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Introduction

The neotropical genus *Pentacalia* Cass. (Compositae, Senecioneae) comprises c. 162 species distributed from southern Mexico to northwestern Argentina, plus two disjunct species occurring in the Brazilian Atlantic Forest. The northern Andes are considered the center of diversity of the genus, Colombia having the foremost number of species, followed by Peru and Ecuador (CALVO & BUIRA, 2018).

Species belonging to genus *Pentacalia* are scandent woody plants with alternate (very rarely opposite), simple leaves, usually corymbiform, thyrsoid-paniculiform or racemiform synflorescences, involucres with supplementary bracts at the base (calycle), radiate, disciform, or discoid capitula with yellow or white corollas, stamens with balustriform filament collar and caudate anther bases, styles with truncate to obtuse branches that usually have a crown of sweeping trichomes (sometimes with a tuft of longer trichomes, but not strictly penicillate), and glabrous or pubescent achenes with a capillary pappus composed of barbellate bristles.

Pentacalia was established by CASSINI (1827) to exclude the Colombian species *Cacalia arborea* Kunth from the genuine *Cacalia* L., based on its 5-ribbed achenes. However, Cassini's genus was not recognized by CANDOLLE (1838) or later botanists who worked on the neotropical Senecioneae (e.g. BENTHAM & HOOKER, 1839; HIERONYMUS, 1900, 1901; GREENMAN, 1923, 1938). *Pentacalia* was finally retrieved by ROBINSON & CUATRECASAS (1978) when revising the species of *Senecio* sect. *Streptothamni* Greenm. from Central America. Its recognition as a genus distinct from *Senecio* L. was supported by the following morphological characters: fruticose to scandent habit with woody stems, distinctly petiolate usually non-stipitate leaves, minutely fistulose or non-fistulose receptacles, tails on the anthers, and the rather stout 5-ribbed achenes. Such circumscription was later broadened by CUATRECASAS (1981) to also embrace the rather erect species with shrubby habit originally treated in *Microchaete* Benth. These species were accordingly placed in *Pentacalia* subg. *Microchaete* (Benth.) Cuatrec., and the lianoid ones retained to the typical subgenus. JEFFREY (1992) did not adopt CUATRECASAS (1981)'s broad sense of *Pentacalia* and elevated to generic rank the subgenus *Microchaete* (under the replacement name *Monticalia* C. Jeffrey) and restricted *Pentacalia* to the lianoid species recovering the narrow concept of the genus established by ROBINSON & CUATRECASAS (1978). Afterward, this criterion has been adopted by most taxonomists working on these groups (NORDENSTAM, 1999; PELSER et al., 2007; BECK & IBÁÑEZ, 2014; PRUSKI, 2018a, b; CALVO, 2021).

Historical overview in Ecuador

Georg H.E.W. Hieronymus (1846–1921) can be considered the first botanist to contribute to the taxonomy of the group in Ecuador, describing four species currently accepted under the genus *Senecio*. Hieronymus received at Berlin material sent by

Jesuit Father Luis [Luigi] Sodiro (1836–1909), Italian botanist established in Quito who intensively collected in the province of Pichincha (JØRGENSEN, 1999). In 1938, the American synanterologist Jesse M. Greenman (1867–1951) described three new species as part of a broad study of the South American *Senecio*. However, it was in the mid-20th century when the number of species belonging to this group notably increased, due to the collections made by Wendell H. Camp (1905–1963), American botanist at the New York Botanical Garden. Camp collected in Ecuador between May 1944 and September 1945 for the United States *Cinchona* missions searching species of that genus with high quinine content (RICKETT, 1963; BALSLEV & JOYAL, 1980). Although the mission was focused on the species of *Cinchona*, Camp and his assistants made general collections of c. 5,800 numbers (c. 26,000 sheets including numerous duplicates). Most of these collections were made in southern Ecuador, in the provinces of Azuay, Morona-Santiago, and Loja. They are of a very high quality and from areas that were barely explored at that time, hence, many of them served as type material (BALSLEV & JOYAL, 1980). The Compositae were later studied by Catalan Josep [José] Cuatrecasas (1903–1996) when he worked at the Field Museum before moving to Washington D.C. in 1955 (ROBINSON et al., 1996; LÓPEZ SÁNCHEZ, 2022). He described several new species, five of them treated herein (CUATRECASAS, 1954). Cuatrecasas devoted part of his career to the study of the tribe Senecioneae in the Northern Andes (Colombia, Ecuador) becoming the foremost specialist of this group in the region (CALVO & BELTRÁN, 2022). At the U.S. National Herbarium, Cuatrecasas collaborated with synanterologist Harold E. Robinson (1932–2020) and together they published 12 new species from Ecuador (one currently accepted as a member of *Dendrophorium* (Cuatrec.) C. Jeffrey) and provided the first identification key for the Ecuadorian *Pentacalia*. After them, Swedish botanist Bertil Nordenstam prepared the genus *Pentacalia* for the *Catalogue of the vascular plants of Ecuador* [hereafter *Catalogue*] accepting 33 species, 24 of them endemic (NORDENSTAM, 1999); see Table 1. Since Nordenstam, two new species have been described (CALVO & BUIRA, 2018; CALVO & PÉREZ, 2023) and two names synonymized (CALVO et al., 2019). The work presented in the following contribution represents the first comprehensive treatment of this genus for Ecuador. Twenty-seven (27) species are recognized (Table 1), eight names are newly synonymized, two names are lectotypified, four new taxa are described, and 15 species are illustrated.

Discussion of characters

Habit – *Pentacalia* species are scandent, woody plants with long dangling branches. While most species are strictly lianoid, *Pentacalia arborea* (Kunth) Cass. and *P. theifolia* (Benth.) Cuatrec. sometimes display a suberect habit leaning over adjacent vegetation.

Table 1.– Accepted species of *Pentacalia* Cass. from Ecuador according to the main treatments.

ROBINSON & CUATRECASAS (1993) [29 spp.]	NORDENSTAM (1999) [33 spp.]	Current treatment (2024) [27 spp.]
<i>Pentacalia andrei</i>	<i>Pentacalia andrei</i>	<i>Pentacalia andrei</i>
<i>Pentacalia arborea</i>	<i>Pentacalia arborea</i>	<i>Pentacalia arborea</i>
--	--	<i>Pentacalia atrovirgosa</i> [publ. 2023]
<i>Pentacalia campii</i>	<i>Pentacalia campii</i>	= <i>Pentacalia corazonensis</i>
<i>Pentacalia carchiensis</i>	<i>Pentacalia carchiensis</i>	= <i>Pentacalia aschersoniana</i>
<i>Pentacalia carmelana</i>	<i>Pentacalia carmelana</i>	= <i>Pentacalia huilensis</i>
<i>Pentacalia cazaletii</i>	<i>Pentacalia cazaletii</i>	= <i>Pentacalia zakii</i>
--	--	<i>Pentacalia celicana</i> [sp. nov.]
<i>Pentacalia corazonensis</i>	<i>Pentacalia corazonensis</i>	<i>Pentacalia corazonensis</i>
<i>Pentacalia disciformis</i>	<i>Pentacalia disciformis</i>	<i>Pentacalia disciformis</i>
<i>Pentacalia dorrii</i>	<i>Pentacalia dorrii</i>	<i>Pentacalia dorrii</i>
<i>Pentacalia floribunda</i>	<i>Pentacalia floribunda</i>	<i>Pentacalia floribunda</i>
<i>Pentacalia gibbiflora</i>	<i>Pentacalia gibbiflora</i>	= <i>Pentacalia oronocensis</i>
<i>Pentacalia hillii</i>	<i>Pentacalia hillii</i>	<i>Pentacalia hillii</i>
<i>Pentacalia hitchcockii</i>	<i>Pentacalia hitchcockii</i>	= <i>Pentacalia theifolia</i>
<i>Pentacalia huilensis</i>	<i>Pentacalia huilensis</i>	<i>Pentacalia huilensis</i>
<i>Pentacalia hurtadoi</i>	<i>Pentacalia hurtadoi</i>	<i>Pentacalia hurtadoi</i>
<i>Pentacalia lanceolifolia</i>	<i>Pentacalia lanceolifolia</i>	= <i>Pentacalia andrei</i>
--	<i>Pentacalia loretensis</i>	[not present in Ecuador]
<i>Pentacalia luteynorum</i>	<i>Pentacalia luteynorum</i>	<i>Pentacalia luteynorum</i> subsp. <i>luteynorum</i>
--	--	<i>Pentacalia luteynorum</i> subsp. <i>lutea</i> [subsp. nov.]
<i>Pentacalia millei</i>	<i>Pentacalia millei</i>	<i>Pentacalia millei</i>
<i>Pentacalia moronensis</i>	<i>Pentacalia moronensis</i>	<i>Pentacalia moronensis</i>
<i>Pentacalia napoensis</i>	<i>Pentacalia napoensis</i>	<i>Pentacalia napoensis</i>
--	--	<i>Pentacalia nordenstamii</i> [sp. nov.]
--	--	<i>Pentacalia oelgaardii</i> [sp. nov.]
<i>Pentacalia oronocensis</i>	<i>Pentacalia oronocensis</i>	<i>Pentacalia oronocensis</i>
<i>Pentacalia pailasensis</i>	<i>Pentacalia pailasensis</i>	[doubtful name]
<i>Pentacalia palaciosii</i>	<i>Pentacalia palaciosii</i>	<i>Pentacalia palaciosii</i>
--	<i>Pentacalia popayanensis</i>	<i>Pentacalia popayanensis</i>
<i>Pentacalia riotintis</i>	<i>Pentacalia riotintis</i>	<i>Pentacalia riotintis</i>
<i>Pentacalia ruficaulis</i>	<i>Pentacalia ruficaulis</i>	<i>Pentacalia ruficaulis</i>
<i>Pentacalia sevillana</i>	<i>Pentacalia sevillana</i>	<i>Pentacalia sevillana</i>
--	<i>Pentacalia sylvicola</i>	[not present in Ecuador]
<i>Pentacalia theifolia</i>	<i>Pentacalia theifolia</i>	<i>Pentacalia theifolia</i>
--	--	<i>Pentacalia todziae</i> [new record publ. 2019]
--	<i>Pentacalia weinmannifolia</i>	[not present in Ecuador]
<i>Pentacalia zakii</i>	<i>Pentacalia zakii</i>	<i>Pentacalia zakii</i>
<i>Pentacalia zamorana</i>	<i>Pentacalia zamorana</i>	= <i>Pentacalia millei</i>

Leaves – Foliar characters such as size, shape, and indumentum are useful for species distinguishing purposes. The degree of prominence of the venation is also taxonomically informative: secondary and tertiary veins are conspicuous on both surfaces in *Pentacalia floribunda* Cuatrec., whereas in *P. luteynorum* H. Rob. & Cuatrec. only the secondary veins are barely conspicuous.

Synflorescences – Two groups of taxa can be easily differentiated according to the position of the synflorescences: (1) species with mostly terminal synflorescences (Fig. 1A → p. 33); (2) species with mostly lateral, axillary synflorescences, where the apical meristem indeterminately elongates (Fig. 1B) (CALVO, 2021). It should be noted that ROBINSON & CUATRECASAS (1993) gave great importance to this character and placed it early in the identification key. Although it certainly has a worthy taxonomic value, it is sometimes difficult to discern on those herbarium specimens not properly or sufficiently collected. *Pentacalia carmelana* H. Rob. & Cuatrec., here treated as a synonym of *P. huilensis* (Cuatrec.) Cuatrec., was originally described as a species with mostly lateral, axillary synflorescences and placed accordingly in Robinson and Cuatrecasas's key. Additional material showed that this species actually displays mostly terminal synflorescences, which is in line with both the description of *P. huilensis* and the key provided in the treatment of the Colombian species (DÍAZ-PIEDRAHITA & CUATRECASAS, 1999). Herein, the author tried to place this character as late as possible in the key.

Three main types of synflorescences are found in *Pentacalia*: (1) corymbiform as in *P. dorrii* H. Rob. & Cuatrec. (Fig. 1C); (2) thyrsoid-paniculiform as in *P. millei* (Greenm.) Cuatrec. (Fig. 1D); (3) racemiform as in *P. hurtadoi* H. Rob. & Cuatrec. (Fig. 1E).

Capitula – The type of capitula is very useful for differentiating species: (1) radiate capitula are heterogamous, with peripheral florets pistillate developing a limb (ligule, lamina) and disc florets hermaphroditic and tubular; the peripheral florets can be well-developed and patent (Fig. 1F) or reduced and curved downward (Fig. 1G); (2) disciform capitula are heterogamous, with peripheral florets pistillate and tubular, and disc florets hermaphroditic and tubular; the peripheral florets usually are shorter than the disc florets and (2–)4–5-lobed (Fig. 1H), sometimes with the lobes somewhat atrophied. Such florets are generally thought to be derived by reduction from ray florets, as well as plants with disciform capitula are generally thought to come from ancestors with radiate capitula (BARKLEY et al., 2006); (3) discoid capitula are homogamous, with all florets hermaphroditic and tubular (Fig. 1I).

Except for *Pentacalia celicana* J. Calvo & G. Benítez (described below) and *P. luteynorum* subsp. *luteynorum* that have white ray florets, all species with radiate capita exhibit yellow ray florets, becoming red burgundy as florets mature in a few

species. *Pentacalia carchiensis* (Cuatrec.) Cuatrec., here synonymized with *P. aschersoniana* (Hieron.) Cuatrec., was originally described as having “flores radii feminei circa 4 subtubulosi, corolla angusta 5 mm longa apice lamina subligulari profunde 3-dentata”. Since the peripheral florets sometimes display a vestigial limb or this is absent, it has been described herein as a subradiate capitula although its identification in the key can be achieved both by subradiate capitula or disciform capitula (step 22). The same occurs for *P. disciformis* (Hieron.) Cuatrec., a disciform species with tubular peripheral florets that sometimes develop a very small limb.

Involucres – The number and length of involucral bracts are usually regular in each species, and therefore, helpful for separating species. In *Pentacalia palaciosii* H. Rob. & Cuatrec., *P. ruficaulis* (Greenm. & Cuatrec.) Cuatrec., and *P. sevillana* (Cuatrec.) Cuatrec. the number of involucral bracts slightly varies. Characters of the supplementary bracts (calycle) such as the number, length, and shape are also useful.

Floral microcharacters – The filament collar is balustriform, which agrees with the placement of the genus *Pentacalia* within the subtribe *Senecioninae* (NORDENSTAM et al., 2009). The anther bases are caudate, sometimes very shortly. In all species examined the style branch apices are truncate with a crown of sweeping hairs. Floral microcharacters are not taxonomically informative at specific rank.

Achenes – The achenes of the Ecuadorian *Pentacalia* are homomorphic, cylindrical, ribbed, and glabrous (papillose in a single collection of *P. oronoensis* (DC.) Cuatrec.). The pappus is ordinarily 1-seriate, capillary and composed of barbellate, whitish bristles. Although the genus *Pentacalia* was coined after the 5-ribbed achenes of the type species, *P. arborea*, the number of ribs varies from five to seven (ten) in the species examined. When the achenes are not completely developed, the number of ribs is difficult to determine. Achene's characters have not been used in this work for species identification purposes.

Phylogenetic relationships

A phylogenetic analysis of the genus *Pentacalia* has not been conducted, however, some insights can be drawn out from the ITS phylogeny of the tribe *Senecioneae* by PELSER et al. (2007). The tree accessions of *Pentacalia* included in the study are nested in the weakly supported *Faujasia*-*Oldfelia* clade: (1) *Pentacalia antioquensis* (Cuatrec.) Cuatrec. based on van der Werff & Giraldo 9736, which corresponds to *P. trianae* (Klatt) Cuatrec. (DÍAZ-PIEDRAHITA & CUATRECASAS, 1999); (2) *Pentacalia arborea* based on Øllgaard & Balslev 8298, identified as *P. theifolia* both here and by Robinson in sched. (AAU); (3) *Pentacalia desiderabilis* (Vell.) Cuatrec. based on Hatschbach & Oliveira 43028. They appear in various parts of the clade