W, 3 April 2011, *N.F.O. Mota et al. 2187* (BHCB); Santana do Riacho, Serra do Cipó, Km 116 ao longo da rodovia Belo Horizonte–Conceição do Mato Dentro, estrada para a trilha do Salitreiro, 19 April 1981, *L. Rossi & M.C.E. Amaral CFSC 7287* (SPF, UEC, UFP); ibid., Parque Nacional da Serra do Cipó, Trilha para o Alto do Palácio, partindo da casa do pesquisador, 19°15’48”S, 43°32’14”W, 1401 m, 15 June 2017, *G.M. Antar & L.J. Sauthier 1641* (SPF); ibid, Km 131, parte alta, 1460 m, 24 April 1950, *A.P. Duarte 1685* (MO, RB, UEC, US).

4. ***Lychnocephalus humillimus*** (Schultz-Bipontinus) Loeuille, Semir & Pirani. *Lychnophora humillima* Schultz-Bipontinus (1863: 371). Type:—BRAZIL. Minas Gerais: Serra da Lapa, in glaerosis, November-December 1824, *L. Riedel 1159* (holotype: LE!; isotypes: BR *e*! [BR0000005520657 (fragment)], F *e*! [F0077176F (fragment)], GH *e*! [GH00009908], K *e*! [K000497119], LE!, LECB (not seen), P *e*! [P00683123, P00683124], US! [US00147443]) (Fig.1 G-H, Fig. 5 A-H)

Subshrub, 20−30 cm tall, decumbent; poorly branched. Stems 3−5 cm diam., flexuous, delicate, canescent, densely lanulose. Leaves sessile, laxly disposed; leaf sheath semi-amplexicaul, 3−6 × 4−7 mm, dirty white, abaxial surface densely lanulose, adaxial surface lanulose, glabrescent; blade narrow oblong, 1.1−2.1 × 0.5−1.2 cm, strongly discolorous, venation eucamptodromous, primary veins abaxially impressed, secondary veins covered by indumentum, abaxial surface dirty white, densely lanulose, adaxial surface dark green, lanulose, glabrescent, scrobiculate, margin entire, slightly revolute, apex obtuse to rounded, base attenuate. Third-order syncephalium 1.5–2 cm tall, 2.5–3.5 cm diam, composed of 3 second-order syncephalia, hemispherical, solitary, terminal, covered by sparsely canescent and lanulose, sessile; tertiary bracts 1.7–2.2 × 0.7–1.2 cm, oblong; secondary bracts 1.1-1.5 × 0.7–0.9 cm, wide lanceolate to deltoid. Capitula 14-25, subinvolucral bracts, 0.6–0.9 × 0.5–0.8 cm, deltoid; involucre campanulate, 7–8.5 cm tall, 0.4–0.6 cm diam; phyllaries 3-seriate, outer series shorter than inner series, oblong, apex obtuse to rounded, sometimes erose, glabrous except for apex densely lanate, margin entire, outer phyllaries 4.1–7 × 1–1.8 mm, inner phyllaries 7–8.5 × 1.5–2 mm; receptacle fimbrillate. Florets 10−15 per capitulum, corolla deeply 5-lobed, purple, 1.3−1.4 cm long, corolla tube 8.1−9 × 0.5−0.8 mm, corolla lobes 4.5−5 × 0.8−1 mm, glabrescent; anthers 3.6−4.5 × 0.1−0.2 mm, purple; style shaft 8–14 mm long, purple, glabrous throughout except for pubescent upper ca. 1.2−2.3 mm beneath style arms, style arms 2.2−2.5 mm long. Cypselae cylindrical to turbinate, 3−3.5 × 1.1−1.5 mm, brown; pappus setae biseriate or uniseriate, stramineous, outer series, vestigial when present, inner series 7.5−8.1 mm, long.

Distribution and habitat: —Brazil (Minas Gerais, Serra do Cipó). *Campo rupestre*; on sandy soils, elevation between ca. 1,223–1,351 m (Fig. 3).

Phenology:—Collected with florets and fruits from March to July

Etymology:—The specific epithet *humillimus*, is the superlative of the adjective *humilis,e*, which means very low, close to the ground, due to the small habit of *L. humillimus*.

Informal Conservation status:— According to analyses carried out in GeoCat, the species is classified as Critically Endangered (CR) (EOO = 0.238 km^2; AOO = 8,000 km^2), according to critera B1ab(i,ii,iii,iv) + B2ab(i,ii,iii,iv) (Fernandez *et al.* 2020). This is a rare and poorly collected species, with very pronounced microendemism in the Serra do Cipó. Until 1991, only materials referring to type material were known, which led Semir (1991) to consider the possible extinction of the species. However, on expeditions to Serra do Cipó later, two populations of *L. humillimus* were found, in the municipalities of Santana de Pirapama and Santana do Riacho, north-west of the Serra do Cipó. However, individuals located in the municipality of Santana do Pirapama are unprotected (Fig. 3), as there are no conservation units covering the area where these individuals occur.

Taxonomic notes:—*L. humillimus* is mainly characterized by its subshrub habit with decumbent branches and phyllaries with densely lanate apex. It is morphologically similar to *L. grazielae*: see that species for a discussion of the differences

Additional specimens examined:—BRAZIL. Minas Gerais: Santana do Pirapama, Serra do Cipó, acesso pela Faz. Inhame, trilha da Senhorinha, primeiro platô, 18°56’12”S, 43° 44’35”W, 1351 m, 9 March 2009, *D.C. Zappi et al. 1959* (SPF); ibid., topo da serra, 18°56’05”S, 43°44’39”W, 1326 m, 27 July 2009, *D.C. Zappi & N.P. Taylor 2257* (K, SPF); ibid., Capela de S. José, subida do da Senhorinha, segundo platô, 18°56’513”S, 43°45’27.67”W, 1340 m, 11 November 2009, *D.C. Zappi et al. 2325* (K, SPF). Santana do Riacho, Ermo dos Gerais, 20 January 2002, *P.L. Viana s.n.* (BHCB69746); ibid., Reserva Particular do Patrimônio Natural Brumas do Espinhaço e Ermo dos Gerais, 1223 m, 19 April 2012, *J. Ordones et al. 1997* (BHZB, HUFU).

5. ***Lychnocephalus jolyanus*** Semir ex F.M.B. Gomes & Loeuille (2021). Type:—BRAZIL. Minas Gerais: Santana do Riacho, Serra do Cipó, Rodovia Lagoa Santa-

Conceição do Mato Dentro (MG 010), depois da estrada para a Usina, beira do riacho, campo rupestre, 14 February 2007, *B. Loeuille & P.T. Sano 112* (holotype: SPF!) (Fig. 5 I-O, 6 A-B).

Treelet, candelabriform, 0.5–5 m tall; poorly branched. Stems 1.2–2.1 cm diam, robust, whitish, densely lanate, glabrescent, surface tessellate. Leaves sessile, weakly imbricate; leaf sheath amplexicaul, 0.9–1.9 × 1.1–1.8 cm, green, abaxial surface lanate or glabrous, adaxial surface glabrous; blade lanceolate, sometimes wide oblong, 4.8–12.2 × 1–3.5 cm, strongly discolorous, mixed venation pattern parallelodromous-cladodromous, primary veins prominent abaxially, secondary veins no covered by indumentum, abaxial surface whitish, lanate, adaxial surface dark-green, lanate, glabrescent, margin entire, slightly revolute, apex acute, base attenuate. Third-order syncephalium 2.1–4.1 cm tall, 3–4.6 cm diam, composed of 4–6 second-order syncephalia, spherical, solitary, terminal, covered by lanulose indumentum or glabrous, pedunculate, peduncle 6.2–10.4 cm long, densely lanate; tertiary bracts 2.5–3.5 × 0.8–1.1 cm, lanceolate to oblong; secondary bracts 1.2–1.6 × 0.4–0.7 cm, lanceolate to deltoid. Capitula 80–100, subinvolucral bracts, 0.8–1.2 × 0.4–0.5 cm, deltoid; involucre cylindrical, 1.1–1.5 mm tall × 0.8–1 cm diam; phyllaries 3 or 4 seriate, outer series shorter than inner series, lanceolate, apex acute, sometimes erose, glabrous, margin entire, outer phyllaries 8–13 × 1.1–2.6 mm, inner phyllaries 8.2–14.1 × 1–2.4 mm; receptacle areolate. Florets 4–7 per capitulum, corolla deeply 5–lobed, purple or white, 1.8–2 cm long, corolla tube 1.2–1.6 cm × 0.7–1 mm, corolla lobes 5–5.3 × 0.7–1.1 mm, glabrous; anthers 5.2–6.5 × 0.3–0.5 mm; style shaft 18–22 mm long, purple, pale lilac or white, glabrous throughout except for pubescent upper 1.5–1.8 mm beneath style arms, style arms 1.8–2.1 mm long. Cypselae cylindrical to obconical, 3.5–6.1 × 0.5–1.5 mm, brown; pappus setae biseriate, whitish to stramineous, outer series 2–2.8 mm long, apex erose, persistent, inner series 12–16 mm long .

Distribution and habitat:—Brazil (Minas Gerais, Serra do Cipó). *Campo rupeste*. It grows among rock outcrops, at elevations between 1,214–1,360 m (Fig. 3).

Etymology:—The epithet honors Dr. Aylthon Brandão Joly (1924–1975) for his numerous contributions to the development of botany in Brazil.

Phenology:—*L. jolyanus* was found with florets and fruits between February and July.

Conservation Status:—Species poorly collected and known only to the western portion of the Serra do Cipó, is classified as Critically Endangered (CR)(EOO = 0 km^2; AOO = 4 km^2), according with the criteria B1ab(i,iv,v) + B21ab(i,iv,v) (Gomes & Loeuille 2021) (see appendix 1).

Taxonomic Notes:—*L. jolyanus* is a remarkable species characterized by its peculiar habit: a treelet reaching 5 m high with a nearly monopodial trunk, poorly branched. It fits into the heterocomoid habit concept of Semir (1991), found in *Heterocoma* Candolle (1810: 190, t. 7) and *Maschalostachys* Loeuille & Roque (2017: 38). This species is morphologically related to *L. sellovii* by their robust densely lanate branches and long leaves (4.8–12.2 vs. 4.5–12.8). However, *L. jolyanus* can be distinguished by its height (0.5–5 vs. 0.5–1.2 m), generally having a long trunk with leaves and inflorescences crowded at the apex (vs. short or reduced trunk, with flowering branches distributed all along), wider leaf blades (1–3.5 vs. 0.5–1.3–(2.8) cm), cylindrical involucre (vs. campanulate), smaller number of florets per head (4–7 vs. 7–12), and larger corolla (1.8–2 vs. 1.3–1.6 cm).

The type of venation is also helpful to set apart both species *L. sellovii* presents prominent primary veins, with the secondary veins covered by the densely lanate indumentum, while in *L. jolyanus*, primary and secondary veins are equally visible. In addition, the florets of *L. jolyanus* are white, rarely pale lilac, a unique characteristic in the genus. *L. jolyanus* is also similar to *L. cipoensis*: see that species for a discussion of the differences.

Additional Specimens examined:—BRAZIL. Minas Gerais: Santana do Riacho, estrada Lagoa Santa-Conceição do Mato Dentro, Km 114, 5 March 1982, *J. Semir & A.B. Martins 13472* (UEC, SPF); ibid., Parque Nacional da Serra do Cipó, Serra das Bandeirinhas, campo rupestre, 1360 m, 26 July 1991, *A. M. Giulietti CFSC 12437* (SPF, UEC); ibid., Serra do Cipó, Estrada para Lagoa Santa-Conceição do Mato Dentro (MG 010), 6,6 Km após a ponte sobre o rio Vacaria, campo rupestre, 19°17’14.6”S, 43°35’12.4”W, 1214 m, 24 April 2006, *B. Loeuille et al. 34* (SPF); ibid., Distrito Cardeal Mota, Serra do Cipó, Fazenda Geraldinho, campo rupestre, 19°12’86”, 43°38’79”W, 1221 m, 16 November 2013, *M. Monge et al. 2165* (UEC). Serra do Cipó, 3.5 miles from Hotel Chapéu do Sol, 19 December 1959, *B. Maguire et al. 44679* (NY); ibid., summit of Serra do Cipó, km 11-120, road from Hotel Chapéu do Sol, 6 Aug 1960, *B. Maguire et al. 49046* (NY); ibid, 12 February 1963, *A.P. Duarte 7.550* (RB); ibid., km 115 (ca. 140 km N. of Belo Horizonte), 19 February

1968, *H.S. Irwin et al. 20.486a* (NY); ibid., estrada Lagoa Santa até Conceição do Mato Dentro, km 109, 30 July 1979, *G.H. Shepherd 10200* (UEC); ibid., s/data, M. *Libon 717* (C); ibid., 500 m antes da pousada Vellozia à direita, 19º17'03"S, 43°35'19"W, 1182 m, 22 July 2019, *F.M.B. Gomes et al. 7* (UFP, RB, K).

6. *Lychnocephalus mellobarretoi* (Barroso) Loeuille, Semir & Pirani (2019: 53), *Lychnophora mellobarretoi* (Barroso 1956: 261). Type:—BRAZIL. Minas Gerais: Santa Luzia, Serra do Cipó, km 138, estrada do Pilar, 2 November 1938, *H.L. de Mello Barreto 8971* (holotype: RB! [RB00650576]; isotypes: BHCB! [BHCB000060], F *e*! [F0077154F]) (Fig. 6 C-D, Fig. 7 A-H).

Shrub, 0.8–1.3 m tall, erect; moderately branched. Stems 0.3–0.5 cm diam, flexuous, delicate, dirty white or ochraceous, densely lanulose, glabrescent, longitudinally striated. Leaves petiolate, petiole 0.5–1.3 cm cm; laxly disposed; leaf sheath amplexicaul, 0.9–1 × 0.6–1.2 cm, dirty white or ochraceus, abaxial surface lanulose, adaxial surface glabrous; blade elliptic, sometimes ovate, obovate, rarely suborbiculate or orbiculate, 2.7–7.2 × 1.9–3.1 cm, strongly discolorous, venation pattern eucamptodromous, primary vein impressed abaxially, secondary veins no covered by indumentum, abaxial surface green, lanulose, adaxial surface dark-green, lanulose, glabrescent, margin entire, slightly revolute, apex obtuse or rounded, base obtuse, rounded or decurrent. Third-order syncephalium 1–2.7 cm tall, 1.5–3.4 cm diam, composed of 3 second-order syncephalia, hemispherical, solitary or grouped by two, terminal or axillary, sparsely covered by lanulose indumentum, pedunculate, peduncle (0.6)–1.5–13 cm long, lanulose; tertiary bracts 1.5–3.7× 0.9–1.8 cm, elliptic to wide elliptic or suborbiculate to orbiculate; secondary bracts 1–1.2 × 0.9–1.2 cm, suborbiculate or orbiculate. Capitula 12–40, subinvolucral bracts 0.6–0.8 × 0.7–0.8 cm, wide lanceolate or deltoid; involucre cylindrical, 6–8 mm tall × 2.2–3.3 mm diam; phyllaries 2 or 3 seriate, outer series shorter than inner series, oblong, apex obtuse to rounded, glabrous except for apex densely lanate, margin entire; outer phyllaries 5–6 × 1.1–2 mm, inner phyllaries 7.2–8 × 1–2 mm; receptacle fimbrillate. Florets 4–6 per capitulum, corolla deeply 5–lobed, purple, (7.5)–0.9–1.2 cm long, corolla tube 0.4–0.7 cm × 0.5–1.3 mm, corolla lobes 2.5–3.5 × 0.3–0.8 mm, pubescent; anthers 3.5–3.8 × 0.1–0.2 mm, purple; style shaft 8–12 mm long, purple, glabrous throughout except for pubescent upper 1.2–1.5(–2) mm beneath style arms, style arms 1.5–2.5

mm long. Cypselae cylindrical, 2.5–3.3 × 1–1.1 mm, brown; pappus setae biseriate stramineous, outer series 0.1–0.3 mm long, apex erose, inner series 4.3–6 mm long.

Distribution and habitat: —Brazil (Minas Gerais, Serra do Cipó). *Campo rupestre*; on sandy soils or between rocky outcrops, in elevation between ca. 1,300–1,350 m (Fig. 3).

Phenology:— Collected with florets and fruits from March to July

Etymology:— The epithet honors Dr. Henrique Lahmeyer de Mello Barreto (1892-1962), a botanist and director of the zoological garden of Rio de Janeiro (Barroso 1956), who contributed significantly to the knowledge of the Brazilian flora, especially of the Serra do Cipó.

Informal conservation status:— Currently only one population of the species is known, located in Private Natural Heritage Reserve (PNHR) Alto do Palácio, north of Serra do Cipó. Analyses performed in GeoCat, showed that the species is considered Critically Endangered (CR) (EOO = 0 km^2; AOO = 4,000 km^2) according to criteria B1ab(i, ii, iii, v) and B2ab (i,ii, iii, v). In the Red List of Endangered species (Fernandez *et al.* 2020), *L. mellobarretoi* is classified as Endangered, however, only a single population of the species with few individuals is known, which can classify it as Critically Endangered.

Taxonomic notes:—*L. mellobarretoi* is easily recognized by its shrub habit with delicate and flexuous branches and pappus with an extremely reduced outer series of setae. The species is similar to *L. grazielae* and *L. tomentosus*. See *L. grazielae* for a discussion of the differences. Like *L. tomentosus*, *L. mellobarretoi* displays petiolate leaveswith eucampdrodomous venation and corolla lobes with pubescent apex. However, *L. mellobarretoi* differs by its delicate branches (0.3–0.5 vs. (0.6–)1–2.3 cm), involucre cylindrical (vs. campanulate), smaller number of florets per head (4–7 vs. (4–)12–15), and extremely reduced outer pappus series (less than 0.5 mm vs. longer than 1 mm).

Additional specimens examined:—BRAZIL: Minas Gerais: Santana do Riacho, Serra do Cipó, km 153, 6 April 1957, *E. Pereira & Pabst 2878* (UEC); ibid., km 131, 2 November 1978, *M.S.F. Silvestre 173* (UEC); ibid., km 128 da rodovia Belo Horizonte–Conceição do Mato Dentro, Alto do Palácio, 27 April 1991, *J.R. Pirani et al. CFSC 12279* (SPF, UEC, UFP); ibid., Cardeal Mota, próxima a casa do IBAMA, 7 October 1998, *M.E. Mansanares et al. 15* (UEC); ibid., 30 May 1991, *J.R. Pirani et al. CFSC 12328* (SPF, UEC); ibid, Cardeal Mota, estrada para Conceição do Mato Dentro, antes da sede do IBAMA, 19°15’38”S, 43°32’00”W, 1390 m, 1 December 2000, *M.E. Mansanares et al. s.n.* (UEC117186); ibid., 23 November 1992, *N. Roque CFSC 1310* (SPF); ibid., 1300 m, 8 June 2002, *J.R. Pirani et al. 5074* (SPF, UEC); ibid., 19°15’37.7”S, 43°31’58.5”W, 1350 m, 12 July 2009, *B. Loeuille et al. 507* (SPF); ibid., próximo à casa do IBAMA, 19°15'39"S, 43°31'56"W, 1347 m, 21 July 2019, *F.M.B. Gomes 3 et al.* (UFP. RB, K).

7. ***Lychnocephalus sellovii*** (Schultz-Bipontinus) Loeuille, Semir & Pirani (2019: 55), *Lychnophora sellovii* Schultz Bipontinus 1863: 372. Type:—BRAZIL. Minas Gerais: Serra do Vento, 1818, *F. Sello(w) 996* (holotype: B†; lectotype: P! [P00683127] designated by Loeuille *et al.* (2019: 55)) (Fig. 6 E-F, 7 I-P).

Lychnophora saxosa Krascheninnikov (1922: 160). Type:—BRAZIL. Minas Gerais: in saxosis Serra da Lapa, December 1824, *L. Riedel 1126* (holotype: LE!; isotypes: LE! [2 specimens]).

Treelet, rarely shrubs, candelabriform, 0.5–1.2 m tall; poorly branched. Stems 1.7–2.4 cm diam, robust, dirty white, densely lanate, glabrescent, surface tessellate. Leaves sessile, weakly imbricate; leaf sheath amplexicaul, 0.9–2.5 × 1.1–2.2 cm, dirty white, abaxial surface densely lanate, adaxial surface glabrous, except by tuff of trichomes; blade narrow lanceolate or linear, 4.5–12.8 × 0.5–1.3–(2.8) cm, discolorous, mixed venation pattern parallelodromous-cladrodomous, primary veins prominent abaxially, secondary veins covered by indumentum, abaxial surface dirty white, lanate, adaxial surface dark-green, lanulose, glabresecent, apex acute, base attenuate. Third-order syncephalium 2.1–4.1 cm tall, 3–4.6 cm diam, composed of 4–6 second-order syncephalia, spherical, solitary, terminal, covered by lanate indumentum, penduculate, peduncle 2.7–9 cm long; tertiary bracts 2.5–3.5 × 0.8–1.1 cm, lanceolate to linear; secondary bracts 1.2–1.6 × 0.4–0.7 cm, lanceolate to deltoid. Capitula 35–100, subinvolucral bracts 0.9–1.1 × 0.4–0.5 cm, deltoid; involucre campanulate, 1–1.1cm tall × 0.5–0.8 cm diam.; phyllaries 3-seriate, outer series shorter than inner series, lanceolate, apex acute, rarely obtuse, glabrous, margin entire, outer phyllaries 8–10 × 1–2 mm, inner phyllaries 10–11 × 1–2.2 mm; receptacle areolate. Florets 7–12 per capitulum; corolla deeply 5–lobed, purple, 1.3–1.6 cm long, corolla tube 10–13 × 0.5–1 mm, corolla lobes 3–5 × 0.5–1 mm, glabrous; anthers 5–6 × 0.3–0.5 mm, purple; style shaft 1.1–1.8 cm long, purple, glabrous throughout except for pubescent upper 1.5–1.8 mm beneath style arms, style arms 1.5–3 mm long. Cypselae cylindrical, 2.8–4 × 1–1.2 mm, brown; pappus setae biseriate, stramineous, outer series 1.1–1.3 mm long, apex erose, inner series 8–9 mm long.

Distribuition and habitat:—Brazil (Minas Gerais, Diamantina Plateau and Serra do Cipó). *Campo rupestre.* Occurring in *campo limpo* phytophysiognomy at elevation between 1,060 and 1,420 m (Fig. 8).

Phenology:—Found with florets and fruits between the months of April and July

Etymology:— The specific epithet honors Friedrich Sello(w) (1789–1831), a german botanist and naturalist who carried out expeditions in Brazil between 1814 and 1831 (Vasconcelos & Pacheco 2012). The spelling of the specific epithet for this species is "*sellovii*" and not "*sellowii*". When establishing that species, Shultz-Bipontinus made an implicit latinization of the surname (ICN, Art. 60.9; Turland *et al.* 2018), thus the spelling used by Shultz-Bipontinus should be preserved over *"sellovii".*

Conservation status:—According to the analyses carried out, *L. sellovii* is classified as Endangered (EN) (EOO = 4,686,792 km^2; AOO = 76,000 km^2) according to criteria B2ab(i,ii,ii,iv) (Fernandez *et al.* 2020). Individuals of *L. sellovii* were registered within the limits of six Protection Area: Environmental Protection Area (EPA) Barão and Capivara, EPA Águas Vertentes, EPA Morro da Pedreira, EPA of te Serra Talhada, Natural Monument (NM) of the Lageado and Serra do Raio, National Park (NP) of the Serra do Cipó. Despite presenting a larger area of distribution compared to most species, the campos rupestres, where *L. sellovi* occurs, is considered threatened due to activities activities that include agriculture, mining companies and population expansion (Costa et al. 2008)

Taxonomic notes:—Diagnostic of that species is the combination of poorly branched candelabriform treelets, leaves with parallelodromous-cladrodomous venation pattern and heads with 7–12 florets. Similar to *L. canus*, *L. cipoensis* and *L. jolyanus* by their leaves with parallelodromous-cladodromous venation pattern: see those species for a discussion of the differences. It is important to note that *L. selovii* and *L. tomentosus* are the only species of *Lychnocephalus* that are not endemic to Serra do Cipó, both have distribution along of the Espinhaço Range (Fig. 8)

Additional specimens examined:—BRAZIL. Minas Gerais: Serra do Cipó, km 129, 1180 m, 17 April 1950, *A.P. Duarte 2631* (UEC); between km 111 and 128 on road from Hotel Chapéu do Sol, 20 December 1959, *B. Maguire et al 44701* (US); ibid., estrada de Datas e Serro, 4 April 1957, *E. Pereira 2859* (UEC); ibid., 11 August 1970, *A.P. Duarte 12817* (UEC); ibid., estrada São Gonçalo até Milho Verde, até Três Barras, 20 July 1980, *J. Semir et al. CFCR 227* (UEC)[2x]; ibid., 11 km NE Gouveia, SW of Dimantina, on Estrada BR-259, 5 October 1980, *G.L. Smith et al. 1017* (NY); ibid., estrada Gouveia-Diamantina, 6 km após o trevo de Gouveia, 16 August 2003, *M.E. Mansanares & C.F. Verola 362* (UEC); ibid., 32 km de Gouveia para Curvelo, entrada a esquerda da usina eólica, fazenda Barro Preto, estrada para torre da telemig, 17 July 2005, *M.D. Moraes 755* (UEC). Datas, 20 km antes de Diamantina, entrada à direita, antes da placa do km 609, próximo à casinha abandonada, 18°21'37"S, 43°40'45"W, 1420 m, 28 November 2000, *M.E. Mansanares et al. s.n.* (UEC 117180).; Congonhas do Norte, Serra da Carapina (Serra Talhada na folha do IBGE), setor N da Serra do Cipó, 18°52'12"S, 43°44'14"W, 1250 m, 2 March 1998, *J.R. Pirani et al. 4122* (SPF, UFP); ibid., 18°52'54"S, 43°43'33"W, 1220 m, 2 March 1998, *J.R. Pirani et al. 4147* (SPF, UFP); Serra talhada, (braço norte da Serra do Cipó), 11,4 km SW da estrada Congohas do Norte-Gouveia, entrada ramificando localmente como "Serra do João Camilo", rumo ao vale do Rio Preto, 18°15'19"S, 43°44'55"W, 1273 m, 20 January 2004, *J.R. Pirani et al. 5178* (SPF); ibid., Serra Talhada (setor nordeste da Serra do Cipó), 9 Km ao Sul de Congonhas do Norte, na estrada para Conceição do Mato dentro, entrada para Extrema seguindo ca. 11 Km, estrada para Lapinha da Serra, 18°56'14.8"S, 43°41'06.1"W, ca. 1250 m, 20 January 2007, *B. Loeuille et al. 78* (SPF, UFP); ibid., *Loeuille et al. 79* (K, SPF, UFP). Diamantina, ca. 23 km of Diamantina, road to Gouveia, 1250 m, 15 January 1969, *H.S. Irwin et al. 22217* (NY); ibid., ca. 11 km NE of Gouveia, BR-357, ca. 1350 m, 5 October 1980, *J.G. Stutts et al. 937* (NY); ibid., Liga de Alumínio, 19 January 1971, *A.P. Duarte 13793* (UEC); ibid., estrada para Milho Verde, a 2 km de Milho Verde (Norte), 18°37'S, 43°29'W, 1283 m, 10 April 1982, *E.M. Iesejima CFCR 3587* (SPF, UEC); ibid., estrada para o povoado de 3 barras, próximo do vilarejo São Gonçalo do Rio das Pedras, 15 April 1987, *D.C. Zappi et al. CFCR 10520* (SPF); ibid., estrada para Milho Verde, 9 December 1997, *N. Roque et al. 415* (BHCB, K, SPF); ibid., estrada para Milho Verde, 10 km da cidade, 7 July 2004, *M.E. Mansanares et al. 396* (UEC); ibid, 12 km da cidade, 7 July 2004, *M.E. Mansanares et al. 416* (UEC); ibid., estrada Gouveia-Curvelo, ca. de 20 km de Diamantina, 18°33'36"S, 43°51'14"W, 1060 m, 23 September 2008, *J.N.*

Nakajima et al. 4965 (HUFU, UEC), 20 km sentido Gouveia, 18°21’32”S, 43°41’02”W, 1377 m, 20 December 2013, *D.A. Chaves 132* (HDJF, UB). Jaboticatubas, along road from Village of Almeida to city of Conceição do Mato Dentro, 3-4 km along road north of “Chapéu do Sol” hotel, 19°19’S, 43°36’W, 1150 m, 10 March 1969, *G. Eiten & L.T. Eiten 10977* (US). Presidente Kubitschek, along the road between Presidente Kubistschek and Congonhas do Norte, 18°37’11”S, 43°35’53”W, 1165-1179 m, 12 October 2001, *F. Almeda et al. 8433* (UEC). Santana de Pirapama, Serra do Cipó, acesso pela fazenda Inhame, 18°55’S, 43°54’W, 22 March 1982, *J.R. Pirani et al. CFSC 8128* (SPF, UEC); ibid., trilha da Senhorinha, 18°56’51”S, 43°45’04”W, 1357 m, 28 February 2009, *D.C. Zappi et al. 1666* (SPF); ibid., Trilha da Serra Morena, 18°55’03”S, 43°47’24”W, 1248 m, 12 March 2009, *D.C. Zappi et al. 2077* (SPF). Santana do Riacho, Serra do Cipó, estrada da Usina, 13 km após início, região do Vau da Lagoa, 21 August 1997, *F.A. Vitta et al. 514* (UEC); ibid., em frente à Fazenda Palácio, na entrada da trilha que vai para a cachoeira na região de Congonhas, 19°17’29”S, 43°33’34”W, 8 February 1998, *V.N. Vaccarelli et al. 4* (UEC); ibid., lado direito da estátua do Juquinha, km 118, 8 February 1998, *V.N. Vaccarelli et al. 6* (UEC); ibid., 19°18’55”S, 43°32’42”W, 11 February 1998, *V.N. Vaccarelli 15* (UEC); ibid., *V.N. Vaccarelli 17* (UEC)[5x]; ibid., Distrito de Cardeal Mota, 16 December 1998, *F. Feres et al. 98* (UEC); ibid., rodovia Belo Horizonte-Conceição do Mato Dentro, Alto do Cupim, elevação entre o córrego Duas Pontes e o vale Córrego Palácio, 19°17’16”S, 43°23’43”W, 1236 m, 6 March 2002, *J.R. Pirani et al. 5043* (SPF); ibid., arredores do córrego Três Pontinhas, 11 January 2006, *A.P. Savassi-Coutinho 972* (ESA, SPF); Trilha do Travessão, 19º17'28"S, 43°33'51"W, 1196 m, 23 July 2019, *F.M.B. Gomes et al. 9* (UFP, RB, K); ibid., 19°18'57"S, 43°32'42"W, 1297 m, 23 July 2019, *F.M.B. Gomes et al. 10* (UFP, RB, K). Serro, distrito de Milho Verde, 17 December 1998, *F. Feres et al. 98* (UEC); ibid., estrada para o Distrito de Capivari, 18°27’46”S, 43°27’05”W, 1250 m, 29 March 2001, *J.N. Nakajima & R. Romero 3078* (HUFU, UEC); ibid., Milho Verde, estrada para Capivari, ca. 10 km da entrada, 18°26’37.6”S, 43°45’50”W, 1245 m, 16 November 2011, *B. Loeuille et al. 580* (SPF, UFP); ibid., EPA Águas Vertentes, serra às margens da estrada para São Gonçalo do Rio das Pedras, à 2 km de Milho Verde, 18°26’57”S, 43°29’18”W, 1185 m, 14 February 2014, *M. Verdi et al. 6787* (RB, SPF).

8. ***Lychnocephalus tomentosus*** Mart. ex Candolle (1836: 83). *Lychnophora tomentosa* (Mart. ex DC.) Schultz Bipontinus (1863: 369). **Type**:—BRAZIL. Minas Gerais: in campis sterilibus, Serro Frio, 25 May 1818, *C.F.P. von Martius 1313 (515)* (holotype: M *e*! [M0029487]; isotypes: G-DC *e*! [G00464243 (fragment)], P! [P02513407 (fragment)]) (Fig. 6 G-H, 9 A-H).

Treelet, rarely shrubs, candelabriform, 1–1.2 m tall; poorly branched. Stems (0.6–)1–2.3 cm diam., robust, dirty white, densely tomentose, glabrescent, surface tessellate. Leaves petiolate, petiole (0.5–)2.5–2.7 cm, laxly disposed; leaf sheath amplexicaul, 0.9–1.9 × 1.1–1.8 cm, dirty white, abaxial surface densely tomentose, adaxial surface glabrous; blade elliptic, rarely ovate or obovate, (2.8–)4.7–13.2 × (0.9–)4.5–5.6 cm, discolorous, venation pattern eucamptodromous, primary vein prominent abaxially, secondary veins no covered by indumentum, abaxial surface ochreous, tomentose to lanulose, adaxial surface dark-green, tomentose, glabrescent, flat, apex obtuse, base decurrent, rarely rounded. Third-order syncephalium (1.1–)2–4.2 cm tall, (1.2–)2–6 cm diam, composed of 3–6 second-order syncephalia, spherical, solitary or sometimes 2–3 grouped, terminal or axilary, covered by tomentose indumentum, pedunculate, peduncle (3–)12.2–20 cm long; tertiary bracts 2.3–4.6 × 1.2–2.7 cm, lanceolate; secondary bracts 1.1–2.1 × (0.6–)1–1.7 cm, lanceolate to deltoid. Capitula (10–)20–120, subinvolucral bracts 0.9–1.1 × 0.5–1 cm, deltoid; involucre campanulate, (0.6–)0.8–10 mm tall × 3.1–4.8 mm diam.; phyllaries 3 or 4-seriate, outer series shorter than inner series, oblong, apex obtuse, sometimes rounded, glabrous, margin entire, outer phyllaries 4–7.1 × 1–3.2 mm, inner phyllaries 6.2–11.1 × 1.5–2.2 mm; receptacle frimbillate. Florets (4)–12–15 per capitulum, corolla deeply 5–lobed, purple, 0.8–1.4 cm long, corolla tube 0.7–1.1 cm × 0.2–0.5 cm, corolla lobes 2.8–4 × 0.4–0.8 mm, pubescent; anthers 3.5–4.8 × 0.1–0.2 mm, purple; style shaft 0.7–13 mm long, purple, glabrous throughout except for pubescent upper 1.5–1.8 mm beneath style arms, style arms 1.5–3 mm long. Cypselae cylindrical, 3.5–4.1 × 0.5–1 mm, brown; pappus setae biseriate, outer series shorter than inner series, stramineous, outer series 1.1–1.3 mm long, apex erose, inner series 5–7 mm long

Distribution and habitat:—Brazil (Minas Gerais,Diamantina Plateau and Serra do Cipó). *Campo rupestre*; occurring on sandy soils, at elevation betwen 1,000 and 1,360 m (Fig. 8).

Phenology:—Specimens found with florets and fruits between February and July.

Etymology:—The epithet refers to the indumentum covering the branches and abaxial surface of leaves.

Informal conservation status:—According to the analyses carried out in GeoCat, the species is considered Endangered (EN) (EOO = 7,311,254 km2; AOO = 88,000 km^2) according to criteria B1ab(i,iv,v) and B2ab(i,iv,v) (Fernandez et al 2020) *L. tomentosus* has occurrence records within the limits of the Protection Units: Environmental Protection Area (EPA) of the Serra Talhada, State Park (SP) Biribiri, EPA Morro da Pedreira, National Park (NP) Serra do Cipó and NP of the Sempre Vivas. However, the species is endangered by factors including urbanization, agriculture, road-opening, introduction of exotic species and tourism (Fernandes & Barbosa 2013).

Taxonomic Notes:—This is the most common species of the genus. It is easily recognized by the combination of robust branches, densely tomentose indumentum and petiolate leaves. The other petiolated leaves species is *L. mellobarretoi*: see that species for a discussion of the differences. Some populations of *L. tomentosus* from the National Park of the Sempre Vivas (Diamantina Plateau) have slender branches and smaller syncephalia, making the specimens similar to *L. mellobarretoi*, but it is clearly distinguished by the habit (treelet vs. shrub) and outer pappus series (longer than 1 mm vs. less than 0.5 mm). In addition, some individuals of these populations have subsessile leaves. However, these morphological variations are uncommon and are unsufficient to justify a distinct formal taxonomic status.

Additional specimens examined:—BRAZIL. Minas Gerais: km 134, 1260 m, 21 April 1950, *A.P. Duarte 2574* (UEC); ibid., entre os municípios Diamantina-Mendanha, 12 December 1980, *I. Cordeiro et al. CFCR 568* (UEC); ibid., rodovia Diamantina-Mendanha (lado esquerdo) km 573,3 km, 7 May 1997, *W. Vichnewski 428* (UEC); ibid., Estrada Conselheiro Mata-Diamantina, km 9, 18°18’28”S, 43°53’39”W, 1265 m, 20 October 2007, *J.N. Nakajima et al. 4991* (HUFU, SPF); Serra do Cipó, 10-20 km NE de Cardeal Mota, caminho a Conceição do Mato Dentro, 19°20’S, 43°25’W, 100-1320 m, 15 May 1990, *M.M. Arbo et al. 4157* (SPF, UEC). Buenópolis, Parque Nacional das Sempre Vivas, estrada em direção ao norte do Parque, 17°55’46.4”S, 43°50’46.5”, 1316 m, 3 September 2014, *C.M. Siniscalchi et al.*

559 (SPF, UFP). Datas, 18 December 1998, *F. Feres et al. 98* (UEC). Diamantina, Liga de Alumínio, 18 August 1970, *A.P. Duarte 12820* (UEC); ibid., entre os km 132 e 133, 1300 m, 9 March 1985, *T.M. Lewinsohn & R.P. Martins s.n.* (UEC 43563); ibid., estrada Diamantina-Biribiri, 10 km de Diamantina, 5 June 1985, *H.F. Leitão Filho et al. 17449* (UEC); ibid., estrada Diamantina-Mendanha, km 585, 6 June 1985, *H.F. Leitão Filho et al. 17562* (UEC); ibid., Distrito de Conselheiro Mata, estrada entre Diamantina e Conselheiro Mata, 10 January 1987, *T.S.M. Grandi et al. s.n.* (BHCB, UEC 74787); ibid., estrada para Mendanha, a 15 km de Diamantina, 18°07'S, 43°30'W, 1200-1225 m, 21 October 1988, *R.M. Harley et al. 25476* (SPF); ibid., a 15 km de Diamantina, 4 July 1989, *J. Semir 25614* (UEC); ibid., afloramento rochoso próximo à AABB, 20 December 1998, *M.E. Mansanares et al. 26* (UEC); ibid., rodovia BR-367, Córrego Soberbo, 23 October 1999, *G. Hatschbach et al. 69584* (INPA, MBM); ibid., estrada Diamantina-Conselheiro Mata, km 182, 4 km do trevo, 18°16'34"S, 43°42'44"W, 1415 m, 31 March 2001, *J.N. Nakajima & R. Romero 3095* (HUFU, UEC); ibid., estrada para conselheiro Mata, 18°18'36.5"S, 43°53'11.8"W, 1305 m, 20 June 2001, *J. Semir et al. s.n.* (UEC 120.420); ibid., afloramento em frente à Trilha dos Escravos, 6 July 2004, *M.E. Mansanares et al. 384* (UEC); ibid., km 685 da rodovia para Medanha (BR-367), lado direito da estrada, elevação ca 300 m da Trilha dos Escravos, 18°13'04"S, 43°35'36"W, 1250 m, 23 January 2007, *B. Loeuille et al. 105* (SPF); ibid., estrada Diamantina-Conselheiro Mata, 18°09'39"S, 43°25'31"W, 17 May 2007, *C.F. Verola & I.R. Costa 48* (UEC); ibid., estrada para Medanha, a 15 km de Diamantina, 18°11'S, 43°32'W, 1245 m, 19 October 2007, *F.N.A. Melo et al. 57* (UEC); ibid., estrada Conselheiro Mata-Diamantina km 9, 18°18'28"S, 43°53'39"W, 1265 m, 20 October 2007, *J.N. Nakajima et al. 4691* (HUFU, UEC); ibid., estrada para Milho Verde, km 14, 18°20'48"S, 43°33'02"W, 1165 m, 19 May 2008, *J.N. Nakajima et al. 4874* (HUFU, SPF); ibid., estrada Diamantina-Conselheiro Mata, km 187, 18°16'29"S, 43°42'46"W, 1405 m, 24 September 2008, *P.O. Rosa et al. 1216* (HUFU, UEC), ibid., Caminho dos Escravos, na rodovia MG 367, km 585 em direção a Couto de Magalhães, do lado esquerdo, 18°12'52.9"S, 43°35'44.1"W, 10 August 2010, *B. Loeuille et al. 528* (SPF, UFP); ibid., estrada Diamantina-Gouveia, ca. de 7 km de Diamantina, 18°20'995"S, 43°40'901"W, 1379 m, 23 September 2010, *J.Y. Costa et al. 164* (HUFU, UEC); ibid., Parque Estadual de Biribiri, Trilha para a cachoeira do Sentinela, 18°12'24.6"S, 43°36'40.7"W, 1228 m, 18 November 2010, *L. Borges et al. 440* (K, RB, SPF, US); ibid., Biribiri, Boa Vista, 18°07’50.2”S; 43°36’59.1W, 1187 m, 18 September 2012, *D. Marques et al. 494* (HUFU, UEC); ibid., estrada Diamantina-Conselheiro Mata, km 182, a 4 km do trevo 18°16’34”S, 43°42’44”W, 1415 m, 18 February 2013, *M. Monge et al. 1420* (UEC); ibid., Campus II da UFVJM, próximo à área de captação de água, 17°27’30”S, 43°34’10”W, 19 February 2013, *M. Monge et al. 1392* (UEC); ibid., estrada Sopa-São João da Chapada 8 km do asfalto, 18°51’80”, 43°44’33”W, 19 February 2013, *M. Monge et al. 1456* (UEC); ibid., estrada para Milho Verde, 3 October 2013, *A.V. Scatigna & G.H. Shimizu 399* (UEC). Gouveia, Fazenda Contagem, 24 February 1986, *J. Semir et al. CFCR 9562* (MO, SPF, UEC). Jaboticatubas, km 128, ao longo da rodovia Lagoa Santa-Conceição do Mato Dentro-Diamantina, 1280 m, 8 June 1970, *A.B. Joly et al. 365* (UEC); ibid., 1 May 1972, *J. Semir & M. Sazima 2086* (UEC); ibid., 26 February 1973, *A.M. Giulietti e N. Menezes 4024* (UEC); ibid., km 125, Cachoeira da Capivara, 9 July 1990, *P.I.K.L. Prado 23816* (UEC). Santana do Riacho, Serra do Cipó, ao longo da rodovia Belo Horizonte-Conceição do Mato Dentro, antigo km 137, 15 August 1979, *N.L. Menezes et al. CFSC 5620* (UEC); Estrada para o Salitreiro, 19 April 1981, *L. Rossi & M.C.E. Amaral CFSC 7289* (SPF, UEC); ibid., Serra da Bandeirinha, 10 September 1987, *C. Kameyama et al. CFSC 10562* (F, K, MBM, RB, MO, SPF); ibid., rodovia Belo Horizonte-Conceição do Mato Dentro, 26 November 1987, *Zappi et al. CFSC 10032* (SPF); ibid., próximo à estátua do Velho Juca, 24 March 1991, J.R. Pirani *et al. CFSC 11930* (SPF, UFP); rodovia Belo Horizonte-Conceição do Mato Dentro, 1320-1370 m, 26 March 1991, *J.R. Pirani et al. CFSC 12050* (SPF, UFP); ibid., rodovia Belo Horizonte-Conceição do Mato Dentro, elevação em frente à estrada do Velho Juca, 26 April 1991, *J.R. Pirani et al. CFSC 12239* (SPF, UFP); ibid., Serra das Bandeirinhas, 1360 m, 26 July 1991, *J.A.M. Giullietii et al. CFSC 12436* (SPF); ibid., Alto do Palácio, Próximo à estátua do Juquinha, 2 February 1993, *V.S.Castro & C.M. Sakuragui 3420* (ESA, UEC); ibid., lado direito da estátua do Juquinha, km 118, 19°15’30”S, 43°33’06”W, 8 February 1998, *V.N. Vaccarelli et al. 6* (UEC); ibid., Distrito de Cardeal Mota, próximo À estátua do Juquinha 5-8 May 1998, *M.E. Mansanares & L.Y.S. Aona 8* (UEC); ibid., Distrito de Cardeal Mota, 16 December 1998, *F. Feres et al. 98* (UEC); ibid., alto do Palácio, estrada Lagoa Santa-Conceição do Mato Dentro (MG 010), 19°14’40”S, 43°33’2”W, 21 April 2006, *B. Loeuille et al. 15* (K, SPF, UFP); ibid., km 118, rodovia MG 010, lado direito, sentido Morro do Pilar, próximo à estátua do Juquinha, 19°15’40”S, 43°33’07”W, 1370 m, 8 July 2007, *M.A. Pena & L. Viana 437* (SPF); ibid., próximo à estátua do Juquinha, 19°15’40”S, 43°33’07”W, 1370 m, 7 September 2007, *M.A. Pena & L. Viana 505* (SPF); ibid., próximo à estátua do Juquinha, 19°15’40”S, 43°33’07”W, 1370 m, 11 March 2008, *M.A. Pena & M.C. Watanabe 783* (SPF); ibid., EPA Morro da Pedreira, Rodovia Lagoa Santa-Conceição do Mato Dentro (MG 010), 19°15’28”S, 43°33’27.3”, 1332 m, 12 July 2009, *B. Loeuille et al. 496* (SPF); EPA Morro da Pedreira, rodovia Belo Horizonte-Conceiçao do Mato Dentro (MG 010), km 129, Alto do Palácio, 19°15’S, 43°32’W, 1250–1300 m, 17 February 2011, *J.R. Pirani et al. 6251* (SPF); ibid., Cardeal Mota, Trilha para o Salitreiro, Campo Limpo, solo arenoso, 19°15'32"S, 43°32'16"W, 1288 m, 1 September 2011, *B. Loeuille et al. 536* (SPF); ibid., elevação em frente à estátua do Velho Juca, km 121, 5 July 2012, *M.T. Kubo 149* (SPF); Trilha para o Salitreiro, 19°15'40"S, 43°32'17"W, 1398 m, 22 July 2019, *F.M.B. Gomes et al. 5* (UFP, RB, K); ibid., 19°16'31"S, 43°32'06"W, 1422 m, 22 July 2019, *F.M.B.Gomes et al. 6* (UFP, RB, K). Santana do Pirapama, Fazenda Inhame, Serra Mineira, 18°55’S, 43°54’W, 21 March 1982, *J.R. Pirani et al. CFSC 8036* (UEC); Fazenda Inhame, trilha para o topo da Serra a partir da Porteira Azul na Estrada Vilarejo, Fazenda Toucan Cipó, 18°56’36,2”S, 43°45’19”W, 1329 m, 19 November 2007, *L.M. Borges et al. 235* (SPF); ibid, acesso pela fazenda Inhame, Trilha do João Carrinho, 19°02’55”S, 43°44’14”W, 1000 m, 25 February 2009, D.C. Zappi et al. 1513 (SPF); ibid., Trilha da Serra Morena, a norte da Fazenda Inhame, 18°55’13”S, 43°47’25”W, 1197 m, 12 March 2009, *D.C. Zappi et al. 2079* (SPF, US); ibid., estrada velha para a mina de manganês, 18°54’30”S, 43°47’21”W, 1212 m, 13 November 2009, *D.C. Zappi et al. 2352* (MBM, SPF, US); ibid., Capela de São José, Trilha da Senhorinha, caminho a Congonhas do Norte, 18°57’25.24”S, 43°44’3.98”W, 1448 m., 25 November 2009, *D.C. Zappi et al. 2541* (SPF, US); ibid., 18°55’58.4”S, 43°45’9.5”W, 1317 m, 25 November 2009, *D.C. Zappi et al. 2562* (SPF, US). Serro, estrada para Gouveia, 11 October 1996, *W. Marcondes-Ferreira et al. 1351* (UEC); ibid., estrada para Gouveia, 11 October 1996, *W. Marcondes-Ferreira 1358* (UEC); Capivari, subida do Pico do Itambé, 17 November 2011, *B. Loeuille et al. 593* (SPF); Trilha da Senhorinha, 18° 57'51"S, 43°46' 22"W, 951 m, 19 July 2019, *F.M.B. Gomes et al. 1* (UFP, K, SPF).

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Author Contribuitions

FMBG designed and wrote the paper, BL wrote Latin description, gave comments and suggestions, and reviewed manuscript.

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APPENDIX I. List of species recognized in this revision

I. *Lychnocephalus canus* Gomes & Loeuille
II. *Lychnocephalus cipoensis* Semir ex Gomes & Loeuille
III. *Lychnocephalus grazielae* Semir ex Gomes & Loeuille
IV. *Lychnocephalus humilimu*s (Schultz-Bipontinus) Loeuille, Semir & Pirani
V. *Lychnocephalus jolyanus* Semir ex Gomes & Loeuille
VI. *Lychnocephalus mellobarretoi* (G.M. Barroso) Loeuille, Semir & Pirani
VII. *Lychnocephalus sellovii* (Schultz-Bipontinus) Loeuille, Semir & Pirani
VIII. *Lychnocephalus tomentosus* Mart. ex Candolle

APPENDIX II. Specimens listed according to the alphabetical order of the first collector. The numbers in parentheses correspond to the species listed above

Almeda, F. *et al.* 8433 (VII); Antar G.M. & Sauthier, L.J. 1641 (III); Antar, G.M. *et al.* 53 (II); G.M. Antar & L.J. Sauthier 1669 (I); Arbo, M.M. *et al.* 4157 (VIII); Arbo, M.M. *et al.* 4945 (II);

Borges, L. *et al.* 440 (VIII); Borges, L.M. *et al.* 235 (VIII);

Castro, V.S. & Sakuragui, C.M. 3420 (VIII); Ceccantini, G.C.T. *et al.* 3916 (II); Chaves, D.A. 132 (VII); Contro, F.L. *et al.* 159 (I); Cordeiro, I. *et al.* CFCR 568 (VIII); Costa, J.Y. *et al.* 164 (VIII); Dias, D. 135 (II); Duarte, A. P. 2181 (II); Duarte, A.P. 12817 (VII); Duarte, A.P. 12820 (VIII); Duarte, A.P. 13525 (II); Duarte, A.P. 13793

(VII); Duarte, A.P. 1685 (III);Duarte, A.P. 2574 (VIII); Duarte, A.P. 2631 (VII); Duarte, A.P. 7.550; Irwin, H.S. *et al.* 20.486a (V);

Eiten, G. & Eiten, L.T. 10977 (VII);

Feres, F. *et al.* 98 (II); Feres, F. *et al.* 98 (VII); Feres, F. *et al.* 98 (VII); Feres, F. *et al.* 98 ; Feres, F. *et al.* 98 (VIII);

Giulietti, A. M. CFSC 12437 (V); Giulietti, A.M. e Menezes, N. 4024 (VIII); Giullietii, J.A.M. *et al.* CFSC 12436 (VIII); Grandi, T.S.M. *et al.* s.n. (UEC 74787)(VIII);

Harley, R.M. *et al.* 25476; Harley, R.M. *et al.* CFCR 6056 (II); Hatschbach, G. *et al.* 28832 (II); Hatschbach, G. *et al.* 69584 (VIII);

Iesejima, E.M. CFCR 3587 (VII); Inácia, A. s.n. (II); Irwin, H.S. *et al.* 22217 (VII);

Joly, A.B. *et al.* 1884 (II); Joly, A.B.*et al.* 365 (VIII);

Kameyama, C. *et al.* CFSC 10562 (VIII); King, R.M. & Bishop, L.E. 8479 (II); King, R.M. & Bishop, L.E. 8495 (II); Kinoshita, L.S. & Mansanares M.E. 181 (II);

Kinoshita, L.S. & Mansanares, M.E. 174 (II); Kinoshita, L.S. & Matsumoto, K. 548 (II); Kubo, M.T. 149 (VIII);

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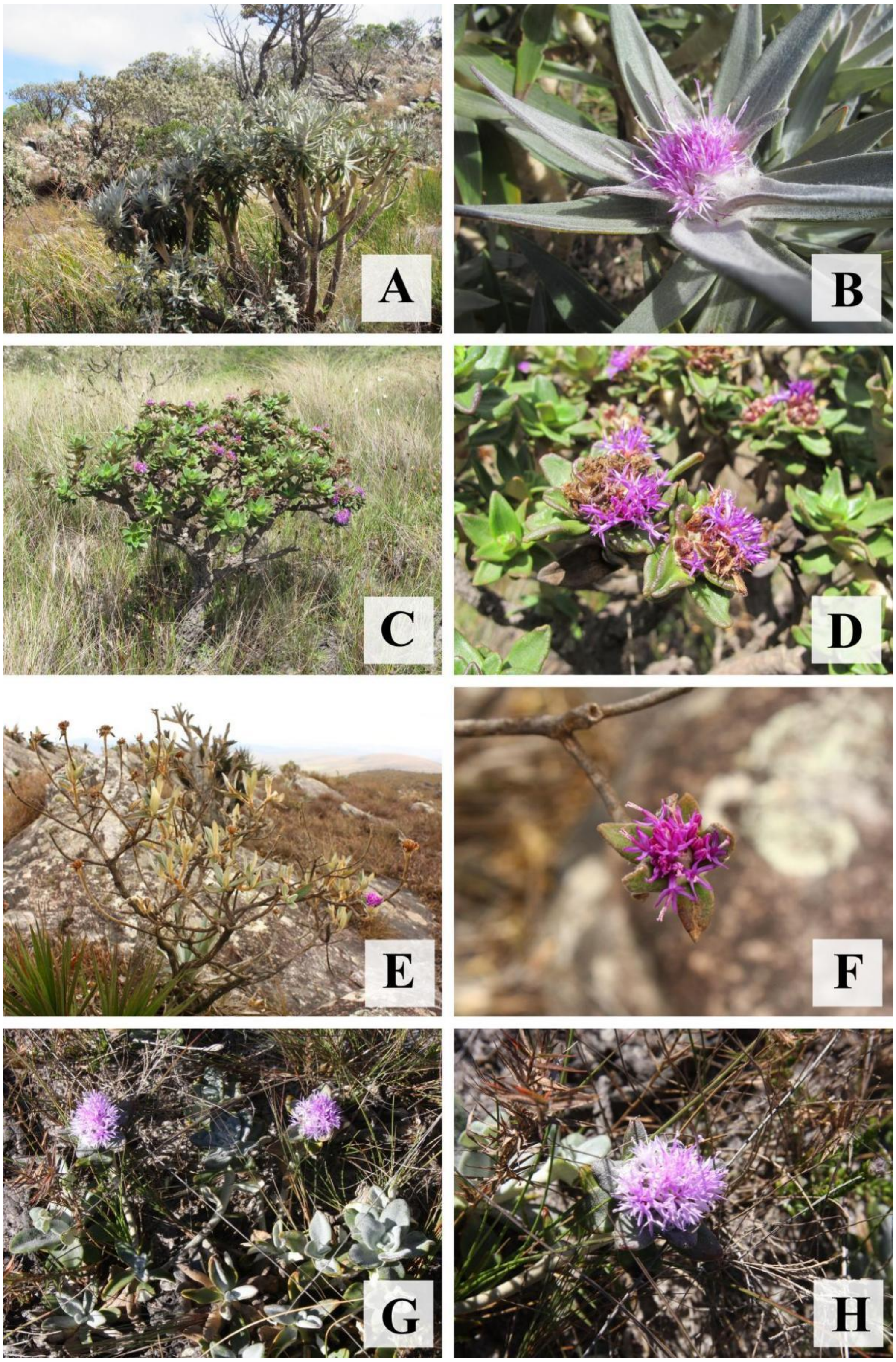

Figure 1 - *Lychnocephalus canus*. **A.** Habit. **B.** Syncephalium. *Lychnocephalus cipoensis*. **C.** Habit. **D.** Syncephalia. *Lychnocephalus grazielae*. **E.** Habit. **F.** Syncephalium. *Lychnocephalus humillimus*. **G.** Habit. **H.** Syncephalium. **A.–F.** by B. Loeuille

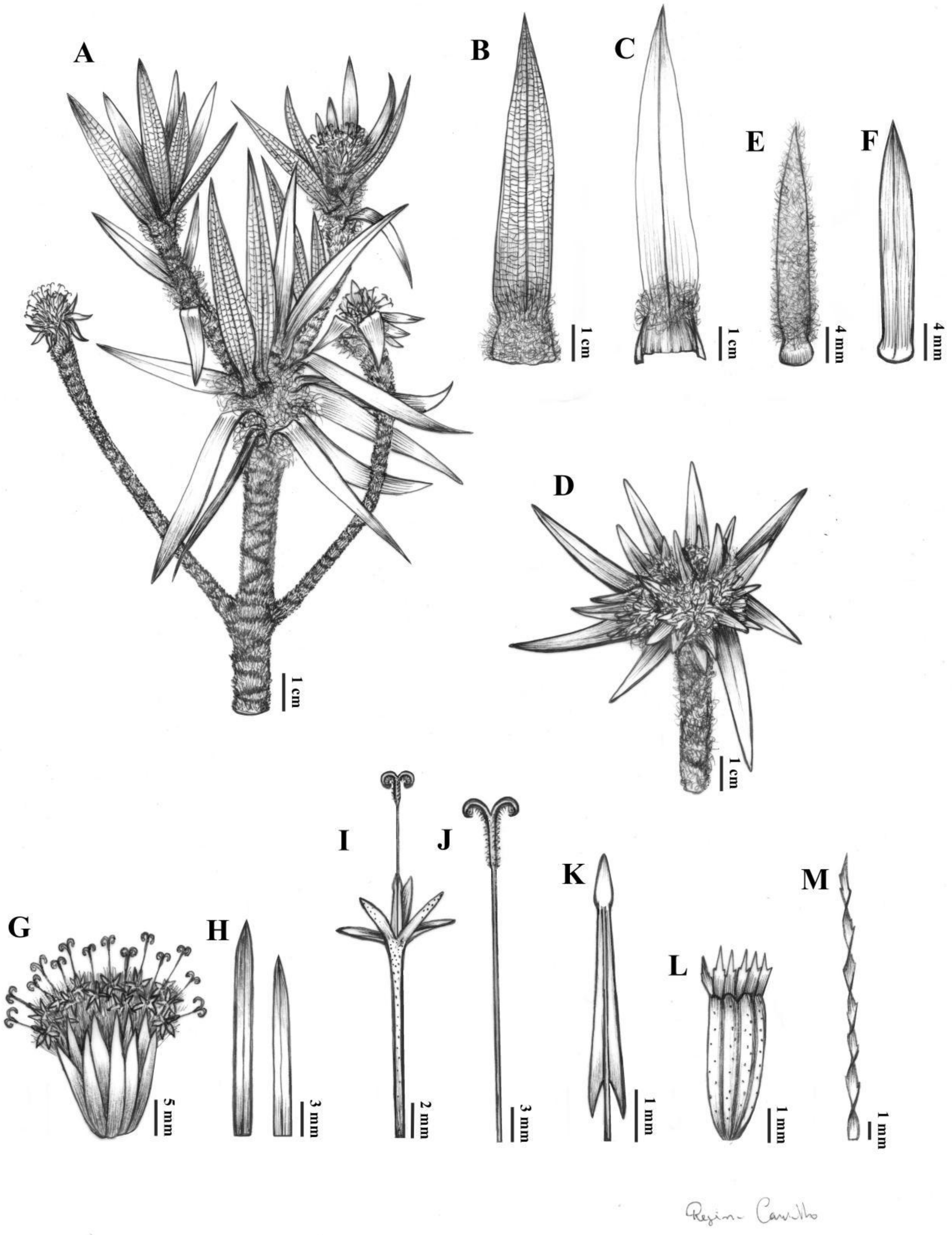

Figure 2 - *Lychnocephalus canus*. sp. nov. **A.** Flowering branch. **B.** Leaf abaxial surface. **C.** Leaf adaxial surface. **D.** Syncephalium. **E.** Abaxial surface involucral bracts. **F.** Adaxial surface subinvolucral bracts. **G.** Capitulum. **H.** Inner phyllary and outer phyllary. **I.** Corolla, androecium and style. **J.** Style. **K.** Anther. **L.** Cypsela. **M.** Pappus element.

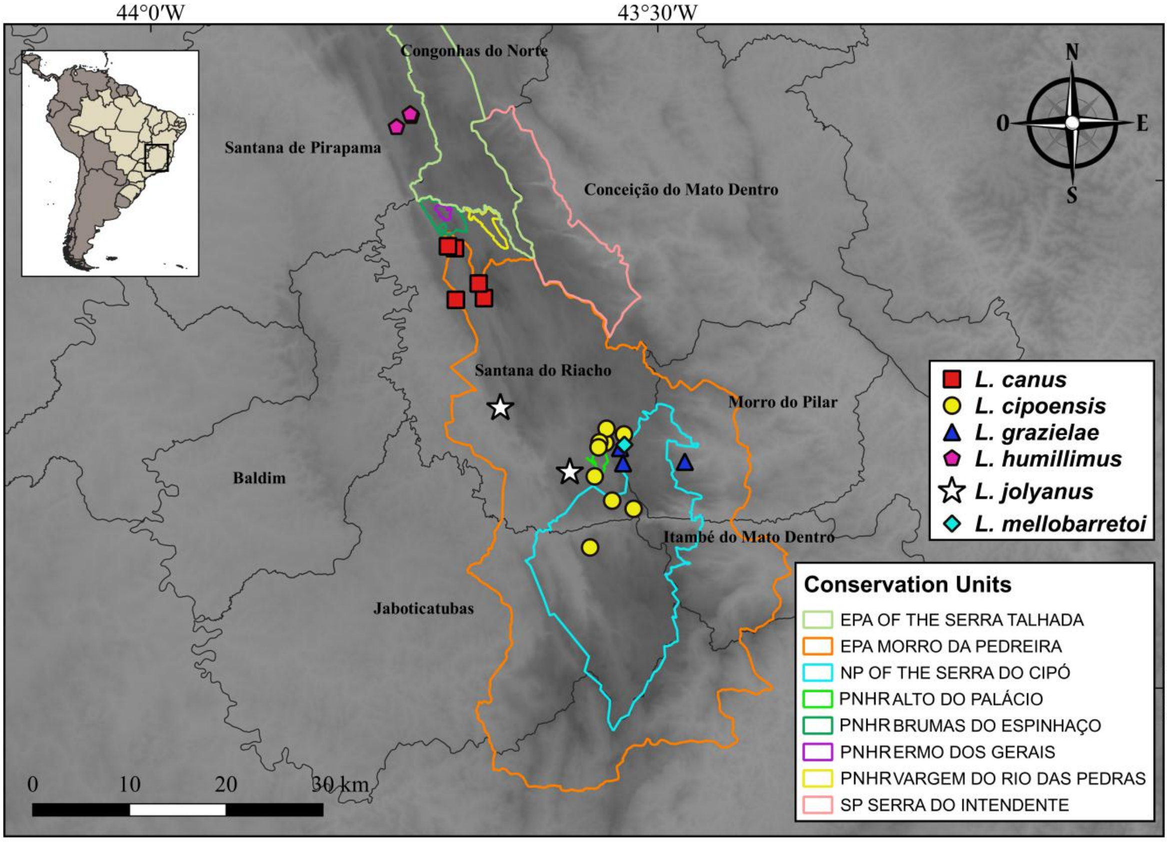

Figure 3- Distribuition of *Lychnocephalus canus* (square), *L. cipoensis* (circle), *L. grazielae* (triangle), *L. humillimus* (pentagon), *L. jolyanus* (star) and *L. mellobarretoi* (diamond).(EPA = Environmental Protection Area; NP= National Park; PNHR= Private Natural Heritage Reserve; SP= State Park)

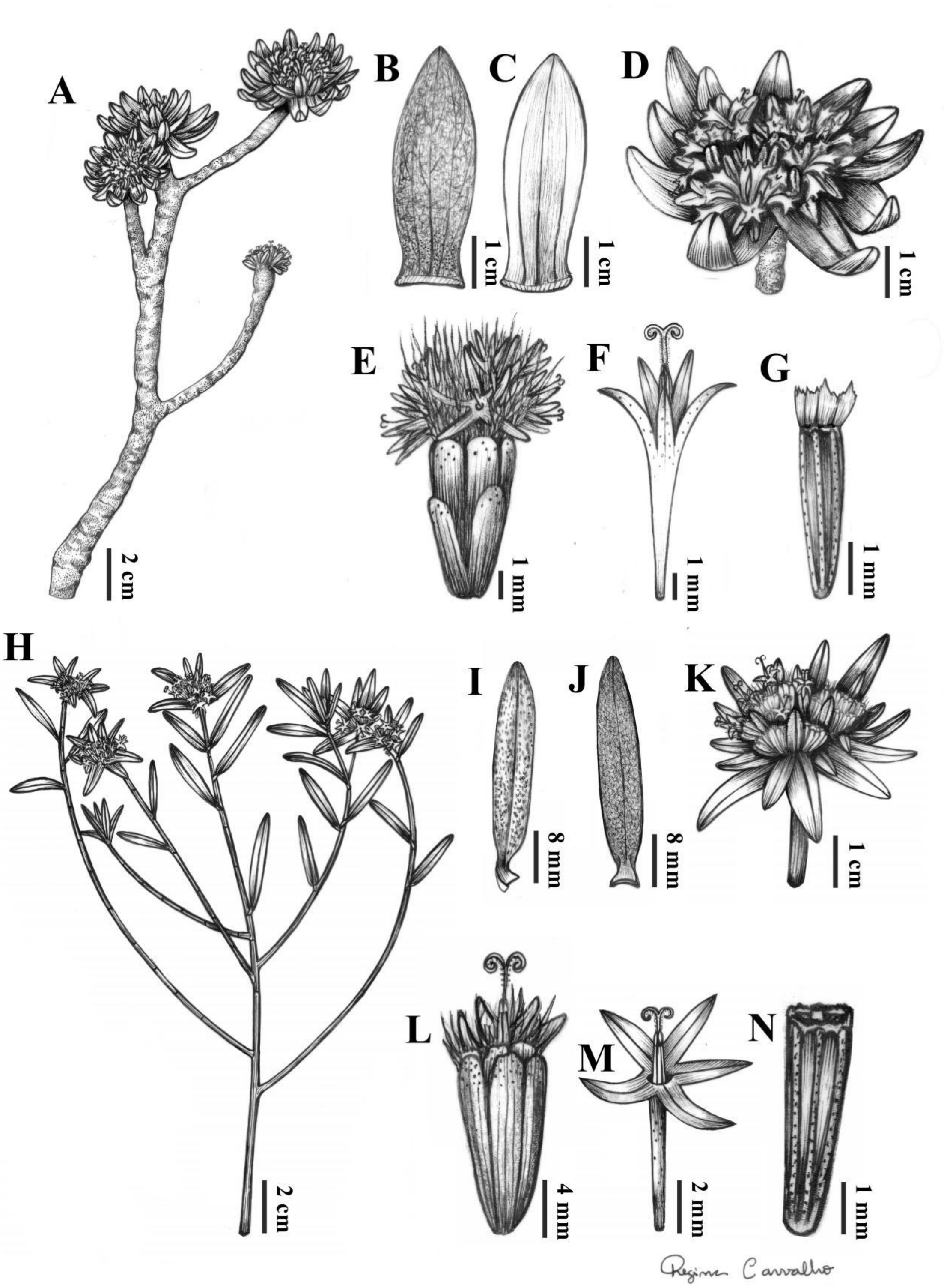

Figure 4 - *Lychnocephalus cipoensis*. **A.** Flowering branch. **B.** Leaf abaxial surface. **C.** Leaf adaxial surface. **D.** Syncephalium. **E.** Capitulum. **F.** Corolla, androecium, and style. **G.** Cypsela. *L. grazielae*. **H.** Flowering branch. **I.** Leaf adaxial surface. **J.** Leaf abaxial surface. **K.** Syncephalium. **L.** Capitulum. **M.** Corolla, androecium, and style. **N.** Cypsela.

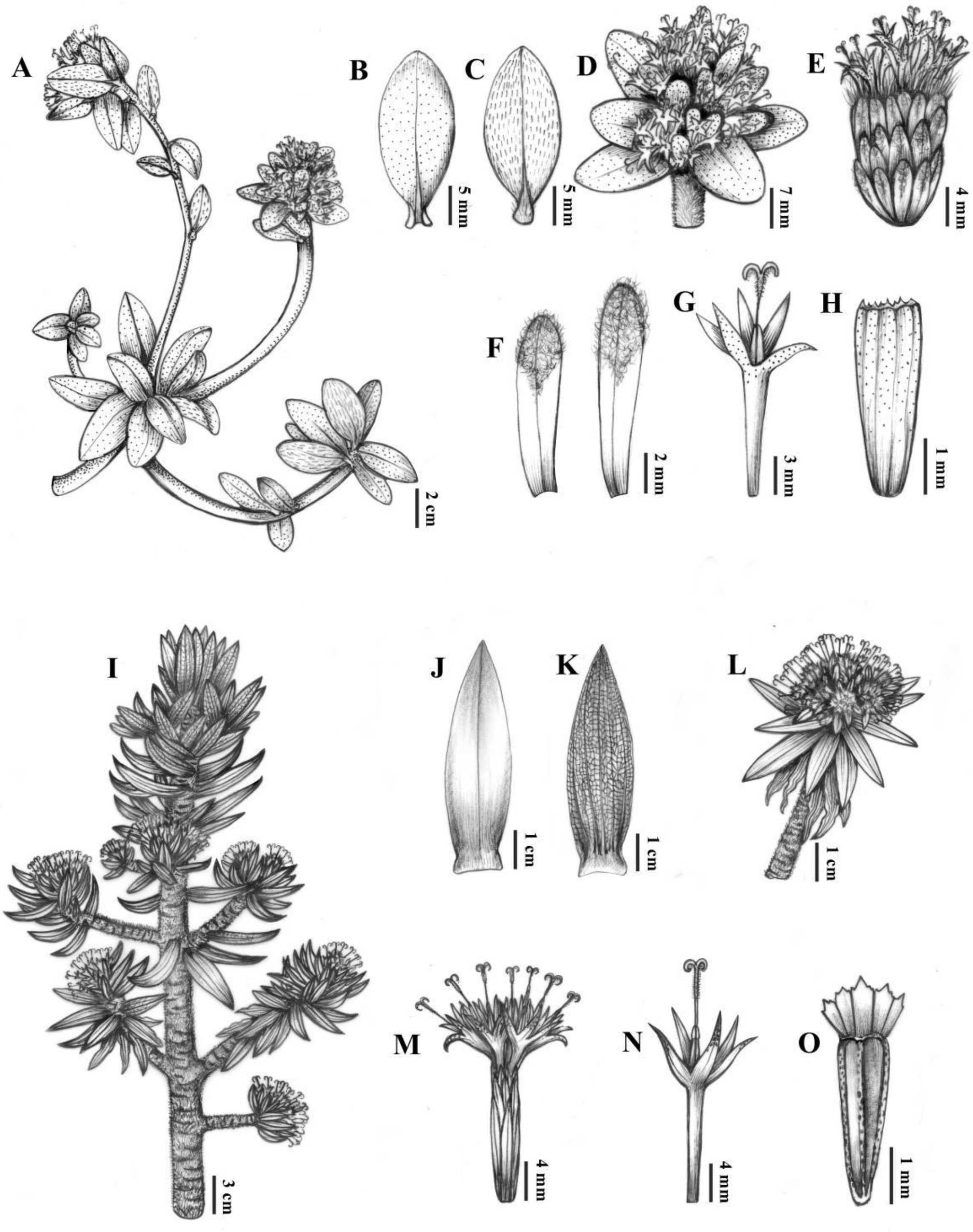

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Figure 5 - *Lychnocephalus humillimus*. **A.** Flowering branch. **B.** Leaf adaxial surface. **C.** Leaf abaxial surface. **D.** Syncephalium. **E.** Capitulum. **F.** Outer phyllary and inner phyllary. **G.** Corolla, androecium, and style. **H.** Cypsela. *L. jolyanus*. **I.** Flowering branch. **J.** Leaf adaxial surface. **K.** Leaf abaxial surface. **L.** Syncephalium. **M.** Capitulum. **N.** Corolla, androecium, and style. **O.** Cypsela.

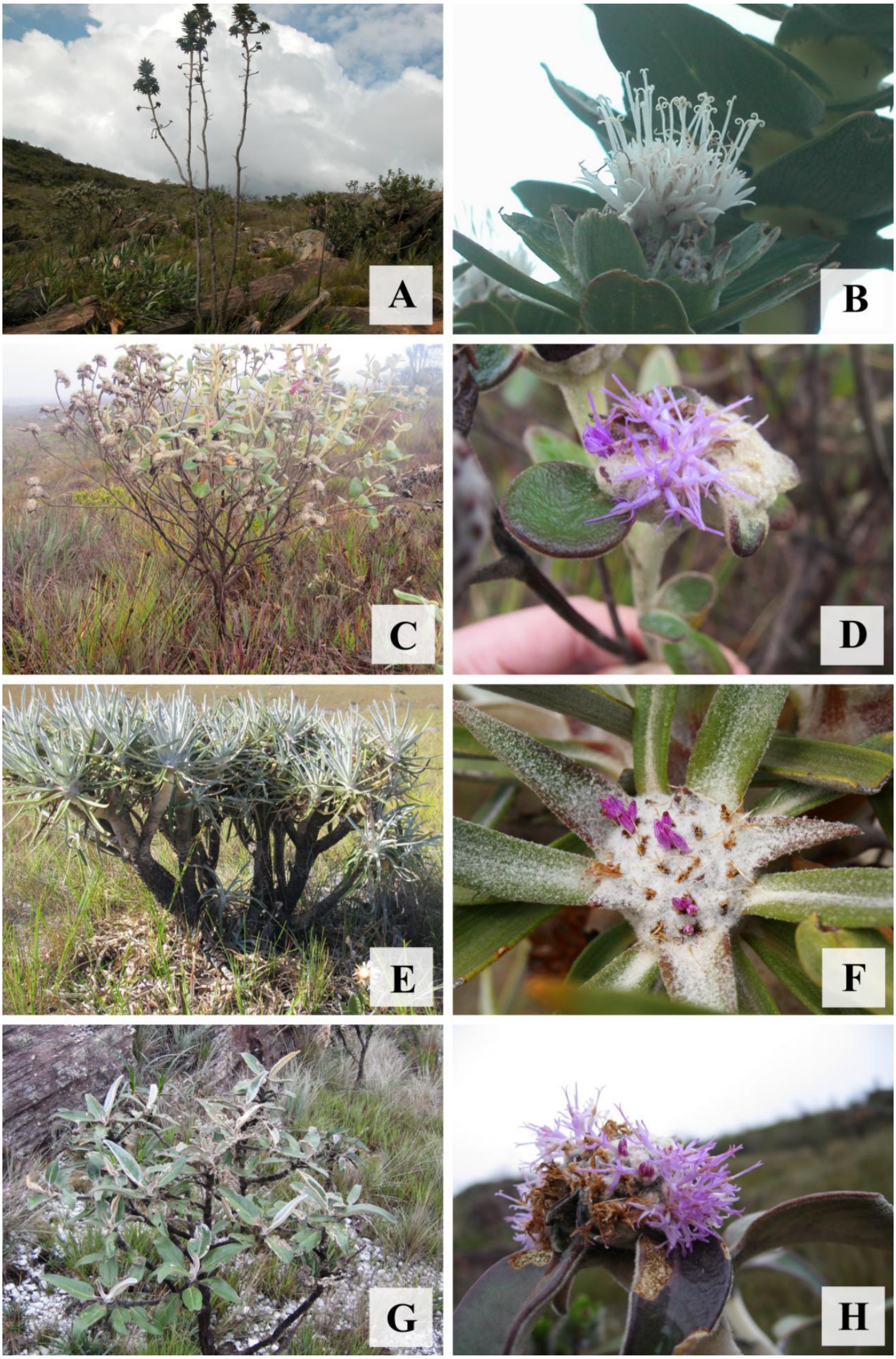

Figure 6 - *Lychnocephalus jolyanus*. **A.** Habit. **B.** Syncephalium. *L. mellobarretoi*. **C.** Habit. **D.** Syncephalium. *L. sellovii*. **E.** Habit. **F.** Syncephalium. *L. tomentosus*. **G.** Habit. **H.** Syncephalium. **A–B.**, **F.–H.** by B. Loeuille. **C.–E.** by F.M.B. Gomes

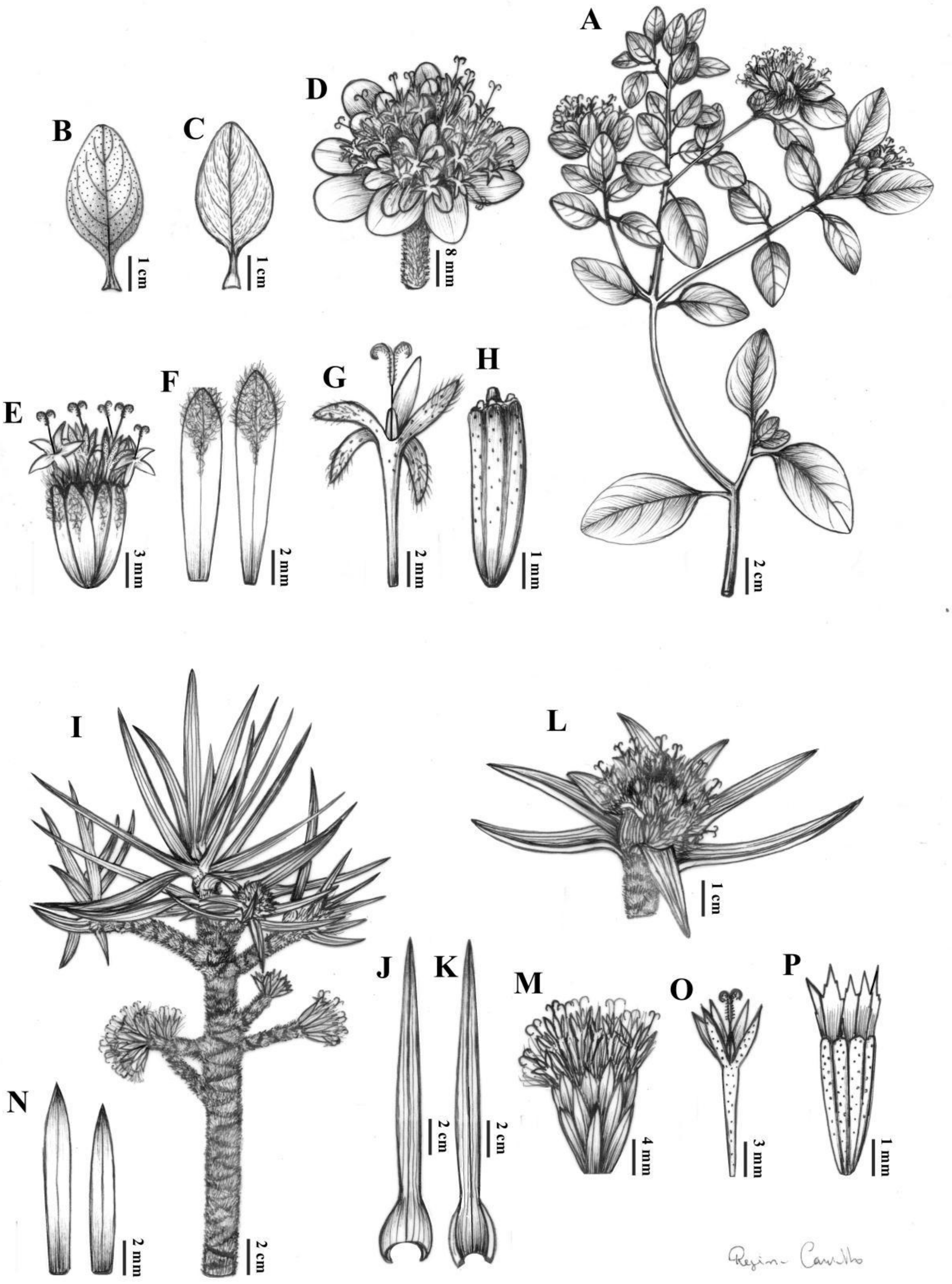

Figure 7 - *Lychnocephalus mellobarretoi*. **A.** Flowering branch. **B.** Leaf adaxial surface. **C.** Leaf abaxial surface. **D.** Syncephalium. **E.** Capitulum. **F.** Outer phyllary and inner phyllary. **G.** Corolla, androecium, and style. **H.** Cypsela. *L. sellovii*. **I.** Flowering branch. **J.** Leaf abaxial surface. **K.** Leaf adaxial surface. **L.** Syncephalium. **M.** Capitulum. **N.** Outer phyllary and inner phyllary. **O.** Corolla, androecium, and style. **P.** Cypsela.

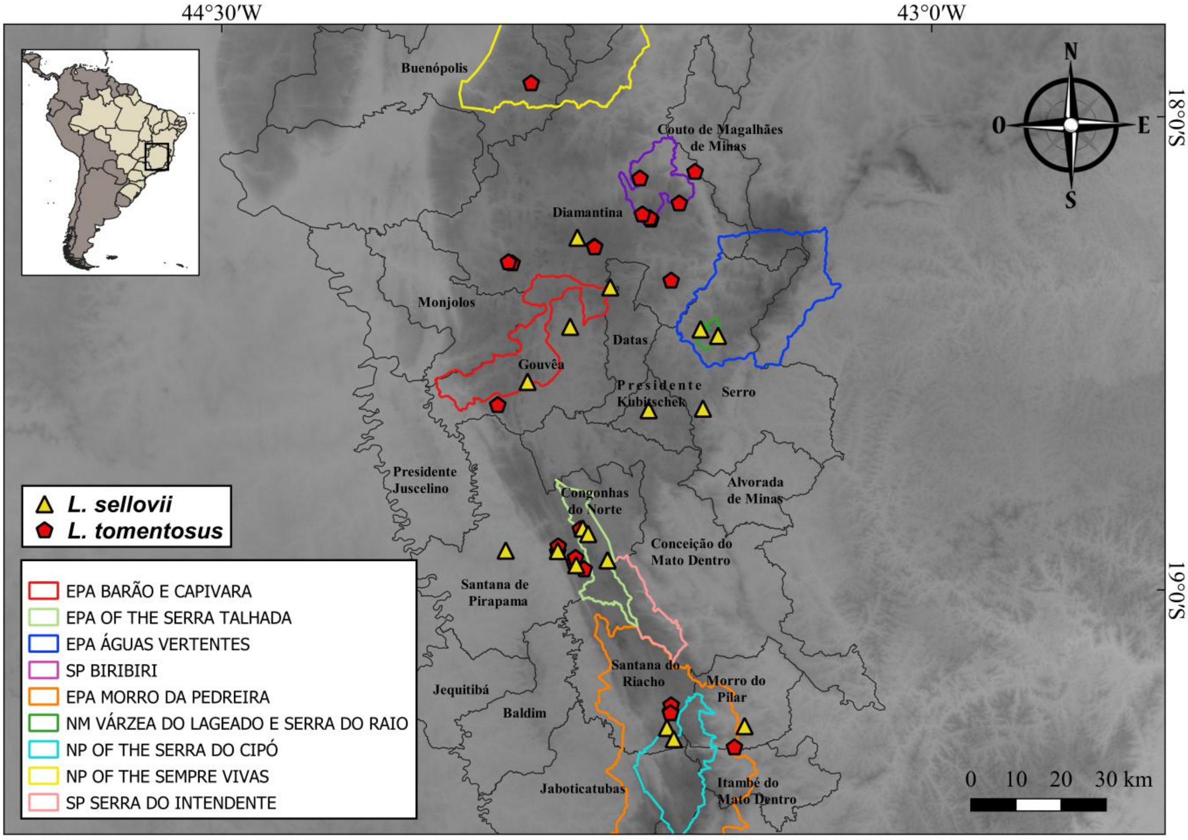

Figure 8 - Distribuition of *Lychnocephalus selovii* (triangle) and *Lychnocephalus tomentosus* (pentagon) (EPA = Environmental Protection Area; NM= Natural Monument; NP= National Park; PNHR= Private Natural Heritage Reserve; SP= State Park)

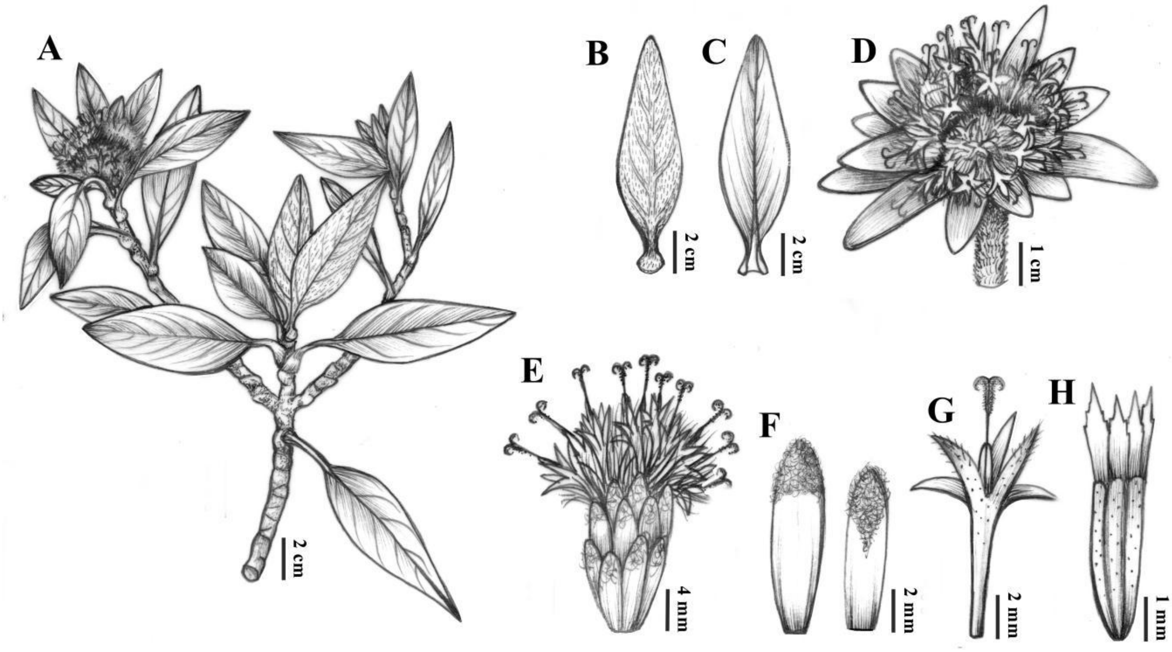

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Figure 9 - *Lychnocephalus tomentosus*. **A.** Flowering branch. **B.** Leaf adaxial surface. **C.** Leaf abaxial surface. **D.** Syncephalium. **E.** Capitulum. **F.** Outer phyllary and inner phyllary. **G.** Corolla, androecium, and style. **H.** Cypsela.

CAPÍTULO 2: LEAF ARCHITECTURE AND ANATOMY OF *LYCHNOCEPHALUS* MART. EX DC (ASTERACEAE:VERNONIAE)

Leaf architecture and anatomy of *Lychnocephalus* Mart. ex DC (Asteraceae:Vernoniae)[1]

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Abstract

Plant anatomy, combined with other tools, have contributed significantly to the taxonomic studies of diverse vegetal groups. *Lychnocephalus* is a genus of Asteraceae that comprises eight species, occurring in the campos rupestres of Cadeia do Espinhaço, Minas Gerais, Brazil. Characteristics related to *Lychnocephalus* leaves, such as shape and indument, are useful in differentiating species. Another characteristic used is the venation pattern, which in some species is described as parallelodromous, a type of venation common in monocotyledones. However, due to the large amount of trichomes on the abaxial surface of these leaves and because they are poorly imprinted on the adaxial surface, it is not possible to determine whether they really are strictly parallelodromous leaves or whether there is a mixed with other types of venation. Thus, the objective of this study is to describe the leaf architecture of species of *Lychnocephalus* Mart ex DC. (Asteraceae: Vernonieae), and to analyse the application of anatomical characteristics as a subsidy to the group's taxonomy. In order to carry out the analyses, both transversal and longitudinal sections of the eight species of the genus were performed, as well as leaf clearing, to observe the venation pattern of the studied species. The results showed differences between the taxa in characteristics of cuticle, parenchymatic tissues, vascular bundles, midrib contour and pericyclic sclerenchyma. Differences in venation patterns were also observed, the primary venation pattern varying between eucampdodromous and paralellodromous, with secondary veins presenting different angles in relation to the midrib in the leaves and veinlets of some species with terminal tracheids. The analysed characters showed to be useful for discriminating the species, being an important tool to the taxonomy of the genus.

Key Words: Campos rupestres, Compositae, Lychnophorinae, Plant anatomy

Introduction

Foliar architecture consists of character descriptions, mainly involving aspects such as shape, size, venation and position of structures of leaf (Sun et al. 2018). These characteristics are intrinsically correlated with physiological mechanisms that include light absorption; reserve of water and nutrients; transport and gas exchange (Hickey 1988; Candela et al. 1999).

Leaf characteristics have been shown to be useful as a support in the identification and classification of plants, given their visual simplicity in distinguishing taxa and for their practicality when floral structures are absent (Manokari & Shekhawat 2016; Maitra & Mukherjee 2017). A comparative anatomy involving both macromorphological and micromorphological leaf characteristics, as subsidy in taxonomic, systematic and ecological studies, has been reported for different groups of plants: such as Amaranthaceae (Fank-de-Carvalho et al. 2010), Asteraceae (Melo-de-Pinna 2004, Rivera et al. 2017, Tugay et al. 2018, Janaćković et al. 2019, Gavrilović et al. 2019), Cyperaceae (Silva et al. 2020), Lauraceae (Gomes-Bezerra et al. 2018), Malpighiaceae (Araújo et al. 2020), Myrtaceae (Oliveira et al. 2011), and Poaceae (Pelegrin et al. 2009)

Asteraceae is considered one of the families of angiosperms with the largest number of species (25,000-35,000), occurring in the most diverse types of ecosystems, which range from desert environments to mountainous regions (Funk et al 2009; Mandel et al. 2020). The family is known for its rapid diversification and dispersion throughout the world, which is attributed to its adaptive success related, among other factors, to the presence of secondary metabolites that help in the chemical protection of its representatives against herbivory and the action of pathogens (Wagner et al 2014).

Lychnophorinae is a subtribe of Vernonieae (Asteraceae) with its representatives occurring mainly in the savannas of Brazil, and currently present 123 species (Loeuille et al. 2015, Loeuille et al. 2019, Bringel et al.

2019, Candido & Loeuille 2020, Gomes e Loeuille 2021) (see apêndix 1). They are chiefly distributed in the Cerrado domain in the phytophysiognomy of campos rupestres (Loeuille et al. 2019).

The campos rupestres are a mosaic of vegetation, with shallow soils and poor in nutrients. In such environments with extreme conditions, plants develop morphological and physiological mechanisms that can guarantee their survival (Silveira et al. 2016). Like other groups of plants of campos rupestres, representatives of Lychnophorinae have developed both morphological and anatomical adaptive mechanisms, including overlapping leaves, large amounts of trichomes on leaves and branches, presence of sclereids and stomatal crypts (Lusa et al 2014; Lusa et al. 2015; Lusa et al. 2018).

Lychnocephalus Mart ex DC is a small genus of Lychnophorinae characterized as subshrubs to candelabriform treelets, presenting leaves with tomentose to densely lanate indumentum,third order syncephalia and external series of pappus with twisted setae and narrowed apex, currently comprising eight species (Gomes and Loeuille 2021) (see apêndix 1). Some anatomical studies involving the subtribe Lychnophorinae have been carried out (Luque 1999, Lusa 2014, Wagner 2014, Lusa 2018), however, none of include all species of *Lychnocephalus.* The pattern of venation of the leaves, one of the characteristics useful in the taxonomy of the group, is barely distinguishable due to the dense amount of trichomes. As a consequence, some confusion arose about the exact nature of the parallelodromous-like pattern observed in several species. A detailed analysis of the venation pattern of the species, including tertiary or quartenary veins pattern and areola structure may highlight characteristics differing between similar species.

Thus, the aim of the present work was to carry out the leaf anatomy and architecture foliar of all currently recognized species of *Lychnocephlaus* and to analyse whether these characteristics may present subsidy in the group's taxonomy.

Materials and methods

Leaf samples of the eight species currently recognized for the genus *Lychnocephalus* were analyzed (Tab. 1).Most of the samples analysed come from collections made in July 2019 in Serra do Cipó, Minas Gerais, Brazil; for species not collected in the field, material deposited in BHCB and UFP herbaria were used (acronyms followed by Thiers (in constant modification). For anatomical analyses, mature leaves from the third and fourth nodes were chosen, and, when possible, three leaves were collected from three individuals from three populations. When three populations of a species were not found, the sampling by individual was increased to nine. These samples were stored in FAA 50 and later transferred to alcohol 70% (Johansen, 1940).

For the study of internal structures, the samples were dehydrated in a gradual series of tertiary ethanol-butanol (50-100%), included in histological paraffin (Kraus and Arduin, 1997), and sectioned in a rotating microtome LUPETEC MR09 with a thickness varying from 10-12µm. Subsequently, they were stained with safranin and blue astra (Kraus et al. 1988) and mounted on permanent slides with Canada Balsam (Gerlach, 1984).

For clearing, Shobe and Lersten's (1967) methodology was followed, with modifications, replacing hydrated chloral with sodium hypochlorite (commercial bleach) 50%. In the case of herborized materials, after to clearing, the leaves were rehydrated using 50% glycerin and water being heated in hot plate. After the discoloration of the leaves, they were stained in safranine and mounted on temporary glass slides, where they were photographed with a Canon PC2256. Photomicrographs were obtained through a light microscope with a Leica DM500 coupled camera using Leica Application Suite version 3.4.0 program (Leica Microsystems, Wetzlar, Germany). The description of the venation pattern followed Hickey (1973; 1979).

Results

Features of the mesophyll

The epidermal cell walls present a straight contour in frontal view and isodiametric shape (Fig. 1A). The cuticle is generally strongly thick for all species, corresponding to about half the size of epidermal cells (Fig. 1B). Differences were also observed in the cuticle surface that has a papilous appearance (Figs. 1B-1H). The epiderms cells of the abaxial surface are and adaxial epidermis varies from flat, wavy, strongly wavy or papillous (Tab. 2). The species presents flat abaxial epidermis, however, the epidermis of the adaxial surface showed differences. Most species have flat adaxial epidermis, except *L. humillimus* and *L. sellovii*, where the surface is wavy (Fig. 1D). The epidermis of all species is uniseriate,

The mesophyll is dorsiventral in all species, displayng the palisade parenchyma and lacunous parenchyma compacted given the wide differentiation of the aquifer multiseriate hypodermis (Fig. 1C). Regarding the number of vascular bundles of the midrib, they vary from one to four (Table 2) (Fig. B, C, E, F, G, H), they are collateral with pericyclic sclerenchyma which disposition varies between species: they can be located only in the portion of the xylem in most species (Figs. 1B, 1C, 1E) or in the phloem and xylem portion (*L. mellobarretoi*, *L sellovii* and *L. tomentosus*). (Fig. 1F-1H).

All species have crypts on the abaxial surface of the lamina, where the stomata are located thus, the leaves of all species of *Lychnocephalus* are hypoestomatic (Fig. 2A). Due to the difficult visualization of the stomata which are concealed by a large amount of trichomes on the leaf's abaxial surface, it was not possible to determine the type of stomata of the species.

A great diversity of trichomes are observed in the genus, with some presenting up to five different types. The most common type of trichome, found in all species are unbranched, long, thin trichomes (type A1)(Fig. 2E), simple stellate trichomes (type E1)(Fig. 2B) and branched, 3- to 5-armed trichomes (type D1). The species *L. cipoensis*, *L. sellovii, L. jolyanus* and *L. canus* presents two types of multiseriate glandular trichomes: one pedunculate, biseriate, and the other with a biseriate head located in depressions of the adaxial epidermis (Fig. 2C, 2D). A new type of trichome has been found in the genus *Lychnocephalus*, in *L. tomentosus*, Y-shaped with equal arms (Fig. 2E).

The midrib shape in most species is flat-convex (Fig. 1C, 1E), but concave-convex in *L. mellobarretoi* (Fig. 1F) and biconvex in *L. tomentosus* (Fig. 1H). It was observed that the main veins of *L. tomentosus* and *L. mellobarretoi* are more voluminous compared to the other species.

Sclereids, distributed in the mesophyll, are present in all species, however, the quantity and type vary. *L. sellovii* displays a greater quantity of this type of cells, and theirs walls are very lignified and very thick (Fig. 2F). In all species, most of these cells are of the brachysclereid type; however, in *L. cipoensis* and *L. mellobarretoi*, elongated sclereids were found. (Fig. 2G).

The collenchyma is angular in all species, except in *L. sellovii*, which presents lacunar collenchyma (Fig. 2H).

Leaves

The leaves of *Lychnocephalus* species present a great variety in size and shape (elliptical, lanceolate to wide lanceolate, linear, ovate to obovate, narrowly oblong to widely oblong) (Fig. 3). All species have a leaf sheath, semiamplexicaul or amplexicaul. Almost all species have sessile leaves, except for *L mellobarretoi* and *L. tomentosus* (Fig. 3F and 3H) and a flat or slightly revolute margin (Fig. 1D).

Venation features

The secondary veins of all species branch off, coming close to the margins, thus, the venation pattern between species can be considered eucamptodromous in *L. grazielae*, *L. humillimus*, *L. mellobarrretoi* and *L. tomentosus* (Figs. 3C, 3D, 3F, 3H) and parallelelodromous-cladrodomous in *L. canus*, *L. cipoensis, L. jolyanus* and *L. sellovii* (Fig. 3A, 3B, 3E, 3G). It was observed that the leaves of *L. sellovii* have secondary veins are curverd, creating a straight angle in relation to primary veins that continue until the apex of the leaves, whereas in the blades of *L. cipoensis* and *L. jolyanus*, these veins are slightly curved, with some veins not reaching the apex of the leaf blade. Furthermore, in these species a slight branching was also observed at the base of the midrib of similar calibre.

All species of *Lychnocephalus* have barely visible veins on the adaxial surface of the leaves and veins printed to prominent on the abaxial surface. *L. grazielae* presents a poor prominent vein at the base and narrowing towards the apex (Fig. 3A). The midrib is straight in *L. mellobarretoi* and *L. tomentosus*

The angle of divergence between the main vein varied between moderate high (45°) (Fig. 4E) and approximately right (approximately 90°)

(Fig. 4F). The pattern of tertiary veins in all species did not vary, presenting an orthogonal reticulate pattern (Fig. 4). The areolas are well developed, with a distinction between veins and veinlets (Fig. 5). Most species presented areoles with a quadrangular shape, in *L. cipoensis* the shape of the areoles varied between triangular to quadrangular (Fig. 5B).

The marginal ultimate venation in looped type was observed in all species (Fig. 6A). The veinlets of all species are simple, varying between linear and curved; *L. canus*, *L. sellovii, L. tomentosus*, presented terminal tracheids in their veinlets (Fig. 6B, 6C). A detailed description of the venation pattern of *Lychnocephalus* species is provided in appendix 1.

Discussion

The campos rupestres comprise a mosaic of different types of vegetation where they are usually associated with quartzitic, metarenite and ferruginous soils (Fernandes et al. 2016). This environment is known for its high biodiversity and endemism (Stannard, 1995; Giulietti et al., 1997, Zappi et al. 2017). These factors are related to their isolation, forming true islands of altitude, which segregate populations and thus contribute to the diversification of species and to the high rates of endemism of this phytophysiognomy (Vasconcelos et al. 2020; Fernandes et al. 2020).

This ecosystem presents so extreme environmental conditions, which include shallow soils, poor in nutrients and high solar radiation (Jacobi et al. 2007). Thus, the plants of campos rupestres have developed adaptations, such as thick cuticle and high density of trichomes, that enable them to survive in these conditions (Melo-de-Pinna 2004; Bombo et al. 2012; Lusa et al. 2018).

Different anatomical features mentioned in the literature were observed in *Lychnocephalus* that contribute to growth in adverse conditions and these characteristics may be useful in the taxonomy of the genus. The aquifer parenchyma of the species of *Lychnocephalus* is developed, mainly in *L. jolyanus*, which presented a very compact mesophyll, due to the high development of this tissue. The presence of these voluminous cell is a characteristic strongly related to the adaptation of xerophytic environments, such as campos rupestres, being responsible for storing water for use in unfavorable periods (Horner et al. 2017).

Cuticle and epidermis

The thick cuticle present in the species of *Lychnocephalus* may be related to the adaptive process of the genus in the campos rupestres, serving as a protection barrier to different biotic and abiotic factors (Lusa et al. 2018). Studies involving the cuticle in plant species show that plants can increase the deposition of cuticular wax when subjected to water stress, thereby preventing excessive sweating (Kosma et al. 2009), also the cuticle would also be responsible for protecting leaves from the high incidence of UV radiation (Sullivan et al 1996) and the action of the wind, besides of being a barrier against the attack of pathogens and herbivory (Serrano et al. 2014). In *Lychnocephalus* is evident the differences in the epicuticular wax, with a very wavy abaxial surface, and an adaxial surface ranging from straight to slightly wavy.

Stomata

All species are hypoestomatic, a similar result was also observed by Luque et al. (1999) in a study carried out with 25 species of *Lychnophora*, into which *Lychnocephalus* was previously classified. Stomatal crypts, a characteristic observed in all species of *Lychnocephalus*, may be related to the protection of stomata in environments with high light intensity (Dickison 2000; Espindola-Jr. et al. 2009, Lusa et al. 2018), and may also be responsible for facilitate the diffusion of CO_2 between the abaxial and adaxial surface of the leaf (Hassiotou et al. 2009). This characteristic can also be strongly associated with adaptation to environments with extreme conditions such as campos rupestres, which may be related to the water saving in the leaves (Lusa et al. 2014).

Mesophyll

Despite of isobilateral mesophyll being very common in xeric environments (Metcalfe and Chalk, 1950), all species of *Lychnocephalus* have dorsiventral mesophyll, the most common type in the family characteristic in

Asteraceae. The number of bundles is also an important taxonomic character, (e.g., Tugay et al. (2019) in *Cousinia*). In the present study, the morphologically related species *L. canus* and *L sellovii* showed two and one bundles respectively, *L. grazielae* and *L. humillimus*, have three and one bundles respectively.

Pericyclic sclerenchyma located close to vascular tissues, are considered common in Asteraceae (Camillotti et al. 2014, Budel et al. 2018) and are probably involved in the conduction process, increasing the proximity between mesophilic cells and conducting tissues (Dengler 1994). In addition, these fibers may be related to the resistance, stiffness, protection and support of parenchymal cells and vascular tissues (Mauseth 1988). The pericyclic sclerenchyma is easy to identify and has considerable taxonomic value, helping to distinguish species or genera from the same family (Metcalfe and Chalk 1950). This character prove to be useful in distinguishing two species of *Lychnocephalus* that are morphologically close: *Lychnocephalus canus* and *Lychnocephalus sellovii* that resemble each other because they are treelets and have involucre campanulate. In *L. canus*, these fibers occur only near the phloem portion, while in *L. sellovii*, they occur both close to the phloem and the xylem.

Trichomes

The presence, type, distribution and density of glandular and non-glandular trichomes in Asteraceae species proved to be significant in the identification of species due to their considerable constancy in the epidermis of leaf blades (Lolis and Milaneze-Gutierre 2003, Melo-de-Pinna 2004; Martins et al. 2006; Hayat et al. 2009). The dense amount of trichomes on the abaxial surface of *Lychnocephalus*, a characteristic shared with the other Lychnophorinae, would be related to the protection of leaves against water stress, fire and herbivory (Wagner et al. 2004; Wagner et al. 2014). In a study involving the diversity of non-glandular trichomes of the subtribe Lychnophorianae, Wagner et al. (2014), registered about five main types and 20 different subtypes of non-glandular trichomes for the subtribe, of that total, five subtypes were registered for *Lychnocephalus* species. In our study, a new non-glandular trichome subtype for the genus was observed, of the type 2-armed, Y-shaped, with arms of equal sizes in *L. tomentosus* (Fig. 2E).

Glandular trichomes were observed on the abaxial surface of all species, however, only the species *L. canus*, *L. cipoensis*, *L. jolyanus* and *L. sellovii*, presented glandular trichomes on the adaxial surface. Studies carried out on the evolution of secondary metabolites in Lychnophorinae (including *Lychnocephalus tomentosus*) showed the presence of phenolic compounds, terpenoids and polyacetylenes (Lusa et al. 2016B).

Midrib

The midrib contour is considered a useful feature in the anatomical identification of species (Araújo 2010; Araújo et al. 2020; Bieras and Sajo 2004; Tugay et al. 2019). Characteristics related to the midrib contour also differed in *Lychnocephalus*, most species showed a right-convex type contour. However, the morphologically related species *L. mellobarretoi* and *L. tomentosus*, the only species of the genus that are petiolate and have pubescent corolla lobes, present concave-convex and biconvex contour, respectively.

Leaf venation

Leaf venation, when compared to other characters, such as leaf size and shape, are considered significant in identification and classification due to their stability at the species level (Fang et al. 2002; Huang and Huang 2004 Sun et al. 2018).

In relation to the contribution of the analysis of venation patterns, one of the differences between species observed is the angle of the secondary veins in relation to the midrib. In *L. tomentosus* this is an approximately right angle, in *L. mellobarretoi* this angle is acute. In addition, *L. cipoensis* was the only species of the genus that presented triangular areoles. Another characteristic observed was the presence of dilated terminal tracheids in the veinlets *L. canus*, *L. cipoensis*, *L. jolyanus*, *L. sellovii* and *L. tomentosus*, also reported for other members of Asteraceae (Melo-de-Pinna 2004, Rojas-Leal

2019).These dilated tracheids, which are approximately isodiametric in shape, are related to the storage of water in the leaves (Venturelli 1981).

The presence of parallel veins in Asteraceae is an uncommon feature and registered only for some groups of the family, examples are the genera *Apopyrus*, *Barkleyanthus*, *Lulia*, *Mikania, Schlechtendalia*, *Soaresia* (Esteves et al. 2008; Ritter and Miotto 2005; Rojas-Leal et al. 2018). The presence of this type of venation in the family is not well understood, since this is a typical characteristic of monocots. However, according to Sack & Scoffoni (2013), as well as other leaf structures, the type of venation in angiosperms can also show high plasticity to adapt to different environmental conditions. In relation to monocotyledons, the vascular system of the leaves itself, mainly to provide faster transport of water and nutrients, in the case of *Lychnocephalus* providing this serious speed essential for greater adaptability of the genus in campos rupestres due to environmental conditions, however, more studies are needed on this type of venation in the genus to better clarify this phenomenon.

Conclusions

All species of *Lychnocephalus* have putative adaptive characteristics, such as thick cuticles, epicuticular wax, high density of trichomes, stomatal crypts that contribute to their development and survival in the campos rupestres. From the results obtained, it was observed that leaf and anatomical characters such as venation, vascular bundles, type of trichomes were useful for the taxonomy of the genus *Lychnocephalus*, since they contributed to the differentiation of species. In addition, terminal tracheids were seen in the veinlets of the species studied, an unprecedented feature for the genus.

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Appendix 1. Foliar architecture of *Lychnocephalus*

Lychnocephalus canus F.M.B. Gomes & Loeuille

Lamina 4.5–9.5×1.5–2.3 cm, sessile, narrow lanceolate, **base** atenuate, apex atenuate, margin slight revolute, sheath amplexicaul 0.7–1.3× 0.9–1.3 cm. **Venation** of lamina paralellodromous (Fig. 3A, 4A). **Primary veins** right, proeminent and thick. **Secondary veins** cladodromous, with de 4–8 pairs of secondary veins diverging from primary veins at acute angle(Fig. 3A). **Secondary veins** curved. **Terciary veins** with angle of with right origin angle, random reticulate, approximately perpendicular to the midrib (Fig 4A) **Quartenary veins** poligonal random reticulate, forming areoles (Fig. 5A). **Areoles** well developed, quadrangular. **Veinlets**, simple, right, with terminal tracheids. **Trichomes** glandular, sessile, located in depressions in the epidermis, multiseriate glandular trichomes (adaxial surface), long and thin non-armed trichomes (A1), simple strellate trichomes (E1).

Lychnocephalus cipoensis Semir ex F.M.B. Gomes & Loeuille

Lamina 2.7–5.1 × 0.7–1.7 cm, sessile, lanceolate, **base** atenuate, **apex** obtuse or rounded, margin slightly revolute, **sheath** amplexicaul 4.3–7.2 × 0.9–8.1 mm. **Venation** of lamina paralellodromous (Fig. 3B, 4B) . **Primary veins** straight to slightly arched. **Secondary veins** cladodromous, with 4-6 pairs of secondary veins, diverging of the primary vein at a acute angle(Fig. 3B). Secondary veins curved. **Terciary veins** with straight origin angle, random reticulate, approximately perpendicular to the midrib (Fig. 4B). **Quartenary veins** regular poligonal reticulate, forming areoles (Fig. 5B). Areoles well developed, triangular or quadrangular. **Veinlets** simple, right-angled, with terminal tracheids. Trichomes glandular, sessile, located in depressions in the epidermis, multiseriate glandular trichomes (adaxial surface), long and thin, non-armed trichomes (A1), simple stellate trichomes (E1) (abaxial surface).

Lychnocephalus grazielae Semir ex F.M.B. Gomes & Loeuille

Lamina 3.1–4.8×0.7–1.2 cm, sessile, narrow oblong, **base** atenuate, **apex** obtuse, margin slightly revolute, **sheath** semiamplexicaul 4–6× 3–5 mm.

Venation of lamina eucampdodromous (Fig. 3C). Primary veins straight, proeminent, with 6–8 pairs of secondary veins, diverging of the primary vein at acute angle (Fig. 4C). **Secondary veins** curved. **Terciary veins** with straight origin angle, random reticulate, aproximately perpendicular the midrib(Fig. 4C). **Quartenary veins** regular poligonal reticulate, forming areoles (Fig. 5C). **Areoles** well developed, quadrangular. **Veinlets** simple, right-angled or curved. Adaxial surfce glabrous, long and thin, non-armed trichomes (A1), simple stellate trichomes (E1)(abaxial surface).

Lychnocephalus humillimus(Schultz-Bipontinus) Loeuille, Semir & Pirani

Lamina 1.1−2.1 × 0.7−1.2, sessile, narrow oblonge, base atenuate, apex rounded, margin slightly revolute, sheath semiamplexicaul, 3−3.5 × 4−5mm.**Venation** of lamina eucampdodromous (Fig. 3D) Primary veins not thick, little diferentied of the secondary. **Secondary venation**, with aproximately 3−4 pairs of secondary veins, diverging of the primary vein at acute angle (Fig. 3D, 4D). **Terciary venation** with straight origin angle, random reticulate, aproximately perpendicular the midrib (Fig. 4D). **Quartenary venation** poligonal reticulate, forming areoles (Fig. 5D). **Areoles** well developed, quadrangular. **Veinlets** simple, right-angled or curved. **Trichomes** non-armed, long and thin (A1), simple stellate trichomes (E1) (abaxial surface).

Lychnocephalus jolyanus Semir ex F.M.B. Gomes & Loeuille

Lamina sessile, 4.8–12.2 × 1–3.5, lanceolate or wide oblonge, **base** obtuse, **apex** obtuse, margin slightly revolute, **sheath** amplexicaul 0.9–1.9 × 1.1–1.8 cm. **Venation** of lamina paralellodromous (Fig. 3E), with central ribs joining slightly at the base. **Primary veins** moderately thick, prominents. **Secondary veins** cladodromous, with 8-10 pais of secondary veins, diverging of the primary veins at acute angle (Fig. 3E, 4E). **Terciary veins** with straight origin angle, random reticulate, aproximately perpendicular of the primary veins (Fig. 4E). **Quartenay veins** regular poligonal reticulate, forming areoles (Fig. 5E). **Areoles** well developed, quadrangular. **Veinlets** simple, right-angled or curve, terminal tracheids. **Trichomes** non-armed, long and thin (A1),simple stellate trichomes (E1).

Lychnocephalus mellobarretoi (Barroso) Loeuille, Semir & Pirani

Leave petiolate, **petiole** 0,5–1.2 cm; **lamina** 2.7–7.2× 1.9–3.1 cm, ovate or obovate, rarely lanceolate, **base** atenuate, **apex** obtuse, margin slightly revolute, **sheath** semiamplexicaul, 0.9–10× 0.6–1.2 mm. **Venation** of lamina eucampdodromous (Fig. 3F). **Primary vein** right, thick. **Secondary venation** reticulate, with 4–8 pairs of secondary veins, diverging of the primary vein at acute angle (Fig. 3F, 4F).**Tertiary veins** with straight angle, random reticulate, aproximately perpendicular of the primary veins (Fig. 4F). **Quartenary veins** regular poligonal reticulate, forming areoles. **Areoles** well developed, quadrangular (Fig. 5F). **Veinlets** simple, right-angled. **Trichomes** non-armed, long and thin (A1), simple stellate trichomes (E1) and Y-shaped trichomes.

Lychnocephalus sellovii (Schultz-Bipontinus) Loeuille, Semir & Pirani

Lamina sessile, 4.5–12.8 × 0.5–1.3–(2.8), lanceolate or linear, base atenuate, apex acute, margin slightly revolute, **sheath** amplexicaul, 0.9–1.9 × 1.1–1.8 cm.**Venation** of lamina paralellodromous (Fig. 3G). **Primary veins** right, thick, prominent. **Secondary venation** reticulate, with 6-8 pairs of secondary veins, diverging of the primary vein at acute angle (Fig. 3G, 4G). **Tertiary veins** with straight angle, random reticulate, aproximately perpendicular of the primary (Fig. 4G). **Quartenary veins** regular poligonal reticulate, forming areoles (Fig. 5G). **Areoles** well develloped, quadrangular. **Veinlets** simple, right-angled, terminal tracheids. **Trichomes** glandular, sessile, located in depressions in the epidermis, multiseriate glandular trichomes (adaxial surface), long and thin, non-armed trichomes (A1), simple stellate trichomes (E1) (abaxial surface).

Lychnonocephalus tomentosus Mart. ex DC.

Lamina peciolate, (2.8)–4.7–13.2 × (0.9)–4.5–5.6 cm, petiole (0.5)–2.3–2.7 cm, elíptic, rarely ovate or obovate, **base** deccurrent, **apex** obtuse, margin flat,**sheath** amplexicaul, 0.9–1.9 × 1.1–1.8 cm. **Venation** of lamina eucampdodromous (Fig. 3H). **Primary veins** very thick at the base, narrowing towards the apex. **Secondary veins** with 5–7 pairs, diverging of the primary vein at aproximately right angle (Fig. 3H, 4H). **Terciary veins** with straight angle, random reticulate, oblique constant of the primary vein (Fig. 4H). **Quartenary veins** poligonal reticulate, forming areoles (Fig. 5H). **Areoles** well develloped, quadrangular. **Veinlets** simple, right-angled, terminal tracheids**. Trichomes** long and thin, non-armed trichomes (A1), simple stellate trichomes (E1), Y-shaped trichomes, simple (abaxial surface)

Species	Locality	Geographic coordinates	Voucher
Lychnocephalus canus F.M.B. Gomes & Loeuille	Lapinha da Serra, Santana do Riacho, MG	19°06'57"S, 43°40' 10"W	F.M.B. Gomes et al. 8 (UFP)
Lychnocephalus cipoensis F.M.B. Gomes, Semir & Loeuille	Santana do Riacho, MG	19°15'38"S, 4332'19"W	F.M.B.Gomes et al. 2 (UFP), F.M.B. Gomes et al. 4 (UFP)
Lychnocephalus grazielae F.M.B. Gomes, Semir & Loeuille	Santana do Riacho, MG	19°15’48”S, 43°32’14”W	G.M. Antar & L.J. Sauthier (SPF)
Lychnocephalus humillimus(Schultz-Bipontinus) Loeuille, Semir & Pirani	Santana de Pirapama, MG	18°56’513”S, 43°45’27.67”W	D.C. Zappi et al. 2325 (SPF)
*Lychnocephalus jolyanu*s F.M.B. Gomes, Semir & Loeuille	Santana do Riacho, MG	19º17'03"S, 43°35'19"W	F.M.B.Gomes et al. 7 (UFP)
Lychnocephalus mellobarretoi (Barroso) Loeuille, Semir & Pirani	Santana do Riacho, MG	19°15'39"S, 43°31'56"W	F.M.B. Gomes et al. 3 (UFP)
Lychnocephalus sellovii (Sch.Bip.) Loeuille, Semir & Pirani	Santana do Riacho, MG	19º17'28"S, 43°33'51"W 19°18'57"S, 43°32'42"W	F.M.B. Gomes et al. 9 (UFP), F.M.B. Gomes et al. 10 (UFP)
Lychnocephalus tomentosus Mart. ex DC.	Santana do Pirapama; Santana do Riacho, MG	18° 57'51"S, 43°46' 22"W, 19°15'40"S, 43°32'17"W, 19°16'31"S, 43°32'06"W	F.M.B. Gomes et al. 1 (UFP), F.M.B. Gomes et al. 5 (UFP), F.M.B. Gomes et al. 6 (UFP)

Table 1: List of examined *Lychnocephalus* specimens and vouchers

Species	Epidermis		Mesophyll					
	AD	AB	Number of vascular bundles	Contour of the midrib	Pericyclic sclerenchyma	Type of sclereids	Collenchyma	Number of palilsade parenchyma layers
L canus	Right	Right	2	Flat-convex	FL	BR	Angular	2-4
L cipoensis	Right	Right	1	Flat - convex	FL	BR/ES	Angular	2-3
L grazielae	Right	Right	3	Flat-convex	FL	BR	Angular	2
L humillimus	Wavy	Right	1	Flat-convex	FL	BR	Angular	1
L jolyanus	Right	Right	1	Flat-convex	FL	BR	Angular	1
L mellobarretoi	Right	Right	3	Concave-convex	FL/XI	BR/ES	Angular	2
L selovii	Wavy	Right	1	Flat-convex	FL/XI	BR	Lacunar	1
L tomentosus	Right	Right	3 a numerous	Biconvex	FL/XI	BR	Angular	1

Table 2: General anatomical characters of *Lychnocephalus*. FL = phloem; XI = xylem; BR = brachysclereids; ES = elongated sclereids

Figure 1: Frontal view **(A)** and transversal sections **(B-H)**: **(A)** adaxial surface of *L. tomentosus* showing cells with straight walls with pentagonal to hexagonal contour; **(B)** Epidermis of the abaxial surface strongly papillose in *L. canus*, presence of two collateral bundles, T-shaped trichome in the abaxial surface continuous arrow); **(C)** Midrib of *L. cipoensis* showingonly one collateral vascular bundle **(D)** Epidermis of adaxial surface strongly wavy in *L. humillimus* and crypts on abaxial surface; **(E)** Rigth cuticle in *L. jolyanus* (continuous arrow, central flat-convex vein, presence of only one collateral bundle and stomata located in crypts (dashed circle), presence of sclereids (discontinuous arrow); **(F)** *L. mellobarretoi* midrib with concave-convex contour.**(G)** Cuticle of the abaxial surface of *L. sellovii* strongly striated (continuous arrow), pericyclic sclerenchyma close to phloem and xylem and sclereids with thick walls (continuous arrow); **(H)** Very prominent midrib of *L. tomentosus*, with biconvex contour, with three collateral vascular bundles. Labels: AP= Aquiferous parenchyma, Cr = Crypt, Fl = Phloem, Sc = Sclerenchymatic fibers, X = Xylem. Scale bars: a, b= 150µm; c, d, e, f, h= 2000µm; g=1000µm. Photos: A: ECP Arruda; B-F: FMB Gomes

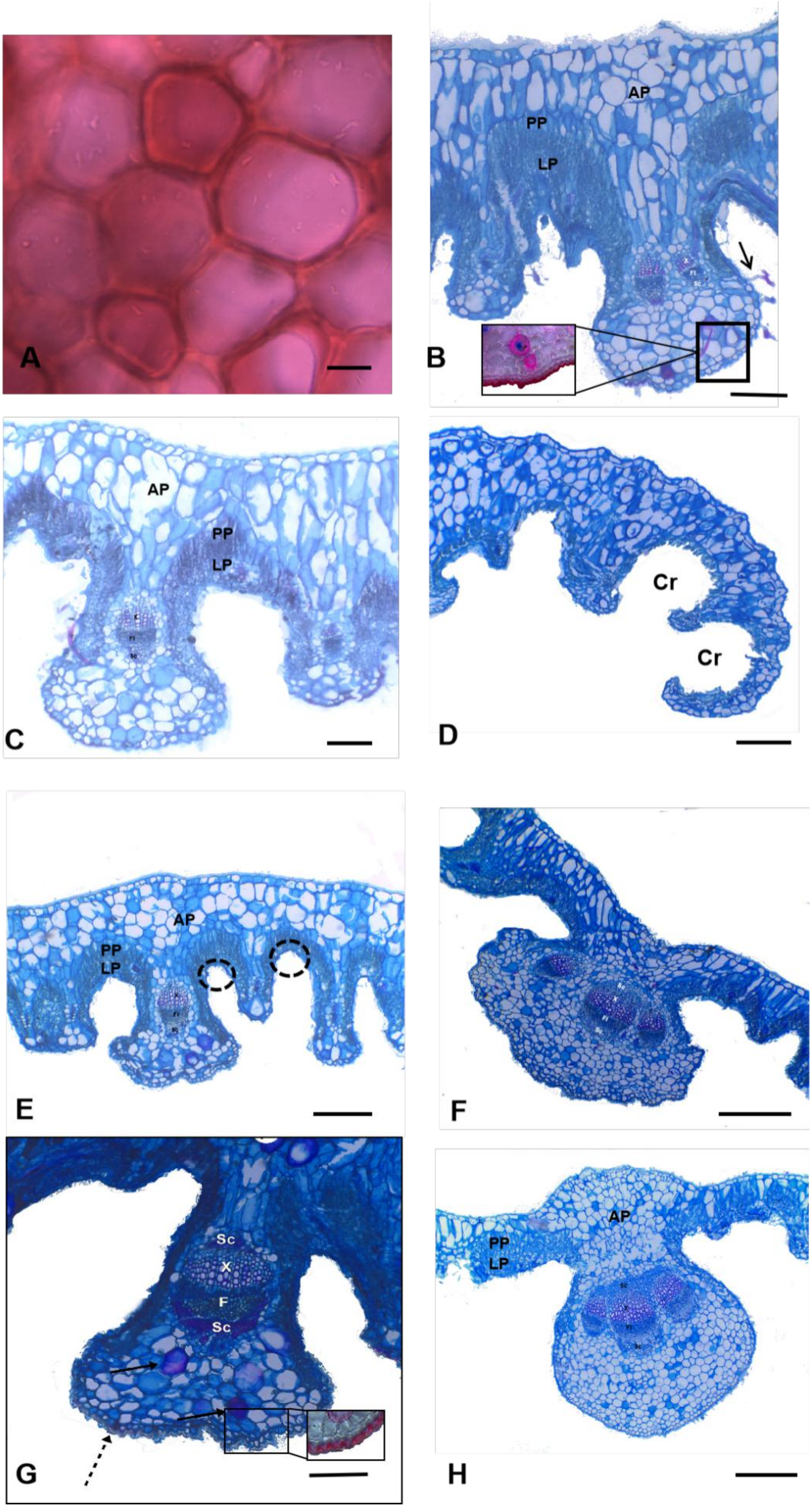
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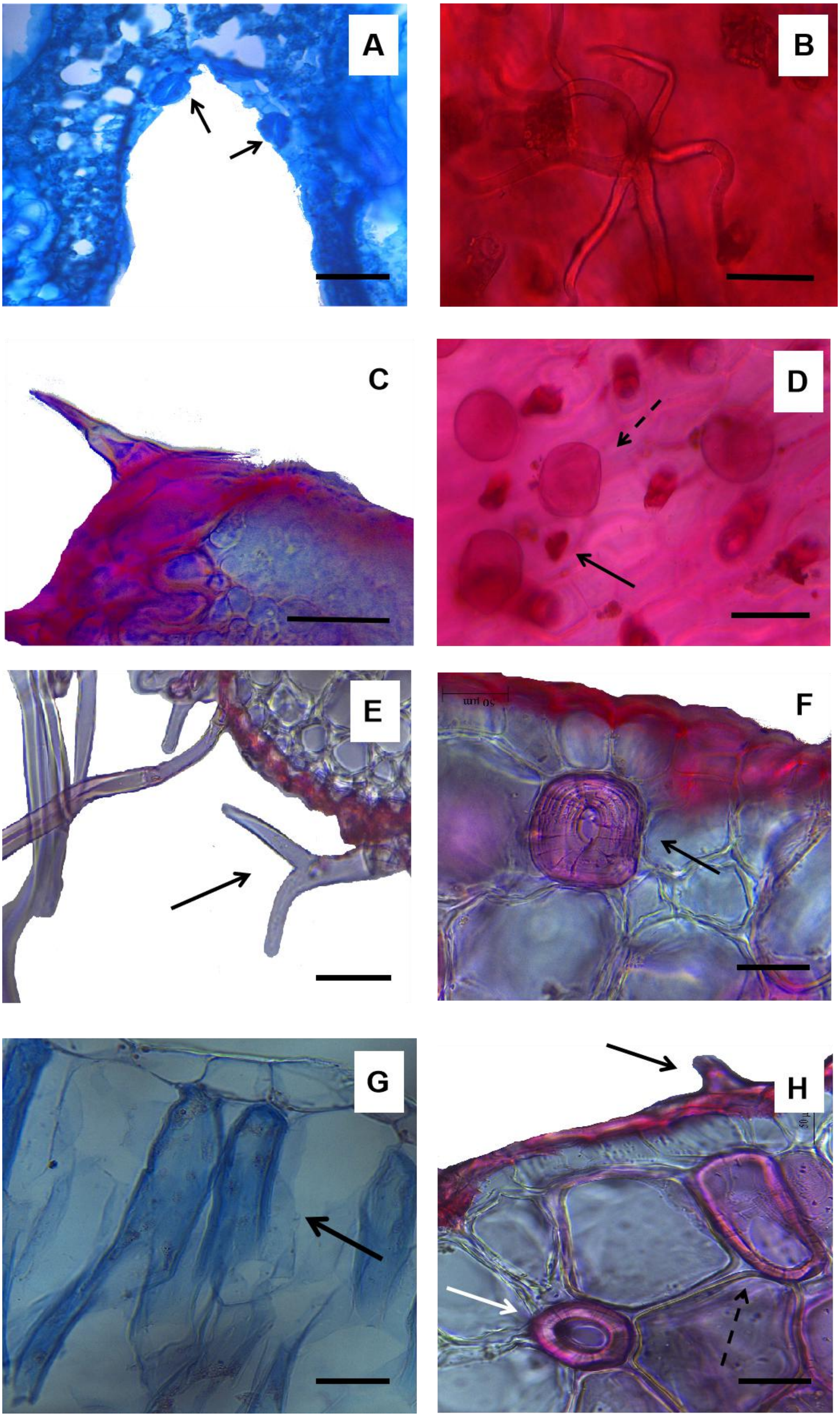
Figure 2: Front view **(B-D)** and transversal sections **(A, C, E, F)**: **(A)** Detail of stomata located in crypts of *L. jolyanus*; **(B)** trichomes of 5-armed type in *L. canus*; **(C)** transversal section showing two types of glandular trichomes on the adaxial face of *L. sellovii* **(D)** Frontal view showing the two trichomes inserted in depressions of the epidermis (continuous arrow) and not sessile (dashed arrow); **(E)** Thin, long trichomes and Y-shaped trichomes in the abaxial surface of *L. tomentosus*, **(F)** Brachysclereids in *L. sellovii*, **(G)** elongated sclereids in *L. mellobarretoi*, **(H)** Lacunar collenchyma in *L. sellovii* (discontinuous arrow), glandular trichome in adaxial epidermis (continuous arrow) and brachysclereid (white arrow). Scale bars: a-h= 150µm. Photos: A: F.M.B. Gomes; B-G: E.C.P. Arruda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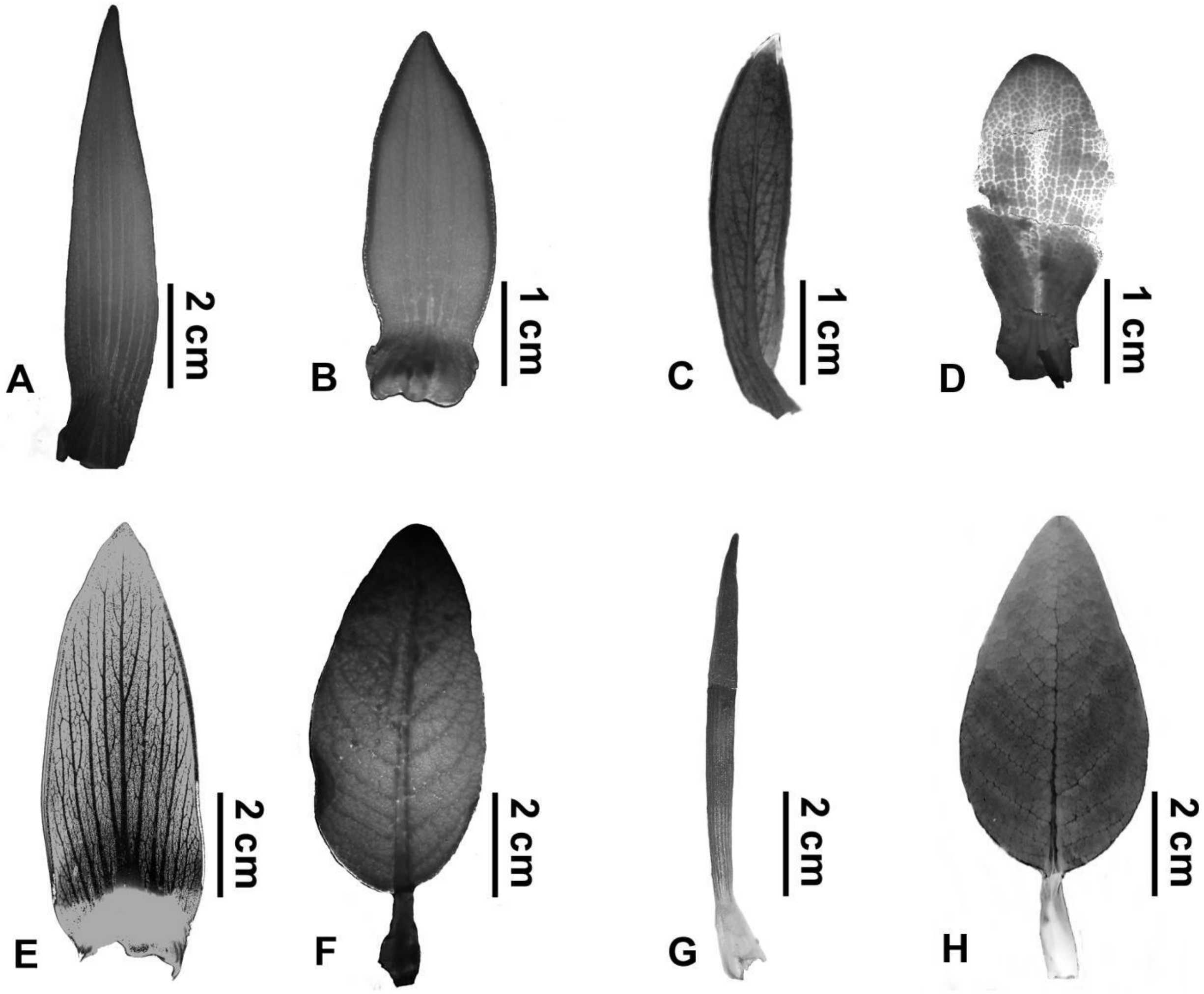

Figure 3: Lamina shape in *Lychnocephalus*: **(A)** *L. canus,* **(B)** *L. cipoensis,* **(C)** *L. grazielae,* **(D)** *L. humillimus*, **(E)** *L. jolyanus,* **(F)** *L. mellobarretoi,* **(G)** *L. sellovii,* **(H)** *L. tomentosus.* Photos: FMB Gomes

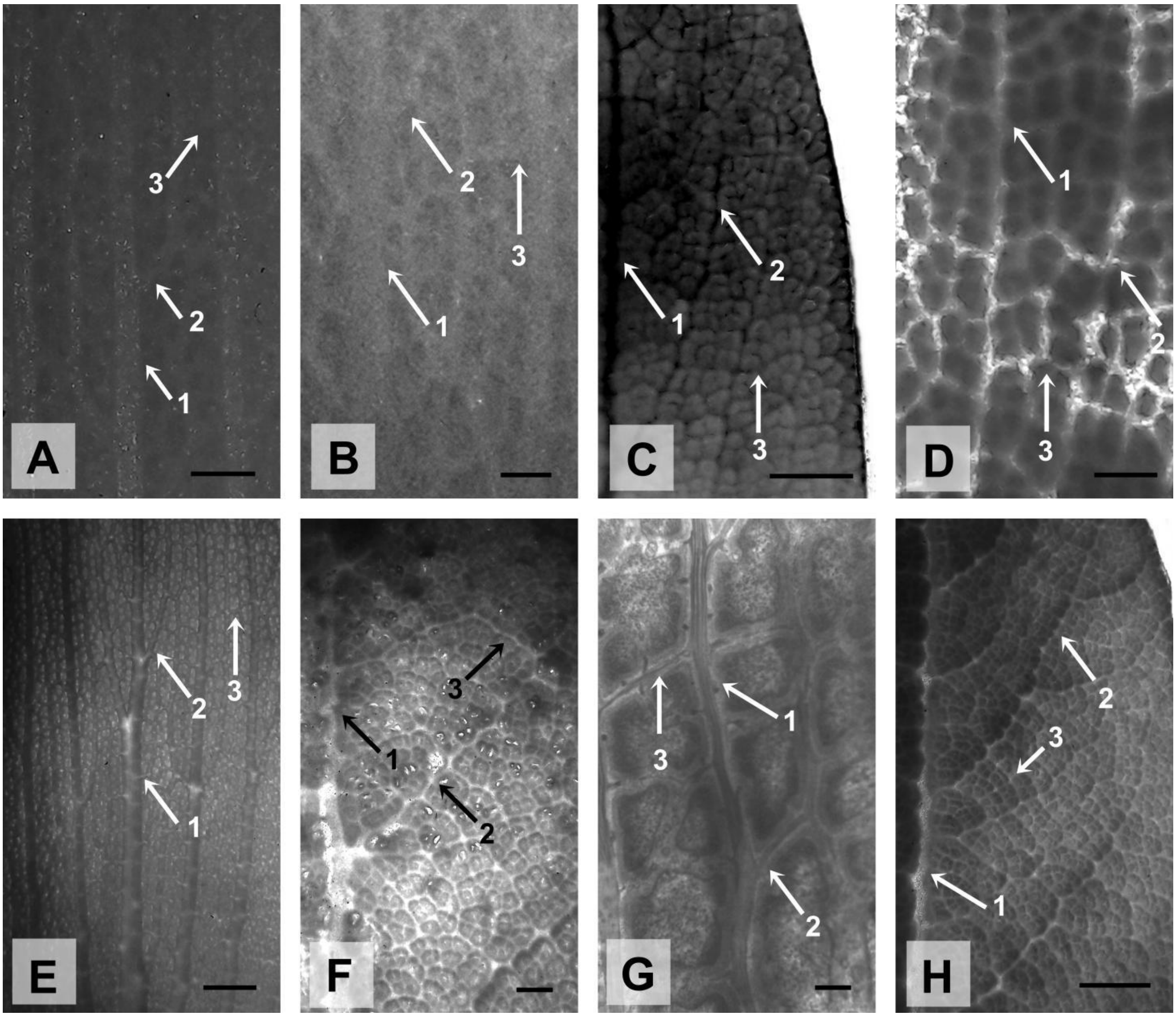

Figure 4: Orientation of intercostal venation in *Lychnocephalus*: **(A)** *L. canus,* **(B)** *L. cipoensis,* **(C)** *L. grazielae,* **(D)** *L. humillimus,* **(E)** *L. jolyanus,* **(F)** *L. mellobarretoi,* **(G)** *L. sellovii,* **(H)** *L. tomentosus*. Sacale bars: 2000 µm Photos: FMB Gomes.

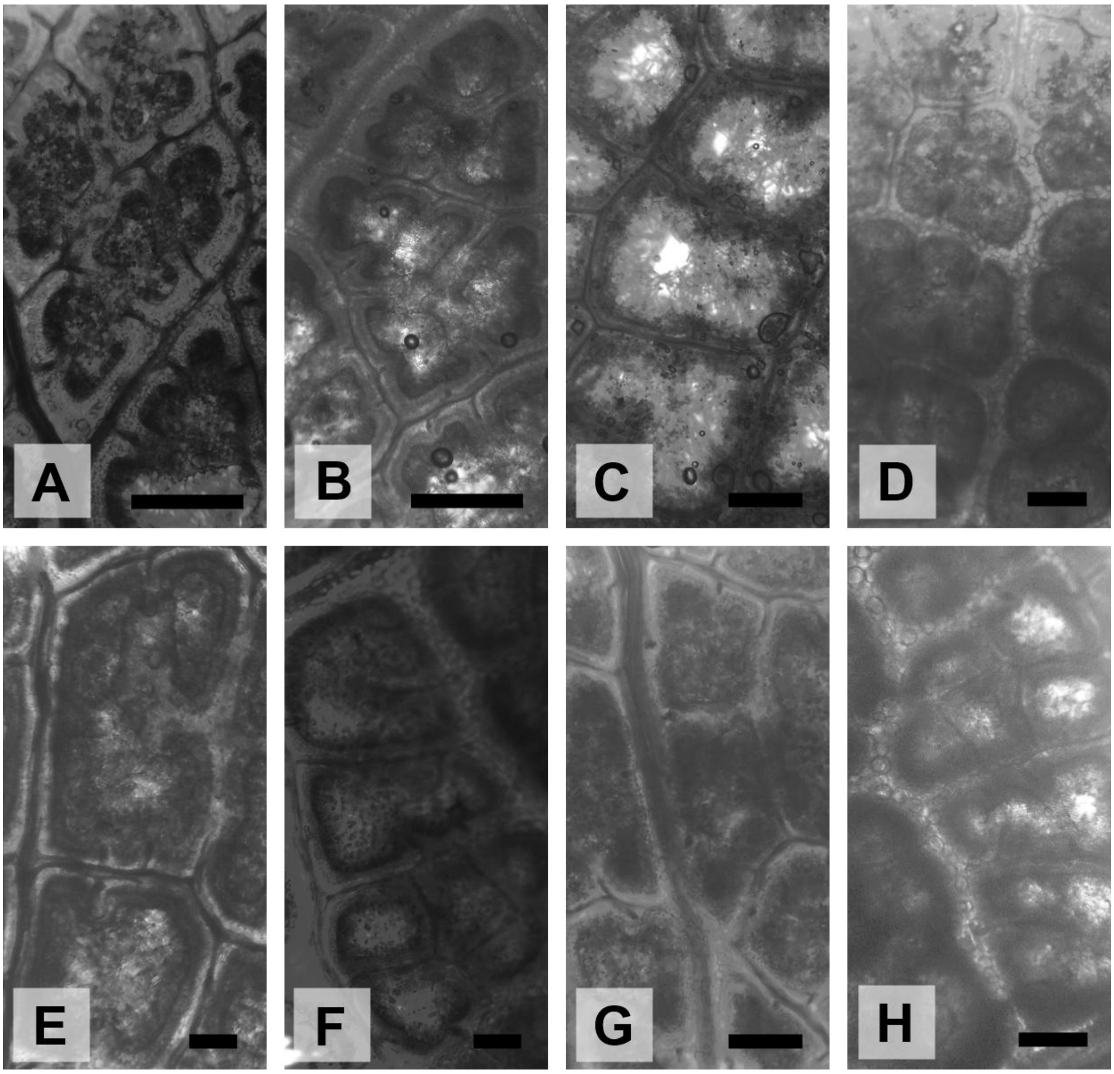

Figure 5: Quaternary veins pattern in *Lychnocephalus:* **(A)** *L. canus,* **(B)** *L. cipoensis,* **(C)** *L. grazielae,* **(D)** *L. humillimus,* **(E)** *L. jolyanus,* **(F)** *L. mellobarretoi,* **(G)** *L. sellovii,* **(H)** *L. tomentosus.* Scale bars: 150 μm. Photos: FMB Gomes

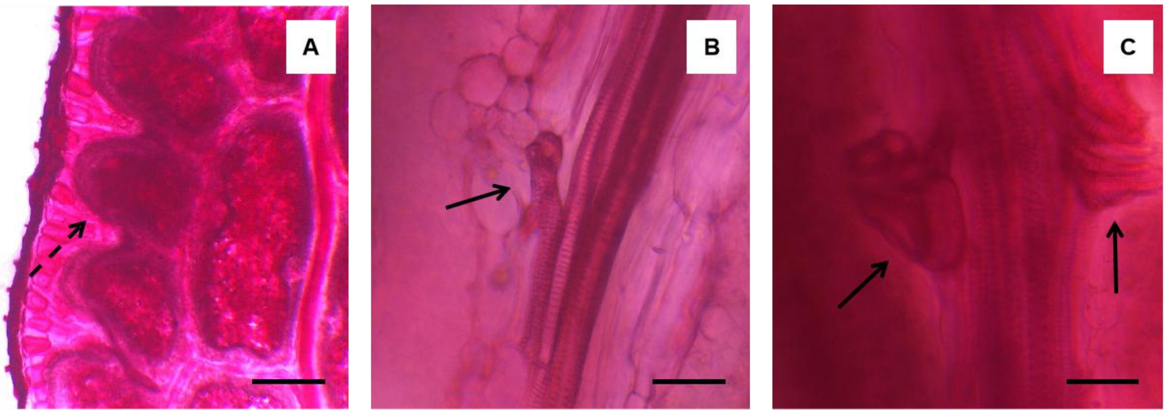

Figure 6: (A) Marginal ultimate venation looped in *Lychnocephalus sellovii*; **(B)** Terminal tracheids in *Lychnocephalus sellovii*; **(C)** Terminal tracheids in *Lychnocephalus tomentosus.* Scale bars: A= 2000 µm, B,C = 150 µm. Photos: A: FMB Gomes, B-C: ECP A

APÊNDICE 1: THREE NEW SPECIES OF LYCHNOCEPHALUS (ASTERACEAE: VERNONIEAE) FROM THE SERRA DO CIPÓ, MINAS GERAIS, BRAZIL

Three New Species of *Lychnocephalus* (Asteraceae: Vernonieae) from the Serra do Cipó, Minas Gerais, Brazil

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Abstract*—*Lychnocephalus cipoensis, ***L. grazielae*** and ***L. jolyanus***, three new species from the Cerrado of the Brazilian Central Plateau, are hereby described and illustrated. *Lychnocephalus* is characterized by its tomentose to densely lanate branches, heads organized in third order syncephalia and inner pappus series with twisted setae and narrowed apex. These new species are microendemic in the campos rupestres of Serra do Cipó, state of Minas Gerais, Southeastern Brazil, and were previously misidentified as other species of the genus. However, they are distinguished by their habit, leaf arrangement, shape and size, presence or absence of petiole, number of florets per head, number of pappus series, among other characteristics discussed here. These new species are described and illustrated, their affinities discussed and a key to all species of *Lychnocephalus* is provided.

***Keywords*—**Campos rupestres, Compositae, Lychnophorinae.

Lychnocephalus Mart ex DC. is a genus of the tribe Vernonieae (subtribe Lychnophorinae), described by Candolle (1836) with a single species, *L. tomentosus* Mart. ex DC. Later, Schultz-Bipontinus (1863) transferred *Lychnocephalus* to *Lychnophora* Mart. and added two new species (*L. humillima* Sch.Bip. and *L. sellovii* Sch.Bip.). He placed the three species in '*Homalophyllum*', an unnamed infrageneric rank, due to their leaves with flat margins and frequently almost parallel veins. Semir (1991) conducted a taxonomic revision of the genus *Lychnophora* in his Ph.D.

dissertation, where he described four new species for the genus. However, only the part referring to *Lychnophora* s. str. has been published (Semir et al. 2011), the authors considering that some species probably did not belong to *Lychnophora.*

In phylogenetic studies carried out later (Loeuille et al. 2015), *Lychnophora* emerged as three distinct lineages, one of them including some species described by Semir in *Lychnophora*. In a synopsis of subtribe Lychnophorinae, Loeuille et al. (2019) reestablished *Lychnocephalus*. Currently, the genus has four species: *Lychnocephalus humillimus* (Sch.Bip.) Loeuille, Semir & Pirani, *L. mellobarretoi* (G.M.Barroso) Loeuille, Semir & Pirani, *L. sellovii* (Sch.Bip.) Loeuille, Semir & Pirani and *L. tomentosus* Mart ex. DC.

Lychnocephalus is recognized by the following set of characters: treelets (sometimes candelabriform), subshrubs or shrubs, indumentum densely tomentose to densely lanate, leaves sessile or petiolate, with semi-amplexicaul or amplexicaul sheath, inflorescence organized in third order syncephalia and pappus uniseriate to biseriate. The genus is endemic to campos rupestres of the southern portion of the Espinhaço Range [Cadeia do Espinhaço], mostly in Serra do Cipó, located in the state of Minas Gerais, in the southern portion of the Espinhaço Range, with the species *L. sellovii* and *L. tomentosus* also occurring in the Diamantina Plateau [Planalto Diamantina] (Semir 1991; Loeuille et al. 2019), located in the central portion of Espinhaço Range, Minas Gerais, encompassing the municipalities of Couto de Magalhães de Minas, Datas, Diamantina, Gouveia, Presidente Kubitscheck, Santo Antônio do Itambé, São Gonçalo do Rio Preto and Serro (Neves et al. 2005).

The campos rupestres (highland rocky grasslands) is a specialized vegetation composed mainly by herbaceous and shrubby species associated to rocky grasslands of quartzitic, granitic or ironstone origin (Silveira et al. 2016; Fernandes 2017). The campos rupestres is presently related to the OCBIL theory (old climatically buffered infertile landscape) which seeks to explain the high level of plant endemism in these ecosystems (Silveira et al. 2016). They occur predominantly in the mountains known as Espinhaço Range in the State of Bahia and Minas Gerais, and in a lesser extent in the states of Goiás and Tocantins, at elevations above 900 m a.s.l. (Silveira et al. 2016; Zappi et al. 2017).

In a review of the family Asteraceae in the Espinhaço Range, 535 species and 106 genera were recorded, with 178 endemic species in campos rupestres, supporting the family diversity in this ecosystem (Campos et al. 2019). In addition, the Serra do Cipó has being considered one of the localities with the greatest plant species diversity in the Espinhaço Range (Conceição & Giulietti 2002; Rapini et al. 2008). This ecosystem can also be found, to a lesser extent, in Bolivia, at altitudes between 800-1200 m a.s.l. (Killeen 1990).

Here we provide the effective publication of three species, *Lychnocephalus cipoensis*, *L. grazielae* and *L. jolyanus*, previously described by João Semir (1937-2018) in the genus *Lychnophora*, in his unpublished PhD dissertation from 1991. In the last few decades, additional field expeditions and herbarium visits have provided new data to better understand the morphological variation of these species and their distribution.

MATERIALS AND METHODS

This study was based on the analysis of herbarium collections (BHCB, ESA, MBM, NY, RB, SPF, UEC, UFP, US), (acronyms according to Thiers 2020, continuously updated), fieldwork observations and a literature review. Morphological analyses were performed with an 8–40 × magnification stereomicroscope. Measurements were taken using a digital caliper rule and optical graticule attached to the microscope. Measurements of the leaves were performed on dry material, while flowers, styles and anthers were rehydrated for analysis and measurements. The terminology used for leaf shape and venation follows Hickey (1973); for indumentum, Harris and Harris (2001); for pappus and receptacle forms, Small (1919) and for general morphology of Lychnophorinae, Loeuille et al. (2019).

The conservation status of the species provided here follows the criteria established by IUCN (2020); in addition, GeoCat (Bachman et al. 2011) was used to calculate and estimate both the extent of occurrence (EOO) and the area of occupancy (AOO) (cell size of 2 km^2). The distribution map was produced in Quantum GIS v. 3.8.1. (QGIS Development Team 2015), based on geographic coordinates of analyzed specimens.

TAXONOMIC TREATMENT

Lychnocephalus cipoensis Semir ex F.M.B.Gomes & Loeuille, sp. nov. TYPE: BRAZIL. Minas Gerais: Santana do Riacho, Serra do Cipó, 26 km ao Sul de Conceição do Mato Dentro, km 123 (Córrego Três Pontinhas), [−19.183333°S,

−43.533333°W], 1250 m, 27 Oct 1988, *R.M. Harley et al. 25416* (holotype: BHCB!; isotypes: SPF!, UEC!, US!).

Species *Lychnocephalo sellovio* habitu (frutice vel arbuscula candelabriforma), foliis sessilibus, parallelinerviis et syncephalis sphaericis gravibusque simile, sed ramificationum densitate (debiliter, non moderate), foliis brevioribus (2.7–5.1 cm, non 6.3–11.2 cm), indumento dense lanuloso (non dense lanato), syncephalis (tertio ordine) minoribus (2–2.8 × 3.2–4.6 cm, non 3.5–4.7 × 3.3–9.5 cm), capitulis cylindricis (non campanulatis), apicibus involucri bractearum (obtusis ad rotundatos, non acutis raro obtusis ad rotundatos), floribus 6–8 (non 7–12) differt.

Shrub or treelet, candelabriform, 0.4–1.1 m tall, rarely up to 1.7 m; moderately branched. **Stems** cylindrical, 0.7–1.4 cm diam., robust, brownish, densely lanulose, turning glabrescent with age, surface tessellate; leaf scars linear, distinctive on leafless portions of stems. **Leaves** alternate, simple, sessile, weakly imbricate, frequently crowded at branch apices, leaf sheath amplexicaul, 4.3–7.2 × 0.9–8.1 mm, abaxial surface lanulose, adaxial surface glabrous, blade lanceolate, 2.7–5.1 × 0.7–1.7 cm, discolorous, coriaceous, venation parallelodromous, primary veins poorly prominent adaxially, tomentum composed of unbranched, long, curly trichomes, abaxial surface ochreous, densely lanulose, adaxial surface dark-green (ferrugineous when dry), lanulose, glabrescent, margins entire, slightly revolute, apex obtuse, rarely rounded, base attenuate. **Inflorescence** composed by capitula fused in a terminal, pedunculate, solitary, frequently in pairs, third order syncephalia, composed of 3–4 second order syncephalia. Third order syncephalium 2–2.8 cm tall, 3.2–4.6 cm diam, spherical, with second order syncephalia completely fused, peduncle 2.2–16.1 cm long; tertiary bracts 2–3.1(–4) × 0.8–1.2 cm, leaf-like, lanceolate; secondary bracts 1.1–1.4 × 0.5–0.9 cm, leaf-like, wide lanceolate. **Capitula** 40–60, homogamous, discoid, sessile, fused for 1/4 of their length, interspersed with leaf-like subinvolucral bracts, 0.7–0.9 × 0.5–0.8 cm, upper half similar to secondary and tertiary bracts, lower half similar to phyllaries, deltoid; involucre cylindrical, 7.8–8.5 cm tall, 0.4–0.6 cm diam.; phyllaries 3 or 4 seriate, weakly imbricate, inner series shorter than outer series, brownish, oblong to spathulate, apex obtuse to rounded or truncate, sometimes erose, glabrous, glandular-punctate, margin entire, outer phyllaries 5.6–6.1 × 1.4–2.3 mm, inner phyllaries 7.8–8.5 × 1.6–2.1 mm, receptacle flat, areolate. **Florets** 6–8 per capitulum, bisexual, fertile; corollas actinomorphic, deeply 5-lobed, purple to pale lilac, glabrous, glandular-punctate, 8.3–10.3 mm long, corolla tube 5.5–7 × 0.4–1.1 mm, corolla lobes 2.8–3.3 × 0.4–0.7 mm, lanceolate, apex acute; anthers calcarate, 2.9–4.1 × 0.1–0.2 mm, purple, apical appendages triangular, acute, anther base strongly sagittate; style shaft 8–12 mm long, purple, glabrous throughout except for pubescent upper 1.2–1.5 mm beneath style arms, style base glabrous, lacking a basal node, nectariferous disc, style arms 1.4–2 mm long, apex acute, pubescent outside throughout, hairs acute. **Cypselae** cylindrical, 1.7–3.5 × 0.5–1 mm, 10-ribbed, glabrous, glandular-punctate, brown; carpopodium inconspicuous. **Pappus** setae biseriate, paleaceous, stramineous, outer series shorter than inner series, apex erose, outer series 0.9–2.2 mm long, straight, persistent, inner series 6.9–7.5 mm long, apex narrowed, barbellate, twisted, caducous. Figures 1, 2A–C

Distribution and Habitat—*Lychnocephalus cipoensis* is distributed in Serra do Cipó, Minas Gerais, in the meridional portion of the Espinhaço Range (Fig. 2D). It occurs in campo rupestre vegetation in rock outcrops or sandy grasslands, between 1110–1380 m a.s.l. (Fig. 3).

Etymology—The epithet *cipoensis* refers to the microendemism of the species to Serra do Cipó.

Phenology—Specimens with flowers and fruits were collected between February and July.

Informal Conservation Status—Currently, *Lychnocephalus cipoensis* is only known from Serra do Cipó in the southern portion of the Espinhaço Range. Although several populations are recorded, most of them are restricted to the western portion of Serra do Cipó (Serra Alto do Palácio, eastern slopes of Serra Morena and western side of Serra das Bandeirinhas). Most populations of *L. cipoensis* are within the limits of protected areas (Serra do Cipó National Park and Environmental Protection Area Morro da Pedreira). However, some populations are close to the main road that crosses the Serra do Cipó and might suffer the effects from intense tourism. According to the GeoCat analyses, (EOO = 211729 km^2; AOO = 44000 km^2) and following the IUCN Red List criteria (IUCN, 2020), *L. cipoensis* could be classified as Endangered (EN), according to criteria B2a, B2b i, ii, iii, iv.

Notes—*Lychnocephalus cipoensis* is morphologically similar to *L. sellovii* and *L. jolyanus* F.M.B. Gomes, Semir & Loeuille in that plants are robust shrubs or candelabriform treelets, with tessellate stems, sessile leaves with parallel primary veins, massive third order syncephalium and biseriate pappus setae. As it closely resembles *L. sellovii* in having a similar habit and spherical syncephalia, *L. cipoensis* specimens are sometimes identified as *L. sellovii* in herbarium collections. However, the new species is markedly different from *L. sellovii* in the branching density (moderately vs. poorly branched), slender stems (0.7–1.4 vs. 1.2–2.1 cm diam.), shorter leaf blades (2.7–5.1 cm vs. 6.3–11.2 cm), smaller third order syncephalia (2–2.8 × 3.2–4.6 cm vs. 3.5–4.7 × 3.3–9.5 cm), apex of the phyllaries (obtuse to rounded vs. acute, rarely obtuse to rounded) and usually fewer florets per capitulum (6–8 vs. 7–12). Another feature that distinguishes the two species is the venation pattern, in *L. cipoensis* the primary vein is less prominent in the abaxial surface, in *L. sellovii* it is much more prominent. The leaf and branch indumentum also differ between the two species: *L cipoensis* has shorter, brownish and very tangled trichomes, whereas in *L. sellovii* the trichomes are longer, dirty-white to whitish and freer.

Lychnocephalus jolyanus, newly described here, is also morphologically related to *L. cipoensis*. Like *L. jolyanus* and *L. sellovii*, *L. cipoensis* possesses sessile leaves, with parallelodromous venation, spherical syncephalia and a biseriate pappus setae. However, *L. cipoensis* differs from *L. jolyanus* in its size (0.4–1.1(–1.7) m vs. 0.5–5 m), being a moderately branched treelet (vs. poorly branched treelet), without an elongated trunk (vs. with an elongated trunk), shorter leaf blades (2.7–5.1 × 0.7–1.7 cm vs. 4.8–12.2 × 1.9–3.1 cm), brownish indumentum with shorter trichomes (vs. whitish, with longer trichomes), phyllaries with obtuse to rounded apex (vs. acute) and shorter corolla (8.3–10.3 mm vs. 18–20 mm). The new species is sometimes sympatric with *Lychnocephalus tomentosus* Mart. ex DC.

Additional Specimens Examined (Paratypes)**—Brazil**.—MINAS GERAIS: Serra do Cipó, Km 137, 1300 m, 7 Dec 1949, *A.P. Duarte 2181* (RB, UEC); Km 137 antigo, próximo a antiga estrada para o Serro, 12 Aug 1971, *A.P. Duarte 13525* (RB, UEC); along road ca. 5 km NE of Chapéu do Sol, 15 Jan 1981, *R.M. King & L.E. Bishop 8479* (UB, US); 16 km E. of Chapéu do Sol, 16 Jan 1981, *R.M. King & L.E. Bishop 8495* (UB, US), Rodovia MG 010, km 119, 6 May 1997, *W. Vichneswskis 425* (UEC); ibid, s/data, *M. Magalhães & C. Shimoya* (VIC 3769). Jaboticatubas, Serra do Cipó, 25 Km ao Norte, 18 Jan 1972, *G. Hatschbach et al. 28832* (MBM); km 139, ao longo da rodovia Lagoa Santa-Conceição do Mato Dentro-Diamantina, 290 m, 17 Apr 1972, *A.B. Joly et al. 1884* (UEC); Serra do Cipó, km 126, 31 Nov 1978, *J. Semir 8653* [mounted on two sheets: UEC120827, UEC120829] (NY, UEC). Morro do Pilar, Parque Nacional da Serra do Cipó, Alto do Palácio, [−19.25°S, −43.516667ºW], 20 Dec 2008*, D. Dias 135* (BHCB). Santana do Riacho, Alto do Palácio, Km 138, ao longo da Rodovia Belo Horizonte-Conceição do Mato Dentro, 15 Nov 1984, *R.M. Harley et al. CFCR 6056* (K,SPF); Serra do Cipó, campo rupestre, *A. Inácia* (BHCB 18183); Serra do Cipó, Retiro Alto do Palácio, 25 Km NE de Cardeal Mota, caminho a Conceição do Mato Dentro, campo rupestre, 1380 m, 12 Feb 1991, *M.M. Arbo et al. 4945* (SPF); Serra do Cipó, km 125 da Rodovia Belo Horizonte-Conceição do Mato Dentro, elevação em frente à estátua do Velho Juca, ca. 1320-1370 m, 7 Dec 1991, *J.R. Pirani et al. CFSC 12844* (SPF); Serra do Cipó, encosta pedregosa e arenosa, antigo Km 140, 4 Apr 1994, *J. Semir & E. Martins 35228* (UEC); em frente à Fazenda Palácio, na entrada da trilha que vai para a cachoeira na região de Congonhas, à 300 m da estrada, Campo rupestre [−19.29139°S, −43.56222°W], 8 Feb 1998, *V.N. Vacarelli et al. 3* (UEC); lado direito da estátua do Juquinha, km 118, [−19.25833°S, −43.55167°W], 8 Feb 1998, *V.N. Vacarelli et al. 5* (UEC); Serra do Cipó, lado direito da estátua do Juquinha, Km 118, campo rupestre [−19.25833°S, −43.55167°W], 8 Feb 1998, *V.N. Vacarelli et al. 7* (UEC); à 500 m da estátua do Juquinha, campo rupestre [−19.25833°S, −43.55167°W], 9 Feb 1998, *V.N. Vacarelli et al. 8* (UEC); à 500 m da estátua do Juquinha, campo rupestre [−19.25833°S, −43.55167°W,], 9 Feb 1998, *V.N. Vacarelli et al. 9* (UEC); região do Congonhas, campo rupestre, [−19.31528°S, −43.545°W], 11 Feb 1998, *V.N. Vacarelli et al. 16* (UEC); distrito Cardeal Mota, 1 km acima da estátua do Juquinha em direção a Serra, 05-08 May 1998, *M.E. Mansanares & L.Y.S. Aona 09* (UEC); ibid., 05-08 May 1998, *M.E. Mansanares & L.Y.S. Aona 10* (UEC); em afloramento rochoso do lado oposto da estrada da estátua do Juquinha, 16 Dec 1998, *F. Feres et al. 98* (UEC); 1 km acima da estátua do Juquinha, 07 Oct 1998, *M.E. Mansanares et al. 16* (UEC); Parque Nacional da Serra do Cipó, campo rupestre próximo a estátua do Juquinha, 22 Nov 2000, *L.S. Kinoshita & M.E. Mansanares 174* (UEC); campo rupestre próximo a estátua do Juquinha, 22 Nov 2000, *L.S. Kinoshita & M.E. Mansanares 181* (UEC); estrada entre Fazenda Palácio e estátua do Juca, 22 Nov 2000, *L.S. Kinoshita & K. Matsumoto 548* (UEC); EPA Morro da Pedreira, entrada para Congonhas, km 112, ao lado da estrada em direção à Conceição do Mato Dentro, [−43.56667°W, −19.28333°S], 27 Feb 2002, *M.E. Mansanares et al. 204* (UEC); Serra do Cipó, estrada entre Belo Horizonte e Conceição do Mato Dentro, próximo a bifurcação para Morro do Pilar, Campo rupestre, 11 Jan 2006, *A.P. Savassi-Coutinho et al 967*

(CTES, ESA, K); Serra do Cipó, Alto do Palácio, Estrada Lagoa Santa-Conceição do Mato Dentro (MG010), 17,4 Km ao norte da ponte sobre o Rio Vacaria, elevação em frente à estátua do Velho Juca, campo rupestre, [−19.244444°S, −43.550556°W], 21 Apr 2006, *B. Loeuille et al. 13* (SPF); EPA Morro da Pedreira, Rodovia Belo Horizonte-Conceição do Mato Dentro (MG 010), Km 118 atual (antigo 125), elevação a leste da estátua do Velho Juca, campo limpo, campo sujo, brejo e capão da mata, [−19.257778°S, −43.557583°W], 1332 m, 12 Jul 2009, *B. Loeuille et al. 497* (K, SPF); Serra do Cipó, EPA Morro da Pedreira, Rodovia Belo Horizonte-Conceição do Mato Dentro (MG010), Km 129, Alto do Palácio, topo das elevações com escarpas voltadas para o vale do Córrego Palácio, campo limpo de cimeira, campo rupestre e afloramentos rochosos, [−19.250000°S, −43.533333°W], ca. 1250-1300 m, 17 Feb 2011, *J.R. Pirani et al. 6252* (SPF); Parque Nacional da Serra do Cipó, Trilha do Travessão, Campo Rupestre, solo arenoso, [−19.331083°S, −43.524444°W], 1100 m, 4 Jul 2012, *G.M. Antar et al. 53* (SPF); Serra do Cipó, Trilha do Travessão, [−19.19245°S, −43.31432°W], 1243 m, 14 Aug 2013, *G.C.T. Ceccantini et al. 3916* (SPF); Serra do Cipó, Trilha atrás do Velho Juquinha, campo rupestre, [−19.263028°S, −43.558472°W], 9 Nov 2013, *B. Loeuille et al. 871* (SPF).

Lychnocephalus grazielae Semir ex F.M.B.Gomes & Loeuille, sp. nov. TYPE: BRAZIL. Minas Gerais: Santana do Riacho, Cardeal Mota, trilha para o Salitreiro, campo rupestre, [−19.27833°S, −43.53417°W], 1450 m, 1 Sep 2011, *B. Loeuille et al. 537* (holotype: UFP!; isotype: SPF!)

Species *Lychnocephalo humillimo* foliis sessilibus, anguste et oblongis, syncephalis hemisphaericis simile, sed frutice erecto (non suffrutice decumbenti), syncephalis pedunculatis (non sessilibus), apicibus involucri bractearum glabrescentibus (non lanatis), floribus 6–8 (non 10–15) differt.

Shrub, 0.3−1 m tall, erect; moderately branched. **Stems** cylindrical, 3.7−4.1 mm diam., flexuous, delicate, ochraceous and densely lanulose, becoming glabrescent with age, longitudinally striate; leaf scars linear, distinctive on leafless portions of stems. **Leaves** alternate, simple, sessile, laxly disposed, leaf sheath semi-amplexicaul, 4−6 × 3−5 mm, abaxial surface lanulose, adaxial surface glabrous, blade narrow oblong, 3.1−4.8 × 0.7−1.2 cm, strongly discolorous, coriaceous, venation eucamptodromous, primary veins abaxially more prominent, tomentum composed of unbranched, long, thin trichomes, abaxial surface ochraceous, lanulose to tomentose, adaxial surface dark green or dark brown, glabrous, scrobiculate, tomentose to lanulose when younger, margins entire, slightly revolute, apex acute, base attenuate. **Inflorescence** composed by capitula fused in a terminal, pedunculate, solitary third order syncephalium, composed of 3 second order syncephalia. Third order syncephalium 1.7–2.8 cm tall, 1.8–3.5 cm diam, hemispherical, with second order syncephalia completely fused, peduncle 8.2–22.5 cm long; tertiary bracts 2.2–3.5 × 0.4–0.9 cm, leaf-like, oblong; secondary bracts 1.5-1.9 × 0.9–1.1 cm, leaf-like, lanceolate to deltoid. **Capitula** 10-15, homogamous, discoid, sessile, fused for 1/4 of their length, interspersed by leaf-like subinvolucral bracts, 0.9–1.4 × 0.4–0.6 cm, upper half similar to secondary and tertiary bracts, lower half similar to phyllaries, deltoid; involucre cylindrical, 1.2–1.3 cm tall, 0.5–0.6 cm diam; phyllaries 2–3-seriate, weakly imbricate, subequal, brownish, oblong, apex obtuse to rounded, sometimes erose, glabrous, glandular-punctate, margin entire, outer phyllaries 6.8–9.1 × 1.3–1.8 mm, inner phyllaries 7.1–9.3 × 1.8–2 mm; receptacle flat, fimbrillate. **Florets** 6−7(−8) per capitulum, bisexual, fertile; corolla actinomorphic, deeply 5-lobed, rarely 6-lobed, purple, glabrous, glandular punctate, 9.4−12.5 mm long, corolla tube 6.2−7.3 × 0.9−1.2 mm, corolla lobes 3.2−5.2 × 0.5−0.7 mm, lanceolate, apex acute; anthers calcarate, 3.1−4.9 × 0.1−0.2 mm, purple, apical appendages triangular, acute, anther base strongly sagittate; style shaft 8–11 mm long, purple, glabrous throughout except for pubescent upper ca. 1.2−1.5 mm beneath style arms, style base glabrous, lacking basal node, nectariferous disc, style arms 1.2−3.2 mm long, apex acute, pubescent outside throughout, hairs acute. **Cypselae** cylindrical, 2.5−3 × 0.8−1 mm, 10−ribbed, glabrous, glandular-punctate, brown; carpopodium inconspicuous. **Pappus** setae biseriate or uniseriate outer series,vestigial when present, paleaceous, stramineous, 6.9−8.1 mm long, apex narrowed, barbellate, twisted, caducous. Figures 4, 5A–C

Distribution and Habitat—*Lychnocephalus grazielae* occurs in Serra do Cipó, Minas Gerais. This species grows in campos rupestres, in rock outcrops or sandy soils, at elevation between 1200 and 1450 m (Fig. 3).

Etymology—The specific epithet honors Dr. Graziela Maciel Barroso (1912-2003) a Brazilian botanist who greatly contributed to the knowledge of the Brazilian flora, mainly in Asteraceae.

Phenology—*Lychnocephalus grazielae* was found with flowers and fruits in April, June and September.

Informal Conservation Status—Based on the results obtained through GeoCat analysis (EOO = 5,379 km^2; AOO = 8,000 km^2) and according to the criteria established by the IUCN Red List (IUCN 2020) the species is considered Critically Endangered (CR), according to the criteria B1ab (i, ii, iii, iv, v) + B2ab (i, ii, iii, iv, v). So far, only two populations of the species are known, both with few individuals, located on Trilha do Salitreiro, western part of Serra do Cipó National Park. In a field expedition carried out in 2018, these small populations were not found again. Additionally, the populations occur close to hiking trail, in addition, the area close to where populations occur has been extensively explored during the extraction of saltpeter in the municipality of Santana do Riacho. Although the populations were located within the limits of Serra do Cipó National Park, these facts lead us to presume that *Lychnocephalus grazielae* is at high risk of extinction

Notes—*Lychnocephalus grazielae* is similar to *L. humillimus,* as both species share narrow oblong leaves and hemispherical syncephalium. However, *L. grazielae* differs the latter by its habit (erect shrub vs. decumbent subshrub), pedunculate syncephalium (vs. sessile), phyllary apex glabrescent (vs. lanate) and heads with 6–7(–8) florets (vs. 10–15). The indumentum is another character that distinguishes both species. The abaxial surface of the leaves of *L. humillimus* are completely covered by a dense lanate indumentum abaxially, making the venation pattern not visible, while the abaxial surface of *L. grazielae* leaves has a lanulose indumentum that does not completely cover the venation.

It also shares similarities to *L. mellobarretoi* (G.M.Barroso) Loeuille, Semir & Pirani, as both species are erect shrubs with slender stems and possess a 2- or 3-seriate phyllaries. However, *L. grazielae* differs by its stature (0.3−1 vs. 1−2 m), sessile leaves (vs. petiolate), narrow oblong leaf blade (vs. elliptic to obovate), capitula with 6−7(−8) florets (vs. 4−6) and glabrous corolla lobes (vs. pubescent).

Additional Specimens Examined (Paratypes)—**Brazil.**—MINAS GERAIS: Morro do Pilar, PARNA Serra do Cipó, Trilha do vale do córrego do Salitreiro, [−19.27694°S, −43.47333°W], 3 Apr 2011, *N.F.O. Mota et al. 2187* (BHCB); Santana do Riacho, Serra do Cipó, Km 116 ao longo da rodovia Belo Horizonte–Conceição do Mato Dentro, estrada para a trilha do Salitreiro, 19 Apr 1981, *L. Rossi & M.C.E. Amaral CFSC 7287* (SPF, UEC, UFP); Parque Nacional da Serra do Cipó, Trilha para o Alto do Palácio, partindo da casa do pesquisador, [−19.26333°S, −43.53722°W], 1401 m, 15 Jun 2017, *G.M. Antar & L.J. Sauthier 1641* (SPF); Km 131, parte alta, 1460 m, 24 Apr 1950, *A.P. Duarte 1685* (MO, RB, UEC, US).

Lychnocephalus jolyanus Semir ex F.M.B.Gomes & Loeuille, sp. nov. TYPE: BRAZIL. Minas Gerais: Santana do Riacho, Serra do Cipó, Rodovia Lagoa Santa-Conceição do Mato Dentro (MG 010), depois da estrada para a Usina, beira do riacho, campo rupestre, 14 Feb 2007, *B. Loeuille & P.T. Sano 112* (holotype: SPF!)

Species *Lychnocephali sellovio* ramis robustissimis, indumento dense lanato, apicibus involucri bractearum acutis (raro obstusis), pappis biserialibus simile, sed trunco elongato usque 5 m alto (non 1–2 m alto), foliis latioribus (1–3.5 cm, non 0.5–1.3 cm), corollis magnis (1.8–2 cm, non 1.3–1.6 cm), capitulis cylindricis (non campanulatis), floribus 4–7 (non 7–12) differt.

Treelet, candelabriform, 0.5–5 m tall; poorly branched. **Stems** cylindrical 1.2–2.1 cm diam, robust, whitish, densely lanate, glabrescent, surface tessellate, leaf scars linear. **Leaves** alternate, simple, sessile, weakly imbricate; leaf sheath amplexicaul, 0.9–1.9 × 1.1–1.8 cm, abaxial surface lanate, adaxial surface glabrous, blade lanceolate, sometimes wide oblong, 4.8–12.2 × 1–3.5 cm, strongly discolorous, coriaceous, mixed venation pattern parallelodromous and reticulodromous, primary veins more prominent abaxially, tomentum composed of unbranched, long, curly trichomes, abaxial surface whitish, lanate, adaxial surface dark-green, lanate, glabrescent, margins entire, slightly revolute, apex acute, base attenuate. **Inflorescence** composed by capitula fused in a terminal, pedunculate, solitary third order syncephalium, composed of 4–6 second order syncephalia. Third order syncephalium 2.1–4.1 cm tall, 3–4.6 cm diam, hemispherical, with second order syncephalia completely fused, peduncle 6.2–10.4 cm long; tertiary bracts 2.5–3.5 × 0.8–1.1 cm, leaf-like, lanceolate to oblong; secondary bracts 1.2–1.6 × 0.4–0.7 cm, leaf-like, lanceolate to deltoid. **Capitula** 80–100, homogamous, discoid, sessile, fused for 1/4 of their length, interspersed by leaf-like subinvolucral bracts, 0.8–1.2 × 0.4–0.5 cm, upper half similar to secondary and tertiary bracts, lower half similar to the phyllaries, deltoid; involucre 1.1–1.5 m tall × 0.8–1 cm diam, cylindrical; phyllaries 4-seriate, weakly imbricate, outer series shorter than inner series, brownish, lanceolate, apex acute, sometimes erose, glabrous, glandular-punctate, margin entire; outer phyllaries 8–13 × 1.1–2.6 mm, inner phyllaries 8.2–14.1 × 1–2.4 mm; receptacle flat, areolate. **Florets** 4–7 per capitulum, bisexual, fertile; corolla actinomorphic, deeply 5–lobed, white or pale lilac, glabrous, glandular-punctate, 1.8–2 cm long, corolla tube 1.2–1.6 cm × 0.7–1 mm, corolla lobes 5–5.3 × 0.7–1.1 mm, lanceolate, apex acute; anthers calcarate, 5.2–6.5 × 0.3–0.5 mm, purple, apical appendages triangular, acute, anther base strongly sagittate; style shaft 18–22 mm long, purple, glabrous throughout except for pubescent upper 1.5–1.8 mm beneath style arms, style base glabrous, lacking basal node, nectariferous disc, style arms 1.8–2.1 mm long, apex acute, pubescent outside throughout, hairs acute. **Cypselae** cylindrical to obconical, 3.5–6.1 × 0.5–1.5 mm, 10–ribbed, glabrous, glandular-punctate, brown, base attenuate, cypselae sometimes connate; carpopodium inconspicuous. **Pappus** setae biseriate, paleaceous, outer series shorter than inner series, outer series 2–2.8 mm long, apex erose, straight, stramineous, persistent, inner series 1.2–1.6 cm long, apex narrowed, barbellate, whitish to stramineous, twisted, caducous. Figures 6, 5D–F

FIG. 6. *Lychnocephalus jolyanus* sp. nov. A. Flowering branch. B. Detail of the indumentum. C. Leaf adaxial surface. D. Leaf abaxial surface. E. Syncephalium. F. Capitulum. G. Inner phyllary and outer phyllary. H. Corolla, androecium, and style. I. Anther. J. Style. K. Cypsela. L. Pappus element.

Distribution and Habitat—*Lychnocephalus jolyanus* is restricted to the western part of Serra do Cipó, in Minas Gerais. It grows in campos rupestres vegetation among rock outcrops, at elevations between 1214–1360 m a.s.l. (Fig. 3)

Etymology—The epithet honors Dr. Aylthon Brandão Joly (1924–1975) for his numerous contributions to the development of botany in Brazil, especially through the study of the flora of Serra do Cipó.

Phenology—*Lychnocephalus jolyanus* was found with flowers and fruits between February and July.

Informal Conservation Status—The new species is restricted to the Serra do Cipó, with most of the records in the western part of Serra Cipó National Park. According to the results obtained in the GeoCat analysis, (EOO = 0 km^2; AOO = 4 km^2) and criteria of the IUCN Red List, the species is classified as Critically Endangered.

Notes—*Lychnocephalus jolyanus* is morphologically similar to *L. sellovii*. Both species are sparsely branched candelabriform treelets, with long leaves (4.8–12.2 cm), parallel primary veins, phyllaries with acute apex (rarely obtuse), and cypselae with biseriate pappus. However, *L. jolyanus* is distinguished from *L. sellovii* by its elongated trunk (vs. short or reduced trunk), wider leaf blade (1–3.5 vs. 0.5–1.3 cm), cylindrical involucre (vs. campanulate), number of florets per head (4–7 vs. 7–12), and longer corolla (1.8–2 vs. 1.3–1.6 cm). The venation of the two also differs, in *L. sellovii* the parallel primary veins are prominent abaxially and the secondary veins are concealed by the indumentum, whereas in *L. jolyanus* the primary and secondary veins are not concealed by the indumentum. The two species also differ in their habitat, *L. sellovii* is generally found in *campo limpo*, while *L. jolyanus* is found among rock outcrops. *L. jolyanus* is also related to the new species *L. cipoensis* but is distinguished by the characteristics presented in the *L. cipoensis* description.

Lychnocephalus jolyanus corollas are almost always white, rarely varying to a very pale lilac, while in the related species *L. cipoensis* and *L. sellovii* the florets are always lilac to purple.

Additional Specimens Examined (Paratypes)—**Brazil.**—MINAS GERAIS: Santana do Riacho, estrada Lagoa Santa-Conceição do Mato Dentro, Km 114, 5 Mar 1982, *J. Semir & A.B. Martins 13472* (UEC, SPF); Parque Nacional da Serra do Cipó, Serra das Bandeirinhas, campo rupestre, 1360 m, 26 Jul 1991, *A. M. Giulietti CFSC 12437* (SPF, UEC); Serra do Cipó, Estrada para Lagoa Santa-Conceição do Mato Dentro (MG 010), 6,6 Km após a ponte sobre o rio Vacaria, campo rupestre, [−19.28722°S, −43.58667°W], 1214 m, 24 Apr 2006, *B. Loeuille et al. 34* (SPF); distrito Cardeal Mota, Serra do Cipó, Fazenda Geraldinho, campo rupestre, [−19.22389°S, −43.65528°W], 1221 m, 16 Nov 2013, *M. Monge et al. 2165* (UEC). Serra do Cipó, 3.5 miles from Hotel Chapeo do Sol, 19 Dec 1959, *B. Maguire et al. 44.679* (NY); summit of Serra do Cipó, km 11-120, road from Hotel Chapéu do Sol, 6 Aug 1960, *B. Maguire et al. 49.046* (NY); ibid, 12 Feb 1963, *A.P. Duarte 7.550* (RB); km 115 (ca. 140 km N. of Belo Horizonte), 19 Feb 1968, *H.S. Irwin et al. 20.486a* (NY); estrada Lagoa Santa até Conceição do Mato Dentro, km 109, 30 Jul 1979, *G.H. Shepherd 10200* (UEC); ibid., s/data, M. *Libon 717* (C).

DIAGNOSTIC KEY FOR SPECIES OF *LYCHNOCEPHALUS* (UPDATED FROM LOEUILLE ET AL. 2019)

1. Leaf blade narrow oblong; pappus usually uniseriate, if biseriate then outer series vestigial …………………………………………………………………………………… 2

1. Leaf blade elliptic, lanceolate, linear, obovate or wide oblong; pappus biseriate, outer series not vestigial …………………………………………………………………… 3

2. Decumbent subshrub; inflorescence sessile; 10–15 florets per capitulum ……………………………………………………………………… *L. humillimus*

2. Erect shrub; inflorescence pedunculate; 6–8 florets per capitulum ……………………………………………………………;…………… *L. grazielae*

3. Leaf petiolate, venation eucamptodromous; corolla lobes pubescent 4

3. Leaf sessile, venation parallelodromous; corolla lobes glabrous …............ 5

4. Stem stout; third order syncephalium spherical; 12–15 florets per capitulum; outer pappus not strongly reduced (> 1 mm) ………………………………………… *L. tomentosus*

4.Stem slender; third order syncephalium hemispherical; 4–6 florets per capitulum; outer pappus strongly reduced (< 0.5 mm) ……………………………… *L. mellobarretoi*

5. Shrub or treelets moderately branched, stems densely lanulose; phyllary apex obtuse or rounded …………………………………………………… *L. cipoensis*

5. Treelets sparsely branched, stems densely lanate; phyllary apex acute (rarely obtuse) ……………………………………………………………………………… 6

6. Secondary veins of abaxial surface not concealed by indumentum; involucre cylindrical, 4–7 florets per capitulum, corolla 1.8–2 cm long....……………………………………………………………………… *L. jolyanus*

6. Secondary veins of abaxial surface concealed by indumentum; involucre campanulate, 7–12 florets per capitulum, corolla 1.3–1.6 cm long……………………………………………………………………………… *L. sellovii*

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AUTHOR CONTRIBUITIONS

FMBG planned and wrote the paper, BL wrote the Latin descriptions, provided comments and suggestions, and reviewed the manuscript

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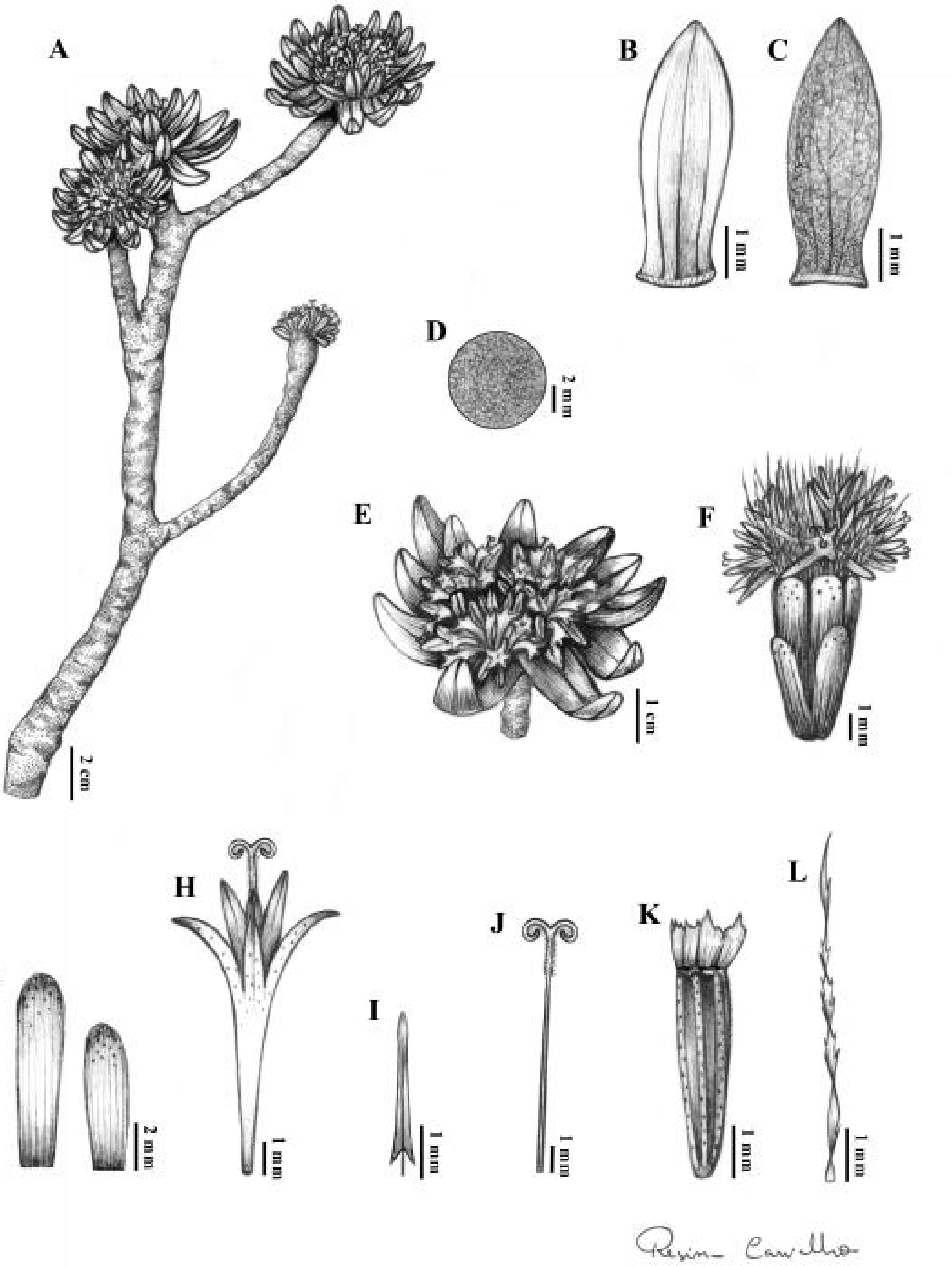

Figure 1. *Lychnocephalus cipoensis* sp nov. A. Flowering branch. B. Leaf adaxial surface. C. Leaf abaxial surface. D. Detail of the indumentum. E. Syncephalium. F. Capitulum. G. Inner phyllary and outer phyllary. H. Corolla, androecium, and style. I. Anther. J. Style. K. Cypsela. L. Pappus element

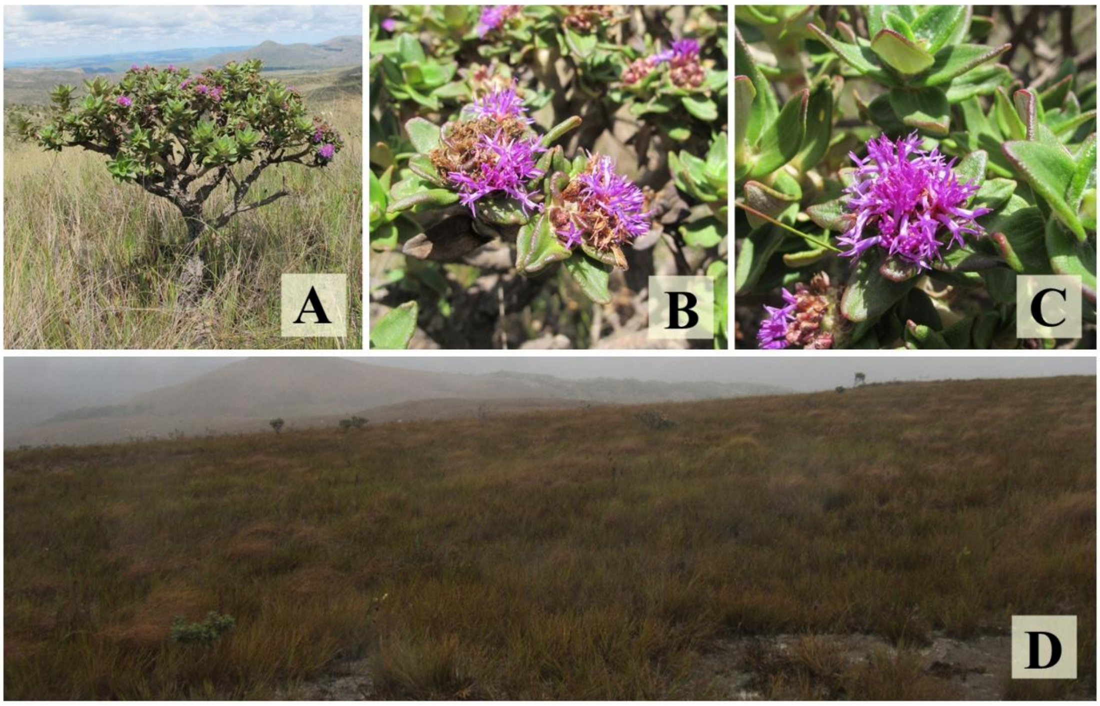

Figure 2. A–C. *Lychnocephalus cipoensis* sp. nov. A. Habit. B. Syncephalium. C. Syncephalia. D. Habitat of *Lychnocephalus cipoensis*. A–D by B. Loeuille.

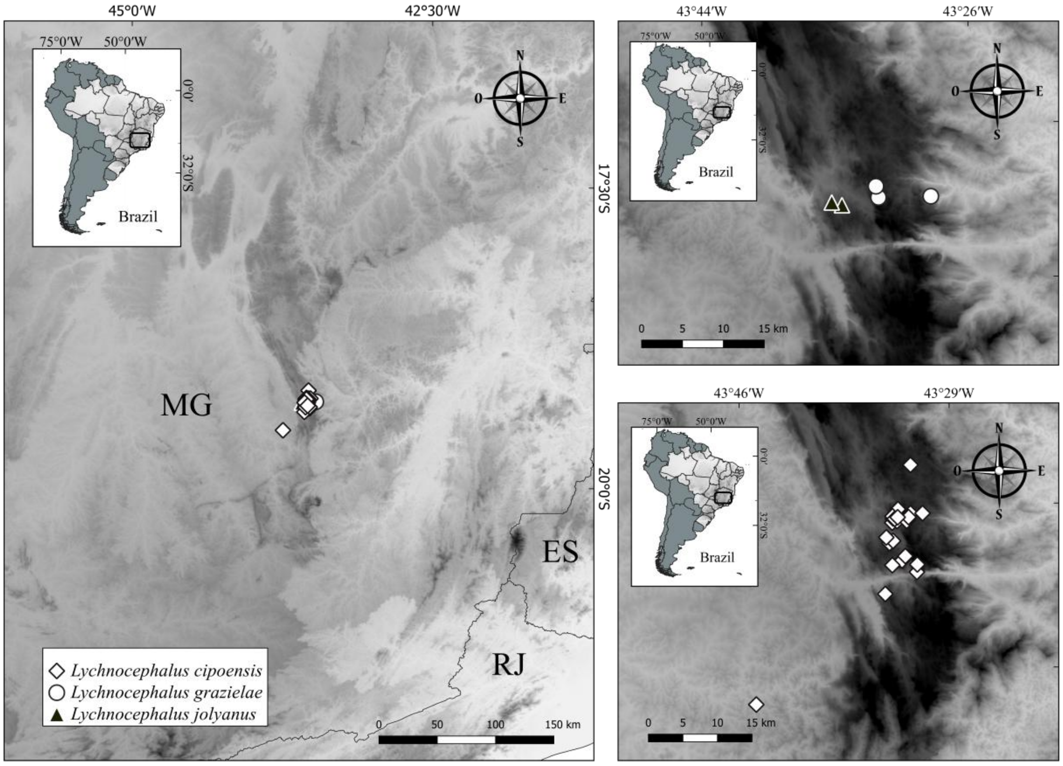

Figure 3. Distribution of *Lychnocephalus cipoensis* (white diamond), *Lychnocephalus grazielae* (white circle) and *Lychnocephalus jolyanus* (black triangle).

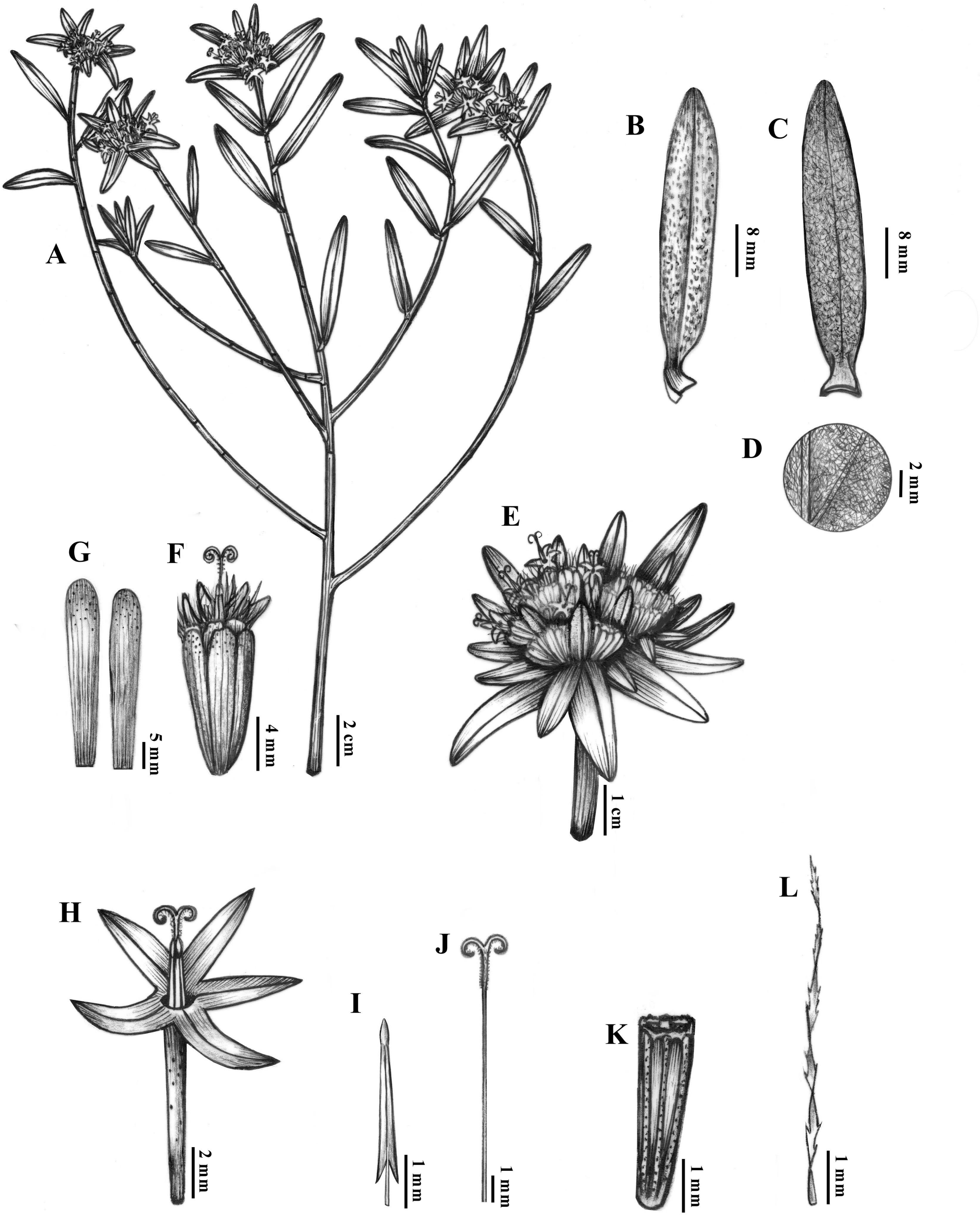

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Figure 4. *Lychnocephalus grazielae* sp. nov. A. Flowering branch. B. Leaf adaxial surface. C. Leaf abaxial surface. D. Detail of the indumentum. E. Syncephalium. F. Capitulum. G. Inner phyllary and outer phyllary. H. Corolla, androecium, and style. I. Anther. J. Style. K. Cypsela. L. Pappus element.

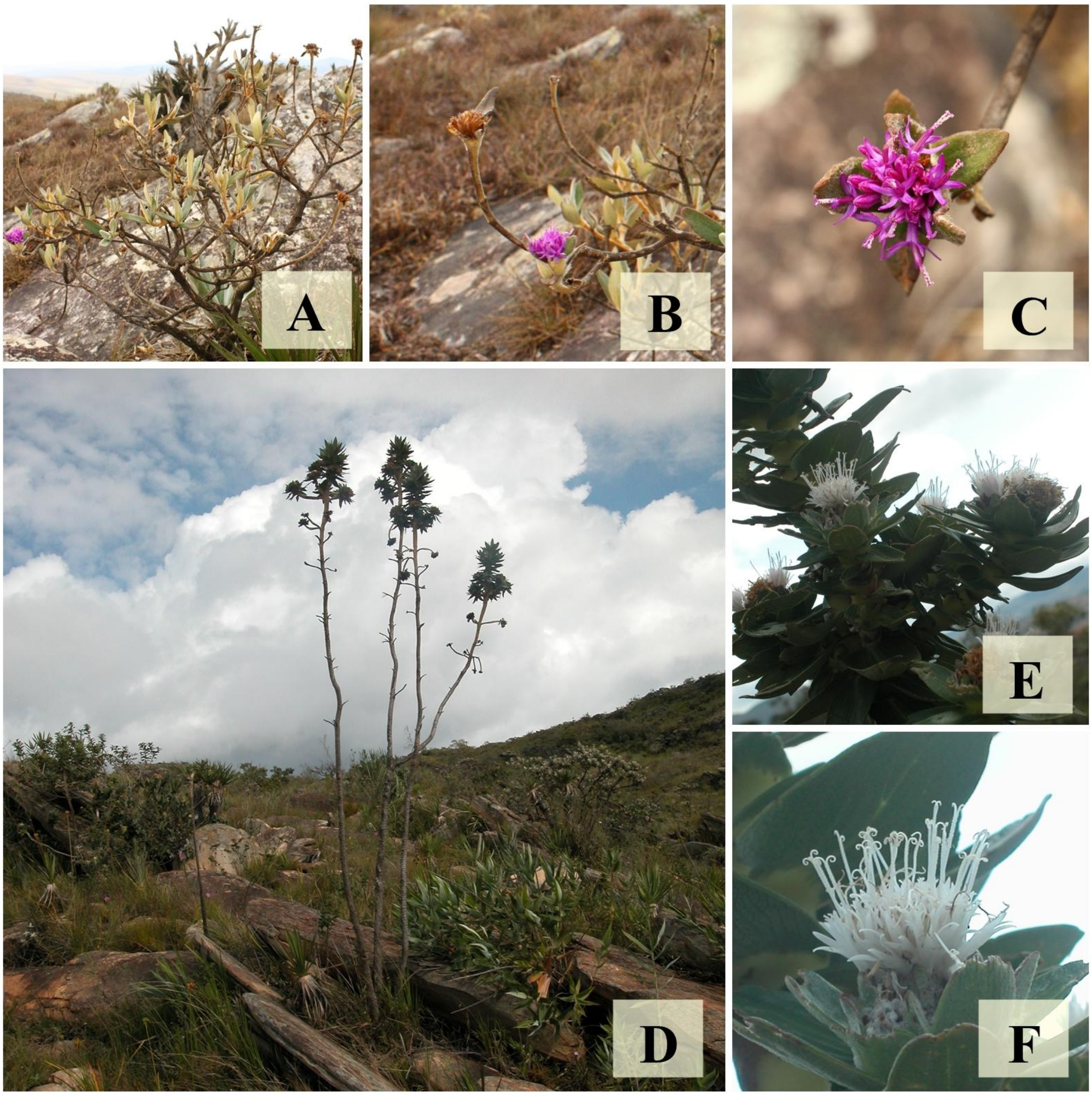

Figure 5. A–C. *Lychnocephalus grazielae* sp. nov. A. Habit. B. Syncephalia. C. Syncephalium. D–F. *Lychnocephalus jolyanus*. D. Habit. E. Syncephalia. F. Syncephalium. A–F by B. Loeuille

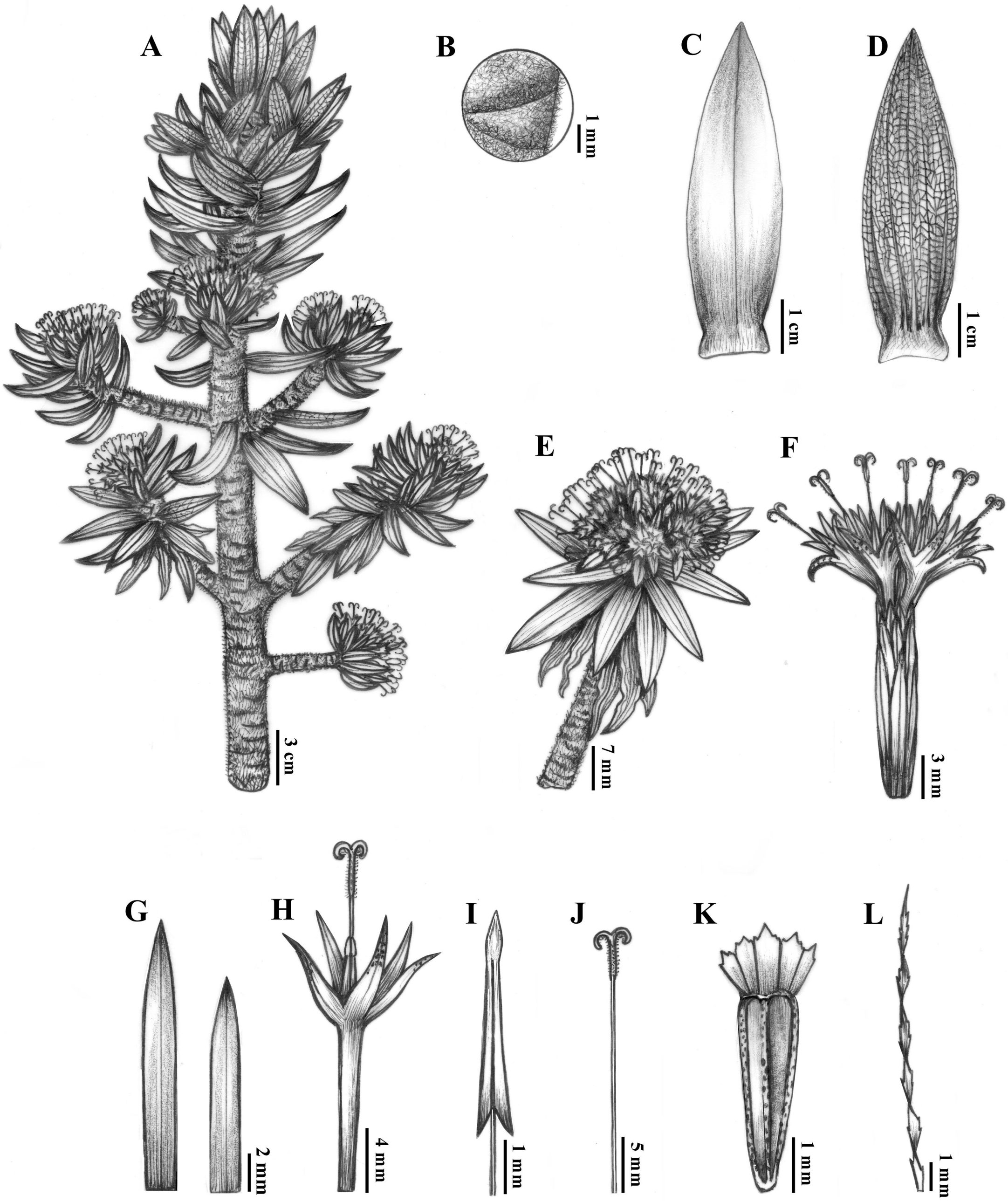

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Figure 6. *Lychnocephalus jolyanus* sp. nov. A. Flowering branch. B. Detail of the indumentum. C. Leaf adaxial surface. D. Leaf abaxial surface. E. Syncephalium. F. Capitulum. G. Inner phyllary and outer phyllary. H. Corolla, androecium, and style. I. Anther. J. Style. K. Cypsela. L. Pappus element

CONSIDERAÇÕES FINAIS

A partir dos resultados obtidos com o presente estudo observou-se a diversidade de caracteres morfológicos em um gênero considerado pequeno e de distribuição restrita. Novas espécies foram descritas contribuindo tanto para o conhecimento do gênero *Lychnocephalus* como para o da subtrtibo Lychnophorinae. Além disso, o uso da anatomia vegetal, com o estudo das lâminas foliares, auxiliou na adição de novos caracteres anatômicos às espécies que auxiliarão na identificação das espécies do gênero. Entretanto, apesar dos resultados obtidos com o estudo da anatomia foliar agregarem e contribuírem para o melhor conhecimento do gênero, ainda são necessários estudos mais completos, com um maior número de populações para que questões como o surgimento do padrão de venação paralelódromo em algumas espécies do gênero sejam esclarecidas.

ANEXO A- LINKS PARA NORMAS DE SUBMISSÃO DAS REVISTAS CIENTÍFICAS

PLANT SYSTEMATICS AND EVOLUTION

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PHYTOTAXA

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