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**CORRECT ORTHOGRAPHY FOR *ASTER ONTARIONIS* VAR. *GLABRATUS*  
WHEN TREATED AS *SYMPHYOTRICHUM* (ASTERACEAE: ASTEREA)**

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**ABSTRACT**

*Aster ontarionis* Wiegand var. *glabratus* Semple (Compositae) was recently provided with a new, formal combination under *Symphotrichum* by L. Brouillet & J. Labrecque. The specific and varietal epithets were, however, presented in incorrect form. The correct orthography is briefly presented here with its rationale.

**KEY WORDS:** *Aster*, Asteraceae, Astereae, Compositae, nomenclature, northeastern North America, orthography, *Symphotrichum*

Recently, Luc Brouillet and Jacques Labrecque (1997) provided a small number of new combinations for *Aster* taxa under the generic name *Symphotrichum* (Asteraceae: Astereae). These new combinations were presented to account for a few taxa which had not received new combinations when Guy Nesom published his outstanding taxonomic review of the genus *Aster* (1994). My purpose in this brief note is simply to correct the orthography of the one or two relevant entities prior to potential use, in incorrect form, in subsequent treatments or publications. It also provides me a cheap opportunity to try to clarify a Latin construction, as I attempted to do a few years ago in the case of masculine first declension substantives when used as genitive infrageneric epithets (Ross 1991).

In their article, Brouillet & Labrecque presented the new combination for *Aster ontarionis* Wiegand var. *glabratus* Semple as:

“*Symphotrichum ontarione* (Wiegand) Nesom  
var. *glabratus* (Semple) Brouillet & Bouchard, *comb. nov.*”

However, within the confines of this nomenclatural combination, both the specific and varietal epithets are orthographically incorrect. I note here that the specific epithet was

first presented incorrectly when Nesom provided the new combination in *Symphytotrichum* (1994, pp. 270, 287), and was retained as "*ontarione*" by Brouillet & Labrecque when they provided the new combination for the "*varietas glabratus*." The specific epithet has again appeared incorrectly in a review of taxonomic updates for North American *Aster s.l.* (Nesom 1997, p. 284).

*Aster ontarionis* is a well-named species, apparently prevalent in the province of Ontario, Canada. Wiegand, in naming the species, *could have* chosen to use the locative case "*ontariensis*" ("hailing from Ontario") as the specific epithet. However, he chose instead to use the genitive case (generally denoting possession, or belonging), treating "Ontario" as a third declension noun as would have been obvious to any good ancient Roman. Latin third declension substantives are among the most confusing to non-Latin readers and writers, owing perhaps to the fact that they encompass a diversity of less frequently encountered word forms, some of them even requiring vowel shifts within the root-word when the case is changed (e.g., *homo*, *hominis*—"a/the man, of a/the man": *homin-* being the root to which case endings are added). In many other third declension substantives ending in *-o* or *-on*, however, the actual root of the word is considered to end in *-on*, without any intrinsic vowel shifts. As a correlative example, I give the Latin word for "nation," which—as the direct, original basis for the English word—is "*natio*, *nationis*." Here, as in "Ontario," there is no intrinsic vowel shift within the root-word. Consequently, suffixes denoting other cases are appended to the *-on* terminus, even if the substantive in the nominative case ends only in *-o*.

For example, if I acquired a *Mammillaria* that I thought was *quite* distinctive (--whether or not I knew *anything* about nipple-cacti--), and I wanted to name it for my friend Otto von Schmegdorffen, from whom I had received it, I might describe it as *Mammillaria ottonis*. The epithet "*ottonis*" means literally "of Otto," or, "Otto's *Mammillaria*." Likewise, if my friend Tom Petersson brought me a top-snatch of an *Erodium* from his weedy backyard in Hollywood, and I decided that it was an undescribed species, I might formally write it up as "*Erodium peterssonis*," or, literally "Petersson's *Erodium*." The *-is* ending appended to the root-word is strictly genitive in meaning.

While a few case endings differ in the third declension between neuter forms and masculine or feminine forms, as a general rule the genitive case ends in *-is* regardless of gender. In the case of "*Ontario*, *Ontarionis*," the genitive form of the specific epithet remains "*ontarionis*" regardless of the gender of the genus to which it is appended. By changing "*ontarionis*" to "*ontarione*," the substantive is completely changed from the genitive case (correct), with the meaning of "belonging to," to the ablative case (incorrect), with several very different meanings. My suspicion is that the basis for this error was in misinterpreting the *-is* ending as an adjectival suffix of two endings: "*-is*" for masculine and feminine; "*-e*" for neuter. *Ontario* is, however, a substantive and not an adjective. As such, the specific epithet should be maintained as "*ontarionis*" whether the species is treated within *Aster* (masculine) or *Symphytotrichum* (neuter).

Secondly, in formalizing the new combination for *Aster ontarionis* var. *glabratus* as a *Symphytotrichum*, Brouillet & Labrecque published the varietal name as "*glabratus*." This does not require much comment other than to point out that the descriptive varietal epithet for this glabrate, shoreline form of the species is, in Latin,

an adjective of three endings (*glabrata* [f.], *glabratus* [m.], *glabratum* [n.]). As such, the correct name for *Aster ontarionis* var. *glabratus*, when treated as a *Symphyotrichum*, should have appeared in the Brouillet & Labrecque paper (1997, p. 138) as follows:

*Symphyotrichum ontarionis* (Wiegand) Nesom var. *glabratum* (Semple) Brouillet & Bouchard, *comb. nov.* BASIONYM: *Aster ontarionis* Wiegand var. *glabratus* Semple, Univ. Waterloo Biol. Ser. 38:60. 1996.

In closing, I would point out that the "authors" of the *International Code of Botanical Nomenclature* (Greuter *et al.* 1994) recommend against the use of infrageneric epithets based on third declension constructions—Chapter VII. Orthography of names and epithets and gender of generic names; Section 1. Orthography of names and epithets; Article 60; Recommendation 60C.2 [*pro parte*]: ". . . Treating modern names as if they were in third declension should be avoided (e.g. *munronis* from Munro, *richardsonis* from Richardson)." I, however, find such a formal recommendation to be groundless, unnecessary, arbitrary, and absurd. Yes, Botanical Latin is evolving independently of Classical Latin, but that provides no justification for discarding proper (*i.e.*, correct) Latin constructions for some *oversimplified, anglicized, (-indeed Americanized)* version of what Latin *should* be.

[In such efforts to try and emend Latin-based errors, I am humbled—especially considering the paucity of my own education in Latin. Nevertheless, I ally myself with a largely parananational body of botanists (speaking from an *Americocentric* standpoint) who believe that Latin should be retained as the formal language of botany. Some of the rationales for my viewpoint may—possibly—be found in print elsewhere (assuming that they are not censored).]

#### ACKNOWLEDGMENTS

I would like to thank my friends and colleagues Vanessa Ashworth, Victor W. Steinmann, and Dr. J. Travis Columbus (all RSA) for their willingness to review and make comments upon this brief note. I also wish to thank Annette Heller Ross for comments on the initial draft. They rank among the few English speakers that I currently know who are willing to embrace and study Latin, rather than sitting back, fighting it, and whining like babies over its botanical use (as seems to be the trend among most lazy American botanists).

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TAXONOMIC NOTES ON *SCHEDONORUS*, A SEGREGATE GENUS FROM *FESTUCA* OR *LOLIUM*, WITH A NEW NOTHOGENUS, × *SCHEDOLOLIUM*, AND NEW COMBINATIONS

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ABSTRACT

The genus *Schedonorus* P. Beauv. is accepted with a new combination, *Schedonorus giganteus* (L.) Soreng & Terrell. A new nothogenus, × *Schedololium* Soreng & Terrell, is created for hybrids between *Schedonorus* and *Lolium*, and five nothospecies are transferred to that; × *Schedololium braunii* (K. Richt.) Soreng & Terrell, × *Schedololium brinkmannii* (A. Braun) Soreng & Terrell, × *Schedololium holmbergii* (Dörf.) Soreng & Terrell, × *Schedololium loliaceum* (Huds.) Soreng & Terrell, × *Schedololium nilssonii* (Cugnac & A. Camus) Soreng & Terrell.

KEY WORDS: *Festuca pratensis* complex, *Lolium*, *Schedonorus*, × *Schedololium*, Poaceae, Poaceae, taxonomy

The taxonomic relationships of the three species traditionally placed in *Festuca*, *F. arundinacea* Schreb. (tall fescue), *F. pratensis* Huds. (meadow fescue), and *F. gigantea* (L.) Vill. (giant fescue), and widely discussed as the *Festuca pratensis* complex, have been subjected to intense scrutiny over the past few years. Darbyshire & Warwick (1992) and Darbyshire (1993; see for review of various data) concluded that several kinds of evidence favored union of the three species with *Lolium* rather than *Festuca*. On the other hand, Aiken *et al.* (1997) took an opposite position, retaining them under *Festuca* subgenus *Schedonorus*.

It is clear that these species have chloroplast DNA (*cpDNA*) types that are derived in common with the types found in *Lolium* and that these types significantly differ from the *cpDNA* types present in *Festuca* proper or in *Vulpia* (Darbyshire & Warwick 1992; Kiang *et al.* 1994; Spangenberg *et al.* 1994; Xu & Sleper 1994; Charmet *et al.* 1997; Soreng & Davis 1998, and unpublished *cpDNA* restriction site data). In the Charmet *et al.* (1997) study, phenetic analysis of ribosomal DNA internal transcribed spacer sequences, of nuclear genome origin, resolved essentially the same relationships between the *Festuca*, *Lolium*, and species of the *Schedonorus* complex as those detected by their analysis of *cpDNA* restriction site bands.

For forthcoming treatments of North American Poaceae we prefer to place the three species in question within the genus *Schedonorus*, which was first created by Beauvois (1812). In order to do so a new combination is needed for *Festuca gigantea*. A prior publication of *Schedonorus giganteus* Gaudin *ex* Roem. & Schult. (*Syst. Veg.* 2:644. 1817.) is invalid as it was published in synonymy, and so the name was not effectively published. A nomenclatural summary of the pertinent names is provided here.

*Schedonorus* P. Beauv., *Ess. Agrostogr.* 99, 162, 177. (1812). *Festuca* subgen. *Schedonorus* (P. Beauv.) Peterm., *Deutschl. Fl.* 643. 1849. *Festuca* sect. *Schedonorus* (P. Beauv.) W.D.J. Koch, *Syn. Fl. Germ. Helv.* 813. 1837. *Lolium* subgen. *Schedonorus* (P. Beauv.) Darbysh., *Novon* 3(3):241. 1993. LECTOTYPUS: *Schedonorus elatior* (L.) P. Beauv., based on *Festuca elatior* L., *nom. rej.* (Reveal *et al.* 1991; = *Schedonorus arundinaceus* [Schreb.] Dumort.).

*Schedonorus arundinaceus* (Schreb.) Dumort., *Observ. Gramin. Belg.* 106. 1824. BASIONYM: *Festuca arundinacea* Schreb., *Spic. Fl. Lips.* 57. 1771. *Lolium arundinaceum* (Schreb.) Darbysh., *Novon* 3(3):241. 1993.

*Schedonorus pratensis* (Huds.) P. Beauv., *Ess. Agrostogr.* 99, 163, 177. 1812. BASIONYM: *Festuca pratensis* Huds., *Fl. Angl.* 37. 1762. *Lolium pratensis* (Huds.) Darbysh., *Novon* 3(3):242. 1993.

*Schedonorus giganteus* (L.) Soreng & Terrell, *comb. nov.* BASIONYM: *Bromus giganteus* L., *Sp. Pl.* 1:77. 1753. *Festuca gigantea* (L.) Vill., *Hist. Pl. Dauph.* 2:110. 1787. *Lolium giganteum* (L.) Darbysh., *Novon* 3(3):241. 1993.

In addition, several naturally occurring hybrids between these species of *Schedonorus* and species of *Lolium* have been named. The most common of these were recognized by Stace (1991) and Humphries (1980) in the hybrid genus × *Festulolium* Asch. & Graebn., but as that nothogenus is restricted to hybrids between *Festuca* and *Lolium*, a new nothogenus is needed to accommodate the hybrids in question. Some of these crosses are likely to occur spontaneously in North America.

× *Schedololium* Soreng & Terrell, *nothogenus nov.*, *Schedonorus* P. Beauv. × *Lolium* L. TYPUS: × *Schedololium loliaceum* (Huds.) Soreng & Terrell.



- × *Schedololium braunii* (K. Richt.) Soreng & Terrell, *comb. nov.* BASIONYM: *Festuca* × *braunii* K. Richt., *Pl. Eur.* 1:103. 1890. × *Festulolium braunii* (K. Richt.) A. Camus, *Bull. Mus. Hist. Nat. (Paris)* 33:538. 1927. *Schedonorus pratensis* (Huds.) P. Beauv. × *Lolium multiflorum* Lam.
- × *Schedololium brinkmannii* (A. Braun) Soreng & Terrell, *comb. nov.* BASIONYM: *Festuca* × *brinkmannii* A. Braun, *Ind. Sem. (Berlin) App.* 11. 1861. × *Festulolium brinkmannii* (A. Braun) Asch. & Graebn., *Syn. Mitteleur. Fl.* 2:769. 1902. *Schedonorus giganteus* (L.) Soreng & Terrell × *Lolium perenne* L.
- × *Schedololium holmbergii* (Dörfl.) Soreng & Terrell, *comb. nov.* BASIONYM: *Festuca* × *holmbergii* Dörfl., *Beih. Bot. Centralbl.* 32:651. 1911. × *Festulolium holmbergii* (Dörfl.) P. Fourn., *Quatre Fl. France* 81. 1935. *Schedonorus arundinaceus* (Schreb.) Dumort. × *Lolium perenne* L.
- × *Schedololium loliaceum* (Huds.) Soreng & Terrell, *comb. nov.* BASIONYM: *Festuca loliacea* Huds., *Fl. Angl.* 38. 1762. *Schedonorus loliaceus* (Huds.) P. Beauv., *Ess. Agrostogr.* 99, 163, 177. 1812. *Lolium* × *festucaceum* Link, *Linnaea* 2:235. 1827. × *Festulolium loliaceum* (Huds.) P. Fourn., *Quatre Fl. France* 81. 1935. *Schedonorus pratensis* (Huds.) P. Beauv. × *Lolium perenne* L.
- × *Schedololium nilssonii* (Cugnac & A. Camus) Soreng & Terrell, *comb. nov.* BASIONYM: × *Festulolium nilssonii* Cugnac & A. Camus, *Bull. Soc. Bot. Fr.* 19:19. 1944. *Schedonorus giganteus* (L.) Soreng & Terrell × *Lolium multiflorum* Lam.

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## COMPARATIVE NUTRITIONAL STUDIES ON THREE VARIETIES OF *HEINSIA CRINITA*

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### ABSTRACT

The paper presents chemical data on three varieties of *Heinsia crinita*, a leafy green vegetable commonly consumed in Southeastern Nigeria. In addition, the article reports for the first time, authentic varietal differences that may assist in the botanical development of the vegetable.

Of the three varieties studied, the White one was found to have highest protein and organic matter, but lowest lipids, fiber, and caloric value (per cent dry matter: 14.7, 96, 1.4, 12.5 and 391 Kcals respectively). Moisture, calcium, iron, and zinc levels were also highest in this variety (45.2% wet weight, 105.6 mg/100 g, 19.9 mg/100 g and 2.9 mg/100 g respectively) while toxic substances were minimal. (Total oxalate: 17.1 mg/100 g; HCN: 8.1 mg/100 g; tannins: 5.0 mg/100 g). These levels were far below toxic limits. Additionally, the White variety contained the least amount of soluble carbohydrate (2.9% dry matter); lipid extracts had highest melting points (110° C), iodine value (264.7), least saponification value (112.2), and linolenic acid was the lipid of prominence.

Major lipids of the Black and Ekoi varieties were identified as lecithins. Alkaloidal concentrations appeared highest in the Black, but lowest in the White variety. The findings and their implications are discussed with special reference to possible nutrient interactions, dietetic and nutritional values of the leafy vegetable to humans.

KEY WORDS: *Heinsia crinita*, varieties, chemical composition, lipid characterization, dietary fiber, micronutrients, antinutrients

## INTRODUCTION

*Heinsia crinita* (Afzel.) G. Taylor (Rubiaceae) is a leafy vegetable widely consumed among the people of Southeastern Nigeria. It is cheap, harvested from the rain forest and many regard its characteristic, slightly bitter flavour as a delicacy. It has antimicrobial properties, justifying its use by native herbalists as a remedy for infections of the gastro-intestinal tract (Ekpa *et al.* 1991). It is rich in lipids, fiber, calcium, and iron (Ekpa *et al.* 1991).

There is a virtual absence of published information on the chemical composition of leafy green vegetables commonly consumed in this region of Nigeria, and even less exists as regards their diverse varieties. A spattering of literature does however exist on *Heinsia crinita*, but of unspecified varieties (Ekpa *et al.* 1991; Eyo *et al.* 1983; Ifon & Bassir 1979). This work is novel because it presents chemical data on three specified varieties that have been hitherto unreported.

It is undisputed that the vegetable has a number of varieties; several have been botanically identified in this paper but there is an absence of botanical development. Many varieties are edible, others not, and yet others preferred for their alleged medicinal values. The more common edible varieties include the White (Ibibio: "afia atama"), Black (Ibibio: "obubit atama"), and "Ekoi". The latter originates from the northern regions of Southeastern Nigeria. The White variety has glossy leathery, light green leaves with scanty hairs along the nerves. The leaves appear fairly succulent and are about 8.0 cm long and 3.2 cm wide on the average. It is preferentially cultivated by natives at subsistence levels. The Black variety has dull leathery, dark green leaves with dense brown hairs along the nerves; 7.5 cm long and 3 cm wide on the average. It is because of the very dark green color of the leaves that it is called black, as compared with the former which has characteristic light green colored leaves. This Black variety is harvested wild from fast disappearing forests for food, but is more popular for its supposed medicinal uses. For instance, it is used by natives as an enema and abortifacient as well as a remedy for diarrhea, peptic ulcer, and pustulation (U.J. Ekott, personal communication, 1990). It has a very bitter taste and must be thoroughly processed before used as food (includes boiling with crude bicarbonate). The Ekoi variety has papery, glossy green leaves, densely hairy along the nerves beneath, and leaves are 13.5 cm long and 4.5 cm wide on the average.

Vegetables from this region have been both unresearched and underexploited nutritionally. Studies such as this one are therefore needful and should be conducted with the view of inclusion in existing food composition tables for the region. With the growing awareness of the crucial role played by diet in the prevention and therapy of many of the ailments that assail man, it has become more critical to establish the chemical compositions of local food varieties used for human nutrition in order to assist their exploitation for health management as well as calculations required by dieticians.

## MATERIALS AND METHODS

### Sample collection and post harvest treatment.

The leaves, fruits, and flowers of the three varieties (White, Black, and Ekoi) were freshly harvested in July and botanically identified. Each sample composite consisted of an average of sixteen to twenty leaves. About ten of such composites were subjected to post harvest treatment which comprised the following steps: leaves were destalked, washed, and oven-dried at 50° C for 48 hrs. The low temperature was a quality control measure to minimize volatilization of characteristic odiferous volatile oils. Fine particulation followed, using a mortar and samples were stored in air-tight, brown bottles.

### Proximate analysis

Methods used for proximate analysis were as recommended by the AOAC (1975: Nos. 7.007 - 7.100). Crude fat determination involved exhaustive Soxhlet extraction of a known weight of sample with petroleum ether (bp. 40-60° C). The microkjeldahl nitrogen method was employed for crude protein ( $N \times 6.25$ ) while crude fiber was obtained from the loss in weight on ignition of dried residue remaining after digestion of fat-free samples with 1.25% each of sulfuric acid and sodium hydroxide solutions under specified conditions. Although the AOAC method employed for crude fiber determination in this study has been superseded by more contemporary procedures such as the AOAC method 991.43 for dietary fiber, the former one was chosen deliberately for two reasons. First, it provides sufficient perspective for the comparison of the three varieties; an absolute measure was not deemed a critical factor here. Secondly, the method was considered relatively simpler in view of the fact that contemporary and expensive equipment are unavailable in laboratories situated in many developing nations.

Quantitation of ash involved incineration in a muffle furnace at 600° C for 24 hrs. Carbohydrates estimates were by difference, while caloric values were obtained by summing the multiplied mean values for protein, fat, and carbohydrate by their respective Atwater factors (4,9,4).

### Micronutrients and antinutrients

Mineral element composition was assayed using the atomic absorption spectrophotometer after acid digestion of the samples (AOAC 1975). Ascorbate estimates were by the method of Scharafert & Kingsley (1955), hydrocyanic acid by the alkaline titration method of the AOAC (1984: No. 26.151) and oxalate by permanganate titration method of Dye (1956). Tannins were measured by the method of Price & Beutler (1978).

### Lipid characterization and other analyses

The second phase of the analysis involved soluble carbohydrate determination as glucose using the Anthrone method (Joslyn 1970). Here again, this relatively simpler method was preferred over current chromatographic ones because of limited equipment. Moreover, the procedure is adequate for the purposes of the present study which is more of a comparative than absolute nature. True protein determination involved bovine albumin as a standard in the Biuret method (AOAC 1975: Nos. 22.012-22.013), while lipid analysis including melting point determination was by the method of AOAC (1984: No. 28.014). Gravimetric iodine value determination was by the method of Devine & Williams (1961) and saponification number determination by the method of Vogel (1962). Lipid extracts were separated by thin layer chromatography using chloroform, petroleum ether, and methanol (20:60:20; v/v/v) as developing solvent. Infra-red spectroscopy of the extracts were performed. Alkaloids were screened for, using routine Meyer's, Wagner's, and Dragendorff's tests.

### Statistical Analysis

Standard deviations were calculated for triplicate determinations. The student's 't' test was applied at the 99% confidence level for each analysis, as well as between varieties.

## RESULTS AND DISCUSSION

Results of the study have been summarized in Tables 1-6. Ash contents of all three varieties (4-5% dry matter) compare well with those of other leafy vegetables commonly consumed in Nigeria (Bassir & Fafunso 1975). Strikingly, the highest ash content was found in the Black variety (Table 1) which also had the highest quantity of alkaloids (Table 2). Alkaloids are known to cause a selective uptake of minerals for chelation (Pelletier 1970). They also elicit diverse pharmacological action and are therefore prized phytochemicals. Infra-red spectroscopy in this study indicated the alkaloids to contain mostly aromatic amines (Table 3 a). Further investigation was however not attempted.

Levels of iron and zinc in all the three varieties were significant (13-20 mg/100 g and 2-3 mg/100 g respectively). The White variety in particular had superior quantities of both iron and zinc. The Recommended Daily Allowances (RDA) for both micronutrients are respectively 10 and 15 mg/d (Davidson *et al.* 1975); all three varieties can thus adequately meet dietary needs for iron. This finding is significant because the Southeastern Nigeria region is malaria-endemic resulting in widespread anemia. Anemic patients may therefore benefit from diets comprising *Heinsia crinita*. Iron bioavailability is favorably modulated by high levels of ascorbic acid and most leafy vegetables are good sources of the vitamin (Dagnelie 1989). All three varieties however show low ascorbate readings (Table 4) compared with reported average values (25 mg/100 g) for other vegetables (Davidson *et al.* 1975).

Table 1. Proximate analysis of the three varieties of *Heinsia crinita* (% dry matter).\*

Varieties	Moisture (% fresh wt.)	Ash	Ether extract	Crude Protein	Crude Fibre	Total Carbo- hydrate	Calorie Value/ Kcals
White	45.2 ± 8.6	4.0 ± 0.6	1.0 ± 0.2	14.7 ± 1.2	12.5 ± 1.3	79.9	391
Black	42.4 ± 9.2	5.0 ± 0.6	4.2 ± 0.3	11.8 ± 1.0	14.8 ± 1.6	79.0	401
Ekoi	33.0 ± 6.8	4.5 ± 0.3	3.4 ± 0.3	9.45 ± 0.8	13.9 ± 0.9	82.7	399

\* Mean ± S.D. of three determination ( $p < 0.1$ ).

Table 2. Nutrient analysis of three varieties of *Heinsia crinita*\*(g/100 ml).

Varieties	Soluble Carbohydrate	True Protein	Alkaloids
White	29.0 ± 0.0	96.0 ± 0.5	+
Black	34.0 ± 0.1	88.0 ± 0.1	+++
Ekoi	49.0 ± 0.0	60.0 ± 0.3	++

\* Mean ± S.D. of triplicate determinations ( $p < 0.1$ ).

+ = present; ++ = present in higher quantity; +++ = present in highest quantities.

Table 3. Infra-red spectroscopy of (a) alkaloids and (b) lipid extracts from *Heinsia crinita*.

## ALKALOIDS

Peaks (cm <sup>-1</sup> )	Assignment	White	Black	Ekoi
3500-3200	N-H stretch of NH <sub>2</sub>	v.w	b	v.w
2900-2800	C-H stretch of alkyl groups	w	s	w
1700-1680	C=O stretch of amides	w	w	v.w
1460-1420	C-H deformation	-	v.w	-

\*b = broad; s = strong; w = weak; v.w = very weak

## LIPIDS

Peaks (cm <sup>-1</sup> )	Assignment	White	Black	Ekoi
3600-3100	O-H stretch	w	v.w	s
2900-2800 (doublet)	C-H stretch of alkyl groups	s	b	w
1730-1680 (centered 1700)	C=O stretch of acids	s	s	v.w
1430-1400	C-H deformation of CH <sub>2</sub> =CH-(S) or CH <sub>2</sub> C=O(M)	w	w	v.w

\*b = broad; s = strong; w = weak; v.w = very weak



Table 4. Ascorbate\* and minerals\*\* in three varieties of *Heinsia crinita* (mg/100 g).

Varieties	Ascorbate	Fe	Mg	Zn	Ca	Cd
White	1.0 ± 0.1	19.9	38.3	2.9	105.6	0.2
Black	0.5 ± 0.2	13.3	79.4	2.2	64.6	0.1
Ekoi	1.0 ± 0.0	14.6	81.4	2.0	62.3	0.1

\*Mean ± S.D. of three determinations ( $p < 0.1$ ).

\*\* automated analysis

Table 5. Antinutrients in three varieties of *Heinsia crinita*\*.

Varieties	HCN (mg/100 g)	Tannin (mg/g catechin)	Total Oxalate (mg/100 g)
White	8.1 ± 1.2	5.0 ± 0.5	17.1 ± 2.1
Black	10.8 ± 1.0	11.5 ± 1.0	13.3 ± 1.8
Ekoi	10.0 ± 2.1	6.2 ± 0.2	29.2 ± 3.3

\*Mean ± S.D. of duplicate determinations ( $p < 0.1$ ).

The Black variety had the lowest ascorbate reading of the three. In view of the rigorous food processing methods needed for the culinary preparation of the vegetable, ascorbic levels may be ultimately compromised since it is easily lost during even the mildest of food processings (Davidson *et al.* 1975). Regarding calcium, the White variety was found to contain amounts that were almost twice that found in the other varieties (*i.e.*, 105 mg/100 g). The RDA for calcium is 800 mg/d for an adult man. Cow milk, one of nature's richest sources of calcium contains about 120 mg/100 g of calcium, while human milk contains 20-40 mg/100 g (Davidson *et al.* 1975). Thus, the White variety compares well with these and may be recommended over the other two for growing children or elderly people who require substantial amounts of the nutrient for adequate bone metabolism. It may be noted that the pervading economic depression in this developing nation makes milk unaffordable to a majority of the people, and *Heinsia crinita* could thus provide a significant source of calcium.

Strikingly, while the Ekoi variety presented the lowest calcium levels, it also had highest levels of oxalate (29.2 mg/100 g), which were nearly double the levels found in the other two varieties (Table 5). Oxalic acid is an established mitigator of calcium uptake (Davidson *et al.* 1975). The observed levels are below toxic limits (Oke 1969; Munro & Bassir 1969), but may however be sufficient enough to interfere with the nutritive value of the Ekoi variety *vis-à-vis* calcium availability.

Table 6. Lipid analysis of *Heinsia crinita* ether extract.\*

Varieties	Saponification Identification	Iodine Number	Melting Point °C	TLC spot
White	112.2 ± 19.3	264.7 ± 18.2	110	Linolenic
Black	202.6 ± 18.5	102.8 ± 21.1	105	Lecithin
Ekoi	168.3 ± 9.6	194.0 ± 16.3	75	Lecithin

\* Mean ± S.D. of triplicate determinations ( $p < 0.1$ ).

### Lipids

Fat levels were relatively low in the three samples as expected (Table 1). The lipid compositions of the three varieties were significantly different from each other ( $p < 0.1$ ) and this is indicative of authentic botanical variation. Results of lipid analysis of the White variety suggest high molecular weight, long chain, polyunsaturated fatty acids and indeed, chromatography verified this by indicating linolenic acid to be the lipid of prominence. The Ekoi variety is the least culinarily aromatic of the three varieties. Its lipids had the lowest melting point, but high unsaturation and lecithin was identified as the most prominent of its lipids. On the other hand, the Black variety is known to be the most aromatic of the three and its lipid analysis, while indicating lecithins also as most prominent, suggested that the fatty acids are short-chained and the least unsaturated (Table 6).

Infra-red spectroscopy of the crude lipid extract showed four major peaks of varying intensities across the three varieties (Table 3b). The Ekoi variety had a unique peak in the OH stretch region, indicating a possible presence of fatty alcohols. Further identification using HPLC and NMR techniques will be necessary to substantiate this. The lipid content of vegetables is often less than 1% by weight (Beare-Rogers 1989), but in this case, the Black variety had up to 4% in the ether extract. Vegetable lipids often consist mainly of essential PUFA particularly from chloroplasts of green leaves. Seasonal differences may occur in absolute contents of linolenic and linolenic acids, and also may vary according to time of harvest, stage of growth, and method of

analysis (Beare-Rogers 1989). Currently, the RDA for linolenic acid is 0.5-1.0% of daily calorie intake (Galli & Simopoulos 1989). Further investigation may establish whether levels of linolenic acid in the leaves will meet significantly recommended allowances.

### Dietary Fiber

Crude fiber content of the three varieties were comparable and ranged between 12.5 and 14.8% dry matter. This is substantial, considering the fact that crude fiber contents of vegetables commonly consumed in this region have documented crude fiber estimates ranging from 10 to 13% dry matter (Odutola & Carl 1983; Ifon & Bassir 1979; Oyenuga 1968). Non-starchy vegetables are the richest sources of dietary fiber (Agostoni *et al.* 1995) and they are employed in the prevention and treatment of such diseases as obesity, diabetes, cancer, and gastrointestinal disorders (Saldanha 1995). The crude fiber assay is currently considered unrepresentative of contemporary definitions of dietary fiber (Hillemeier 1995). However, in developing nations where sophisticated equipment are unavailable, the method still finds usefulness in certain studies, especially those that emphasize relativeness over absoluteness. Future research may be directed at estimating both soluble and insoluble fiber contents of this vegetable. Such studies will assist in the proper exploitation of the vegetable for health purposes; 12 g dietary fiber is the RDA required for every 100 Kcal of food consumed (Nishimune *et al.* 1993). Therefore, 100 g of the vegetable can meet this requirement adequately.

Soluble carbohydrate concentrations ranged between 29 and 49 g/100 ml (Table 2). Low concentrations of soluble carbohydrates often reflect a complementary high fiber content, but the White variety strikingly had both the lowest soluble carbohydrate as well as lowest crude fiber levels (Tables 1 and 2). This suggests that the variety may contain appreciable amounts of soluble fibers such as hemicelluloses, pectin, and/or other hydrocolloids (Agostoni *et al.* 1995).

### Protein and Tannins

Finally, the White variety was observed to have the highest protein, but least tannin content (Tables 1 and 5). Tannins mitigate the bioavailability of protein (Davidson *et al.* 1975). Thus, the significant levels of leaf protein in this variety are favorably complemented by its low tannin levels. Highest tannin levels were found in the Black variety, which may account for its characteristic astringent taste. The biological value of fiber foods is considered low because plant proteins lack the full complement of essential amino acids (Young & Pellett 1994). A vegetable such as the Black variety of *Heinsia crinita*, with low protein and high tannin would therefore be considered as nutritionally poor.

## CONCLUSIONS

Conclusively, the nutritional assay of three commonly consumed varieties of the *Heinsia crinita* leaf is novel, and seen here to establish authentic varietal differences. The White one appears to be most nutritive of the three because its highest protein content is complemented with least tannins, highest calcium complemented with low oxalate, and highest moisture complemented with least fiber for succulence. It further possesses a significant presence of the essential fatty acid, linolenic acid. In addition, it had more iron, zinc and calcium than the other varieties as well as least all around antinutritional principles. The Black variety, on the hand, was found to have the highest ash, ether extract, crude fiber, hydrocyanic acid, tannin, and alkaloids. All these constitute distinct "pluses" for plants with high medicinal potential. This variety actually is that used by native herbalists for medicinal concoctions. Future research could therefore be directed towards the pharmacological fingerprinting of this Black crinita. For proper maintenance of health and nutrition, use of the White variety should be encouraged over the other two. It could find usefulness in the dietetic management of several disease conditions as described in the text.

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LECTOTYPIFICATION OF *COSCINODON CALYPTRATUS* (MUSCI,  
GRIMMIACEAE)

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ABSTRACT

*Coscinodon calyptratus* (Drumm.) Kindb. is lectotypified with a NY specimen. Alaskan specimens previously referred to this species are *Coscinodon hartzii*.

KEY WORDS: *Coscinodon*, Grimmiaceae, Musci, lectotypification, nomenclature

In a recent paper (Muñoz 1998), I revised the distribution and taxonomic circumscription of *Coscinodon calyptratus* (Drumm.) Kindb. This species was originally described in Drummond's *Musci Americani Exsiccata*. Published in 1828, this exsiccata was widely distributed. Early bryophyte exsiccatae were often based on mixed collections, in which case the elements in one set may be different from those of other sets, even though they have the same name and number. For example, in Macoun's *Canadian musci* or *Canadian mosses*, each individual number may represent as many as four different taxa in the different sets distributed.

In the case of *Coscinodon calyptratus* it is especially important to lectotypify the name in order to fix its application permanently, and avoid future changes in usage. Since the label, which constitutes the protologue, was printed and distributed with the specimens, it is clear that all of the material was in Drummond's possession when it was prepared, so all specimens must be considered part of the original material, and any one may serve as lectotype.

The specimen in the herbarium of the New York Botanical Garden (NY) is consistent with all aspects of the protologue, and conforms to established taxonomic usage (Flowers 1973; Jones 1933; Lawton 1971; Sullivant 1864), so I hereby designate it as a lectotype for this species:

*Coscinodon calyptratus* (Drumm.) C.E.O. Jensen ex Kindb., *Species of European and Northamerican Bryineae* (Mosses) 241. 1897 [published 1898]. BASIONYM: *Grimmia calyptrata* Drumm., *Musci Americani*, no. 60. 1828. TYPE: U.S.A. Rocky Mountains, *Drummond* [Drummond, *Musci Americani*, no. 60] LECTOTYPE [selected here]: NY; Isolectotypes: FH,H).

Muñoz (1998) treated Alaskan specimens (Steere 1978) under *Coscinodon calyptratus*. After studying an isotype of *C. hartzii* C.E.O. Jensen housed at Paris (PC), I now agree with Murray (1992) that these Alaskan specimens should be referred to *C. hartzii*, which is characterized by 2-3(-4)-stratose, generally plicate leaves, and dioecious sexuality.

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## HISTORICAL NOTES ON LOUISIANA PRAIRIES: SIZE CHANGES IN A CENTURY AND A HALF

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### ABSTRACT

Using land survey records and aerial photographs, we assessed prairie size changes on the Winn Ranger District of the Kisatchie National Forest. Prairie has been lost mainly by conversion to agricultural uses and by woody invasion. Over 90 percent of prairie present in 1835 is now gone, and over 50 percent of the prairie present in 1940 is gone.

**KEY WORDS:** prairie, Kisatchie National Forest, Louisiana, woody invasion, ecology

### INTRODUCTION

Numerous observations show that in the absence of naturally occurring "disturbances" — for example, periodic fire — grasslands are encroached by woody species largely from the edges. Eventually, prairies convert to shrublands or forests. In areas with low precipitation conversion to woody vegetation is slow, but in wetter areas it can occur rapidly, often in a few decades (Sauer 1950; DeSelm & Murdock 1993). There are many documented instances of prairies being lost to woody vegetation.

In a Wisconsin prairie, Chavennes (1941) noted a 50% decrease in area in 25 years. Smith (1983) observed a 33% reduction of a Tennessee prairie in 43 years. Annala & Kapustka (1983) and Annala *et al.* (1983) observed a loss of between 47% and 66% in Ohio prairies in 33 years. Bragg & Hulbert (1976) found a 34% loss in 32 years in Kansas prairies. Penfound (1964) noted rapid loss in thirteen years in midwest prairies and estimated that only 35 years would be necessary to convert



grasslands to woodlands. Nyboer (1981) and Gleason (1913, 1922) noted rapid invasion of woody species in previously heavily grazed prairies in Illinois. Kucera (1960) recorded rapid invasion of a Missouri prairie, and Moran *et al.* (1997) found a 60-80% decrease in Mississippi Blackland prairies in the period 1936 to 1989.

In presettlement times, small, isolated prairies were an integral part of north and central Louisiana (MacRoberts & MacRoberts 1997a, 1997b, 1997c). These, like the Blackland Prairies of Alabama, Arkansas, and Mississippi, are southeastern "outliers" of the vast prairie that runs from Texas to Canada (Rostlund 1957; Foti 1989; Irving *et al.* 1980; DeSelm & Murdock 1993; Kucera 1992). Like most southeastern prairies, the central and northern Louisiana calcareous prairies were generally small, the largest being about five square miles in area (MacRoberts & MacRoberts 1997b). Floristically these outliers are classifiable as tallgrass prairies with such characteristic grasses as *Andropogon gerardii* Vitman, *Panicum virgatum* L., *Schizachyrium scoparium* (Michx.) Nash, *Sorghastrum nutans* (L.) Nash, and *Sporobolus asper* (Michx.) Kunth. Families especially well represented are the Apiaceae, Asteraceae, Fabaceae, Lamiaceae, Rosaceae, and Scrophulariaceae (Smith *et al.* 1989; MacRoberts & MacRoberts 1995, 1996a, 1996b, 1997a).

Almost all presettlement prairies in the southeastern United States have been destroyed (DeSelm & Murdock 1993): less than one percent of Louisiana prairies remain (Allen & Vidrine 1989; MacRoberts & MacRoberts 1997b, 1997c; Thomas 1986). The most intact extant Louisiana prairies occur on the Winn Ranger District of the Kisatchie National Forest in Winn and Grant parishes. These prairies are inclusions in the Shortleaf Pine/Oak-hickory Forest (Allen 1993; Smith *et al.* 1989; MacRoberts & MacRoberts 1996b).

The Winn District has two groups of prairies. The northern group, about 13 km west of Winnfield, is known as the Keiffer Prairies (Smith *et al.* 1989). These presently consist of about 45 openings, which range from approximately 0.2 to 6.0 ha and total about 70 ha (Smith *et al.* 1989). The southern group, the Packton Prairies, occurs 18 km south of Winnfield. These five prairies range from about 0.4 to 5.0 ha and total about 15 ha (MacRoberts & MacRoberts 1996a).

The early land-use history of these prairies is not known in detail. Bison and Native Americans were eliminated from Louisiana in the first half of the nineteenth century (Lowery 1974), when domestic cattle and Europeans came in. The prairies were grazed until the 1970's and undoubtedly grazing was often heavy (Smith *et al.* 1989). One of the Packton prairies was heavily grazed in 1996 (and probably in previous years). A few of the prairies were farmed for hay at least up until the 1940's. Most were apparently never plowed (Smith *et al.* 1989). How extensive fire suppression was in the last century is not known, but by the second half of the twentieth century it was standard forestry practice. The two largest prairies on the Winn District were converted to pine plantations and no longer exist (part of one of these, Tancock's Prairie, is on private land).

Although nineteenth and early twentieth century travelers and botanists knew of these prairies (Smith *et al.* 1989; MacRoberts & MacRoberts 1997b), almost nothing was known about them until the 1980's. Consequently, only land survey records and aerial photographs are useful in determining size.

## METHODS

**Land Survey Records:** Because surveyors recorded prairies, the plat and field notes of the 1832-1836 land surveys of what is now the Winn District were examined. These plats were found to contain both detailed drawings of the prairies crossed by section lines and field notes on their exact dimensions.

Five Keiffer prairies are shown on surveyors' plats and described in the survey notes by one survey line (Milam [12-2], Carpenter Road [8-5], Donna's [5-1], Upper Range Creek [1-1 through 1-5], Upper Range Creek [1-6 through 1-9]). One prairie (Keiffer [3-1 through 3-5]) falls on a corner; there are two directions for it. Thus, there are seven measurements given for the land surveys for six of the Keiffer prairies, which can be compared directly with current prairie measurements. In the Packton group, there are four land survey measurements for Tancock Prairie and three for Bartram's Prairie. In all, there are fourteen measurements from the 1830's.

**Aerial Photographs:** Prairies have distinctive signatures on aerial photographs. Using the earliest aerial photographs (1940) and comparing them with the most recent (1991), we have been able to compare prairie size changes over the past half century. We surveyed all the Winn District prairies to determine current condition and to ensure that we were dealing with a prairie and not some other surface feature (MacRoberts & MacRoberts 1996a). For this work we used a randomly selected sample of sixteen prairie openings from the Keiffer group. We have included no prairie in this sample that has been obliterated by direct mechanical means; only a few in the Keiffer group have been so destroyed since the 1940's.

We photocopied aerial photographs, adjusting for possible differences in scale by using obvious landmarks, and measured actual area by the cut and weigh method (Lind 1974) using a Mettler Analytical Balance adjusted to a standard sample.

## RESULTS

Table 1 compares the land survey measurements of the 1830's with measurements taken from 1991 aerial photographs. Table 2 compares the size changes in the sample of prairies and prairie complexes between 1940 and 1991. Since personal equations will always lead to slightly different size measurements, the important measure here is the percent change.

Table 1. Land survey measurements of prairies in the 1830's and modern equivalents in meters and percent change.

Prairie Name	1830	1991	Change %
<b>KEIFFER PRAIRIES</b>			
1-1 (Upper Range Creek)	570	70	-88
1-7 (Upper Range Creek)	270	110	-60
3-3 (Keiffer N-S)	1210	250	-79
3-3 (Keiffer E-W)	960	190	-80
5-1 (Donna's)	210	46	-78
8-5 (Carpenter Rd. East)	290	290	none
12-2 (Milam)	220	110	-50
<b>PACKTON PRAIRIES</b>			
Tancock's Prairie	1010	0	-100
Tancock's Prairie	390	0	-100
Tancock's Prairie	790	0	-100
Tancock's Prairie	740	0	-100
Bartram's Prairie	595	0	-100
Bartram's Prairie	2728	0	-100
Bartram's Prairie	1445	0	-100
<b>Total</b>	<b>11428</b>	<b>1066</b>	<b>-91</b>

Table 2. Size changes in hectares and percent in samples of prairies and prairie complexes: 1940-1991.

Prairie	1940	1991	% Change
1-1 & 2 (Upper Range)	1.39	0.66	-53
1-6,7,8 (Upper Range )	6.87	2.75	-60
2-1 (Coldwater)	7.97	5.50	-37
5-1 (Donna's)	1.02	0.34	-67
5-2 (Donna's)	3.00	0.78	-74
6-1 (Bright Rd.)	7.95	3.45	-57
7-1 (Carpenter Rd.)	3.47	1.93	-44
8-1 (Carpenter Rd. East)	0.75	0.35	-49
8-5 (Carpenter Rd. East)	4.79	3.08	-38
9-3 (Little Rock Creek)	2.34	0.88	-62
10-1 (Long)	1.74	0.66	-64
12-1 & 2 (Milam Branch)	9.23	5.40	-42
<b>Totals:</b>	<b>50.52</b>	<b>24.78</b>	<b>-51</b>

## DISCUSSION/CONCLUSIONS

In historic times, there has been a dramatic loss of prairie throughout the United States. Less than one tenth of one percent remains (Whitney 1994; Noss 1997). This also holds true for Louisiana where there was once extensive prairie in the southern part of the state and many small isolated prairies in the central and northern parts of the state. Some of the most intact prairie remaining in Louisiana occurs on the Winn District of the Kisatchie National Forest where perhaps as much as 85 ha still exist. However, when the land surveys were done in the 1830s, there was much more prairie, of which approximately 91% has been lost. Much of this loss was due to conversion of prairie to other uses, largely farming and forestry. But the loss continues. Since 1940, about 51% has been lost to woody invasion. No prairie has either increased in size or remained stable. These loss rates are comparable to the loss of prairie taking place in other parts of the United States.

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**UNA NUEVA ESPECIE Y SEIS NUEVAS COMBINACIONES EN LAS  
MYRSINACEAE DE COSTA RICA Y PANAMA**

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**ABSTRACT**

A new species of *Ardisia* Sw. from Costa Rica is described and the relationships are discussed. Six new combinations in *Ardisia* are proposed here.

**KEY WORDS:** Myrsinaceae, *Ardisia*, *Auriculardisia*, *Icacorea*, Costa Rica, Panamá, systematics

**RESUMEN**

Se describe una nueva especie de *Ardisia* Sw. para Costa Rica y sus relaciones son discutidas. Seis nuevas combinaciones en *Ardisia* son propuestas.

**PALABRAS CLAVE:** Myrsinaceae, *Ardisia*, *Auriculardisia*, *Icacorea*, Costa Rica, Panamá, sistemática

La familia Myrsinaceae está representada en Costa Rica por seis géneros, siendo el género *Ardisia* Sw. el más grande de ellos, con aproximadamente 40 especies. En el proceso de elaboración del tratamiento de Myrsinaceae para el *Manual de las Plantas* de Costa Rica, una nueva especie de *Ardisia* Sw. fue descubierta, la cual es descrita a continuación. Adicionalmente, se proponen seis nuevas combinaciones en *Ardisia*.

**ARDISIA GLOMERIFLORA** J.F. Morales, *spec. nov.* TIPO: COSTA RICA. Limón: Cantón de Pococí, Cordillera Central, forest mainly to E of main branch of Quebrada El Molinete, 480-520 m, 24 July 1994, Grayum & Perry 10691 (HOLOTIPO: INB; Isotipos: CR,MO).

Arbor parva, ramuli glabris; folia 8-15 × 3.4-5.2 cm, obovata, apice acuminata, integra, glabra; inflorescentia capitata, pedicelli 2-4 mm longi; sepala 3-4 mm longa, apice obtusa, petala 5, basi connata 4.0-4.5 mm longa. Fructus ignotus.

Arbustos 2.0-2.5 m de alto; ramitas glabras. Hojas: peciolo 0.3-0.6 cm largo; láminas 8-15 × 3.4-5.2 cm, obovadas, abruptamente acuminadas en el ápice, abruptamente obtusas en la base, margen entero, glabras, con numerosas puntuaciones negro-punteadas. Inflorescencias terminales a caulifloras, subcapitadas a muy cortamente racemoso-subcapitadas, 2-3 cm largo, densamente aglomeradas, glabras a esparcidamente lepidotas, pedúnculos inconspicuos, pedicelos 2-4 mm; brácteas escariosas, sépalos 3-4 mm oblongo-obovados, obtusos apicalmente, enteros, el margen hialino, conspicuamente negro-punteados; pétalos 4.0-4.5 mm, oblongos, agudos apicalmente, sin puntuaciones oscuras rosados; anteras 3.0-3.5 mm largo, lineares, filamentos inconspicuos; ovario glabro. Frutos desconocidos.

*Ardisia glomeriflora* es conocida solamente de la localidad tipo, 400-600 m, donde es localmente abundante a lo largo de la Quebrada El Molinete (tributaria del Río Sucio). Esta especie es muy distintiva reconocible por sus inflorescencias subcapitadas a cortamente racemoso-subcapitadas y densamente aglomeradas. Se encuentra bastante relacionada con *A. dodgei* Standl., de la que se distingue por sus sépalos y pétalos más pequeños y brácteas de la inflorescencia escariosas, no foliáceas.

Especímenes adicionales examinados. COSTA RICA. Limón: Cantón de Pococí, Faldas de Cordillera Central, Terrenos de Teleférico, Quebrada El Molinete, 400 m, 4 Aug. 1997 (fl), *Abarca et al.* 3 (INB); Pococí, cerca límite del Parque Braulio Carrillo, Quebrada El Molinete, 12 July 1995 (fl), *Abarca s.n.* (INB).

## NUEVAS COMBINACIONES

En el prologo introductorio de su serie "Neotropical Myrsinaceae XX", Lundell (1986), indicó que "Solo por que el muy distinto género *Icacorea* Aublet ha sido ridiculamente incluido como un subgénero de *Ardisia* Sw. por generaciones, también se puede asumir que los caprichos de taxónomos resultarán en la reducción de géneros recientemente descritos como *Auricularia* Lundell, *Gentlea* Lundell, *Graphardisia* Lundell, *Oerstedianthus* Lundell, *Ibarraea* Lundell, *Amatlanina* Lundell, and *Zunilia* Lundell a subgéneros de *Ardisia*. La transferencia de las siguientes especies para este último género se hace para evitar el incentivo de taxónomos de emprender estas reducciones innecesarias a subgéneros." Seguidamente el realizó la transferencia de 60 especies descritas previamente en los géneros antes mencionados a *Ardisia* y describió dos especies nuevas.

Sin embargo, de acuerdo al artículo 34 del *Código Internacional de Nomenclatura Botánica*, las combinaciones propuestas por Lundell en dicho tratamiento fueron inválidamente publicadas. Esto por cuanto dicho artículo en su inciso a y b establece que un nombre es inválidamente publicado cuando:



- a. "No es aceptado por el autor en la publicación original"
- b. "es meramente publicado en anticipación de la futura aceptación del grupo en cuestión o de una particular circunscripción, posición o rango del grupo"

Por lo tanto, en vista de que Lundell obviamente incumplió con estas dos normas del capítulo mencionado se hace necesario validar la publicación de algunas de las especies propuestas por Lundell para Costa Rica y Panamá. Aunque varias de estos nombres representan sinónimos de especies bastante comunes como *Ardisia compressa* Kunth, según mi criterio, al menos seis de dichas combinaciones representan especies válidas restringidas a Costa Rica y Panamá y deben ser, por lo tanto, nuevamente combinadas. La validación de las restantes combinaciones quedará pendiente hasta que se aclare la sinonimia presente dentro de *Ardisia* para Mesoamérica.

### NUEVAS COMBINACIONES

**ARDISIA APODOPHYLLA** J.F. Morales, *nom. nov.* BASIONIMO: *Auriculardisia sessilifolia* Lundell, *Wrightia* 7:272. 1984., non *Ardisia sessilifolia* Mez. TIPO: COSTA RICA. *L. Williams et al.* 28998 (HOLOTIPO: F).

**ARDISIA BEKOMIENSIS** (Lundell) J.F. Morales, *comb. nov.* BASIONIMO: *Icacorea bekomiensis* Lundell, *Phytologia* 56:414. 1984. TIPO: COSTA RICA: *Davidse* 25710 (HOLOTIPO: TEX-LL; Isotipos: INB,MO).

**ARDISIA EURUBIGINOSA** (Lundell) J.F. Morales, *comb. nov.* BASIONIMO: *Auriculardisia eurubiginosa* Lundell, *Phytologia* 56:413. 1984. TIPO: PANAMA. *Davidse et al.* 25486 (HOLOTIPO: TEX-LL; Isotipos: INB,MO).

**ARDISIA QUADRATA** (Lundell) J.F. Morales, *comb. nov.* BASIONIMO: *Auriculardisia quadrata* Lundell, *Phytologia* 56:413. 1984. TIPO: COSTA RICA. *Davidse et al.* 25645 (HOLOTIPO: TEX-LL; Isotipos: INB,MO).

**ARDISIA SORDIDA** (Lundell) J.F. Morales, *comb. nov.* BASIONIMO: *Auriculardisia sordida* Lundell, *Wrightia* 7:272. 1984. TIPO: COSTA RICA. *Croat* 43538 (HOLOTIPO: TEX-LL; Isotipos: CR,MO).

**ARDISIA SQUAMATA** (Lundell) J.F. Morales, *comb. nov.* BASIONIMO: *Auriculardisia squamata* Lundell, *Phytologia* 56:19. 1984. TIPO: COSTA RICA. *Burger et al.* 5853 (HOLOTIPO: F; Isotipo: CR).

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## LITERATURA CITADA

Lundell, C.L. 1986. Neotropical Myrsinaceae XX. *Phytologia* 61:62-68.

**MORFOMETRIA DEL GENERO *BOUTELOUA* LAG. (POACEAE) DE MEXICO**

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**RESUMEN**

*Bouteloua* es un género de aproximadamente 50 taxa, nativos de las regiones semiáridas del Nuevo Mundo. Cuarenta y cuatro de ellos se distribuyen en México, la mayoría son componentes dominantes en los pastizales mexicanos, siendo considerados excelentes forrajes, responsables de la producción de carne de alta calidad, al libre pastoreo. El género consta de dos subgéneros: *Bouteloua* sensu str. y *Chondrosium* Desv. (Gould 1979). Clayton & Renvoize (1986) elevaron el rango de estos subgenera y propusieron la división del género, otros agrostólogos aceptaron y siguen dicha propuesta. En el presente estudio se revisaron cerca de 3000 especímenes provenientes de ejemplares de herbario y de material colectado; todos ellos fueron registrados en una base de datos para contribuir a un macroproyecto de Biodiversidad (que realiza la CONABIO) de las especies mexicanas. Se analizaron en este estudio los caracteres morfológicos, el contenido de flavonoides y los caracteres anatómicos de: la epidermis foliar y la sección transversal del tallo en los 44 taxa mexicanos de este género. Se reportan en el presente informe solamente los resultados del estudio morfométrico de *Bouteloua* de México. Se reconoce un solo género con base en el análisis fenético de los caracteres morfológicos estudiados. Los resultados de los estudios anatómicos ya fueron presentados anteriormente (Siqueiros & Herrera 1996; Rosales & Herrera 1996); mientras que los perfiles de flavonoides están siendo analizados. Las descripciones de los taxa con claves de separación de especies y variedades, así como sus repuestas ecológicas y distribución geográfica se analizaron separadamente. Un análisis filogenético del género completo se encuentra en proceso.

**PALABRAS CLAVE:** *Bouteloua*, Poaceae, monografía, biosistemática

## ABSTRACT

*Bouteloua* is a genus of approximately fifty taxa, native to the New World semiarid regions. Forty four taxa occur in México; most of them are dominant components in the Mexican grasslands, being considered the producers of high quality beef in free livestock. The genus consists of two subgenera: *Bouteloua* sensu str. and *Chondrosium* Desv. (Gould 1979). Clayton & Renvoize (1986) elevated the rank of these subgenera and proposed division of the genus, and other agrostologists followed them. About 3000 specimens from field collections and herbaria were reviewed and scored to produce a data base, in order to contribute to an ongoing biodiversity survey of the Mexican species (CONABIO). Morphological characters, flavonoid profiles, leaf epidermis, and culm anatomical characters of the taxa were analyzed in this study. One genus is recognized based on the phenetic analyses of the morphological features as presented in this report; the anatomical results were already reported (Siqueiros & Herrera 1996; Rosales & Herrera 1996); flavonoid profiles are being analyzed. Descriptions of the taxa and a key to separate species, their ecological responses and geographic distribution were analyzed separately. A phylogenetic analysis of the entire genus is in progress.

KEY WORDS: *Bouteloua*, Poaceae, monograph, biosystematics

## INTRODUCCION

El género *Bouteloua* ha sido reconocido como uno de los más importantes géneros de las gramíneas componente de las praderas y planicies en la parte sur de Norte América, no solo debido a que sus especies son elementos significativos de las asociaciones naturales de pastizales, sino que también son las de mayor calidad forrajera en las áreas de libre pastoreo. Las especies más ampliamente distribuidas y económicamente importantes de las casi 40 especies reconocidos son *B. curtipendula* (Michaux) Torrey (banderilla o triguillo), *B. gracilis* (Kunth) Lagasca ex Griffiths (navajita), *B. hirsuta* Lagasca (navajita peluda), y *B. eriopoda* (Torrey) Torrey (navajita negra).

El género *Bouteloua* se distribuye solamente en el Nuevo Mundo. Se encuentra bien representado en México, donde 35 de las aproximadamente 40 especies reconocidas son elementos importantes de las zonas áridas y semiáridas del país. Cuatro especies de más amplia distribución se les encuentra en los pastizales de toda América y solamente una especie *B. megapotamica* (Spreng.) Kuntze se restringe a América del Sur; y otra más al Caribe *B. juncea* (Desv. ex P. Beauv.) Hitchc. La especie más fina como forraje natural *B. curtipendula*, ha sido introducida a las islas del Hawaii por su polimorfismo y agresividad naturales.

Clayton & Renvoize (1986) reconocen un total de 34 especies de *Bouteloua* distribuidas desde Canada hasta Argentina, la mayoría en México. Gould (1979) reconoce 34 especies tan solo para México y tres más fuera de nuestro país. Los

principales estudios relativos a la taxonomía del género son: Griffiths (1912) y Gould (1979).

El esfuerzo realizado anteriormente en la búsqueda del conocimiento de este género, no ha sido suficiente, y en ocasiones resulta difícil separar los taxa a nivel específico e infraespecífico, ya que se carece de información básica relativa a las descripciones de los taxa y formas de separación de especies, de sus preferencias de distribución, y de sus relaciones filogenéticas, indicadoras del curso que ha seguido el intercambio genético y la evolución del grupo. Por todo lo anterior, en el presente trabajo se llevó a cabo un estudio fenético de los caracteres morfológicos del género *Bouteloua* de México, a fin de contribuir en la definición del género y sus taxa.

## MATERIALES Y METODOS

Los especímenes utilizados en este proyecto fueron tomados de dos fuentes: a) Colectas de campo a nivel nacional, que se llevaron a cabo en las localidades de distribución natural de cada taxón (Cuadro 1) y b) Ejemplares de Herbario, con el fin de observar la mayor variación interespecífica posible, así como para complementar el estudio de especies no encontradas en campo.

Herbarios nacionales revisados: MEXU, ENCB, CHAPA en el D.F.; IEB en Pátzcuaro, Mich.; IBUG y UAG en Guadalajara, Jal.; CIIDIR en Durango, Dgo.; HUAA en Aguascalientes, Ags.; ANSM en Saltillo, Coah.; SLPM en San Luis Potosí, S.L.P. Herbario revisado en EUA: US en Washington, D.C.

La metodología que se utilizó en el estudio morfológico es aquella propuesta por Lot & Chiang (1990), que se emplea regularmente en los estudios florísticos. Se llevaron a cabo las descripciones de los taxa, claves para su separación, e ilustraciones, mismos que serán reportados separadamente.

## RESULTADOS

Se escogieron deisiseis caracteres morfológicos clave (Cuadro 2) de las 35 especies y siete variedades analizadas en este estudio (Cuadro 1). Con ellos se construyó una matriz de caracteres (Cuadro 3) que fué sometida a un análisis de similitudes utilizando el programa "Multivariate Statistical Package", versión 1.31 (Kovach 1987), aplicando el Índice de Euclidean Normalizado, para generar la matriz de similitudes, a partir de la cual se construye el árbol de similitudes o dendrograma (Figura 1) mediante la utilización de UPGMA (unweighted pair group mathematical average clustering analysis).

Cuadro 1. Especies de *Bouteloua* analizadas para el presente estudio.

- Bouteloua alamosana* Vasey. Oaxaca: 92 miles of Oaxaca, mpio. Oaxaca de Juárez, 14-XI-65, F.W. Gould 11661 (ENCB).
- Bouteloua americana* (L.) Scribner. Yucatán: Carretera a Ocum, 2 km al S de Mérida, 8 m, 15-X-82, J.S. Flores, C. Chan, & M. Burgos 9563 (ENCB).
- Bouteloua annua* Swallen. Baja California: Gulf of California, isle San Esteban, 22-III-62, L.W. Wiggins 17212 (ENCB).
- Bouteloua aristidoides* (Kunth) Griseb. var. *aristidoides*. Coahuila: 5.5 km al NW de Nva. Delicias, Vertiente E de la Sierra Delicias, 1230 m, Herrera y col. 1489 (CIIDIR-HUA). Colima: Km 11 Autopista 110 Colima-Manzanillo, 2 km de los Amoles, Herrera y Cortés 1467 (CIIDIR-HUAA). Jalisco: 14 km de Tonaya rumbo al Gruyo, 1080 m, Herrera, Esparza, & Rosales 1476 (CIIDIR-HUAA).
- Bouteloua barbata* Lagasca var. *barbata*. Sonora: km 24 Autopista #15 Hermosillo-Nogales lado E de la carretera, 400 m, 25-XI-94, Herrera & Siqueiros 1322 (CIIDIR-HUAA); Km 126 Autopista #15 Hermosillo-Nogales, 780 m, 25-XI-94, Herrera & Siqueiros 1328 (CIIDIR-HUAA); Km 132 Autopista #15 Hermosillo-Nogales, 770 m, 25-XI-94, Herrera & Siqueiros 1330 (CIIDIR-HUAA).
- Bouteloua barbata* var. *rothrockii* Vasey. Sinaloa: ± 46 km al W de Culiacán, por la carretera al Tate frente al ejido La Bandera, y 2 km al W de Valdés Montoya orilla de carretera, 90 m, 21-XI-94, Herrera & Siqueiros 1316 (CIIDIR-HUAA).
- Bouteloua barbata* var. *sonorae* (Griffiths) Gould. Sinaloa: Culiacán, Cajón Río Pioxtila, San Ignacio, carretera Mazatlán-Culiacán, en el cruce del Río Pioxtila, 130 m, 20-XI-94, Herrera & Siqueiros 1309 (CIIDIR-HUAA).
- Bouteloua breviseta* Vasey. Coahuila: Sierra de Parras, Parras, 1850 m, 29-IX-78, M.A. Copo & J. Valdés 1354 (ANSM); 2 km al N de Cañada Blanca, km 17 carr. 57 Saltillo-Monclova, 1800 m, 4-X-95, Herrera y col. 1479, 1481 (CIIDIR-HUAA).
- Bouteloua chasei* Swallen. Coahuila: 40 km al SW de Saltillo, rumbo a Zacatecas, en el km 295 de la carretera 54, 19-XII-94, Herrera y Cortés 1457 (CIIDIR). Nuevo León: 8 km al entronque de San Roberto, rumbo a Galeana, mpio. Galeana, 17-XII-94, Herrera y Cortés 1449 (CIIDIR). San Luis Potosí: Km 145 carr. 57 S.L.P.-Matehuala, 8 km sobre desviación a Guadalcázar, 1800 m, 26-XI-94, Herrera & Cortés 1446 (CIIDIR).
- Bouteloua chondrosioides* (Kunth) Benth. ex S. Watson. Durango: Km 5.5 carr. Santiago Papasquiario-Los Altares, 2000 m, 6-X-90, A. Benítez 2731 (CIIDIR).
- Bouteloua curtipendula* (Michaux) Torrey var. *curtipendula*. Coahuila: 2 km al N de Cañada Blanca, km 17 carr. 57 Saltillo-Monclova, 1800 m, 4-X-95, Herrera y col. 1481 (CIIDIR-HUAA). Durango: Rancho Tarahumara, Agua Blanca, Canatlán, Herrera & González 1019 (CIIDIR).
- Bouteloua curtipendula* var. *caespitosa* Gould & Kapadia. Aguascalientes: Km 12 carretera Aguascalientes-Calvillo, al N del cerro el Picacho, 1900 m, 8-XII-94, Herrera & Cortés 1384 (CIIDIR-HUAA).
- Bouteloua curtipendula* var. *tenuis* Gould & Kapadia. Durango: 1 km al W de Tepehuanes, Bravo 200 (CIIDIR).
- Bouteloua distans* Swallen. Puebla: 12 miles NNW of Huajapan de León, Oaxaca, along Hwy. 190, 17° 56' 35" N, 97° 52' 34" W, Columbus 2403 (RSA, HUAA cultivada).

## Cuadro 1. (cont.)

- Bouteloua disticha* (Kunth) Benth. Guanajuato: 10 miles E of El Gruyo, 2 mi W of San Miguel, 915 m, 27-IX-74, *R. Reeder 6381* (ENCB).
- Bouteloua elata* Reeder & Reeder. Colima: Km 17 Autopista 110 Colima-Manzanillo, Col. 1440 m, 5-II-95, *Herrera & Cortés 1466* (CIIDIR). Jalisco:  $\pm$  8 km al N de Autlán de Navarro sobre la carr. Federal #80, Autlán de Navarro, 1000 m, 4-II-95, *Herrera & Cortés 1462* (CIIDIR-HUAA).
- Bouteloua eludens* Griffiths. Sonora: 3 km al S de Nogales, por autopista a Hermosillo, mpio. Nogales, 1300 m, 24-XI-94, *Herrera & Siqueiros 1336* (CIIDIR-HUAA).
- Bouteloua eriopoda* (Torrey) Torrey. Chihuahua: Rancho Experimental La Campana, *Herrera & Siqueiros 1340* (CIIDIR-HUAA). Coahuila: Universidad Autónoma Agraria Antonio Narro, Saltillo, *H. García s/n* (ENCB,SLPM).
- Bouteloua eriostachya* (Swallen) Reeder. Coahuila: 5.5 km al NW de Nva. Delicias, Vertiente E de la Sierra de las Delicias, 1230 m, 4-X-95, *Herrera y col. 1491* (CIIDIR-HUAA).
- Bouteloua gracilis* (Kunth) Lagasca ex Griffiths. Aguascalientes: Universidad Autónoma de Aguascalientes, 1880 m, Octubre de 1995, *Rosales s/n* (HUAA); 5 km al N del poblado Gracias a Dios, J. María, 2050 m, 14-XI-94, *Herrera y col. 1306* (CIIDIR-HUAA). Durango: 66 km al W de Bermejillo y 22 km al W de Mapimí rumbo a la Zarca, 1800 m, 26-XI-94, *Herrera 1346* (CIIDIR).
- Bouteloua hirsuta* Lagasca var. *glandulosa* (Cerv.) Gould. Zacatecas: 40 miles N of Guadalajara, in Mex. 41, 1800 m, 25-VIII-70, *L.H. Harvey 8703* (ENCB).
- Bouteloua hirsuta* var. *hirsuta*. Aguascalientes: 8 km antes de San Antonio de los Ríos, Sn. J. Gracia, 2100 m, 24-IX-80, *De la Cerda 385A* (HUAA). Chihuahua: Rancho La Campana, potreros del lado W, 1590 m, 25-XI-94, *Herrera & Siqueiros 1341* (CIIDIR-HUAA).
- Bouteloua johnstonii* Swallen. Coahuila: Sierra de la Paila, Valle de Parreña, Mpio. Gral. Cepeda, 2000 m, 31-X-87, *J.A. Villarreal 4173* (IEB).
- Bouteloua karwinskii* (Fournier) Griffiths. Coahuila: Km 45 carr. 40 Saltillo-Torreón, 1 km al N del ejido La Rosa, 1600 m, 4-X-95, *Herrera y col. 1478* (CIIDIR-HUAA). San Luis Potosí: 3 km al SW de San Lorenzo, Mpio. Villa Hidalgo, 1450 m, 27-VIII-59, *Rzedowski 11460* (ENCB).
- Bouteloua media* (Fournier) Gould & Kapadia. Puebla: 12 km W of Izucar de Matamoros, along Hwy. 57, near km 74, 19° 56' 20" N, 99° 21' 40" W, *Columbus 2632* (RSA,HUAA cultivada).
- Bouteloua parryi* (Fournier) Griffiths var. *gentryi* (Gould) Gould. Durango: Río Nazas, márgenes arenosos, km 175 de Dgo. a Parral, Mpio. Rodeo, Dgo., 1550 m, 26-XI-94, *Herrera & Siqueiros 1350* (CIIDIR-HUAA). Sinaloa: 21 km al S de Culiacán, frente al entronque de la presa Vivorilla a orilla de carretera, Mpio. Culiacán, 230 m, 21-XI-94, *Herrera & Siqueiros 1315* (CIIDIR-HUAA); 86 km de Culiacán a Guasave al W de la autopista sobre una terracería, 130 m, 21-XI-94, *Herrera & Siqueiros 1317* (CIIDIR-HUAA).
- Bouteloua parryi* var. *parryi*. Colima: Ejido Madrigal, Mpio. Tecomán, *Flores 123* (IEB).

## Cuadro 1. (cont.)

- Bouteloua pedicellata* Swallen. Guanajuato: 6 km al W de Pozos, sobre el camino a la autopista de Gto., 2300 m, 10-IX-87, *J. Rzedowski 44714* (IEB). Puebla: near Puebla-Tlaxcala border, 8 km SW of El Carmen (Tequixquitla) along Hwy. 129, 19° 17' 18" N, 97° 42' 41" W, *Columbus 2634* (RSA, HUA A cultivada).
- Bouteloua quiriegoensis* Beetle. Sonora: 10 km al SE de Alamos, 330 m, 22-XI-94, *Herrera & Siqueiros 1320* (CIIDIR-HUA A).
- Bouteloua radicata* (Fournier) Griffiths. Aguascalientes: 5 km al N del poblado Gracias a Dios, km 1 al S de la Hacienda La Boveda, Jesús María, 2050 m, 14-XI-94, *Herrera y col. 1300* (CIIDIR-HUA A).
- Bouteloua reflexa* Swallen. Sinaloa: 15 km al S de Culiacán, sobre la carr. federal Mazatlán-Culiacán, 180 m, 20-XI-94, *Herrera & Siqueiros 1311* (CIIDIR-HUA A).
- Bouteloua repens* (Kunth) Scribner & Merrill. Aguascalientes: *Esparza 53* (HUA A). Jalisco: 5 km al W de Tecolotlán camino a Tenamaxtlán, 1580 m, 7-IX-95, *Herrera, Rosales, & Esparza 1474* (CIIDIR-HUA A). Sonora: 3 km al S de Nogales, autopista a Hermosillo, 1300 m, 24-XI-94, *Herrera & Siqueiros 1339* (CIIDIR-HUA A).
- Bouteloua rigidiseta* (Steudel) Hitchcock. *Columbus 1023* (RSA).
- Bouteloua scorpioides* Lagasca. Coahuila: Km 162 carretera Matehuala-Saltillo, 18-XII-94, *Herrera & Cortés 1452* (CIIDIR-HUA A).
- Bouteloua simplex* Lagasca. Aguascalientes: 5 km al N del poblado Gracias a Dios, Jesús María, 2050 m, 14-XI-94, *Herrera y col. 1302* (CIIDIR-HUA A); Universidad Autónoma de Aguascalientes, 1880 m, Octubre 95, *Rosales s/n* (HUA A).
- Bouteloua triaena* (Trin.) Scribner. Querétaro: Alrededores de Macún, mpio. Cadereyta de Montes, 1800 m, 10-XI-88, *J. Rzedowski 47645* (IEB, CIIDIR).
- Bouteloua trifida* Thurber in S. Watson. Coahuila: 2 km al N de Cañada Blanca, km 17 carr. 57 Saltillo-Monclova, 1800 m, 4-X-95, *Herrera y col. 1480* (CIIDIR-HUA A); 8 km al SE de Palau, camino a Barroteras, Múzquiz, 24-V-77, *J. Valdés 939* (IEB). Tamaulipas: Ejido el Sauz, mpio. Antigua Morelos, 160 m, 18-VIII-81, *I. Carrasco 034* (IEB); Rancho San Alfonso, mpio. Soto la Marina, 400 m, *J.A. Barrientos 765* (IEB); Camino a San Nicolás, mpio. San Nicolás, 400 m, 4-IX-81, *J.A. Barrientos 085* (IEB).
- Bouteloua uniflora* Vasey var. *coahuilensis* Gould & Kapadia. Aguascalientes: 9 km al E de Tepezalá, por el camino a Asientos, mpio. Tepezalá, 2250 m, 16-XI-94, *Herrera & Rosales 1307* (CIIDIR-HUA A).
- Bouteloua uniflora* var. *uniflora*. Coahuila: Al pie de la Sierra La Gavia, km 117 carr. 57 Saltillo-Monclova, 1650 m, 4-X-95, *Herrera y col. 1486* (CIIDIR-HUA A).
- Bouteloua warnockii* Gould & Kapadia. Coahuila: 5.5 km al NW de Nva. Delicias, Vertiente E de la Sierra de las Delicias, 1230 m, 5-X-95, *Herrera y col. 1492* (CIIDIR-HUA A).
- Bouteloua williamsii* Swallen. Aguascalientes: Ladera N Cerro del Picacho, mpio. Jesús María, 1980 m, 4-IX-81, *De la Cerda 1006* (HUA A).
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Cuadro 2. Caracteres morfológicos para el análisis fenético.

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1. Pubescencia en láminas foliares: 1) glabras, 2) pilosas, 3) papilosas, 4) lanosas.
  2. Longitud de láminas foliares.
  3. Longitud de las espigas.
  4. Número de espiquillas/espiga.
  5. Longitud de las espiquillas.
  6. Longitud de la primera gluma.
  7. Longitud de la segunda gluma.
  8. Longitud de la lema.
  9. Arista de la lema: 0) ausente, 1) terminal, 2) emergiendo entre lobulos.
  10. Longitud de la arista.
  11. Longitud de la pálea.
  12. Número de flores rudimentarias.
  13. Longitud de la flor rudimentaria.
  14. Longitud de la arista de la flor rudimentaria.
  15. Longitud de la cariopsis.
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## DISCUSION Y CONCLUSIONES

*Bouteloua* es un género del Nuevo Mundo que se distribuye desde el NW Americano, muy ampliamente en el W de México, con algunos elementos en Mesoamérica; Argentina. Es abundante en los pastizales naturales de México, en los matorrales, en los bosques templados y en menor cantidad en las selvas; se le encuentra en un amplio intervalo altitudinal que va desde el nivel del mar hasta los 3000 m, con preferencia por los 1500 a 2500 m. Sus especies perennes son todas componentes de vegetación primaria, no son favorecidas por el disturbio, ni esparcidas por las carreteras. En contraste, las especies anuales *B. aristidoides* (Kunth) Griseb. y *B. barbata* Lagasca crecen en condiciones de disturbio y en áreas bien drenadas tales como lugares gravosos.

Los resultados del estudio morfológico mostraron que cada taxón que aquí se reconoce es distinto y que aparentemente existen 36 especies y catorce variedades en México.

El dendrograma muestra tres grupos de afinidades morfológicas cercanas (Figura 1). Dichos agrupamientos contradicen la teoría de elevar a nivel de género a los dos subgéneros; propuesto por agrostólogos como Clayton & Renvoize (1986), Pohl (1994), ya que dentro de cada uno de los tres grupos de afinidades morfológicas existen elementos tanto del subgénero *Bouteloua* como del subgénero *Chondrosum*.

Cuadro 3. Caracteres morfométricos del género *Bouteloua* de México.

Caracteres:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Taxon:																
1. <i>B. alamosana</i>	3	6.5	13.00	3.5	9.50	6.00	6.00	6.25	2	0.50	6.50	1.0	5.30	15.00	2.20	4.25
2. <i>B. americana</i>	3	8.5	2.75	7.5	5.40	4.25	4.25	6.75	1	1.50	6.25	1.0	0.80	6.00	1.20	3.25
3. <i>B. annua</i>	2	5.0	2.75	5.5	12.00	3.75	7.00	8.00	2	0.50	8.00	1.0	8.00	6.50	4.50	2.75
4. <i>B. aristoides</i>	2	9.5	2.25	4.5	7.00	2.25	6.50	6.50	2	0.50	6.50	1.0	9.00	4.00	3.50	2.75
5. <i>B. barbata</i> var. <i>barbata</i>	1	7.0	1.75	25.0	2.50	1.15	2.00	2.90	2	1.75	2.75	1.0	2.00	2.40	1.10	0.90
6. <i>B. barbata</i> var. <i>rothrockii</i>	1	6.0	1.50	37.5	3.25	1.25	2.75	3.25	2	2.25	3.25	1.0	4.00	2.70	1.10	.075
7. <i>B. barbata</i> var. <i>sonorae</i>	1	3.0	1.50	27.5	3.10	1.25	2.25	3.10	2	1.75	3.00	1.0	3.00	1.20	1.10	1.25
8. <i>B. brevifolia</i>	1	2.0	2.25	35.0	3.50	2.25	3.10	5.75	2	1.10	5.75	1.5	4.50	4.00	1.20	1.10
9. <i>B. chasei</i>	1	4.0	2.00	21.5	4.00	1.75	3.50	4.25	1	2.50	3.00	1.0	1.50	2.20	1.20	0.75
10. <i>B.</i> <i>chondrosioides</i>	4	5.5	9.00	9.0	7.25	3.50	5.50	5.50	2	0.50	5.40	1.0	5.00	4.50	3.10	2.25
11. <i>B. curtispindula</i>	2	55.0	2.00	4.0	7.50	7.00	7.25	6.00	2	0.75	6.00	1.0	1.90	5.00	3.50	3.30
12. <i>B. distans</i>	2	35.0	7.00	2.5	8.50	3.75	8.50	8.50	0	0.00	7.50	1.0	5.00	5.00	1.75	2.50
13. <i>B. disticha</i>	2	37.5	4.75	4.0	6.50	4.75	6.25	6.00	2	0.50	6.00	1.0	6.00	6.00	1.75	2.35
14. <i>B. elata</i>	1	22.0	5.00	70.0	4.75	2.90	3.25	2.50	2	2.40	2.25	1.5	2.25	1.10	1.65	1.00
15. <i>B. eludens</i>	4	12.5	9.00	4.0	5.75	3.75	5.50	5.50	2	1.25	5.50	1.0	4.50	1.50	1.65	5.00
16. <i>B. eriopoda</i>	1	5.5	3.50	13.0	7.50	2.50	7.50	4.00	1	2.25	3.50	1.0	3.50	4.00	2.00	2.75
17. <i>B. eriostachya</i>	1	5.5	3.50	7.5	7.50	2.50	7.50	5.50	2	2.25	5.50	1.0	5.50	6.00	2.00	2.75
18. <i>B. gracilis</i>	1	2.5	3.50	70.0	5.75	2.50	5.75	4.00	2	1.10	4.00	1.5	4.50	2.75	2.50	2.10
19. <i>B. hirsuta</i>	1	2.5	3.00	35.0	5.50	2.50	5.50	5.00	2	1.00	4.00	2.0	5.00	3.50	2.25	1.75
20. <i>B. johnstonii</i>	4	9.0	11.50	9.0	6.00	3.75	6.00	4.50	2	2.50	3.75	1.5	4.50	2.50	2.00	2.10
21. <i>B. karwinskii</i>	1	4.5	1.40	12.5	3.50	1.75	2.25	2.75	2	1.25	2.75	1.5	1.00	1.50	1.75	1.75
22. <i>B. media</i>	2	11.0	5.00	20.0	5.50	3.00	4.80	5.75	2	0.50	5.75	1.0	6.00	6.50	2.70	2.20
23. <i>B. parryi</i> var. <i>gentryi</i>	1	4.0	1.50	32.5	4.50	1.65	3.25	2.75	2	2.00	2.75	2.0	3.00	2.50	1.90	1.50
24. <i>B. parryi</i> var. <i>parryi</i>	1	6.0	2.25	50.0	3.75	1.40	3.25	2.75	2	2.00	2.75	2.0	2.00	2.50	1.90	1.50
25. <i>B. pedicellata</i>	2	15.0	9.00	1.0	8.50	4.50	8.50	7.50	0	0.00	6.50	1.0	6.50	4.25	2.75	2.75
26. <i>B. purpurea</i>	2	40.0	7.50	4.0	6.50	3.50	7.50	6.50	2	0.50	6.25	1.0	6.50	3.00	3.50	2.25
27. <i>B.</i> <i>quíriegoensis</i>	1	2.0	1.75	18.0	4.50	1.90	2.75	4.25	2	1.50	3.75	1.0	4.50	4.25	1.10	1.25
28. <i>B. radicata</i>	3	10.0	2.75	10.5	7.50	5.50	7.50	9.00	2	2.00	8.00	1.0	11.00	8.00	3.50	4.50
29. <i>B. reflexa</i>	2	70.0	2.50	7.0	4.50	2.75	4.00	4.50	2	0.50	4.50	1.0	4.50	6.00	4.00	3.50
30. <i>B. repens</i>	3	8.0	2.25	8.0	7.50	5.50	7.50	6.25	2	0.50	6.00	1.0	6.50	5.00	1.90	2.25
31. <i>B. rigidiseta</i>	1	5.0	1.20	3.5	5.50	5.50	2.75	3.25	2	4.50	3.25	1.5	3.50	0.00	1.50	3.60
32. <i>B. scorioides</i>	1	1.0	4.75	70.0	5.50	3.00	5.50	4.50	2	1.75	4.50	2.0	5.50	4.25	3.00	2.00
33. <i>B. simplex</i>	1	1.0	2.00	55.0	4.50	2.50	4.25	3.50	2	2.00	3.00	1.5	3.00	2.50	0.80	1.90
34. <i>B. triaena</i>	2	50.0	1.00	1.0	6.00	2.50	4.00	4.00	0	0.00	3.50	1.0	3.00	1.25	2.50	3.00
35. <i>B. trifida</i>	1	4.5	2.00	16.0	5.50	3.50	4.75	2.25	2	6.25	2.00	1.0	2.00	5.75	0.55	1.10
36. <i>B. uniflora</i> var. <i>coahuilensis</i>	2	30.0	10.00	2.0	8.50	3.50	7.50	7.00	0	0.00	6.50	0.5	7.50	8.00	3.00	3.00
37. <i>B. uniflora</i> var. <i>uniflora</i>	2	50.0	13.00	1.5	7.00	3.50	7.50	7.00	0	0.00	6.50	0.5	7.50	8.00	3.00	3.00
38. <i>B. warnockii</i>	2	12.0	7.00	4.0	5.75	3.50	4.50	5.75	2	0.75	5.75	1.0	5.75	4.25	2.10	3.40
39. <i>B. williamsii</i>	3	10.5	4.50	16.0	5.50	3.75	5.25	5.00	2	2.50	6.00	1.0	3.50	5.00	2.50	3.50

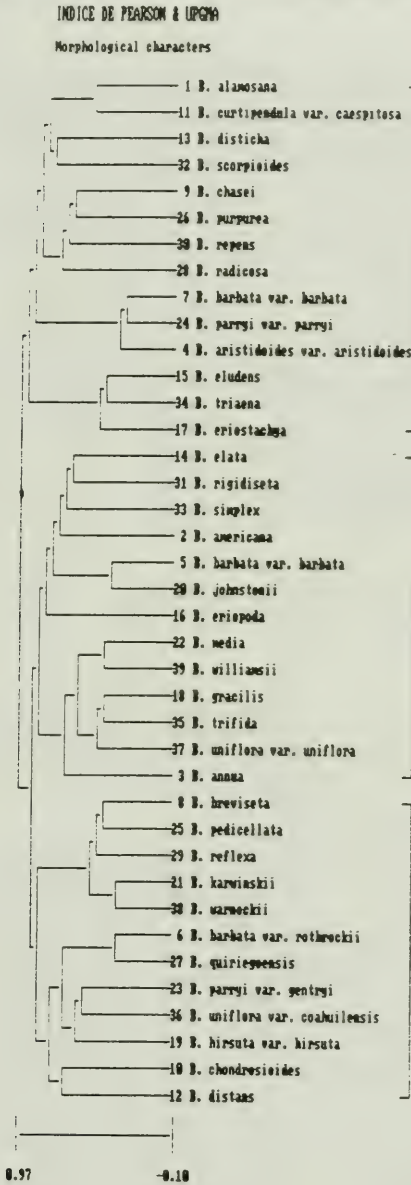


Figura 1.

La variación morfológica entre las poblaciones de *Bouteloua radicata* (Fournier) Griffiths y *B. williamsii* Swallen sugieren niveles de hibridación gradual, evidenciada por caracteres morfológicos intermedios que hacen difícil la separación de especies en ejemplares de localidades simpátricas. Estudios interpoblacionales de estas dos especies podrían dar más luz acerca de un posible caso de hibridación natural.

Todos los miembros del género *Bouteloua* muestran una inflorescencia con una a varias espigas racemosas unilaterales, el raquis persistente, las espiguillas numerosas, sésiles, pectinadas (subgénero *Chondrosom*); o un racimo de 1 a numerosas espigas cortas, unilaterales, desarticulándose como una unidad y las espiguillas a veces también desarticulándose arriba de las glumas (subgénero *Bouteloua*). Las espigas por lo general con 3 a numerosas espiguillas, insertas en 2 hileras a lo largo del lado inferior del raquis. Las espiguillas son comprimidas lateralmente con una flor perfecta y 1 a 2 flores rudimentarias, estaminadas o estériles, modificadas u ornamentadas de forma variable. Las glumas son desiguales a subiguales, generalmente más cortas que la lema, 1-nervada, la primera más corta que la segunda. La lema fértil es cartilaginosa, 3-nervada, las nervaduras a menudo excurrentes como aristas. La pálea es 2-carinada, con el ápice 2-dentado o 2-mucronado. La lema de la flor rudimentaria es generalmente reducida, con aristas alargadas. Presentan 2 lodículos, 3 estambres, 2 estilos. El fruto es una cariopsis de 1/2 a 4/5 partes la longitud de la espiguilla, con el hilum punteado.

Las especies de este género son en su mayoría de áreas restringidas (el 50%), 30% de ellas son de amplia distribución, y 20% son endemismos.

#### Áreas Restringidas:

*B. alamosana*  
*B. americana*  
*B. aristidoides* var. *arizonica*  
*B. barbata* var. *rothrockii*  
*B. barbata* var. *sonorae*  
*B. curtispindula* var. *tenuis*  
*B. curtispindula* var. *curtispindula*  
*B. disticha*  
*B. elata*  
*B. eriopoda*  
*B. hirsuta* var. *glandulosa*  
*B. karwinskii*  
*B. media*  
*B. parryi* var. *gentryi*  
*B. pedicellata*  
*B. purpurea*  
*B. reflexa*  
*B. rigidiseta*  
*B. trifida*  
*B. uniflora* var. *uniflora*  
*B. uniflora* var. *coahuilensis*  
*B. williamsii*

#### Ampliamente distribuidas:

*B. aristidoides* var. *aristidoides*  
*B. curtispindula* var. *caespitosa*  
*B. barbata* var. *barbata*  
*B. chondrosioides*  
*B. distans*  
*B. gracilis*  
*B. hirsuta* var. *hirsuta*  
*B. parryi* var. *parryi*  
*B. radicata*  
*B. repens*  
*B. scorpioides*  
*B. simplex*  
*B. triaena*

#### Endémicas:

*B. annua*  
*B. breviseta*  
*B. chasei*  
*B. chihuahuana*  
*B. eludens*  
*B. eriostachya*  
*B. johnstonii*  
*B. quiriegoensis*  
*B. warnockii*

Se consideran especies restringidas aquellas que ocurren en hábitats específicos de un área geomórfica definida, como es el caso de la Sierra Madre Occidental, el Eje Volcánico Transversal, o la Sierra Madre del Sur. Las preferencias de hábitat unido al aislamiento geográfico altitudinal parece haber prevenido su expansión a una segunda área geomórfica. Las especies restringidas de este estudio no se dispersan sobre las carreteras, tienen preferencias de hábitat definidos los cuales han sido modificados por los cambios geofísicos naturales y por la acción de las actividades humanas, que provocan la destrucción de los hábitats y por consiguiente el aislamiento ecológico de las especies.

La distribución actual y preferencias ecológicas que exhiben las especies mexicanas del género *Bouteloua* sugieren que el grupo tuvo su origen probablemente como parte del bosque mesófilo mexiclado. La completa ausencia de este grupo de especies en Europa y Asia confirma esta idea. Se presume entonces que los taxa perennes de este género evolucionaron del mismo ancestro, cuyo origen podría haber sido durante el intervalo templado del Mioceno, cuando comenzaron a ocurrir condiciones más templadas y más secas en Norte América, y el bosque decíduo de hojas anchas cambió a bosque de coníferas en las floras del Mioceno temprano en el NW del Pacífico y Europa (Wolfe 1978). La especiación pudo haber ocurrido como consecuencia del incremento de la sequía en las costas occidentales de los continentes, por un proceso de adaptación y aislamiento. Los patrones de distribución actual del género sugieren que su probable centro de especiación debe ser México, ya que aquí se encuentra el mayor número de taxa (44), con un alto porcentaje de especies restringidas a unidades geomórficas (50%) restringidas y con endemismos (20%), principalmente en las regiones altas del W de México. Esto confirma una de las teorías expresadas por Rzedowski (1987).

Del análisis fenético de los caracteres morfológicos y de la distribución geográfica de este grupo, se puede inferir que la divergencia de los taxa no fué reciente, que la especiación geográfica ocurrió en forma gradual, a medida que las poblaciones divergieron en muchas características a través del tiempo.

Evidencia electroforética ayudaría posiblemente a resolver los mecanismos que ha seguido la especiación dentro del género *Bouteloua*. Los estudios electroforéticos son muy reconocidos como una fuente suplementaria a los estudios morfológicos y fitoquímicos para inferir los modos de especiación en plantas, como se sumaria en Crawford (1985). Algunos ejemplos documentados de investigaciones hechos con plantas de varias familias son: Adiantaceae (Ranker 1990); Cyperaceae (Ford, Ball, & Ritland 1991; Standley 1990); Asteraceae (Rieseberg *et al.* 1991). En el caso de gramíneas, principalmente los cereales han sido examinados (*Avena*, *Hordeum*, *Triticum*, y *Zea*). Kahler & Price (1987) sumarian una cantidad extensa de referencias de estudios hechos en cereales. Otras gramíneas estudiadas alozímicamente, que no son cereales son las reportadas por Peterson & Herrera (1995).

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## ANÁLISIS FENÉTICO DE LAS MALEZAS DEL GÉNERO *AMARANTHUS* EN EL ESTADO DE DURANGO

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### RESUMEN

El género *Amaranthus* ha recibido muy poca atención sistemática si se compara con la importancia económica de sus especies, tanto las cultivadas para alimento humano, como las que son malezas de cultivos. Siendo *Amaranthus* un género predominantemente monoico, es interesante encontrar que algunas especies de Norte América han evolucionado a un estado dioico. En el presente estudio se analizaron los caracteres morfológicos de las poblaciones de cinco especies monoicas: *A. chihuahuensis*, *A. spinosus*, *A. cruentus*, *A. hybridus*, y *A. powelli*, y de una especie dioica: *A. palmeri*; todas ellas del estado de Durango. Los caracteres clave, resultantes de un estudio morfológico de estas especies, fue analizado a través de un análisis estadístico multivariado con el fin de visualizar la distribución fenética de las malezas de este género en Durango.

**PALABRAS CLAVE:** *Amaranthus*, Amaranthaceae, malezas, análisis fenético, biosistemática

### ABSTRACT

The genus *Amaranthus* has received very little systematic attention relative to the economic importance of some of its species, some of which are cultivated for human consumption, and others of which are weeds in cultivated fields. Although *Amaranthus* is a genus of predominately monoecious species, it is interesting that some North American species have evolved a dioecious condition. In the present study, morphological characters of five monoecious species: *A. chihuahuensis*, *A. spinosus*, *A. cruentus*, *A. hybridus*, and *A. powelli*, are studied along with those of one dioecious species: *A. palmeri*; all six from the state of Durango. The key characters resulting from a morphological analysis of these species, were analyzed through a

multivariate statistical analysis with the purpose of producing a phenetic distribution of the weeds of this genus in Durango.

KEY WORDS: *Amaranthus*, Amaranthaceae, weeds, phenetic analysis, biosystematics

## INTRODUCCION

El género *Amaranthus* L. (Amaranthaceae), ha recibido muy poca atención sistemática si se compara con la importancia económica de sus especies, tanto las cultivadas para alimento humano, como las que son malezas de cultivos. Cuenta con un número estimado de 60 especies de amplia distribución en el mundo. De ellas 26 especies son consideradas como nativas en América y Norte de México. En el estado de Durango encontramos seis especies silvestres, nativas, o introducidas. Son particularmente abundantes como malezas de cultivos, pero asimismo se les encuentra en otras áreas con disturbio. Algunas de sus especies fueron domesticadas y utilizadas en la dieta alimenticia por las comunidades de nativos americanos desde tiempos muy antiguos. "Alegría, bledo o quelite" son los términos más comunes que se les aplica a las especies cultivadas en México.

## ANTECEDENTES

*Amaranthus* es un género con especies predominantemente monoicas en América, presentando un número menor de especies que han evolucionado hasta la condición de ser dioicas. Poblaciones de especies dioicas: *A. palmeri* S. Wats. y de especies monoicas: *A. chihuahuensis* S. Wats., *A. spinosus* L., *A. cruentus* L., *A. hybridus* L., y *A. powelli* S. Wats., todas ellas presentes en forma natural en Durango, fueron analizadas morfológicamente en el presente estudio.

El CIIDIR IPN Unidad Durango, en un intento por introducir el cultivo de Amarantho (*Amaranthus hypochondriacus* L.) como una alternativa viable en los terrenos temporales del estado de Durango, esta llevando a cabo estudios sistemáticos de las especies de este género que crecen en forma natural en el Estado. Resultados de estudios anteriores (S. Esparza y col. 1996), no arrojaron mucha información de valor sistemático, dada la homogeneidad de los caracteres anatómicos encontrados en las especies estudiadas.

Los resultados numéricos de un estudio morfológico de las malezas del género *Amaranthus* en Durango, fueron sometidos a un análisis de similitudes utilizando un análisis estadístico multivariado, con el fin de visualizar la distribución fenética de las malezas de este género presentes en nuestro Estado. Se llevó a cabo el análisis fenético con base en las relaciones de parentesco cercano entre las especies que comparten un área determinada para su desarrollo, así como por la naturaleza continua que presentan muchos de sus caracteres morfológicos, mismos que son utilizados para distinguir las especies.



## MATERIALES Y METODOS

Los ejemplares del herbario (CIIDIR) fueron revisados y en ellos se tomaron medidas de varios caracteres importantes como son el largo y ancho de las brácteas, tépalos, utrículo; la forma de dehiscencia del fruto.

La metodología que se utilizó en el estudio morfológico es aquella propuesta por Lot y Chiang (1990), que se emplea regularmente en los estudios florísticos. Se llevaron a cabo las descripciones de los taxa, claves para su separación e ilustraciones, mismos que serán reportados separadamente.

## RESULTADOS

*Amaranthus L., Sp. Pl.* 2:989. 1753.; *Gen. Pl.*, ed. 5, 427. 1754.

Referencia: K.R. Robertson. 1981. The genera of Amaranthaceae in the southeastern United States. *J. Arn. Arb.* 62(3):267-314.

Plantas anuales, muy rara vez perennes, la mayoría son malezas de cultivos o de las orillas de carreteras, robustas, herbáceas u ocasionalmente leñosas en la base. Tallos erectos, ascendentes o infrecuentemente decumbentes, simples o muy ramificados desde la base, desarmados a rara vez con un par de espinas en las bases de las hojas, a veces estriados y/o carnosos, color verde a rojizos o blanquecinos, emergiendo de una base fuerte. Hojas alternas, enteras o unduladas, rómbicas, lanceoladas, ovadas, oblanceoladas, ovobadas o rara vez espatuladas y emarginadas, algunas veces son más o menos carnosas, color verde a rojizas o amarillentas, con la nervadura central a menudo excurrente y en ocasiones espinescente; peciolo por lo general alargados; estípulas ausentes. Inflorescencias densas, terminales y/o axilares, dispuestas en dicasios compuestos arreglados en espigas, panículas o glomérulos, con los ejes en ocasiones endurecidos, la unidad de inflorescencia frecuentemente subtendida por hojas reducidas; cada dicasio subtendido por una bráctea persistente, usualmente espinosa en el ápice. Flores pequeñas, verdosas o rojizas, imperfectas y las plantas pueden ser monoicas o dioicas. Tépalos usualmente 3 a 5, o ausentes o rudimentarios en las flores femeninas, membranáceos, de tamaño similar o los exteriores excediendo los interiores, glabros, la nervadura central usualmente excurrente y a menudo espinescente. Estambres 3 a 5, ausentes en las flores femeninas; filamentos libres en la base; anteras dorsifijas, introrsas, con 4 lóculos y 2 líneas de dehiscencia. Estilo corto o ausente; estigmas 2 o 3, subulados, persistentes; ovario ovoide, ausente en las flores estaminadas; ovulo 1, erecto, el microfilo inferior, el funículo corto. Utrículo con 1 semilla, membranáceo y circuncísil, con 2 a 3 picos, irregularmente dehiscente o indehiscente. Semilla lenticular a subglobosa, lisa, brillante; embrión enroscado en un anillo alrededor del perisperma, la radícula inferior.

Cuadro 1. Especies de *Amaranthus* incluidas en el presente estudio.

---

*Amaranthus chihuahuensis* S. Wats.

Durango: Municipio Vicente Guerrero, 8 km al SSE del pueblo de Vicente Guerrero por la carretera a SÚchil, S. González & Y. Herrera 1458 (CIIDIR, ENCB, HUAA).

*Amaranthus cruentus* L.

Durango: Municipio Canelas, 200 m al S de Canelas, M. Vizcarra 55 (CIIDIR).

*Amaranthus hybridus* L.

Durango: Municipio Nombre de Dios, 2.5 km al S, 1 km al W de Gral. Gabriel Hernández, A. García 501 (CIIDIR, ENCB); Berros, S. Acevedo 91 (CIIDIR, ENCB, HUAA); Municipio Santiago Papasquiari, Los Altares, A. Benítez 1596 (CHAP, CIIDIR); Km 2.5 carr. Santiago Papasquiari-Los Altares, A. Benítez 2774 (CHAP, CIIDIR); Municipio SÚchil, al SW de SÚchil, límites con Zac., S. González & Y. Herrera 1370, 1369 (CIIDIR); Municipio Tepehuanes, pasando el puente de Tepehuanes del camino hacia Guanacevi, B. Bravo 97 (CHAP, CIIDIR); orillas del Pueblo de Tepehuanes, B. Bravo 356 (CHAP, CIIDIR); Municipio Vicente Guerrero, Ejido San Francisco Javier, A. García 104 (CIIDIR, ENCB, MEXU); Ejido San Francisco, M. González s/n (CIIDIR); Municipio Villa Unión, Volcán del poblado Cieneguilla, O. García 27 (CIIDIR).

*Amaranthus hypochondriacus* L.

Durango: Municipio Vicente Guerrero, Vivero del CIIDIR IPN Unidad Durango, Ejido San Francisco Javier, G. Alejandre s/n (CIIDIR, HUAA).

*Amaranthus palmeri* S. Wats.

Durango: Municipio Gómez Palacio, alrededores de Santoña, Pacheco 31 (CIIDIR, MEXU); Municipio Santiago Papasquiari, carretera Santiago Papasquiari-Los Altares, A. Benítez 2774 (CHAP, CIIDIR); Municipio Vicente Guerrero, Ejido San Francisco Javier, S. Acevedo 220 (CIIDIR, ENCB, HUAA, MEXU).

*Amaranthus powelli* S. Wats.

Durango: Municipio SÚchil, Mesa del Burro, 6 km al SW de Piedra Herrada, S. González & R. Fernández 2132 (CIIDIR, ENCB, MEXU).

*Amaranthus spinosus* L.

Durango: Municipio Canelas, proximidades al poblado de Canelas, monte Mojino, A. Benítez 1734 (CHAP, CIIDIR).

---

Cuadro 2. Caracteres morfológicos "clave" usados en el presente análisis.

- 
1. Alto de la planta.
  2. Largo de las hojas.
  3. Ancho de las hojas.
  4. Plantas: 1) monoicas, 2) dioicas.
  5. Largo de la inflorescencia.
  6. Ancho de la inflorescencia.
  7. Largo de las brácteas.
  8. Ancho de las brácteas.
  9. Largo de los tépalos.
  10. Ancho de los tépalos femeninos.
  11. Número de tépalos.
  12. Largo del utrículo.
  13. Ancho del utrículo.
  14. Ramas del estilo.
  15. Número de estambres.
  16. Diámetro de la semilla.
  17. Color de la semilla: 1) café-rojizo, 2) negro.
- 

Cuadro 3. Matriz de caracteres utilizados en el análisis fenético.

---

Caractere *A. chihuahuensis* *A. cruentus* *A. hybridus* *A. palmeri* *A. powelli* *A. spinosus*

---

1	0.45	0.45	2.00	0.90	1.15	0.75
2	14.00	16.50	6.40	5.00	4.50	4.00
3	3.50	6.00	4.50	2.70	2.20	2.20
4	1.00	1.00	1.00	2.00	1.00	1.00
5	7.00	11.00	25.00	14.50	14.50	10.50
6	3.50	7.00	5.00	9.50	1.50	6.00
7	1.75	3.00	5.00	5.00	2.50	1.80
8	1.10	0.80	1.00	0.90	0.50	0.70
9	2.00	1.75	1.75	3.00	2.50	1.90
10	1.20	0.60	0.50	1.50	0.50	0.65
11	5.00	5.00	5.00	5.00	4.00	5.00
12	1.50	2.45	2.25	2.00	1.80	2.00
13	1.00	1.15	1.60	1.00	0.80	1.20
14	3.00	3.50	3.00	2.00	3.00	3.00
15	5.00	5.00	5.00	5.00	4.00	5.00
16	0.80	0.90	1.20	1.15	1.10	0.90
17	1.00	2.00	2.00	1.00	2.00	1.00

---

Se escogieron deisiete caracteres morfológicos "clave" (Cuadro 2) de las seis malezas analizadas en este estudio (Cuadro 1). Con ellos se construyó una matriz de caracteres (Cuadro 3) que fué sometida a un análisis de similitudes utilizando el programa "Multivariate Statistical Package" versión 1.31 (Kovach 1987), aplicando el Índice de Euclidean Normalizado, para generar la matriz de similitudes, a partir de la cual se construyó el árbol de similitudes o dendrograma (Figura 1) mediante la utilización de UPGMA (unweighted pair group mathematical average clustering analysis).

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