

ABAXIAL FOLIAR VESTITURE OF
DESMODIUM DESV. (FABACEAE) IN NORTH CAROLINA
AND VEGETATIVE RECOGNITION OF THE SPECIES

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ABSTRACT

Desmodium Desv. (Fabaceae) is perhaps the most difficult genus among Carolina legumes. Diagnostic recognition of the species has historically been based on mature loment and flower characters. To facilitate the vegetative identification and teaching of the twenty-two *Desmodium* species of North Carolina, an illustrated survey of abaxial foliar vestiture and a diagnostic key are provided.

Desmodium Desv. (Fabaceae) comprises twenty-two species in North Carolina (Wilbur 1963; Radford et al. 1968) and is perhaps the most difficult genus among Carolina legumes (Wilbur 1963). Diagnostic recognition of the species has historically been based on mature loment and flower characters (Schubert 1950a&b; Wilbur 1963; Radford et al. 1968; Isely 1998). In an attempt to define evolutionary relationships among *Desmodium* species occurring in the *Gray's Manual* range (see Fernald 1950), Schubert (1950a) erected five series based primarily on loment and flower characters (Table 1). However, foliar morphological features, particularly type and degree of pubescence are also useful – at least diagnostically. Descriptions of foliar vestiture are easy to follow when benefitted by a comparative herbarium specimen collection. Broader use of the character is limited by lack of adequate illustrations. Similarly, teaching the vegetative recognition of *Desmodium* is limited if no comparative herbarium collection is available. An illustrated survey of abaxial foliar vestiture is presented to facilitate the diagnosis of sterile specimens and teaching of Carolina *Desmodium* species.

Additionally, a key based primarily on vegetative features is provided for North Carolina species of *Desmodium*.

METHODS

The foliar morphology of North Carolina *Desmodium* species was critically studied based on 501 herbarium specimens (all at NCSC, except for *D. ochroleucum* M.A. Curtis [NCU] and *D. sessilifolium* (Torr.) Torr. & A. Gray [NCU]). Images of representative specimens were captured using a Nikon SMZ 800 microscope and Hitachi KP-D50 color digital camera system. The images were taken at two magnifications (20x and 63x) and are thus at comparable scales for all species. Trichome measurements were taken with DIGIPA-brand digital calipers. Leaf dimension and petiole measurements are taken from the thorough treatment provided by Wilbur (1963).

RESULTS and DISCUSSION

North Carolina *Desmodium* species can be artificially categorized into three basic groups based on leaflet shape (Fig. 1). Abaxial leaf surface and midvein vestiture further comprise useful variation for distinguishing among species. North Carolina species exhibit two basic types of trichomes on the abaxial midveins: straight-tipped and uncinete-tipped. Straight-tipped (hereafter 'straight') trichomes may be either short and appressed (strigose; e.g., Fig. 4 bottom), long and appressed (e.g., Fig. 11 bottom), or long and spreading (pilose; e.g., Fig. 10 bottom). Uncinete-tipped (hereafter 'uncinete') trichomes are typically only a fraction in size of the straight trichomes and are generally antrorse (hook facing the leaf apex). In *D. nuttallii* (Schindl) Schub. some basal uncinete trichomes are also retrorse (hook facing the leaf base). The longest uncinete trichomes are found in *D. canescens* (L.) DC. (ca. 0.2 mm).

Images of abaxial leaflet vestiture in North Carolina *Desmodium* are provided in Figs. 2-23, following the key. Species are arranged alphabetically within the 3 main leaf type groups (see Fig. 1). Abbre-

viations are as follows: RAB = Radford et al. (1968); W = Wilbur (1963). Page references to the respective species description in these works are provided for all species. Appendix A provides petiole and leaf dimensions.

TABLE 1. Series of *Desmodium* Desv. (Fabaceae) erected by Schubert (1950a). Species not occurring in North Carolina are noted in brackets.

Series *Americana*: “Ascending or erect herbs; the loments with an essentially straight upper suture, narrow isthmi, deep sinuses, and large somewhat asymmetrical articles.”

TYPE: *D. glutinosum* (Muhl. ex Willd.) Wood

OTHER MEMBERS: *D. nudiflorum* (L.) DC. and *D. pauciflorum* (Nutt.) DC.

NOTES: Members of this series exhibit monadelphous stamens. Members of all other series exhibit diadelphous stamens (9 and 1) (Schubert 1950).

Series *Stipulata*: “These are prostrate or erect herbs with conspicuous ovate-attenuate stipules, cordate or semi-cordate at the base.”

TYPE: *D. canescens* (L.) DC.

OTHER MEMBERS: *D. illinoense* A. Gray, *D. rotundifolium* DC., *D. ochroleucum* M.A. Curtis.

NOTES: *D. canescens* and *D. illinoense* [not found in NC] are both upright species, whereas *D. rotundifolium* and *D. ochroleucum* are prostrate species.

Series *Pauciarticulata*: “More or less spreading herbs with small bracts and flowers and few-articulate loments with small or medium-sized articles.”

TYPE: *D. ciliare* (Muhl. ex Willd.) DC.

OTHER MEMBERS: *D. sessilifolium* (Torr.) Torr. & A. Gray, *D. tenuifolium* Torr. & A. Gray, *D. strictum* (Pursh) DC., *D. rigidum* (Elliott) DC. [not in NC], *D. marilandicum* (L.) DC., *D. lineatum* DC.

Series *Longibracteata*: “Stout herbs with long stipules, large conspicuous, but early deciduous, primary bracts, large flowers and short stipitate loments.”

TYPE: *D. canadense* (L.) DC. [not in NC]

OTHER MEMBERS: *D. cuspidatum* (Muhl. ex Willd.) Loud.

Series *Stipitata*: “Usually stout herbs with the primary bracts and the flowers smaller than in the *Longibracteata*, but the loments much longer stipitate.”

TYPE: *D. viridiflorum* (L.) DC.

OTHER MEMBERS: *D. nuttallii* (Schindl.) Schub., *D. fernaldii* Schub., *D. glabellum* (Michx.) DC., *D. paniculatum* (L.) DC., *D. perplexum* Schub., *D. humifusum* (Muhl.) Beck [not in NC], *D. laevigatum* (Nutt.) DC.

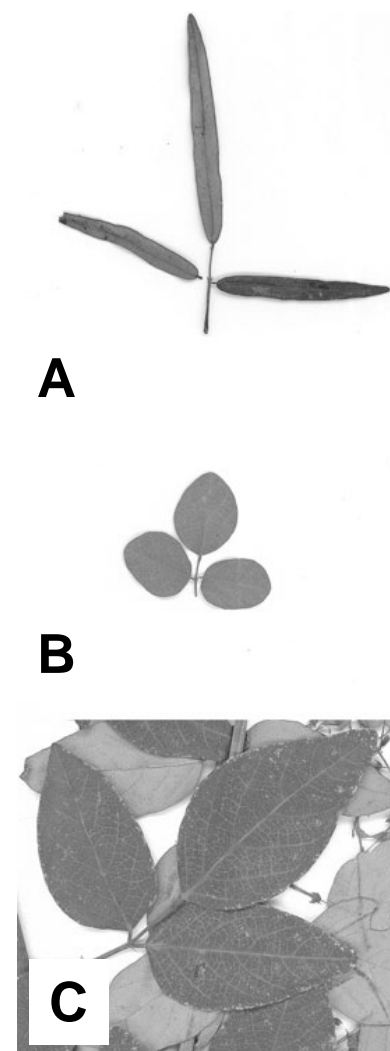


FIG. 1. Leaflet shape groups in North Carolina *Desmodium* Desv. (Fabaceae). A: Terminal leaflet length ≥ 4 x width. B: Terminal leaflet length ≤ 2.5 x width, small, (0.7) 1-3.5 (5) cm x 0.5-2 (3) cm. C: Terminal leaflet length ≤ 2.5 x width, large, (2) 3-12 (15) cm x (0.7) 1-9 (12) cm (most plants at least with a few leaves ≥ 5 cm long).

Artificial key to North Carolina *Desmodium*

- 1. Terminal leaflet length ≥ 4 x width [**Group A**, p. 148]2.
- 1.' Terminal leaflet length ≤ 2.5 x width.....5.
- 2. (1.) Straight trichomes of the abaxial midvein spreading; petioles 0.1-0.3 (0.4) cm long; rare, Cabarrus Co.
.....*D. sessilifolium* (p. 149)
- 2.' Straight trichomes of the abaxial midvein appressed or only somewhat spreading; petioles (0.1) 0.4-3.5 (5.3) cm long; relatively common, throughout.....3.
- 3. (2.') Terminal leaflets (0.6) 1-2 (2.5) cm wide; appressed, straight trichomes of the abaxial midvein ca. 0.2 mm long.....
..... *D. paniculatum* (p. 148)
- 3.' Terminal leaflets 0.3-0.7 (0.8) cm wide; appressed, straight trichomes of the abaxial midvein ≤ 0.08 mm long.....4.
- 4. (3.') Upper margin of loment segments flattened or somewhat concave; plants of dry, sandy or clayey pinelands or turkey oak sandhills *D. strictum* (p. 150)
- 4.' Upper margin of loment segments convex; plants of savannas, pocosin margins, or shallow ditches *D. tenuifolium* (p. 151)
- 5. (1.') Leaflets relatively small, (0.7) 1-3.5 (5) cm x 0.5-2 (3) cm [**Group B**, p. 152].....6.
- 5.' Leaflets larger, (2) 3-12 (15) cm x (0.7) 1-9 (12) cm, most plants with at least a few leaves ≥ 5 cm long [**Group C**, p. 156].....9.
- 6. (5.) Stems prostrate, trailing *D. lineatum* (p. 153)
- 6.' Stems erect or ascending7.
- 7. (6.') Leaflet adaxial surface drying light olive-green to yellow-green, the venation very conspicuous and contrasting to the surface.....*D. obtusum* (p. 155)

- 7.' Leaflet adaxial surface drying dark-brown to dark reddish-brown, the venation mostly inconspicuous8.
- 8. (7.') Stems and petioles sparsely to densely, long, spreading-pilose; longest straight trichomes of the abaxial midvein 0.5 mm long, spreading*D. ciliare* (p. 152)
- 8.' Stems and petioles glabrous to scattered uncinulate-puberulent; longest straight trichomes of the abaxial midvein appressed, 0.04-0.08 mm long.....*D. marilandicum* (p. 154)
- 9. (5.') Abaxial leaflet surfaces velvety-tomentose10.
- 9.' Abaxial leaflet surfaces glabrous, or if pubescent, at least not velvety-tomentose11.
- 10. (9.) Terminal leaflets of medial leaves typically rhombic to deltoid, the bases truncate to cuneate, width mostly $2/3$ x length....
.....*D. viridiflorum* (p. 169)
- 10.' Terminal leaflets of medial leaves elliptic-ovate, the bases generally rounded, width mostly ca. $1/2$ x length.*D. nuttallii* (p. 163)
- 11. (9.') Lateral leaflets orbicular or suborbicular, the apices rounded to emarginate..... *D. rotundifolium* (p. 167)
- 11.' Lateral leaflets variously shaped, but distinctly longer than wide and not orbicular, the apices obtuse, acute, or acuminate ...
.....12.
- 12. (11.') Leaflet apices acuminate13.
- 12.' Leaflet apices obtuse, rounded, or acute.....15.
- 13. (12.) Stipels present; abaxial midvein glabrate or with scattered, long, appressed, straight trichomes, uncinuate trichomes essentially absent*D. cuspidatum* (p. 157)
- 13.' Stipels absent or obsolete; abaxial midvein with long, spreading, straight trichomes, uncinuate trichomes sporadic14.

14. (13.) Terminal leaflets (4) 6-9 (12) cm wide; flowering stems emanating from a leafy stem; pedicels < 1 cm long
*D. glutinosum* (p. 160)
- 14.' Terminal leaflets 3-6 (8) cm wide; flowering stems typically leafless and emanating from an underground caudex; pedicels ≥ 1 cm long*D. nudiflorum* (p. 162)
15. (12.) Straight trichomes of the abaxial midvein dense, long, spreading, uncinata trichomes lacking or nearly so; trichomes of the abaxial leaflet surfaces distinctly spreading toward the leaf margins and away from the midvein*D. glabellum* (p. 159)
- 15.' Combination not as above 16.
16. (15.) Uncinate trichomes of the abaxial midvein dense, straight trichomes appressed, scattered.....*D. fernaldii* (p. 158)
- 16.' Combination not as above 17.
17. (16.) Stipules 0.5-1.5 cm long, the bases wide, partially clasping; straight and uncinata trichomes of the abaxial midvein dense, the straight trichomes long and spreading (the longest ca. 1 mm long), the longest uncinata hairs ca. 0.2 mm
 *D. canescens* (p. 156)
- 17.' Combination not as above 18.
18. (17.) Abaxial midvein glabrate, sporadically strigose or the straight trichomes somewhat spreading, uncinata trichomes inconspicuous, scattered*D. laevigatum* (p. 161)
- 18.' Abaxial midvein with long, straight, spreading or appressed trichomes and shorter uncinata trichomes 19.
19. (18.) Stems prostrate or trailing.....*D. ochroleucum* (p. 164)
- 19.' Stems erect or strongly ascendent 20.
20. (19.) Stipels absent*D. pauciflorum* (p. 165)

- 20.' Stipels present21.
21. (20.) Plant annual from a taproot; stipel cilia multi-cellular
*D. tortuosum* (p. 168)
- 21.' Plant perennial; stipel cilia unicellular ... *D. perplexum* (p. 166)

Group A: Terminal leaflet length $\geq 4 \times$ width

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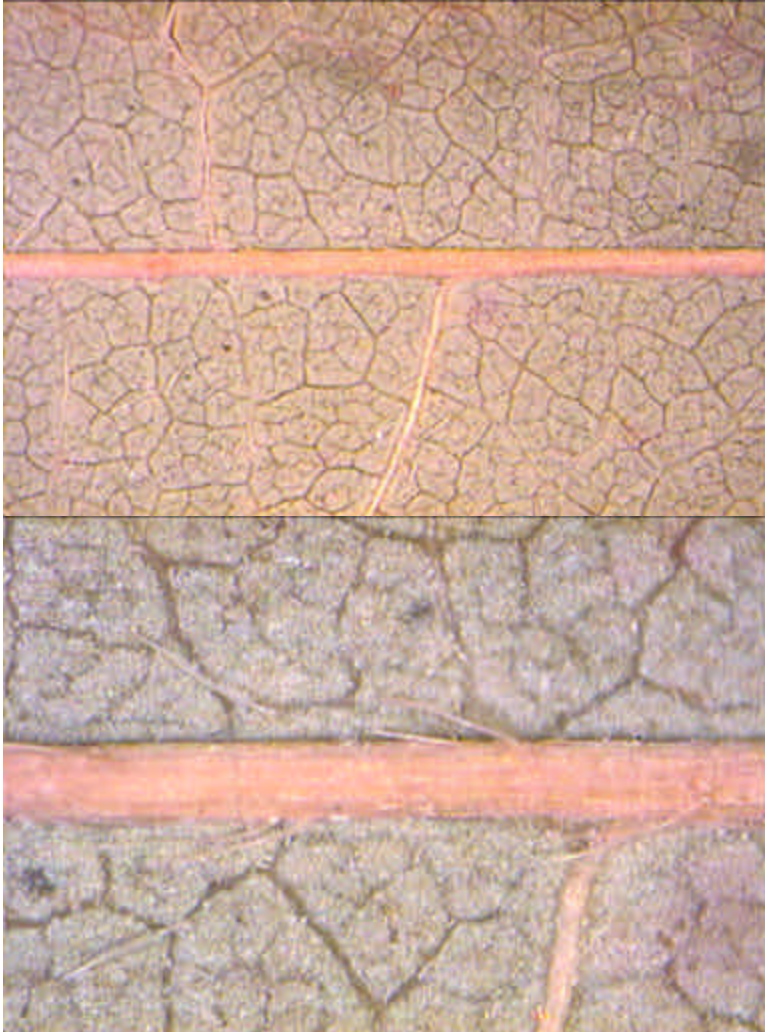


FIG. 2. *Desmodium paniculatum* (L.) DC., Prodr. 2: 329. 1825. Top (20x): Abaxial leaflet surface with scattered trichomes. Bottom (63x): detail of midvein vestiture showing long, appressed to somewhat spreading trichomes (uncinate trichomes are very sporadic or absent). Based on: *Godfrey 48519* (NCSC). W: 162; RAB: 610.

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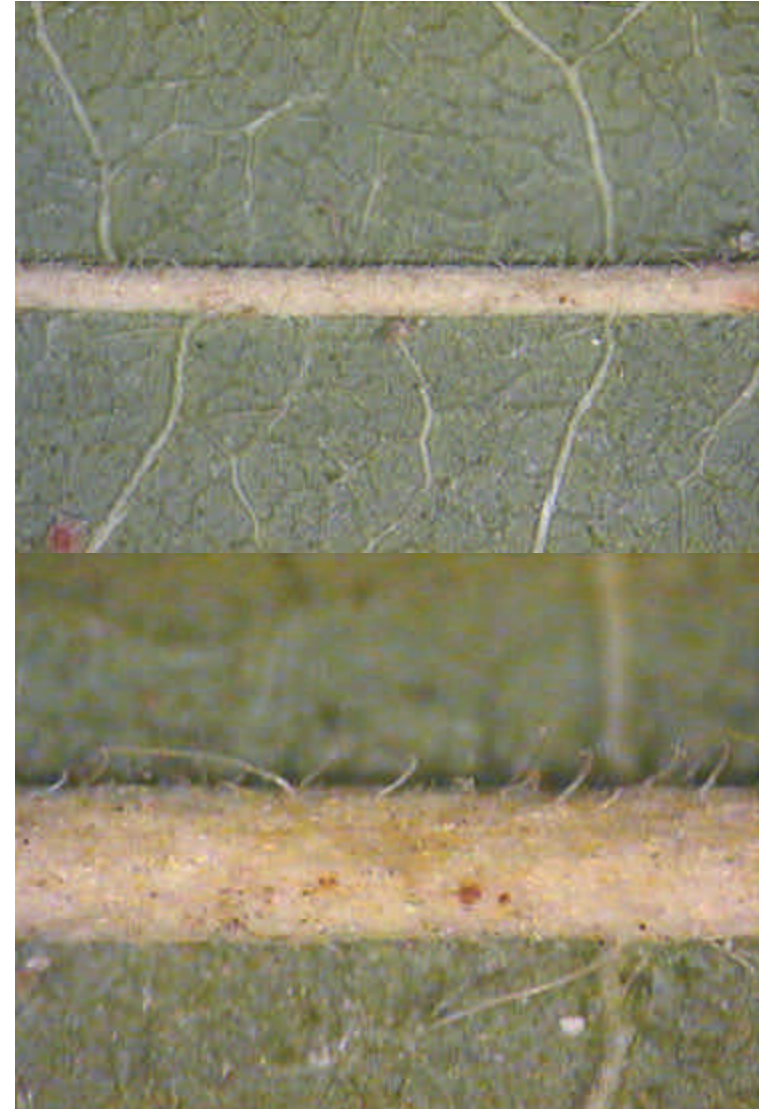


FIG. 3. *Desmodium sessilifolium* (Torr.) Torr. & A. Gray, Fl. N. Amer. 1(3): 363. 1840. Top (20x): Abaxial leaflet surface. Bottom (63x): detail of midvein vestiture showing long, spreading trichomes and shorter, uncinata trichomes. Based on: *Balogh 104* (NCU). W: 154; RAB: 608.

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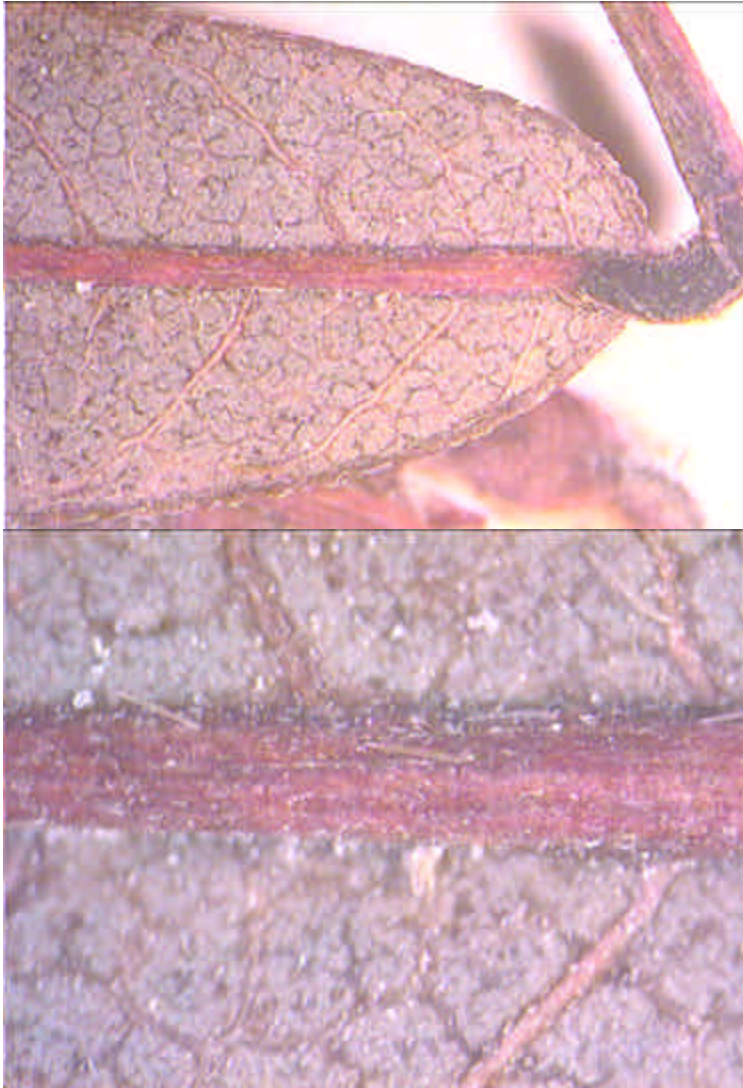


FIG. 4. *Desmodium strictum* (Pursh) DC., Prodr. 2: 329. 1825. Top (20x): Abaxial leaflet surface with scattered trichomes. Bottom (63x): detail of midvein vestiture showing strigose trichomes (uncinate trichomes are minute and occur near the midvein base [not shown]). Based on: *Buell 1488* (NCSC). W: 156; RAB: 609.

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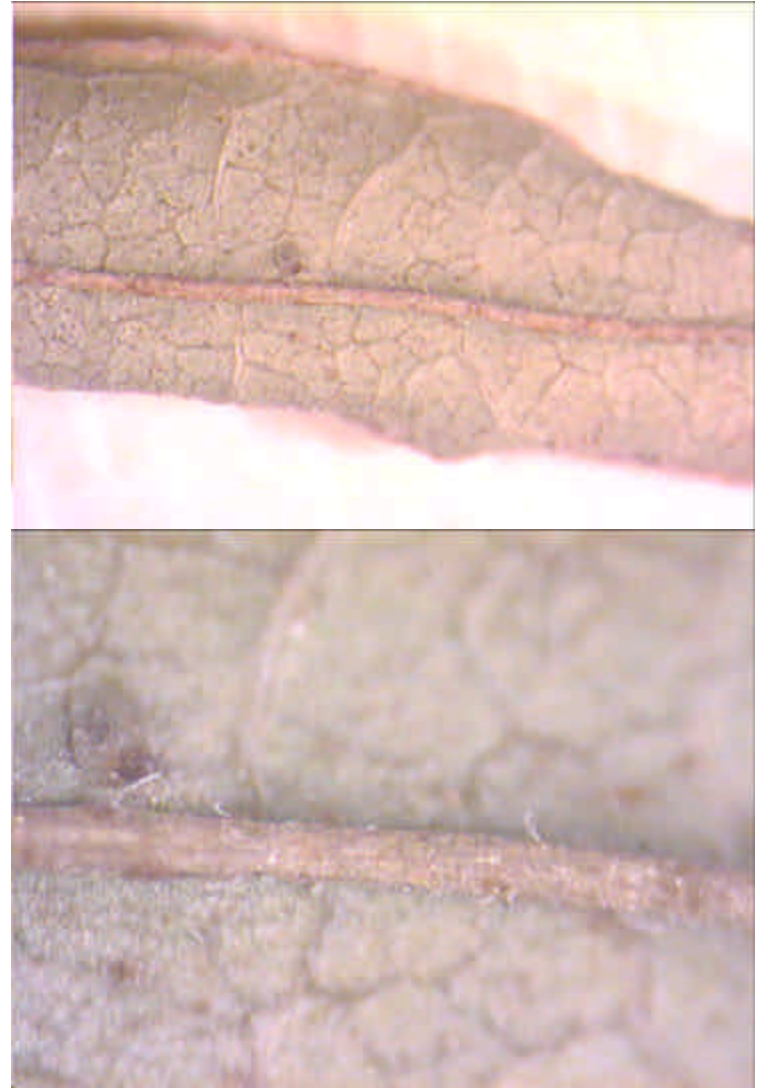
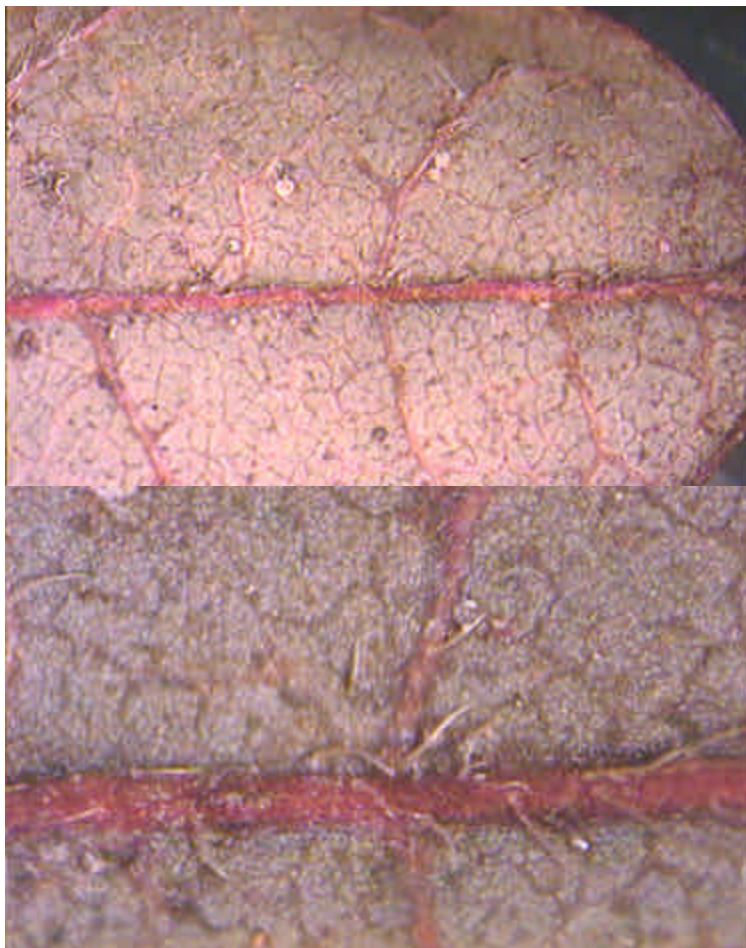


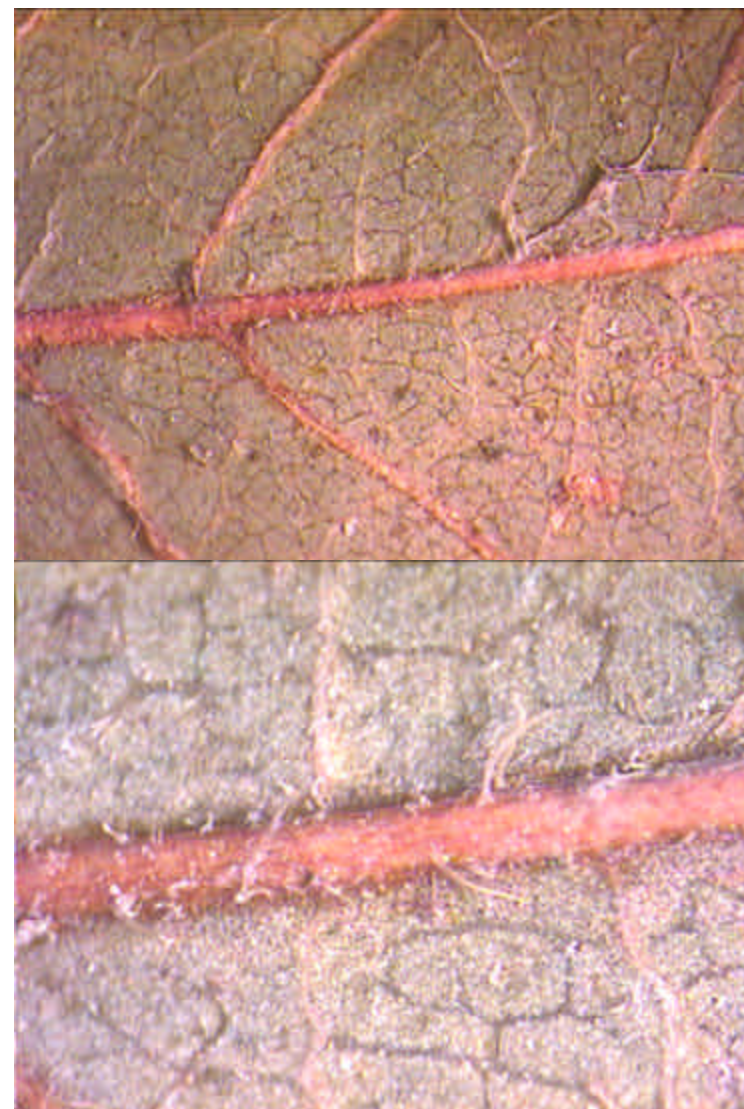
FIG. 5. *Desmodium tenuifolium* Torr. & A. Gray, Fl. N. Amer. 1(3): 363. 1840. Top (20x): Abaxial leaflet surface. Bottom (63x): detail of midvein vestiture showing strigose or short, somewhat spreading trichomes, and shorter, uncinata trichomes. Based on: *Fox & Godfrey 2652* (NCSC). W: 154; RAB: 608.

Group B: Terminal leaflets (0.7) 1-3.5 (5) cm x 0.5-2 (3) cm, length \leq 2.5 x width



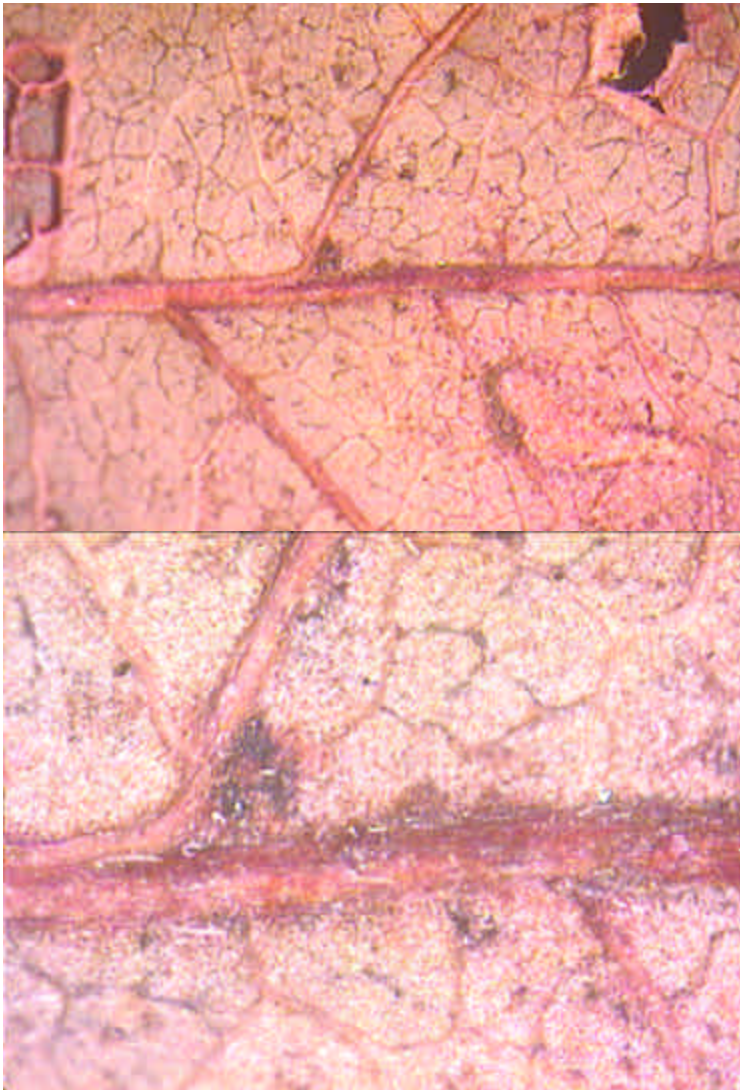
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FIG. 6. *Desmodium ciliare* (Muhl. ex Willd.) DC., Prodr. 2: 329. 1825. Top (20x): Abaxial leaflet surface with scattered trichomes. Bottom (63x): detail of midvein vestiture showing scattered, spreading trichomes (uncinate trichomes are also present, but these are generally minute and inconspicuous, \leq 1/10 the length of the pilose trichomes). Based on: Fox & Godfrey 3418 (NCSC). W: 156; RAB: 609.



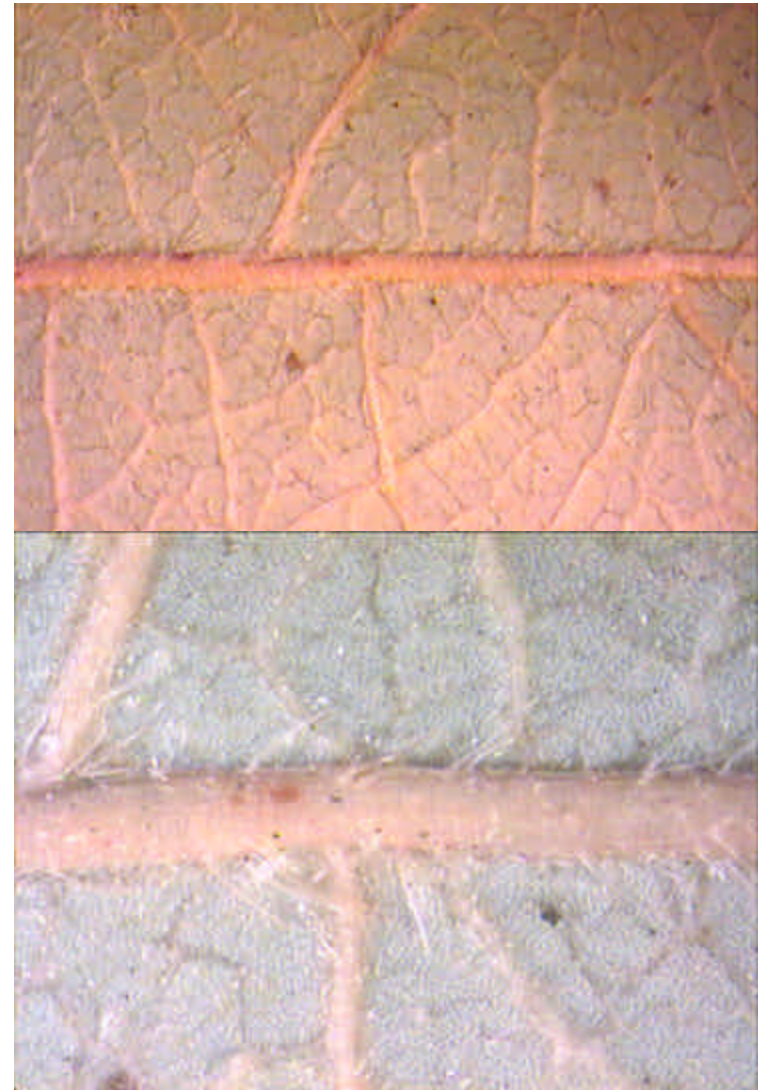
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FIG. 7. *Desmodium lineatum* DC., Prodr. 2: 330. 1825. Top (20x): Abaxial leaflet surface with scattered trichomes. Bottom (63x): detail of midvein vestiture showing long, spreading trichomes, and shorter, uncinately curved trichomes, these to $\frac{1}{2}$ as long as the long, spreading trichomes. Based on: Fox & Godfrey 4190 (NCSC). W: 147; RAB: 608.



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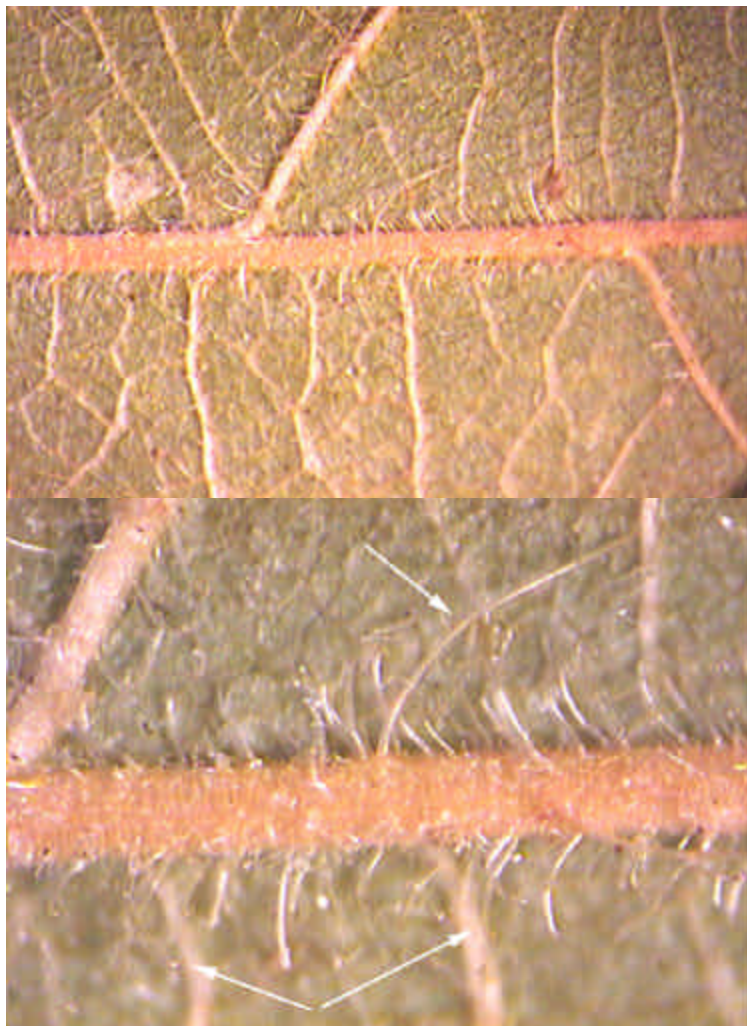
FIG. 8. *Desmodium marilandicum* (L.) DC., Prodr. 2: 328. 1825. Top (20x): Abaxial leaflet surface. Bottom (63x): detail of midvein vestiture showing strigose trichomes and sporadic, shorter, uncinuate trichomes, these to 1/3 as long as the strigose trichomes. Based on: *Fox & Godfrey 3310?* (NCSC). W: 159; RAB: 610.



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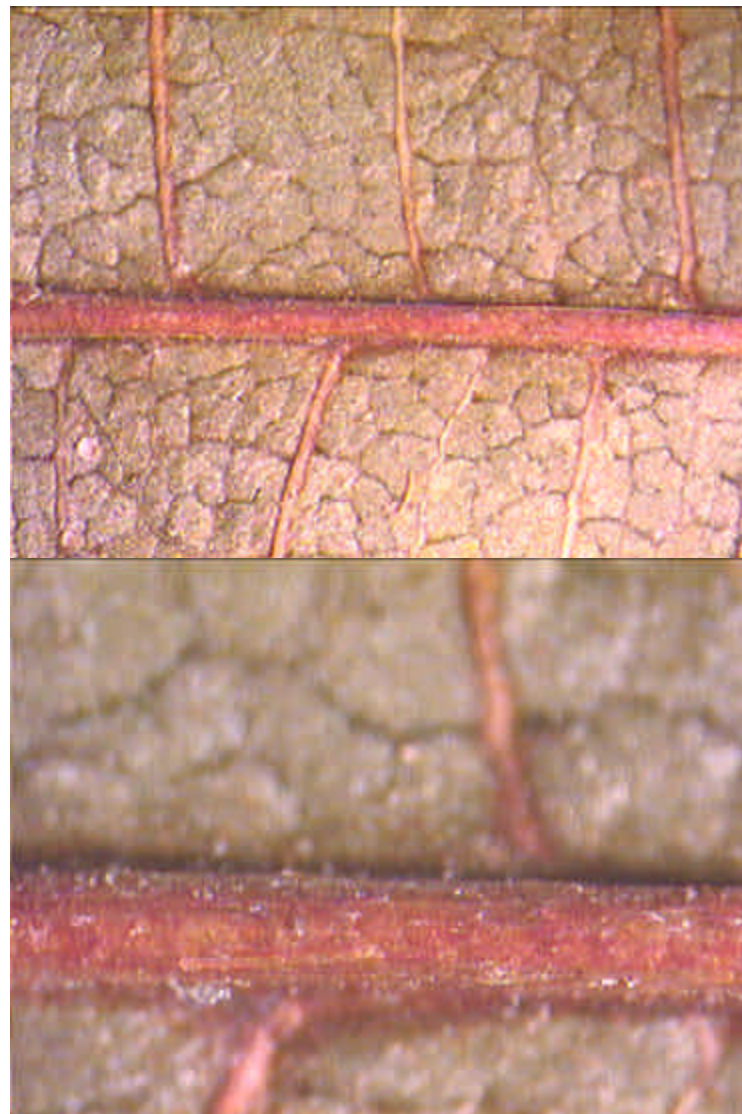
FIG. 9. *Desmodium obtusum* (Muhl. ex Willd.) DC., Prodr. 2: 329. 1825. Top (20x): Abaxial leaflet surface with short-pubescent trichomes. Bottom (63x): detail of midvein vestiture showing medium-length, spreading trichomes, and shorter, uncinuate trichomes. Based on: *Fox & Godfrey 4271* (NCSC). W: 162; RAB: 610.

Group C: Terminal leaflets (2) 3-12 (15) cm x (0.7) 1-9 (12) cm, most plants at least with a few leaves ≥ 5 cm long, length ≤ 2.5 x width



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FIG. 10. *Desmodium canescens* (L.) DC., Prodr. 2: 328. 1825. Top (20x): Abaxial leaflet surface. Bottom (63x): detail of midvein vestiture showing scattered, long spreading trichomes, and dense, shorter, uncinuate trichomes. Based on: *Mullen s.n.* (NCSC). W: 145; RAB: 607.



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FIG. 11. *Desmodium cuspidatum* (Muhl. ex Willd.) Loud., Hort. Brit. 309. 1830. Top (20x): Abaxial leaflet surface. Bottom (63x): detail of glabrate midvein (scattered, long, appressed trichomes present; uncinuate trichomes essentially absent). Based on: *Wilbur 4400* (NCSC). W: 147; RAB: 607.

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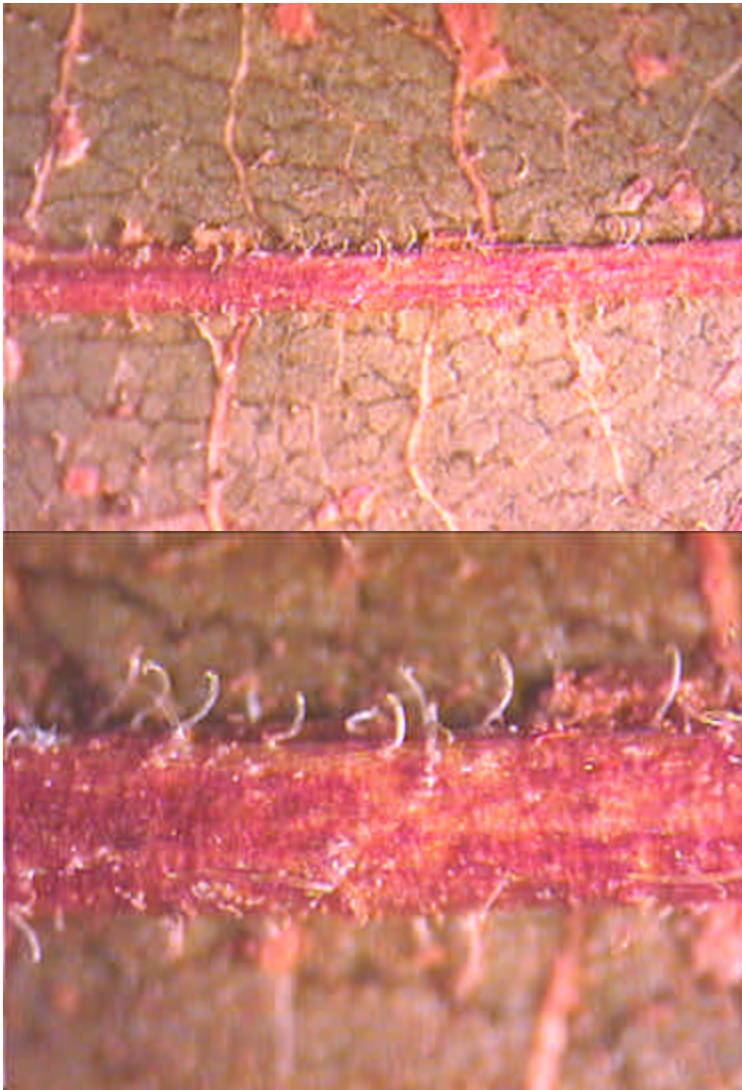


FIG. 12. *Desmodium fernaldii* Schub., Rhodora 52(618): 147-148. 1950. Top (20x): Abaxial leaflet surface. Bottom (63x): detail of midvein vestiture showing scattered, long, appressed trichomes and conspicuous unciniate trichomes, the latter 1/3 to 1 x as long as the appressed trichomes. Based on: Fox & Godfrey 4242 (NCSC). W: 166; RAB: 612.

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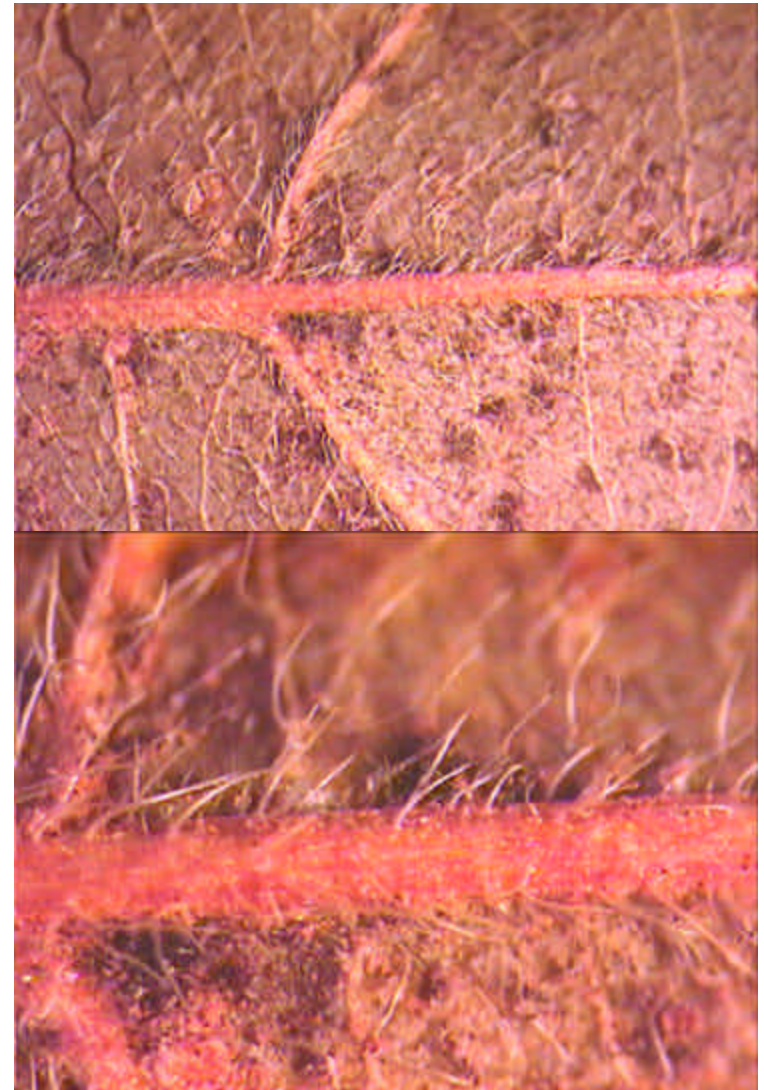
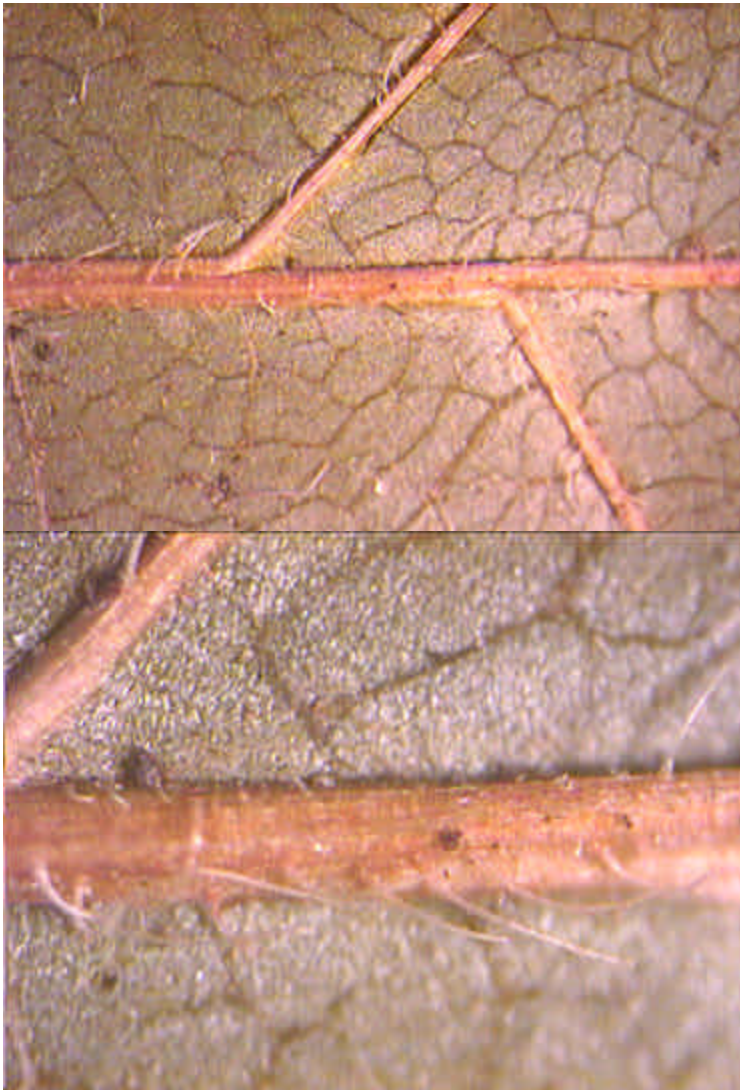
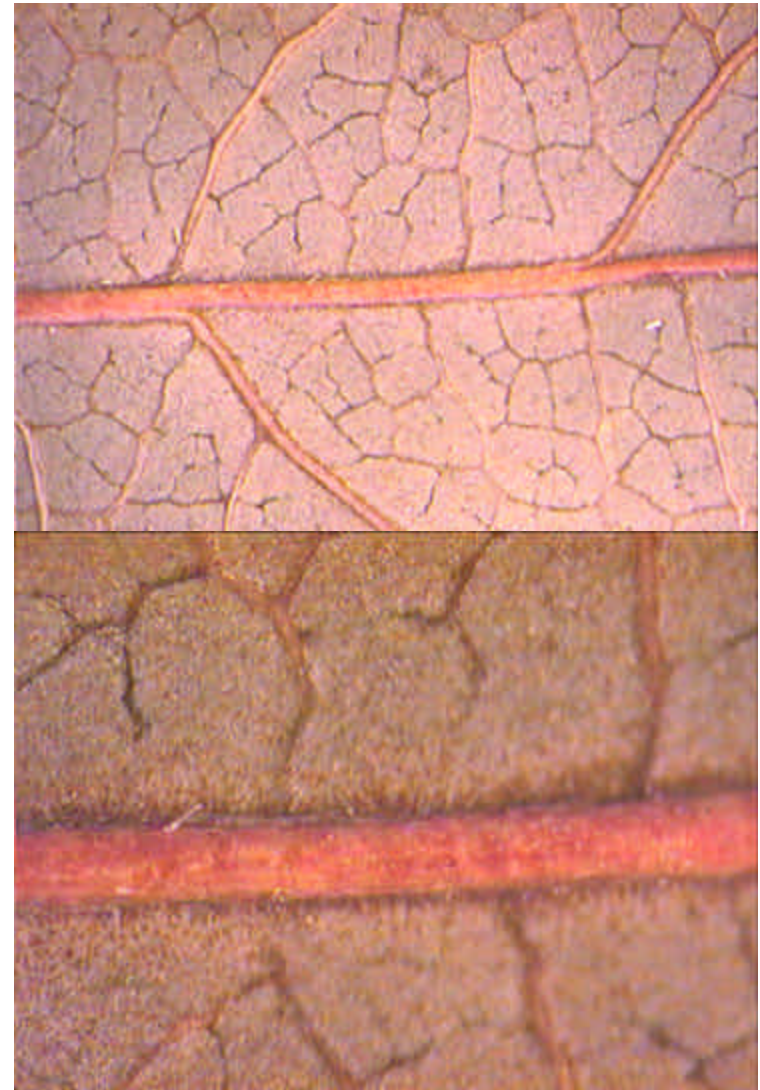


FIG. 13. *Desmodium glabellum* (Michx.) DC., Prodr. 2: 329. 1825. Top (20x): Abaxial leaflet surface. Bottom (63x): detail of midvein vestiture showing long, spreading trichomes (uncinate trichomes are lacking or nearly so). Based on: Biltmore Herbarium 3797 (NCSC). W: 166; RAB: 612.



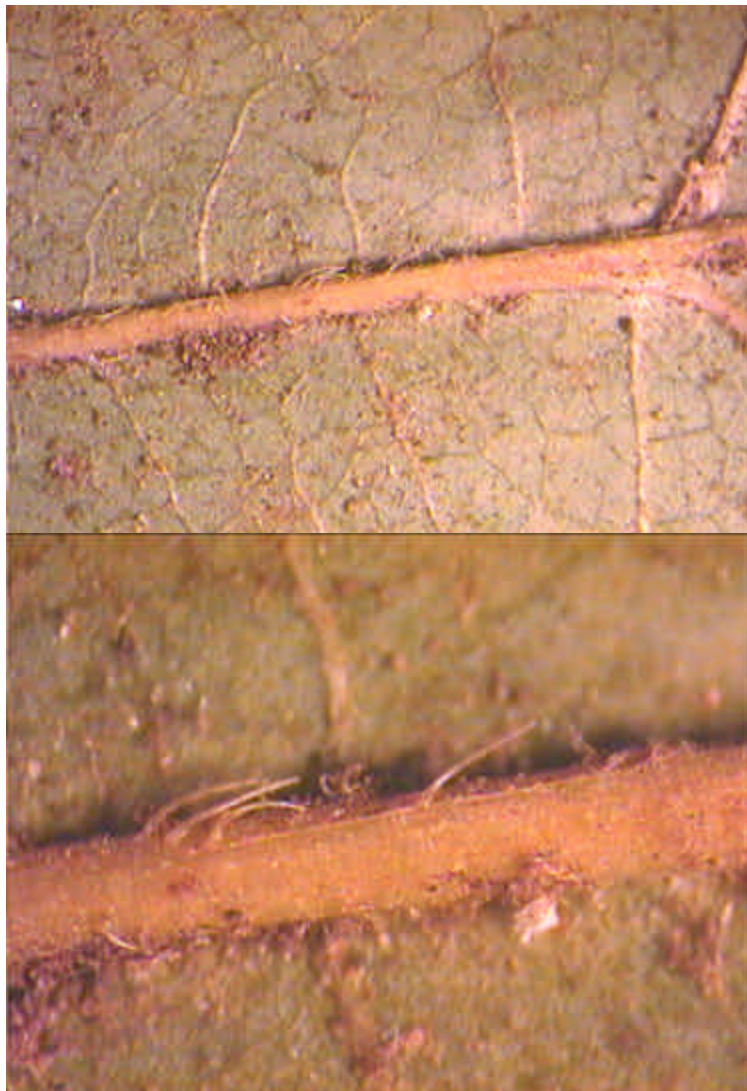
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FIG. 14. *Desmodium glutinosum* (Muhl. ex Willd.) Wood, Class-book Bot. 2: 120. 1845. Top (20x): Abaxial leaflet surface. Bottom (63x): detail of midvein vestiture showing long, spreading trichomes and sporadic shorter, uncinuate trichomes, $\leq 1/5$ x as long as the long trichomes. Based on: *Cappel & Godfrey 138* (NCSC). W: 138; RAB: 606.



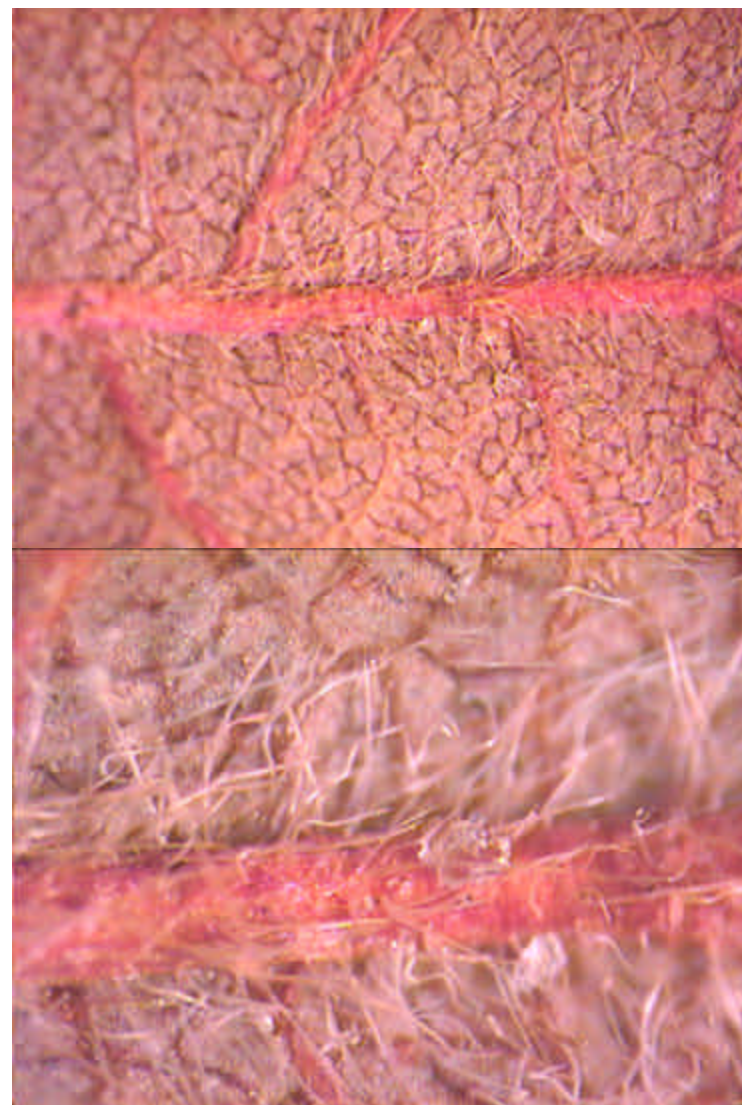
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FIG. 15. *Desmodium laevigatum* (Nutt.) DC., Prodr. 2: 329. 1825. Top (20x): Abaxial leaflet surface. Bottom (63x): detail of midvein vestiture showing strigose to somewhat spreading trichomes (uncinate trichomes are inconspicuous, scattered, and to $1/3$ as long as the strigose trichomes). Based on: *Fox & Godfrey 4250* (NCSC). W: 164; RAB: 611.



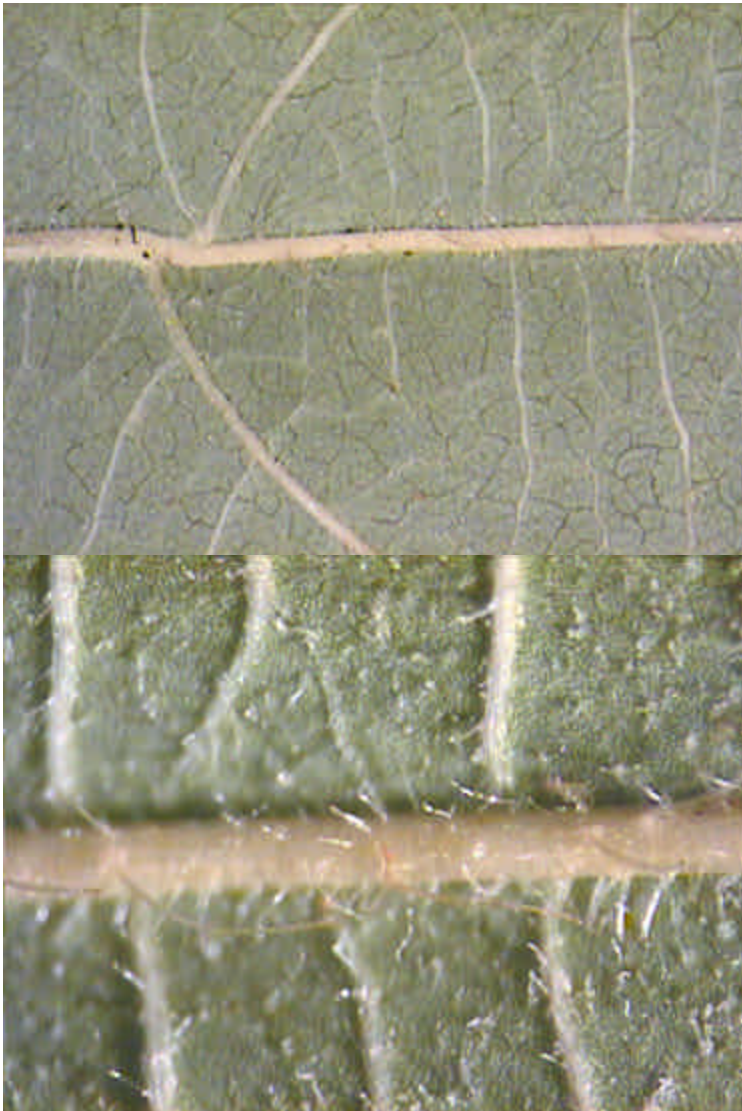
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FIG. 16. *Desmodium nudiflorum* (L.) DC., Prodr. 2: 330. 1825. Top (20x): Abaxial leaflet surface. Bottom (63x): detail of midvein vestiture showing long, spreading to appressed trichomes and sporadic, shorter, uncinuate trichomes, these to 1/3 as long as the long trichomes. Based on: Fox & Godfrey 3398 (NCSC). W: 138; RAB: 605.



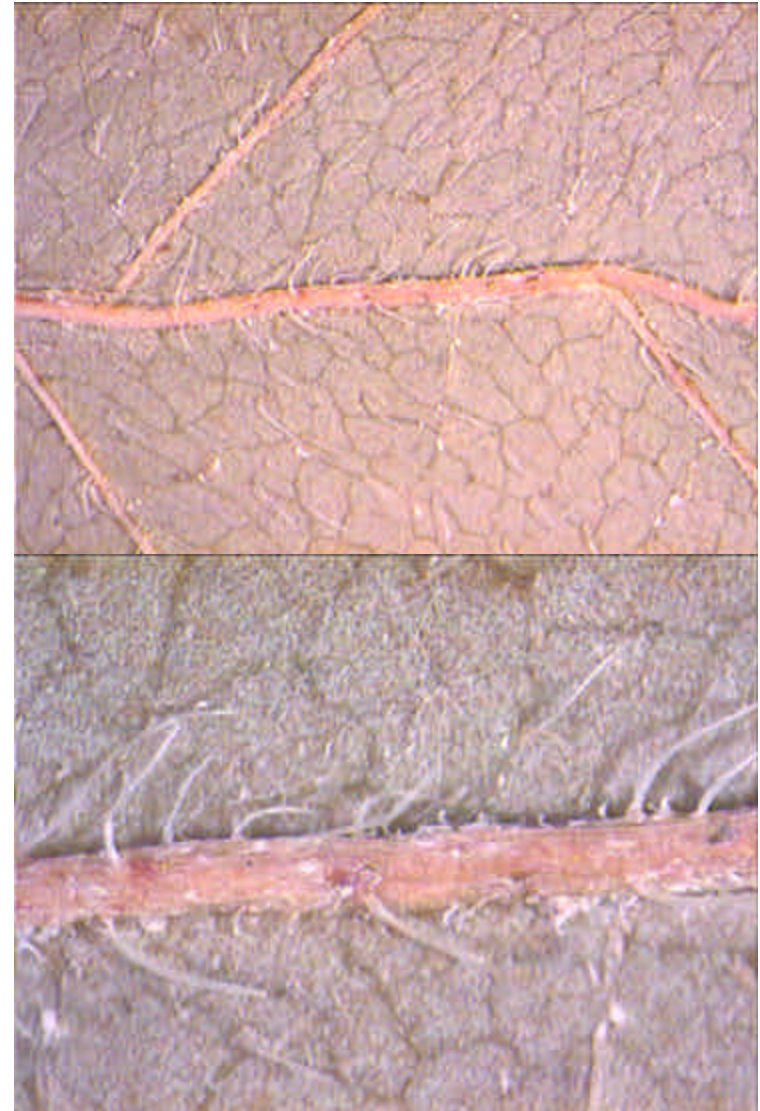
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FIG. 17. *Desmodium nuttallii* (Schindl.) Schub., Rhodora 52(618): 142-143. 1950. Top (20x): Abaxial leaflet surface. Bottom (63x): detail of midvein vestiture showing dense, long, spreading trichomes, intermixed with shorter, uncinuate trichomes (both antrorse and retrose), these to 1/2 as long as the spreading trichomes. Based on: Fox, Godfrey & Boyce 4296 (NCSC). W: 149; RAB: 611.



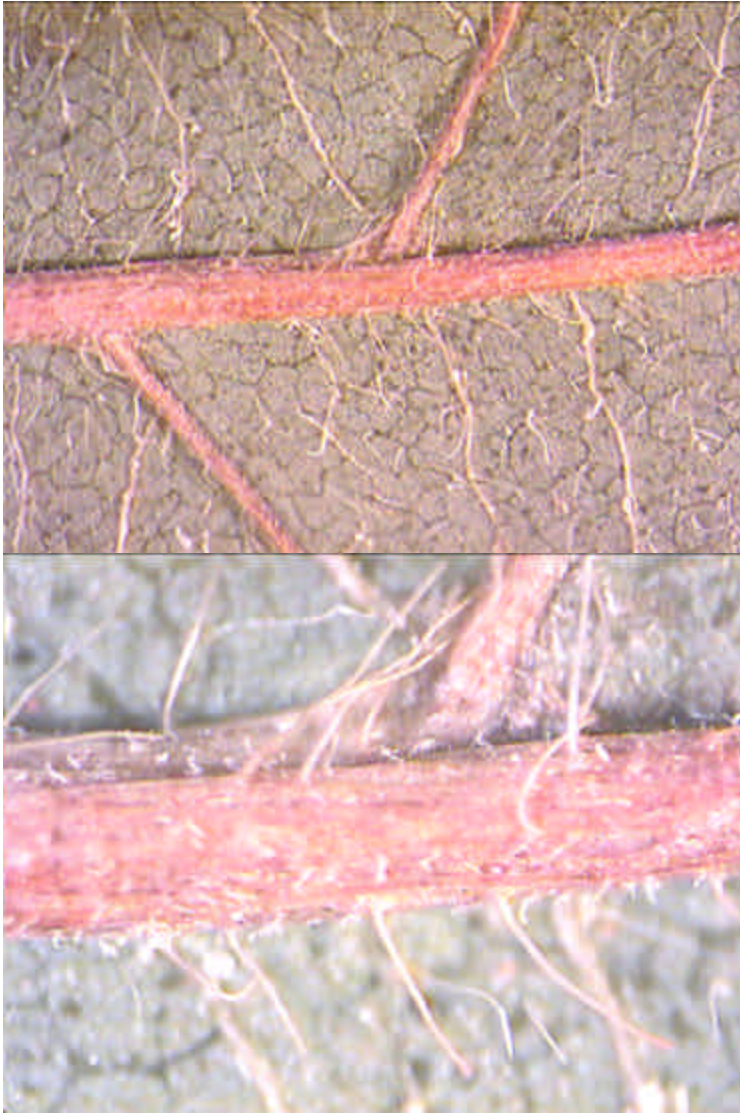
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FIG. 18. *Desmodium ochroleucum* M.A. Curtis, Proc. Acad. Nat. Sci. Philadelphia 17. 1864. Top (20x): Abaxial leaflet surface. Bottom (63x): detail of midvein vestiture showing long, spreading trichomes and shorter, uncinata trichomes. Based on: Ahles & James 60998 (NCU). W: 142; RAB: 606.



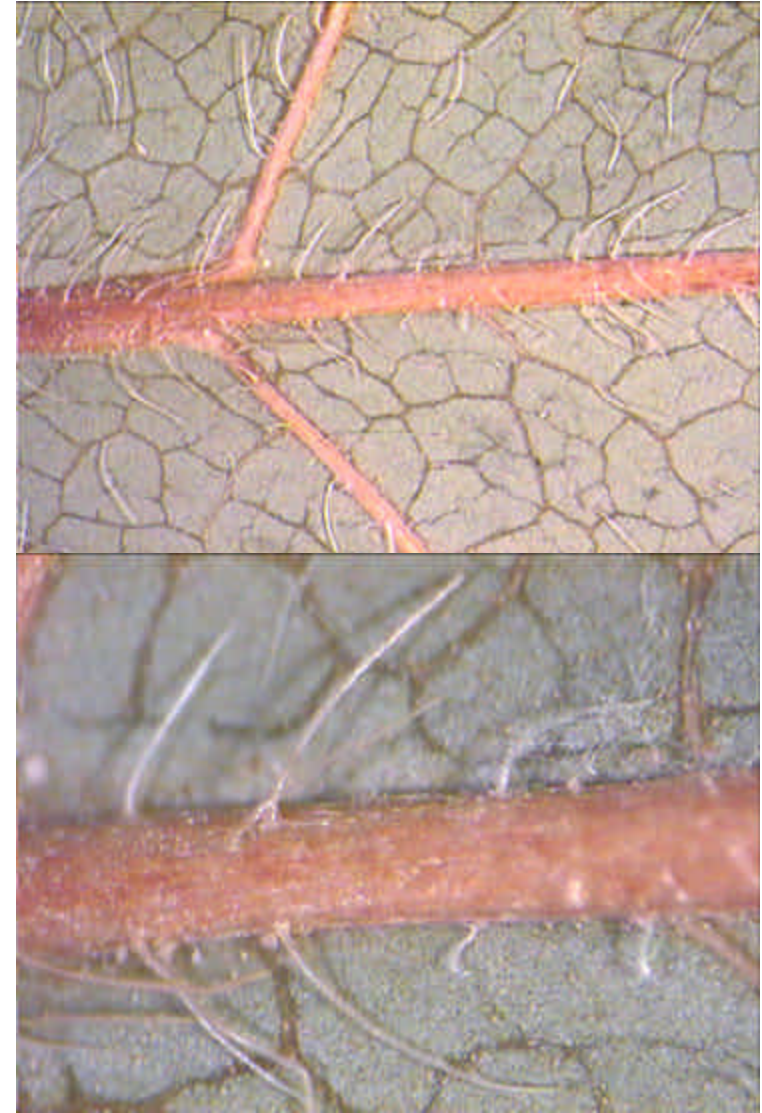
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FIG. 19. *Desmodium pauciflorum* (Nutt.) DC., Prodr. 2: 330. 1825. Top (20x): Abaxial leaflet surface. Bottom (63x): detail of midvein vestiture showing long, spreading trichomes, and shorter, uncinata trichomes. Based on: Cappel & Fox 475 (NCSC). W: 140; RAB: 606.



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FIG. 20. *Desmodium perplexum* Schub., Rhodora 52(618): 154-155. 1950. Top (20x): Abaxial leaflet surface. Bottom (63x): detail of midvein vestiture showing long, spreading or appressed trichomes, and shorter, uncinates. Based on: Fox & Godfrey 3417 (NCSC). W: 171; RAB: 613.



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FIG. 21. *Desmodium rotundifolium* DC., Prodr. 2: 330. 1825. Top (20x): Abaxial leaflet surface. Bottom (63x): detail of midvein vestiture showing long, spreading trichomes and shorter, uncinates. Based on: Somers s.n. (NCSC). W: 142; RAB: 606.



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FIG. 22. *Desmodium tortuosum* (Sw.) DC., Prodr. 2: 332. 1825. Top (20x): Abaxial leaflet surface. Bottom (63x): detail of midvein vestiture showing long, spreading trichomes, and dense, shorter, uncinuate trichomes. Based on: *Fox 5604* (NCSC). W: 152; RAB: 608.



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FIG. 23. *Desmodium viridiflorum* (L.) DC., Prodr. 2: 329. 1825. Top (20x): Abaxial leaflet surface. Bottom (63x): detail of midvein vestiture showing dense, long, spreading trichomes (uncinate trichomes are inconspicuous amidst the spreading trichomes). Based on: *Swab 620* (NCSC). W: 149; RAB: 611.

ACKNOWLEDGEMENTS

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APPENDIX A. Petiole and leaf dimensions of the twenty-two species of *Desmodium* (Fabaceae) in North Carolina. Measurements based on Wilbur (1963).

<i>Species</i>	<i>Petiole length (cm)</i>	<i>Terminal leaflet length x width (cm)</i>
<i>D. canescens</i>	(2) 5-10 (12)	5-12 (15) x 3-8 (10)
<i>D. ciliare</i>	0.1-10	1-2.5 (3) x 0.5-1.2 (1.7)
<i>D. cuspidatum</i>	4-8 (10)	(5) 6-10 (14) x (3) 4-5.5 (7)
<i>D. fernaldii</i>	0.7-1.5 (2.5)	(3) 4-8 (9.3) x 1.8-4 (5)
<i>D. glabellum</i>	(0.2) 0.8-3 (4)	(2) 3-6 (8) x (1) 2-4 (5)
<i>D. glutinosum</i>	(2) 5-9 (12)	6-10 (15) x (4) 6-9 (12)
<i>D. laevigatum</i>	(1.2) 2-5 (6.6)	(3) 4-7 (9) x 2-5
<i>D. lineatum</i>	(0.2) 0.8-2 (3)	(0.7) 1-2.5 (3) x (0.6) 1-2 (3)
<i>D. marilandicum</i>	(0.2) 0.8-1.6 (2.7)	(1) 1.5-2.5 (5) x (0.6) 1-2 (2.6)
<i>D. nudiflorum</i>	5-9	4-10 (12) x 3-6 (8)
<i>D. nuttallii</i>	0.5-2.5 (3.3)	(3) 4-8 (10) x 2.5-5.5
<i>D. obtusum</i>	(0.2) 0.5-2 (2.5)	(0.8) 2-3.5 (4.5) x (0.7) 1-1.8 (2)
<i>D. ochroleucum</i>	(1) 2.5-5 (6)	3.5-7 x 2.5-5
<i>D. paniculatum</i>	(0.2) 1-3.5 (5.3)	(2) 3.5-7 (10) x (0.6) 1-2 (2.5)
<i>D. pauciflorum</i>	3-7.5	(2.5) 4-7 (9) x (2) 3-6
<i>D. perplexum</i>	(1) 2.5-5 (7.5)	(2) 3-7 (10) x 2-4 (6)
<i>D. rotundifolium</i>	3-5	3-5 (7) x 3-5 (7)
<i>D. sessilifolium</i>	0.1-0.3 (0.4)	(2.5) 3-6 (7.3) x (0.45) 0.6-1.2 (1.4)
<i>D. strictum</i>	0.5-1.5 (2.5)	3-5 (7) x 0.3-0.7
<i>D. tenuifolium</i>	(0.1) 0.4-1 (1.7)	(2.5) 4-6 (8) x 0.3-0.6 (0.8)
<i>D. tortuosum</i>	0.5-3 (4.5)	(2) 3-8 (14) x (0.7) 1-3 (6.5)
<i>D. viridiflorum</i>	(0.5) 1.5-5 (7)	(3.5) 4-9 (11.8) x (2) 3-6 (9.5)