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A NEW GENUS FOR *PANAX TRIFOLIUS*

Panax trifolius L. (Apiaceae) is long-lived, eastern North American herb inhabiting a range of forested situations. In the northeast, it frequents deciduous and mixed evergreen-deciduous types, often in association with streams, flood plains, or vernal seeps. Save for new genus erected for North American members of ginseng made by Alphonso Wood (see below), *P. trifolius* has apparently not been questioned as to its appropriate placement in the genus *Panax*. This article discusses the contrasting morphological, ecological, structural, and phylogenetic data that support this plant being placed in a genus distinct from *Panax*.

Panax trifolius differs substantially from all other members of the genus (as previously circumscribed) in a number of traits. Its habit and phenology are useful starting points in the discussion of differences between this small herb and other species of *Panax*. *Panax trifolius* is a spring ephemeral that emerges early in the season prior to leaf expansion of the canopy trees. It flowers in the month of May in Maine and produces mature fruit within 30 days or so. The plant senesces early, with the aerial portions completely disappearing during the month of June. *Panax quinquefolius*, on the other hand, is a later flowering herb that produces its flowers in the latter half of June through July in the same region (Maine). Its fruits mature in mid-September in most years. It senesces in the early part of Autumn when many other forest herbs are also entering dormancy for the winter. This elongated period for flowers to mature into fruits is also present in Asian species of *Panax* (Shu 2007).

The underground storage organ of *Panax trifolius* is a spherical tuber to which the aerial shoot connects (Figure 1). Over the basal length of the aerial shoot it thins in diameter to a fragile connection with the tuber (found in some other spring ephemeral species; e.g., *Claytonia caroliniana*, *Eythronium americanum*). In the other species of *Panax*, the underground storage organs are elongate, and frequently branched, roots (Figure 2). The aerial shoot does not taper down to a narrow connection at the apex of the roots, rather it is firmly connected.



Figure 1. Tuber and basal portion of aerial shoot of *Panax trifolius*.



Figure 2. Root of *Panax quinquefolius*. Photograph by Katie Trozzo.

The flowers of *Panax trifolius* are strikingly different in color from the other species of *Panax*. Those of *P. trifolius* have white petals that are rarely tinged with pink (Figure 3), whereas the other species of *Panax* have light green petals (Figure 4). They also differ in style number for most species, with *P. trifolius* having three styles and most other species have two styles (though variation occurs, e.g., *P. japonicus* has 2–5 styles).



Figure 3. Flowering habit of *Panax trifolius*; note the white petals.



Figure 4. Flowers of *Panax quinquefolius*; note the light green petals. Photograph by Walter Muma.

An interesting difference in the inflorescences of *Panax trifolius* and the other species of *Panax* is the orientation of the inflorescence when in bud. *Panax trifolius* has a nodding inflorescence (Figure 5), where the peduncle itself arches toward the ground. The peduncle straightens as the inflorescence matures. The other species of *Panax* have an erect inflorescence when in bud (Figure 6).



Figure 5. Nodding inflorescence of *Panax trifolius* when the flowers are in bud.



Figure 6. Budding inflorescence of *Panax quinquefolius*, which was erect from emergence.

The fruits of *Panax trifolius* are very distinct relative to other species currently placed in the genus (Figure 7). They are yellow-green at maturity, whereas the fruits of other species of *Panax* are red (sometimes with dark apical coloration; Figure 8). Another difference is the cross-sectional shape. They are distinctly triangular

cross-section in *P. trifolius* and vary from oval to nearly circular in the other species of *Panax* (rare exceptions exist when 3-carpellate flowers are produced). Finally, there are differences in the outer surface. In *P. trifolius*, the fruits are ribbed on the outer surface, with 2–5 raised ribs on each of the three surfaces. They also tend to be smaller, around 5 mm in length. The outer surface of the other species of *Panax* are smooth or nearly so and are generally larger (5–12 mm long; Shu 2007).



Figure 7. Fruits of *Panax trifolius*. Note sharp angles on fruit and longitudinal ribs.



Figure 8. Fruits of *Panax quinquefolius*. Note rounded angles and lack of longitudinal ribs.

Wen and Nowicke (1999) studied the pollen of ten species of *Panax* and six species of *Aralia*, including both North American and Asian representatives of the genus. The pollen of *Panax trifolius* was found to have large columellae and granular inner surfaces of the tetra

that were prominently striate. This sharply contrasted with the small columellae of all the other species of *Panax* examined, which also had psilate and striato-reticulate tecta. As they noted, such large columellae and striate tecta are unknown in the pollen of any other member of the *Aralia* alliance they examined. In their results, they write:

“The pollen of *Panax trifolius* is sufficiently different from the remaining nine species to merit a separate description.”

Phylogenetic study by Wen and Zimmer (1996) indicated that *Panax trifolius* is basal to the other species of *Panax*. While it does form a clade with the type species of *Panax*, it is important to realize that the authors of the aforementioned study also found that the nrDNA ITS sequence divergence between *P. trifolius* and the outgroup species (six taxa of *Aralia*) was less than the sequence divergence between *P. trifolius* and the ingroup species (species of *Panax*). As noted by Wen and Zimmer (1996), *P. trifolius* is “phylogenetically isolated.” Choi and Wen (2000) used cpDNA data to reconstruct the phylogeny of ginseng species and found also that *P. trifolius* was sister to all other species of *Panax*, corroborating the nrDNA ITS placement of *P. trifolius*.

Panax trifolius is also unusual in a particular life-history trait: it is diphasic (Schlessman 1987). This species is capable of changing sex, switching between plants with all flowers staminate and plants with all flowers bisexual from one year to the next. This has not been observed in other species of *Panax* (though the number of ovules within a flower has been observed to increase with age in *P. quinquefolius*—Schlessman 1987). This peculiar feature of *P. trifolius* is suggested to be related to the brief appearance of its aerial shoot and resource allocation needed to produce ovules.

Panax trifolius is morphologically, ecologically, structurally, phylogenetically, and phenologically distinct from the genus *Panax*. If the species had been recently discovered as a new species, it would be placed in its own genus. In other words, it is only tradition holding it within the Linnaean concept of *Panax*. Given its many and substantial differences from other species of ginseng, and the fact its recognition does not create paraphyletic genera, it is here proposed to transfer this to a new genus.

Alphonso Wood erected the genus *Ginseng* with two species: *G. quinquefolium* (L.) Alph. Wood and *G. trifolium* (L.) Alph. Wood (Wood 1871). Because Wood included *Panax quinquefolius* in his new genus, which is the type of the genus *Panax* (named by Linnaeus in *Species Plantarum* 1753), the generic name *Ginseng*

automatically became a synonym of the name *Panax*. Therefore, this name is not available as a genus for the dwarf species.

***Nanopanax* A. Haines**, Genus nov.

Type Species: *Panax trifolius* L., *Species Plantarum* 2: 1059. 1753.

Description: Plants herbaceous, perennial, unarmed, senescing early in the growing season, perennating by means of a spherical tuber. Leaves whorled, compound, with 3 or 5 palmately arranged, serrulate leaflets. Inflorescence a solitary, pedunculate, simple umbel, nodding in bud. Flowers 5-merous as to the perianth, with white (or rarely pink-tinged) petals and usually 3 styles. Fruits fleshy, green-yellow at maturity, bluntly trigonous in cross-section.

Etymology: *Nano-* is a Greek word initial meaning “dwarf”. The combination of *Nano-* and *-panax* are used to create the generic name “dwarf-ginseng.”

***Nanopanax trifolius* (L.) A. Haines**, comb. nov.

Basionym: *Panax trifolius* L., *Species Plantarum* 2: 1059. 1753.

Synonym: *Ginseng trifolium* (L.) Alph. Wood, *Amer. Bot. Fl.* 142 (1871).

Key to distinguish *Nanopanax* from *Panax*.

- 1a.** Petals white (rarely tinged with pink); inflorescence nodding in bud; underground storage organ a spherical tuber; fruit green to green-yellow; plants spring ephemeral ***Nanopanax***
1b. Petals light green; inflorescence erect in bud; underground storage organ an +/- elongate root, this vertical or horizontal, and sometimes branched; fruit red; plants deciduous toward end of growing season ... ***Panax***

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Acknowledgments

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Article contributed by Arthur Haines (Native Plant Trust, 180 Hemenway Road, Framingham, MA 01702; ahaines@nativeplanttrust.org).

FOUR NEW COMBINATIONS IN THE PONTEDERACEAE

Pellegrini et al. (2018) recently wrote an extensive monograph on the Pontederiaceae and presented compelling evidence that some genera required a new circumscription in order that the naming system within that family reflect monophyletic lineages. The authors used multiple lines of evidence to support that the current definition of *Eichhornia* Kunth was polyphyletic. Two obvious approaches existed to remedy this situation: split *Eichhornia* into monophyletic genera or subsume *Eichhornia* in *Pontederia*. The latter approach, which also required subsuming *Monochoria* in *Pontederia*, was followed by the authors. After making 18 new combinations, *Pontederia* was redefined by Pellegrini et al. to create a larger genus that included both *Eichhornia* and *Monochoria*. They then erected subgenera to distinguish the monophyletic groups within *Pontederia*.

The paper prepared by Pellegrini et al. (2018) is a substantial tome of work, with excellent attention to the many morphological characters that distinguish the subgenera of their newly defined *Pontederia*. In fact, they present more than enough evidence to treat all the subgenera as genera. Each subgenus is well-supported in their phylogenetic trees and has a suite of macro- and micromorphological characters that substantiate the recognition of these taxa. Pellegrini et al. (2018) do entertain the idea of splitting *Eichhornia*, which would only require four new combinations to do so (rather than the 18 they make). To justify their stance, they offer two

statements regarding why they should make one, larger, compingenus. The first justification is:

“The first option is considerably more taxonomically stable and would greatly facilitate the identification of Pontederiaceae specimens, especially for the non-specialists, ecologists, plant growers, farmers etc.”

As I explained in Haines (2003), I do not believe the opinions of those untrained in plant systematics should be used to support any naming system. Following this logic too far would force us to stop distinguishing many subtle and/or cryptic species that are currently recognized. The limitations of non-specialists are not what guides plant evolution (i.e., it is an arbitrary factor on which to base a naming system).

But more to the point, I disagree that such a taxonomic system proposed by Pellegrini et al. (2018) facilitates the naming of Pontederiaceae specimens, and it is certainly less stable given it makes more combinations. The naming of specimens requires those with training to identify the plants to the species level (or below). Whether or not we recognize one large genus or several smaller genera does not make the identification of species easier. At some point in the identification process, we need to separate the groups within the family. Whether we treat them as genera or subgenera does not make the process easier (i.e., we still need to examine the specimens with care and interpret the structures to make a species-level determination). The point really becomes how we want to discuss the supraspecific variation as genera or subgenera. Keeping in mind that most taxonomists focus on ranks like family, genus, and species, using a subgeneric system essentially hides the variation being used to form monophyletic groups to all except those who will do more extensive studying of the literature. Treating the subgenera *sensu* Pellegrini et al. as genera makes visible (within the dichotomous keys) the rationale for the division of these various monophyletic groups.

Given that Pellegrini et al. (2018) themselves state that:

“we recover *Pontederia* s.l. arranged in five main lineages, each representing a well-supported morphological group (i.e. *Eichhornia paniculata* group, *Monochoria*, *E. crassipes* group, *Eichhornia* s.s. and *Pontederia* s.s.)”

They themselves recognize these groups are defensible taxonomic ranks.

They justify their treatment of these ranks as subgenera again using this second line of reasoning:

“... since many of the characters supporting each clade are not always easy to observe, especially in dried specimens.”

In other words, they recognize that the characteristics exist, but because in one form (dried herbarium specimen) some are difficult to observe, they chose to include both *Eichhornia* and *Monochoria* in *Pontederia*. There are many species that have their identifications complicated on herbarium specimens, but this is not rationale for subsuming any taxa, it only requires a study of live material to fully understand the morphology of the group.

Based on the arguments presented in the previous paragraphs, an alternate approach is of splitting *Eichhornia* into three genera is adopted here to create monophyletic supraspecific taxa. This method maintains the current circumscriptions of both *Monochoria* and *Pontederia*, better illuminates the definitions of the evolutionary groups within *Eichhornia*, and only requires four new combinations. This approach is supported by the fact these three genera can be distinguished on gross examination of the plants (a more detailed morphological description follows the new combinations).

Cabanisia: erect plants with very short stems (i.e., the leaves congested) and leaves without inflated petioles.

Eichhornia: prostrate plants with elongate stems (i.e., the leaves not congested) and leaves without inflated petioles.

Piaropus: floating plants with very short stems (i.e., the leaves congested) and leaves with inflated petioles.

***Cabanisia meyeri* (A.G. Schulz) A. Haines**, comb. nov.
Basionym: *Eichhornia meyeri* A.G.Schulz, Darwiniana 6: 56. 1942.

Lectotype: ARGENTINA. Chaco, Cote Lai, 25 Jun 1939, fl., fr., *Meyer 2640* (SI).

Synonym: *Pontederia meyeri* (A.G.Schulz) M.Pell. & C.N.Horn,

***Cabanisia paniculata* (Spreng.) A. Haines**, comb. nov.

Basionym: *Pontederia paniculata* Spreng., Neue Entdeck. Pflanzenk. 3: 18. 1822.

Neotype: Brazil, Mar 1817, *Wied s.n.* (BR).

Synonyms: *Piaropus paniculatus* (Spreng.) Small, Fl. S.E. U.S. (ed. 2): 1328. 1913. *Eichhornia paniculata* (Spreng.) Solms, Monogr. Phan. 4: 530. 1883. *Cabanisia caracasana* Klotzsch ex Schltl., Abh. Naturf. Ges. Halle 6: 176. 1862.

***Cabanisia paradoxa* (Mart.) A. Haines**, comb. nov.

Basionym: *Pontederia paradoxa* Mart. in Schultes & Schultes f., Syst. Veg. (ed. 15 bis) 7: 1144. 1830.

Lectotype: Brazil, Maranhão: Alcântara oppidium at ad Porto de Carvalho, fl., fr., 1817, *Martius 2575* (M).

Synonyms: *Eichhornia paradoxa* (Mart.) Solms, Monogr. Phan. 4: 531. 1883. *Eichhornia schultesiana* Seub., Fl. Bras. 3: 94. 1847.

***Piaropus crassipes* (Mart.) A. Haines**, comb. nov.

Basionym: *Pontederia crassipes* Mart., Sp. Pl. 1: 9. 1823.

Lectotype: Brazil, Bahia, Provinciae Minas Gerais, in stagnis ad fl. St. Francisci prope Malhada, s.dat., *Martius 60* (M).

Synonyms: *Piaropus mesomelas* Raf., Fl. Tellur. 2: 81. 1837. *Eichhornia crassipes* (Mart.) Solms, Monogr. Phan. 4: 527. 1883.

Based on these new combinations, *Monochoria* remains as a distinct genus with tens species and *Eichhornia s.l.* would now be classified in the three genera as follows:

Cabanisia: Emergent plants with erect stems and leaves congested at apex of very short stem, the sessile leaves early deciduous, the petiolate leaves borne in more than two ranks, never with inflated petioles; stolons absent; ligules flabellate; inflorescences erect post anthesis; perianth salverform, +/- 20–30 mm in diameter, tightly enclosing developing fruit; style glandular-pubescent

Cabanisia meyeri (A.G. Schulz) A. Haines
Cabanisia paniculata (Spreng.) A. Haines
Cabanisia paradoxa (Mart.) A. Haines

Eichhornia: Emergent plants with trailing stems and leaves evenly distributed along the elongate stems, the sessile leaves late deciduous, the petiolate leaves borne two ranks, never with inflated petioles; stolons absent; ligule truncate; perianth funnellform, +/- 7–45 mm in diameter; loosely enclosing the developing fruit; style glabrous

Eichhornia azurea (Sw.) Kunth
Eichhornia diversifolia (Vahl) Urb.
Eichhornia heterosperma Alexander
Eichhornia natans (P.Beauv.) Solms

Piaropus: Floating plants with leaves congested at apex of very short stem, the sessile leaves early deciduous, the petiolate leaves borne in more than two ranks, with inflated petioles; stolons present; ligules truncate; inflorescence deflexed post anthesis; perianth salverform, +/- 40–70 mm in diameter, loosely enclosing the developing fruit; style glandular-pubescent

Piaropus crassipes (Mart.) A. Haines

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***ELYMUS MACGREGORII* VAR. *HIRSUTISPICULUS*, A NEW VARIETY OF EARLY WILD-RYE**

Within the genus *Elymus* (Poaceae), several infraspecific taxa are recognized on the basis of spikelet pubescence (more specifically, by hairs present on the glumes and lemmas). For example, *E. villosus* var. *arkansanus* (Scribn. & Ball) J.J.N. Campb. differs from the typical variety in the lack of pubescence on the aforementioned floral scales (var. *villosus* has glumes and lemmas pubescent). Several other *Elymus* taxa also have varieties that are distinguished (chiefly or in part) on the basis on spikelet pubescence (e.g., *E. canadensis*, *E. glabriflorus*, *E. hystrix*, *E. virginicus*). As noted by different authors, there often exists subtle differences in morphology and/or ecology that distinguish the infraspecific taxa but are difficult to quantify (Chase and Hitchcock 1950, Campbell 1995).

Elymus macgregorii R. Brooks and J.J.N. Campbell is a recently described wild rye from eastern North America (Campbell 2000). Within this species, there exist two morphologies that can be distinguished: the more common plant with glabrous to scabrous lemmas and glumes and a hitherto unnamed plant with pubescent lemmas and glumes. The type of *E. macgregorii* (US!) has glabrous glumes and lemmas. Important to this discussion is *E. virginicus* L. var. *minor* Vasey ex L.H. Dewey, which is conspecific with *E. macgregorii* (i.e., if *E. macgregorii* were to be recognized as a variety, it would be treated as var. *minor*). The holotype (US!) also shows glabrous lemmas and glumes. Therefore, the plant

with pubescent floral scales is currently undescribed. It is here provided a name to allow a consistent naming system within *Elymus* and call attention to the morphological variation within the species.

***Elymus macgregorii* R. Brooks & J.J.N. Campb. var. *hirsutispiculus* A. Haines, var. nov.**

Holotype: Maine, York County, Limington, valley of the Saco River, alluvial woods, 28 Aug 1910, *Fernald & Long 12739* (NEBC).

Diagnosis: Similar to *Elymus macgregorii*, but with lemmas and glumes pubescent (vs. glabrous or scabrous).

Etymology: *hirsuti-* refers to the pubescence on the floral scales and *-spiculus* refers to the spikelets.

Paratypes: Kentucky. Estill County. KY 1571 3.9 mi E of jct KY 52, wet ditch at base of dry wooded slope near railroad tracks across from lock no. 12, 17 Jun 1987, *Gueting 254* (EKY). Indiana. Posey County. Frequent in an open post oak flat on the south side of Half Moon Pond, 27 Jul 1926, *Deam 43505* (IND). Maine. Oxford County. Hiram, Mt. Cutler, ledges, 20 Jul 1909, *Merrill s.n.* (MAINE). York County. Hollis, Saco River, at Salmon Falls, 24 Aug 1926, *Norton et al. 17782* (NHA). Limington, Saco River, alluvial thicket. 17 Aug 1948. *Griscom 2236* (BRU). Limington, valley of the Saco River, 29 Aug 1910, *Fernald et al. 11746* (NHA). Massachusetts. Berkshire County. Sheffield, bank of the Housatonic River, alluvial silt, 29 Jul 1988, *Weatherbee 1467* (NHA). North Carolina. Alleghany County. Cherry Lane Township, Roaring Gap, located along the Upper Trailhead-Stone Mountain Loop, 10 Jul 2009, *Poindexter 09-780* (BOON). Pennsylvania. Berks County. Reading, streambank, alt. 220 ft., ¼ mi. N.W. of Tulpehocken, 23 Jul 1942, *Berkheimer 3356* (PH). Tennessee. Polk County. Plants of Ocoee River Gorge, Dam 2, wetland area above dam beneath wooden bridge, abundant in shallows in mud and on edge of lake, 19 Jun 2012, *Estes et al. 2012 245* (TENN). Vermont. Windsor County. Hartland, banks of Conn. River, Aug 1926, *Carpenter s.n.* (VT). Virginia. Alexandria, Jones Point Park, just northeast of Jones Point Lighthouse along the Potomac River Shore, 8 Jun 2004, *Simmons 2219* (AVCH).



Figure 1. *Elymus macgregorii* var. *macgregorii* from the Merrimack River in MA. This is the common form with glabrous to scabrous lemmas and glumes.



Figure 2. *Elymus macgregorii* var. *hirsutispiculus* from a rocky woodland in western Maine. This is the less common infraspecific taxon with pubescent lemmas and glumes.

Early collections of *Elymus macgregorii* var. *hirsutispiculus* were primarily identified as *E. virginicus* forma *hirsutiglumis* (now referred to as *E. virginicus* var. *intermedius*). Some collections in northeastern herbaria were more recently annotated to *Elymus virginicus* var. *intermedius*, but awn length, spike internode length, and spikelet orientation distinguish these collections from members of the *E. virginicus* species complex. In the southeastern United States, *E. macgregorii* var. *hirsutispiculus* was sometimes determined as *E. villosus*, but spike orientation, spike internode length, and glume width distinguish the two.

Elymus macgregorii var. *hirsutispiculus* is much less common than var. *macgregorii*. During the study for preparation of the manuscript, I would estimate for each collection of var. *hirsutispiculus* I would encounter, I examined approximately 30 collections of var. *macgregorii*. This new variety is likely rare in most states it is encountered in. For example, in Maine, it is currently known from a single, extant location. Naming of this variety will help foster its conservation throughout the eastern United States where it is found.

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_____. 2000. Notes on North American *Elymus* species (Poaceae) with paired spikelets: I. *E. macgregorii* sp. nov. and *E. glaucus* ssp. *mackenzii* comb. nov. *Journal of the Kentucky Academy of Science* 61: 88–98.

Chase, A., and A.S. Hitchcock. 1950. *Manual of Grasses of the United States*, second revised edition. U.S. Department of Agriculture Miscellaneous Publications No. 200.

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