Morphometric Analysis and Synopsis of *Pseudognaphalium* (Gnaphalieae, Asteraceae) in North America

SUSANA E. FREIRE, MARIANA A. GROSSI, NÉSTOR D. BAYÓN & CLAUDIA MONTI

Abstract: *Pseudognaphalium* Kirp. (Asteraceae, Gnaphalieae) consist of about 60 species mainly distributed in South, Central, and North America. As a first contribution toward a comprehensive taxonomic review of *Pseudognaphalium*, we perform here the first morphometric analysis of North American species, using UPGMA method for the construction of the dendrogram. Based upon these results we present a synopsis including a key to identify species and their associated synonymy. Thirty-seven species are recognized, two taxa are newly synonymized, *Pseudognaphalium microcephalum* under the name *P. canescens* and *Pseudognaphalium semilatanum* under the name *P. semiamplexicaule*, and two other names are confirmed as synonyms as previously proposed, *Pseudognaphalium microadenium* as a synonym of *P. helleri* and *Pseudognaphalium crenatum* as a synonym of *P. viscosum*. Lectotypes are newly designated for *Gnaphalium beneolens*, *G. berlandieri* (= *Pseudognaphalium stramineum*), *G. decurrens* (= *Pseudognaphalium macounii*), *G. leucocephalum*, *G. oxyphyllum*, *G. oxyphyllum var. semilatanum* (= *P. semiamplexicaule*), *G. semiamplexicaule*, *G. sulphurescens* (= *P. stramineum*), *G. thermale*, and second-step lectotypifications are proposed for *G. helleri* and *G. wrightii* (= *P. canescens*). In addition, the first illustrations of *Pseudognaphalium helleri* and *P. semiamplexicaule*, and a colour figure of *P. canescens* and *P. beneolens* emphasizing the results of the morphometric analysis are provided.

Key words: Cluster analysis/UPGMA dendrogram, compositae, morphology, phenetics, taxonomy.

INTRODUCTION

*Pseudognaphalium* Kirp. (Asteraceae, Gnaphalieae) was segregated from *Gnaphalium* L. by Kirpichnikov & Kuprijanova (1950). Estimates of the number of species ranges between about 90 (Anderberg 1991, Bayer et al. 2007) and 150 (Dillon 2005), and they are mainly distributed in South, Central, and North America, but some species also occur in Asia and Africa. However, as treated in recent revisions of the South American species (Freire et al. 2014a, b, 2018), the number of taxa accepted in *Pseudognaphalium* has been reduced to ca. 60. The genus is mainly characterized by its herbaceous habitat and the presence of disciform, heterogamous capitula in clusters arranged in corymb or panicles, the possession of monochromous phyllaries with a divided stereome, truncate style branches with apical sweeping hairs, achenes either glabrous or with short oblong myxogenic duplex hairs, and pappus bristles free at the base. Studies of detailed morphological characters (Hilliard & Burtt 1981) and phylogenetic analysis inferred from morphology (Anderberg 1991) and molecular data (Bayer et al. 2007, Ward et al. 2009, Smissen et al. 2011, Galbany-Casals et al. 2010, 2014) have been interpreted as providing
support for recognizing *Pseudognaphalium* as a distinct genus. However, the most recent molecular phylogenies (e.g. Nie et al. 2016, Acosta Maindo & Galbany-Casals 2018) recover *Pseudognaphalium* as polyphyletic in two independent clades: a clade containing mainly North American species (Canada, United States of America, and Mexico), and the other clade including mainly South American species. The generitype, *Pseudognaphalium oxyphyllum* (DC.) Kirp., was included in the North American clade with the other North American species. Both clades were nested within the southern African HAP clade (*Helichrysum, Anaphalis, Pseudognaphalium*, etc.) showing a southern African origin of *Pseudognaphalium* (Nie et al. 2016).

Taxonomic treatments and catalogues of North American species of *Pseudognaphalium* were carried out by Espinosa-García (1985, 2005, sub *Gnaphalium*), and Villaseñor (2016) for Mexican species, and by Nesom (2006) for North American North Mexican species. These treatments include several taxonomically critical groups of closely related species, as well as polymorphic species with complex intraspecific variation. As an example, the species *Gnaphalium beneolens* Davison, *G. microcephalum* Nutt., *G. thermale* E.E.Nelson, and *G. wrightii* A.Gray, were accepted by Ferris (1960), Munz & Keck (1959), and Munz (1968, 1974). On the other hand, Cronquist (1950) recognized *Gnaphalium thermale* as a variety of *G. microcephalum* while Douglas (1986) considered it as a subspecies. Stebbins & Keil (1992) and Stebbins (1993) merged all these species into a single polymorphic species, *Gnaphalium canescens*, recognizing *G. beneolens*, *G. microcephalum*, and *G. thermale* as subspecies, and placing *G. wrightii* into synonymy. Meanwhile, Nesom (2004) considered these four taxa as species under *Pseudognaphalium*, accepting *Gnaphalium wrightii* as a synonym of *P. canescens*. This taxonomic instability affects the identification of specimens of these and other species, and this prompted an investigation based on multivariate analysis to shed light on the delimiting morphologically close, infraspecific taxa or species classification. Cluster analysis and other multivariate techniques have been useful for solving taxonomic problems and circumscribing taxa from morphometric variability data. Several authors have used this type of study to identify entities based on morphology in diverse groups of plants (Owen et al. 2006, Lopez Laplhit et al. 2011, Grossi et al. 2011, Robbiati et al. 2014, Fernández et al. 2017).

The purpose of this study is to examine the current circumscription of the North American *Pseudognaphalium* taxa to define which species should be recognized based on the variation of morphological characters, including diagnostic characters, using cluster analysis for delimitation of species.

**MATERIALS AND METHODS**

**Sample collection**

A total of 297 specimens (including type material), representing 41 of the 43 North American species of *Pseudognaphalium* recognized in previous studies (Nesom 2006, Villaseñor 2016, Villarreal-Quintanilla et al. 2020), were chosen for the morphometric analysis (Appendix 1). Only two species, *Pseudognaphalium altamiranum* and *Gnaphalium oaxacanum* could not be included in the analysis since no material was available from these species. Herbarium material was examined from G, GH, M, MEXU, MO, NY, S, and UC (acronyms following Thiers 2020). Type images at high resolution from BM, C, G-DC, GH, L, LINN, MEXU, MICH, NDG, OS, P, RM, TEX, UC, US, and WIS were also examined (http://plants.jstor.org/).
Morphological data and cluster analysis

We analyzed a total of 36 characters: 13 vegetative and 23 reproductive. A list of the characters and their states can be seen in the Table I. All characters used to separate the North American species of *Pseudognaphalium* by former authors were included in our analysis. The measurements were performed on mature specimens. All specimens were studied by direct observation and by using a WILD Heerbrugg M5-26799 stereoscope; measurements were taken using a calibrated ocular micrometer. The leaf-blade observations were limited to the mid-section of flowering branches. Three florets per capitulum at same stage of anthesis from 2 or 3 capitula in each specimen were dissected. When the availability of specimens made it possible, replicates of three measurements for each character were obtained and the average was used in the ensuing statistical analyses.

We carried out a cluster analysis on all the OTUs. The similarity between two OTUs was calculated on the basis of Gower’s general similarity coefficient (Gower 1971) and the UPGMA method was used for the construction of the dendrogram (Sneath & Sokal 1973).

The multivariate analyses with Gower’s (1971) coefficient are suitable for the analysis of mixed characters, e.g., qualitative (binary and ordinal) and quantitative characters to generate a distance/dissimilarity matrix (Mapaya & Cron 2016). Likewise, UPGMA is an accurate and spread method to deduce similarity/dissimilarity among OTUs (Radford 1986, Ward 1993). The qualitative characters were coded accordingly as binary (presence/absence) or a code was assigned for each character state (see Table I for the list of characters and coding). Cluster analysis was performed on all the OTUs using all 36 characters, to obtain information about general relationships and similarities between them. The analyses were carried out using the software’s PAST (Hammer & Harper 2006).

Concepts of species delimitation

The treatment here reported is based on the conservative and widely accepted morphological species concept. According to this concept, continuous variation of characters is allowed within the species, while discontinuous variation in more than one character define distinct species (Davies & Heywood 1967).

Table I. Morphological characters and character states evaluated in the study.

<table>
<thead>
<tr>
<th>Vegetative characters:</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. plant height (cm); 2. stem (1 = 0, 2 or 3 = 1, 4 or more = 2); 3. winged stem (absent = 0, present = 1); 4. filiform stems (absent = 0, present = 1); 5. stem pubescence (woolly = 0, lanuginose = 1, glandular = 2); 6. leaf length (cm); 7. leaf width (cm); 8. leaf apex (acute = 0, acuminate = 1, obtuse to rounded = 2); 9. leaf base (attenuate = 0, rounded = 1, decurrent = 2, clasping = 3); 10. leaf margins (flat = 0, undulate = 1); 11. leaf adaxial surface (lanuginose = 0, wolly = 1, glandular = 2, arachnoid = 3); 12. leaf abaxial surface (lanuginose = 0, wolly = 1, glandular = 2); 13. basal rosette of leaves at flowering (whitered = 0, fresh/persistent = 1).</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reproductive characters:</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>14. capitula arrangement (lax corymb = 0, dense corymb = 1, paniculiform corymb = 2); 15. involucre height (mm); 16. involucre diameter (mm); 17. number of series of phyllaries (3 or 4 = 0, 5 or 6 = 1, 7 or more = 2); 18. phyllary number (#); 19. outer phyllary length (mm); 20. outer phyllary width (mm); 21. outer phyllary apex (acute = 0, obtuse = 1); 22. inner phyllary length (mm); 23. inner phyllary width (mm); 24. inner phyllary apex (acute or acuminate = 0, obtuse to rounded = 1); 25. inner phyllary color (white or creamy = 0, brownish = 1, yellowish or stramineous = 2, pinkish or purple = 3); 26. inner phyllary transparency (shiny = 0, opaque = 1); 27. marginal florets number (#); 28. marginal floret corolla length (mm); 29. disc florets number (#); 30. disc corolla length (mm); 31. disc corolla lobes (yellowish = 0, dark = 1); 32. disc corolla lobes pubescence (smooth = 0, papillose = 1); 33. achenes length (mm); 34. achenes diameter (mm); 35. achenes epidermis (smooth = 0, papillose = 1); 36. pappus length (mm).</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
RESULTS AND DISCUSSION

The cluster analysis (UPGMA) (Figure 1a) showed that most of the specimens of each species grouped together in separated clusters. A few specimens were intermingled in four main groups (Figure 1b), each with little metric distance suggesting high similarity between the species of each group.

The first group (I) includes *Pseudognaphalium canescens* (Figure 2a, b) and *P. microcephalum*. These species are morphologically similar with weakly discolored leaves, which are oblanceolate, not decurrent and eglandular, and corymbiform capitulescences. Both are confined to United States of America and Mexico and are sympatric in part of their distributions, i.e. they are found together in Chihuahua (Mexico) and California (USA). Stebbins & Keil (1992), suggested that *Pseudognaphalium beneolens* (= *G. beneolens*), *P. microcephalum* (= *G. microcephalum*), and *P. thermale* (= *G. thermale*) could be treated as subspecies within a single polymorphic species, *P. canescens* (= *G. canescens*). Nesom (2004) considered these four taxa as separate species mainly by leaf base, shape of leaves, nature of tomentum, apex of phyllaries, capitulescence, number of florets, and size of capitula. Our results recovered *P. beneolens* and *P. thermale* in separate clusters. *Pseudognaphalium beneolens* (Figure 2c, d) is characterized by its linear to linear-oblanceolate leaves and paniculate capitulescences, and *P. thermale* characterized by its concolorous oblanceolate leaves, decurrent leaf base, and corymbiform capitulescences. However, the specimens of *P. microcephalum* and *P. canescens* appear intermingled. Consequently, based on this study, we consider *Pseudognaphalium microcephalum* as a synonym of *P. canescens*.

Figure 1a. UPGMA cluster analysis of the whole set of 297 specimens of the North American species of *Pseudognaphalium*, using a matrix calculated from 36 characters (Gower’s coefficient of similarity). I: *P. canescens* and *P. microcephalum*; II: *P. semilanatum* and *P. semiamplexicaule*; III: *P. helleri* and *P. micradenium*; IV: *P. crenatum* and *P. viscosum*. 
The second group (II) includes Pseudognaphalium semiamplexicaule (Figure 4a-g) from Mexico and Mesoamerica and P. semilanatum, endemic to Mexico. These two species have discolorous lanceolate leaves, clasping leaf bases, white shiny phyllaries and corymbiform to paniculate capitulescences. Villaseñor (2016) accepted both names as valid species. Espinosa-García (2005) considered Pseudognaphalium semiamplexicaule as a valid species and P. semilanatum as a dubious species. According to Pruski (2018) the identity of Pseudognaphalium semiamplexicaule would be based on its adaxially stipitate-glandular leaves (vs. arachnoid-tomentose in P. semiamplexicaule). The present analysis shows specimens with glandular and eglandular leaves of Pseudognaphalium semilanatum and P. semiamplexicaule intermingled. Consequently, based on this study, we consider Pseudognaphalium semiamplexicaule as a synonym of P. semilanatum.

The third group (III) includes Pseudognaphalium hellerii (Figure 3 a-h) and P. micradenium from East of United States of America, characterized by narrow oblong-lanceolate leaves. Pseudognaphalium hellerii (= Gnaphalium helleri) was mainly described based on its densely glandular-pubescent stems and obtuse phyllaries. According to Weatherby (1923), the identity of Pseudognaphalium micradenium (= Gnaphalium obtusifolium var. micradenium) was based on its glandular-puberulent stems (vs. glandular-villous in P. helleri), linear or linear-lanceolate leaves (vs. leaves oblong-lanceolate in P. helleri), and acute phyllaries (vs. obtuse phyllaries in P. helleri). Mahler (1975), considered Pseudognaphalium micradenium (= Gnaphalium obtusifolium var. micradenium) as a variety of P. hellerii (= G. helleri; i.e. G. helleri var. micradenium). Cronquist (1980) distinguished Pseudognaphalium obtusifolium (= Gnaphalium obtusifolium) from P. helleri (= G. helleri, including G. obtusifolium var. micradenium as its synonym) by its wooly pubescence (vs. principally glandular in P. helleri). Nesom (2006) considered Pseudognaphalium obtusifolium, P. helleri, and P. micradenium as separate species, using leaf shape, pubescence, and the number of florets as a way to distinguish them. The present cluster analysis shows the specimens of Pseudognaphalium obtusifolium in a separate cluster, but those of P. helleri and P. micradenium appear intermingled. Consequently, based on this study, we consider Pseudognaphalium micradenium as a synonym of P. helleri as was previously suggested by Cronquist (1980).

Figure 1b. Groups I-IV of the UPGMA cluster analysis of the North American species of Pseudognaphalium (continued from Fig. 1a). I: P. canescens and P. microcephalum; II: P. semilanatum and P. semiamplexicaule; III: P. helleri and P. micradenium; IV: P. crenatum and P. viscosum.
The fourth group (IV) includes Pseudognaphalium crenatum from Mexico and P. viscosum, from United States of America (Texas), Mexico, and Mesoamerica, characterized by its stipitate-glandular stems, linear-lanceolate leaves, white shiny phyllaries, and numerous pistillate florets. Villaseñor (2016) accepted Pseudognaphalium crenatum as a valid species, but McVaugh (1984) and Pruski (2018) placed P. crenatum into synonymy of P. viscosum.

The present cluster analysis shows the type specimen of P. crenatum grouped together with the specimens of P. viscosum and confirms previously proposed synonymy.

Therefore, in agreement with our results Pseudognaphalium consists of 37 North American species (Figures 1a, b), and the corresponding synonyms for the three newly circumscribed species are indicated in the taxonomic treatment provided below.

**Taxonomic Treatment of Pseudognaphalium in North America**


**Type:** Gnaphalium oxyphyllum DC. ≡ Pseudognaphalium oxyphyllum (DC.) Kirp.


Annual, biennial or perennial herbs, woolly or glandular woolly. Leaves alternate, entire, sessile, often stem-clasping and decurrent. Capitula small, heterogamous, disciform, sessile or short pedunculate, in small clusters arranged in corymbs or panicles; involucre often campanulate; phyllaries in 3–many-series, papery, phyllary lamina monochromous opaque or hyaline and shiny, white, yellowish, brownish, straw, pinkish or purple coloured, stereome divided; receptacle smooth or honeycombed. Florets many, pistillate florets usually outnumbering bisexual; pistillate florets corollas filiform or narrowly tubular; bisexual florets corollas tubular, scarcely broaded above, 5-lobed, all corollas yellowish or whitish, lobes glandular and often yellowish or whitish; anthers with a small obtuse apical anther appendage;
tails slightly longer or shorter than the filament collar; style branches truncate and penicillate. Achenes glabrous smooth or with imbricate microscopic papillae, rarely setuliferous with short duplex myxogenic hairs; carpopodium symmetrical, continuous; pappus monomorphic, of free capillary, barbulate bristles, apical cells sometimes inflated, bases cohering by patent cilia.

Worldwide distribution, mostly American, some African and Asian species. About 60 species of which 37 grow in North America.

Key to Species of *Pseudognaphalium* in North America

1. Leaves ≤ 1.5 cm long.......................... *P. brachyphyllum*  
1’. Leaves ≥ 2 cm long......................................2

2(1’). Stem leaves strongly decurrent on stem (wings extending down beyond middle of internode).......................................................3

2’. Stem leaves not to moderately decurrent on stem (wings never extending down beyond middle of internode) ........................................4

3(2). Leaves linear-oblong, adaxial surface arachnoid ........................................ *P. bourgovii*  
3’. Leaves lanceolate, adaxial surface stipitate-glandular ........................................ *P. nataliae*  
4(2’). Leaves pseudopetiolate (long-attenuate at the base)................................. *P. ehrenbergianum*  
4’. Leaves sessile (shortly or not attenuate at base)................................................5

5(4’). Adaxial surface of leaf blades glandulose, arachnoid or lanuginose, abaxial surface white-lanose .......................................................6

---

Figure 3. *Pseudognaphalium helleri*. a. Plant; b. Capitulum; c, Inner phyllary; d-e, Foliar and stem trichomes; f. Pistillate floret; g. Bisexual floret; h. Bristle pappus [a-c, f-h. Fernald & Bayard Long 7696, PH; d. Bush 1000, MO; e. Demaree 16387, GH].
5’. Adaxial and abaxial surface of leaf blades glandulose, lanuginose, glandular-lanuginose or lanose .......................................................... 23
6(5). Adaxial surface of leaf blades conspicuously stipitate-glandular .......................................................... 7
6’. Adaxial surface of leaf blades not stipitate-glandular .......................................................... 16
7(6). Bases of leaf blades not clasping ......................... 8
7’. Bases of leaf blades clasping ............................................. 13
8(7). Leaves narrowly linear to linear-lanceolate, margins strongly revolute .......................................................... 9
8’. Leaves lanceolate, oblanceolate or elliptic, margins slightly revolute .......................................................... 11
9(8). Phyllaries acute ................. P. australotexanum
9’. Phyllaries obtuse to rounded .................................. 10
10(9’). Phyllaries shiny; pistillate florets 200–400; achenes papillose ......................... P. viscosum
10’. Phyllaries opaque; pistillate florets ≤ ca. 125; achenes smooth ............................................. P. leucocephalum
11(8’). Stems lanose; leaves lanceolate to elliptic .......................................................... P. elegans
11’. Stems glandular; leaves lanceolate to oblanceolate .......................................................... 12
12(11’). Stem leaves moderately decurrent ......................... P. macounii
12’. Stem leaves not decurrent ......................... P. helleri
13(7’). Phyllaries brownish ................. P. monticola
13’. Phyllaries white ............................................. 14
14(13’). Involucre narrowly campanulate, 2.5–3 mm diam; capitula ≤ 40-flowered ......................... .......................................................... P. pringlei
14’. Involucre obconic, 3–6 mm diam; capitula ≥ 70-flowered .......................................................... 15
15(14’). Stems lanose; involucre 4–5(5.5) mm high ............................................. P. bialettii
15’. Stems glandular-lanuginose; involucre (5–)
5.5–6 mm high ............................................. P. brachypterum
16(6’). Leaves narrowly linear 1–2.5 mm wide, 30–50 times as long as wide ......................... P. greenmanii
16’. Leaves linear, linear-oblong, linear-oblancheolate or lanceolate > 2.5 (rarely 2) mm wide, up 23 times as long as wide ............................................. 17
17(16’). Phyllaries purple ................. P. purpurascens
17’. Phyllaries white, yellowish, purple, pinkish, brownish or straw coloured ......................... 18
18(17’). Bases of leaf blades not clasping, not decurrent .......................................................... 19
18’. Bases of leaf blades clasping or moderately decurrent .......................................................... 20
19(18). Leaves lanceolate or linear-lanceolate, acute-acuminate ......................... P. attenuatum
19’. Leaves linear-oblancheolate, acute or subobtuse .......................................................... 21
20(19’). Phyllaries white, occasionally pinkish .......................................................... 21
20’. Phyllaries brownish .......................................................... 22
21(20). Leaves lanceolate, apex acuminate .......................................................... P. semiamplexicaule
21’. Leaves lanceolate-oblong to linear-oblong, apex acute .......................................................... P. roseum
22(20’). Capitula arranged in corymb; leaf blade margins flat ............................................. P. arizonicum
22’. Capitula arranged in panicles; leaf blade margins undulate ............................................. P. inornatum
23(5’). Annual herbs ............................................. 24
23’. Perennial herbs ............................................. 25
24(23). Achenes setuliferous; leaves linear-oblong; stems 15–70 cm high ......................... P. luteoalbum
24’. Achenes glabrous; leaves oblanceolate; stems 5–30 cm high ............................................. P. saxicola
25(23’). Capitula arranged in elongate to broadly columnar panicles ............................................. P. ramosissimum
25’. Capitula arranged in corymb or paniculiform corymb ............................................. 26
26(25’). Phyllaries brownish .......................................................... 27
26’. Phyllaries white, whitish, pinkish, yellowish or straw coloured ............................................. 28
27(26). Leaves apices acute; basal rosette of leaves usually persisting at flowering .......................................................... P. liebmannii
27’. Leaves apices attenuate; basal rosette of leaves withered at flowering ............................................. P. conoideum
28(26’). Stem leaves obovate ............................................. 29
28'. Stem leaves predominantly lanceolate or linear ...........................................................31
29(28). Leaves oblong-obovate, 5–10(–20) mm wide, margins undulate .......................... P. nubicola
29'. Leaves linear-obovate, 4–10 mm wide, margins flat.......................................................30
30(29'). Leaves concolorous, glandular-pubescent under wool .......................... P. thermale
30'. Leaves weakly discolorous, eglandular or with few short glandular trichomes hidden under wool ...................... P. canescens
31(28'). Stem leaves predominantly lanceolate .................................................................32
31'. Stem leaves predominantly linear..................................................................................34
32(31). Phyllaries opaque, white .......................................................... P. oxyphyllum
32'. Phyllaries shiny, whitish, yellow-greenish or purple .................................................. P. chartaceum
33(32). Leaves lanceolate, glandular-stipitate on both surfaces; pistillate florets 7-15 (24) times as many as bisexual florets ...................... P. californicum
33'. Leaves oblong-lanceolate, glandular-lanuginose on abaxial surface; pistillate florets 1–1.5 times as many as bisexual florets ................................................................. P. stramineum
34(31'). Phyllaries yellowish ............................ P. stramineum
34. Phyllaries white or whitish .........................................................................................35
35 (34'). Leaves glandular on both surfaces, margins undulate .......................... P. hintoniorum
35'. Leaves lanuginose on both surfaces or with short glandular trichomes hidden under the woolly trichomes on adaxial surface, margins flat .................................................................36
36(35'). Leaf apices acute, capitula 45–ca.100-flowered ................................. P. beneolens
36'. Leaf apices attenuate; capitula ca. 140–270-flowered ................................. P. jaliscense


Distribution: Mexico and United States of America.


Distribution: Mexico and Mesoamerica [Belice, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama (Pruski 2018)].


Distribution: Mexico.


Distribution: Mexico and United States of America.

Crescenta, Sep 1917, F. E. Burlew 3275 (lectotype, designated here: GH 00008291!; isolectotypes: RSA 0001209!, RSA 0001210!). Figure 2c, d.

Observation: Nesom (2004): 782 indicated the type of *Gnaphalium beneolens* Davidson as ‘Type: U.S.A. California. [Los Angeles Co.]: Crescenta, 1 Sep 1917, E.E. Burlew 3275 (Isotype: GH!)’. This citation of an ‘isotype’ (after 1 January 2001) cannot be corrected to a designation of a lectotype (Art. 9.10 of the ICN, Shenzhen Code; Turland et al. 2018), because they did not use the phrase ‘designated here’ or an equivalent (ICN, Art. 7.11, Shenzhen Code; Turland et al. 2018) in their associated statement. Consequently, Nesom’s typification for the name *G. beneolens* was not effective (ICN, Art. 9.23, Shenzhen Code; Turland et al. 2018). The specimen GH 00008291 which presents the most complete plant is designated here as the lectotype of *G. beneolens*.

Distribution: Mexico and United States of America.


Distribution: Mexico and United States of America.


Distribution: Mexico.


Distribution: Mexico and Mesoamerica [Guatemala].


Distribution: Mexico and Mesoamerica [El Salvador, Guatemala, Honduras, Nicaragua (Pruski 2018)].


Distribution: Mexico and United States of America.


Gnaphalium wrightii A. Gray (1882): 214. **Type:** UNITED STATES OF AMERICA. Texas, [El Paso or Hudspeth Co.] between El Paso and Guadalupe Mts., Oct 1849, C. Wright 394 (lectotype [first step], designated by Nesom (2004): 783: GH; **lectotype [second step], designated here:** GH 00008314; isolectotypes: GH 00008313!, US 00129567!).

Gnaphalium albatum Osterh. (Osterhout 1906): 141. **Type:** UNITED STATES OF AMERICA. Colorado. Larimer Co., canyon of Thompson River, [between the foothills and Estes Park], 16 Aug 1905, G. E. Osterhout 3158 (holotype: RM 0001102!; isotype: NY 00169466!).


Gnaphalium texanum I.M.Johnst. (Johnston 1924): 86. **Type:** UNITED STATES OF AMERICA. Texas, Brewster Co., Mouth of Tarlinga Creek, Sep 1883, V. Havard 26 (holotype: GH 00008310!; probable isotype: US 00129562! [s.n.]).

Gnaphalium viridulum I.M.Johnst. (Johnston 1924): 84. **Type:** UNITED STATES OF AMERICA. New Mexico, Grant Co., Bear Mts., near Silver City, 2400 m, 19 Sep 1903, O. B. Metcalfe 742 (holotype: GH 00008312!; isotype: US 00129565!).

Gnaphalium albidum I.M.Johnst. (Johnston 1924): 86. **Type:** UNITED STATES OF AMERICA. Texas, Brewster Co., Mouth of Tarlinga Creek, Sep 1883, V. Havard 26 (holotype: GH 00008310!; probable isotype: US 00129562! [s.n.]).

**Observations:**
1. According to the protologue, *Gnaphalium canescens* was based on the specimen ‘in Mexico ad Leonem ultras Guanaxuato legit cl. Mendez’. We found at G-DC, where the original herbarium of Candolle is deposited, the sheet G 00312669 ‘Mexiq. (Léon à l’ouest de Guanajuato), 1829, M. Mendez’ [sheet 1], which is in accordance with the protologue and is considered as the holotype of *Gnaphalium canescens*.
2. According to the protologue, *Gnaphalium microcephalum* was based on the specimen ‘St. Diego, Upper California’. We found at BM, where the original herbarium of Nuttall is mainly deposited, the sheet Nuttall s.n. BM 001010942, which is in accordance with the protologue and matches the locality. Since Nuttall mentioned in the protologue ‘(I have seen but a single specimen)’ this specimen is almost surely the holotype. There are other two collections on the same sheet BM 001010942, i.e. Suksdorf s.n. and Maccoun s.n.
3. Nesom (2004): 782 indicated the type of *Gnaphalium wrightii* A.Gray as ‘Type. U.S.A. Texas [El Paso or Hudspeth Co.] valley between El Paso and the Guadalupe Mts., Oct [1849], C. Wright 394 (Lectotype, designated here: GH; Isolectotypes: GH!, US!)’. This constitutes a valid [first-step] lectotypification. Since we located two sheets of this collection at GH, ‘second-step’ lectotypification is required (ICN, Art. 9.17. Shenzhen Code; Turland et al. 2018). The specimen GH 00008314 which presents the most complete plant is here designated as the lectotype of *G. wrightii*. Furthermore, this is the specimen that was labelled as the ‘lectotype’ by Kittredge in 2009, and shows that Nesom did not annotate either of the two sheets in GH.
4. The types of new species described by Osterhout were deposited in his private herbarium and, upon his death, all his sheets were bequeathed to the Rocky Mountain Herbarium in Laramie, Wyoming. Consequently, the only collection kept at RM (RM 0001102) is considered as the holotype of *Gnaphalium albatum*.

**Distribution:** Mexico and United States of America.


*Gnaphalium poeppigianum* DC. (Candolle 1838: 227). **Type:** PERU. Dpto. Huánuco, Cuchero, Sep 1829, E. F. Poeppig n. 34 diar. 1368 (lectotype, designated by Freire et al. (2018: 330): G-DC G-00469598!; isolectotypes: F 881500!, F 970435!-fragment, B† photo F0BN015138!, GH 00008361! fragment, GH 00008362!, HAL 112159!, NY 00169513!, P 00704530!, P 00704531!). **Distribution:** Mexico, Mesoamerica [Costa Rica, Guatemala, Honduras, Nicaragua, Panama (Pruski 2018)] and South America [Colombia, Ecuador, Peru, Venezuela (Freire et al. 2018), Guyanas (Boggan et al. 1997)].


Distribution: Eastern United States of America.


Distribution: Mexico.


Distribution: Mexico and United States of America.


Distribution: Mexico and United States of America.


Observation. In the protologue of Gnaphalium leucocephalum, Gray (1853) mentioned ‘G.
polycephalum Gray, Pl. Wright p. 124. no. 393, non Michx.– Bed of mountain torrents near Santa Cruz, Sonora; Sept. (1285). Stafleu & Cowan (1976) stated that the herbarium types of Asa Gray are at GH. We located at GH two specimens of C. Wright 1285 (GH 00254927 and GH 00008297) and three other specimens of C. Wright 393 (GH 00008296, GH 00008299 and GH 00282538). Only two of these specimens, Wright 1285-GH 00254927 and Wright 393-GH 00008296, were there when Asa Gray described the species, the remaining are duplicates transferred to GH from the Boston Natural History Society at a later date. We selected the specimen C. Wright 1285-GH 00008297 as lectotype of Gnaphalium leucocephalum, because it bears the name of the new species written on it in Gray’s own hand with the annotation ‘n. sp’ and it is better preserved. There are other two collections on the same sheet GH 00254927, i.e. Thurber 924 GH 00254926 and Xantus 66 GH 00008298.

**Distribution:** Mexico and United States of America.


*Gnaphalium vulcanicum* I.M.Johnst. (Johnston 1923): 100. **Type:** MEXICO. [Veracruz], Pico de Orizaba, near timber line, Sep 1907, C. A. Purpus 2782 (holotype: GH 00008328; isotype: US 00129566!).

**Distribution:** Mexico and Mesoamerica [Guatemala (Pruski 2018)].

only one sheet, we prefer not to lectotypify the name at the moment.

**Distribution:** Eurasian species with cosmopolitan distribution, being adventitious in Mexico and United States of America (Pruski 2018).


*Gnaphalium ivesii* A.Nelson & J.F.Macbr. (Nelson & Macbride 1916): 46 as nom. nov. for *Gnaphalium decurrens* Ives (1819: 380), hom illeg., non *G. decurrens* L. 1759. **Type:** Plate s.n. sub. ‘*Gnaphalium decurrens*’ (Ives 1819) (lectotype, designated here).

**Observations.** The protologue of *Gnaphalium decurrens* Ives does not include any reference to the collector: ‘This plant was observed by me in company with Mr. C. Whitlow, in July, 1817, by the margin of a brook, a few rods north of Mr. E. Whitney’s gun manufactory, near New Haven. It is also found on the margin of the Housatonic about thirty miles from Long Island soon where it was observed by Dr. Alfred Monson, the last summer’. The name of this species is accompanied by an illustration, which is here selected as the lectotype.

**Distribution:** Canada and United States of America.


**Distribution:** Mexico and Mesoamerica [Guatemala (Pruski 2018)].


**Distribution:** Mexico.


**Distribution:** Mexico.


**Distribution:** United States of America and adjacent Canada.


**Type:** UNITED STATES OF AMERICA. California. Monterrey (“Monterey”), W. Gambel s.n., -Types: GH 00008306!, GH 00008307!, K 001096583! “Nuttall from Gambel”, written on sheet.

**Distribution:** United States of America.


**Type:** MEXICO. ‘Crescit in covalli Guanaxuatensi, alt. 1700 hex. (Regno Novae Hispaniae) Floret Septembri’ Guanajuato, F. W. H. A. Humboldt & A. J. A. Bonpland s.n. (holotype: P 00322305!).

**Distribution:** Mexico, Central America (Belize, Guatemala, Honduras, Nicaragua (Pruski 2018)), and United States of America.


**Distribution:** United States of America.


**Type:** MEXICO. ‘Vittoria a Tula, Nov 1830’, J. L. Berlandier 2188 (lectotype, designated here: G-DC G-00469541!; isolectotypes: G 00223947!, G-DC G-00469542!, GH 00008348!, K 001096583!, P 00704575!, PH 0012624!). Figure 4a-g.

Observations:
1. According to the protologue, Gnaphalium semiamplexicaule was based on the specimen ‘in Mexico inter Vittoria et Tula legit cl. Berlandier pl. exs. n. 2188’. We found two sheets at G-DC, G-DC G-00469541[sheet 2] and G-DC G-00469542 [sheet 1]. We propose the specimen G-DC G-00469541 which bears the number ‘2’ written in pencil in the top right hand corner, as the lectotype of Gnaphalium semiamplexicaule, since this is the only one that bears the annotations provided by Candolle.
2. Candolle (1838: 225) mentioned ‘β. semilanatum, foliis subtùs albo-lanatis, ̶  Cum var. α mixtum in pl. Mendezianis. (v.s.)’. We located at G-DC, where the original herbarium of Candolle is deposited, the collection ‘Villalpando, au Sud est de Guanajuato, J. Mendez s.n.’ G-DC G-00469505 of four sheets (see observation of Pseudognaphalium oxyphyllum). On sheet 1 and 2 the three plants on right have discolorous lanceolate leaves, with abaxial surface white lanate. We propose the sheet 1- G-DC G-00469505

Figure 4. Pseudognaphalium semiamplexicaule. a, b. Flowering branches; c. Capitulum; d. Phyllaries; e. Pistillate floret; f. Bisexual floret; g. Achene [a-g. Rzedowski 36561, MEXU].
as the lectotype of *Gnaphalium oxyphyllum* var. *semilanatum*.

**Distribution:** Mexico and Mesoamerica [Belice, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama (Pruski 2018)].


*Gnaphalium gossypinum* Nutt. (Nuttall 1841): 403. **Type:** UNITED STATES OF AMERICA. Oregon [Río Columbia], 1834-1835, T. Nuttall s.n. (not seen).

*Gnaphalium chilense* Spreng. var. *confertifolium* Greene (1897): 400. **Type:** UNITED STATES OF AMERICA. California. San Francisco, 27 May 1893, E. L. Greene (holotype, NDG 59239!).

*Gnaphalium sulphurescens* Rydb. (Ryder 1900: 415). **Type:** UNITED STATES OF AMERICA. Yellowstone Park, Lower Geyser Basin, 7500 ft, 4 Aug 1897, P. A. Rydberg & E. A. Bessey 5135 (lectotype, designated here: NY 00169483!; isolectotypes: E 00433320!, GH 00008309!, K 000978305!, NDG 59124!, NEB-v-000112!, NEB-v-000111!, PH 00012625!, RM0001109!, US 00129561!, US 00130793!).

*Gnaphalium lagopodioides* Rydb. (Ryder 1900: 416). **Type:** UNITED STATES OF AMERICA. Yellowstone Park, Lower Geyser Basin, 7500 ft, 4 Aug 1897, P. A. Rydberg & E. A. Bessey 5134 (holotype: NY00169473!; isolectotypes: GH 00008295!, NDG 59122!, NEB-v-000110!, US 00129542!).

*Gnaphalium proximum* Greene (1902): 279. **Type:** UNITED STATES OF AMERICA. Wyoming. In moist ground about warm springs, Mammoth Hot Springs, Yellowstone Park, 21 Jul 1899, A. Nelson & E. Nelson 6036 (holotype: NDG 59162; isolectotypes: NY 00169479!, RM 0001107!, RM 0001108!, US 00129553!).

**Observations:**

1. Rydberg (1900: 415) mentioned in the protologue of *Gnaphalium sulphurescens*: 'Yellowstone Park: Lower Geyser Basin, August 4, 1897, Rydberg & Bessey, 5135; Hot Springs, 1884, Tweedy, 172; Mud Springs, 1871, Hayden Survey'. We propose as the lectotype of *G. sulphurescens* the collection *Rydberg & Bessey 5135* kept at NY which is a widely distributed collection (duplicates seen at E, GH, K, NDG, NEB, PH, RM, and US), and the specimen kept at NY, NY 00169483, because, according to the preface to Rydberg’s paper, ‘Rydberg & Bessey, 1897’ type materials are found in this herbarium.

2. Candolle (1838:223) mentioned for *Gnaphalium berlandieri*: ‘circa urbem Mexico media aestate legit cl. Berlandier pl. exs. n. 471! … (v.s.)’. We found two sheets at G-DC of the collection *Berlandier 471* G-DC G-00469600 [sheet 1], 24 Jun 1827 and G-DC G-00469612 [sheet 2], 30 Jun 1827. We selected as the lectotype of *G. berlandieri*, the specimen G-DC G-00469612 with the pencil number ‘2’ in the top right hand corner, which is the only one annotated by de Candolle and has an annotation on the original Berlandier label indicating there were ‘14 ex’ [= duplicates].

**Distribution:** Canada (Pruski 2018), Mexico, United States of America and Mesoamerica [Guatemala, Honduras (Pruski 2018)].


**Distribution:** United States of America.


*Gnaphalium leptophyllum* DC. (Candolle 1838: 226). *Type*: MEXICO. 1831, L. Alaman s.n. (holotype: G-DC G-00469611!).


**Distribution:** Mexico, United States of America, and Mesoamerica [Guatemala, Honduras (Pruski 2018)].
Excluded species


*Gnaphalium sprengelii* Hook. et Arn. (1841[1833]: 150) is a nomen superflum because this name was used to replace Sprengel’s *Gnaphalium chilense* (1826: 480), adopted by Lessing (1831): 525 for Californian plants. Rémy (1849): 228, mentioned *Gnaphalium chilense* Hook. & Arn. (1841[1833]: 31), non *G. chilense* Spreng. (1826), as a synonym of *G. falcatum* Lam. [= *Gamochaeta falcata* (Lam.) Cabrera]. One sheet of *Gnaphalium chilense* Spreng., ‘Chili. Chamisso. Peru?’, that bears the label ‘Sprgl. herb. no.: 827, Syt. III, 480... 168’, was located at P, P 00704592, where most of the original material used by Sprengel for his new taxa, in Systema Vegetabilium, is deposited. According to the digital image, the two plans on the sheet correspond to *Gamochaeta falcata* by having capitula arranged in spikes, pappus bristles basally connate, and linear obovate to obovate leaves.

Names of Dubious Identity


**Gnaphalium oaxacanum** Greenm. (Greenman 1904): 96. **Type**: MEXICO. Oaxaca. 1750 m, Jul-Aug 1900, C. Conzatti & V. González 1012 (holotype: GH 00008334!, isotypes: MEXU 00525673!, TEX 00000467!).

Since we were able to see only the images of type specimens of *Pseudognaphalium altamiranum*, *Gnaphalium oaxacanum* and *G. nubicola* var. *panniforme*, and we have seen no other material that can be assigned to these species, the identity of them is not clear to us.

Acknowledgments

We thank the anonymous reviewers for their valuable suggestions on an earlier and the revised version of this paper. Special thanks are due to Nicholas Hind (K) who kindly helped us with nomenclature aspects. Appreciation is expressed to the directors and curators of the herbaria G, GH, M, MEXU, MO, NY, S, and UC for the loan of specimens that made this study possible. We thank María Alejandra Migoya (LPAG) for the illustrations of *Pseudognaphalium helleri* and *P. semiamplexicaule*. Also thanks to ‘Adumbratio Ilustración Científica’ for designing the figure 1 (a and b). Finally, we thank John Avise for making available to us the photographs of *Pseudognaphalium conescens* and Neal Kramer and Michael Mitchell the photographs of *P. beneolens*. Financial support (PIP 112-201501-00843) was provided by Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Argentina, and Universidad Nacional de La Plata, Programa de Incentivos, Secretaría de Políticas Universitarias, Ministerio de Educación, Argentina.

REFERENCES


FASSETT NC. 1931. Notes from the Herbarium of the University of Wisconsin-VI. Rhodora 33: 72-75.


NUTTALL T. 1841. Descriptions of new species and genera of plants in natural order of the Compositae, collected in a tour across the continent to the Pacific, a residence in Oregon, and a visit to the Sandwich Islands and Upper California, during the years 1834 and 1835. Trans Amer Philos Soc 7: 283-454.


SCHULTZ BIPONTINUS CH. 1856. Lechler’s neueste Sammlungen aus Peru und Chile. Bonplandia 4: 50-54.


WEBB PB. 1849. Spicilegia Gorgonea; or a catalogue of all the plants as yet discovered in the Cape de Verd Islands, from the collections of J.D. Hooker, Esq. M.D.R.N., Dr. T. Vogel, and other travellers. In: Hooker WJ (Ed), Niger Flora or, an enumeration of the plants of western tropical African, collected by the late Dr. Theodore Vogel, botanist to the voyage of the expedition sent by Her Britannic Majesty to the River Niger in 1841, under
the command of Capt. H.D. Trotter, R.N. etc. Hippolyte

How to cite
FREIRE SE, GROSSI MA, BAYÓN ND & MONTI C. 2022. Morphometric
Analysis and Synopsis of Pseudognaphalium (Gnaphalieae, Asteraceae)
in North America. An Acad Bras Cienc 94: e20200082. DOI 10.1590/0001-
376520220200082.

Manuscript received on February 06, 2020;
accepted for publication on September 09, 2020

SUSANA E. FREIRE¹
https:/ /orcid.org/0000-0001-7141-8058

MARIANA A. GROSSI²
https:/ /orcid.org/0000-0002-9837-9156

NÉSTOR D. BAYÓN³
https:/ /orcid.org/0000-0003-1446-129X

CLAUDIA MONTI³
https:/ /orcid.org/0000-0002-9481-6708

¹Museo Argentino de Ciencias Naturales (MACN-
CONICET), División Plantas Vasculares, Av. Ángel Gallardo
470, C1405DIR Ciudad de Buenos Aires, Argentina
²Museo de La Plata, División Plantas Vasculares,
Paseo del Bosque, 1900, La Plata, Argentina
³Facultad de Ciencias Agrarias y Forestales (UNLP),
Sistemática Vegetal, Avda. 60 y 117, 1900, La Plata, Argentina

Correspondence to: Susana Edith Freire
E-mail: sfreire@darwin.edu.ar

Author contributions
SEF planned and designed the research and led the writing
of the paper. MAG conducted the morphometric analysis
and produced figures 1a, b. SEF, NDB, and CM, examined
morphological characters of taxonomic relevance. All
authors contributed to literature review, interpretation of
the analysis, discussion of the taxonomy of North American
Pseudognaphalium, participated in decisions about the
placement of particular taxa, and approved the final draft.