

A NOVEL SPECIES OF *NAMA* (NAMACEAE)  
FROM NORTHERN ARIZONA, U.S.A.

Richard A. Crawford and Glenn Rink

Northern Arizona University

P.O. Box 5640

Flagstaff, Arizona 86011, U.S.A.

*rich\_crawford1@yahoo.com; faroutbotany@gmail.com*

ABSTRACT

***Nama arizonica*** R.A. Crawford & G. Rink (Namaceae) is a novel *Nama*, restricted to Coconino and Navajo cos, northern Arizona. Previously, these plants have been determined as *N. dichotoma* (Ruiz & Pav.) Choisy, to which it may be most closely related, though it has morphological similarities to *N. hispida* as well. We present images of plants in the field, seeds, vestiture, and chromosomes.

RESUMEN

***Nama arizonica*** R.A. Crawford & G. Rink (Namaceae) es una nueva *Nama*, restringida a Coconino y Navajo cos, en el norte de Arizona. Anteriormente, estas plantas habían sido determinada como *N. dichotoma* (Ruiz & Pav.) Choisy, con la que puede estar más estrechamente relacionada, aunque también tiene similitudes morfológicas con *N. hispida*. Presentamos imágenes de plantas en el campo, nueces, indumento y cromosomas.

KEY WORDS: Boraginaceae, Namaceae, *Nama*, Arizona, endemic, plant

INTRODUCTION

While developing a plant checklist for the lower Little Colorado River Gorge, Coconino County, Arizona, Richard Crawford noticed that plants that appeared to be *Nama dichotoma* (Ruiz & Pav.) Choisy were distinctive. Whereas *N. dichotoma* leaves, stems and calyx segments have distinctive pedicellate glands, the plants Crawford noticed mostly lacked pedicellate glands on the stems, instead having sessile glands. Also, they have very straight, stiff, hispid, and hirsutulous hairs on the stems which *N. dichotoma* mostly lacks. These novel plants have shorter leaves and often shorter internodes than those of *N. dichotoma*. *Nama dichotoma* is tetraploid while *N. arizonica* is diploid. These plants differ from *N. hispida* in their smaller flowers, smaller habit, and vestiture. They can have many stem leaves as with *N. hispida* A. Gray, or few, as in *N. dichotoma*. Our purpose is to describe this novel taxon.

*Nama* L. was described in the Boraginaceae by Linnaeus (1753). Brand (1913) recognized 36 species. Approximately 20 species have been described since Hitchcock's (1933) major revision of *Nama* (Taylor 2012). With the addition described herein, six species of *Nama* occur in Arizona. Arizona's one record of *N. rothrockii* is excluded as a spurious record.

"Chance and Bacon (1984) examined SEM images of the seed coats of 37 species of *Nama* to investigate variation within the genus and to examine whether observed patterns in seed coats correlated to Hitchcock's (1933) subgeneric classification system" (Taylor 2012). Taylor (2012) added images of the seed coats of 12 additional species to provide a more complete data set of seed coat characters. We provide seed coat images of *N. arizonica* and *N. dichotoma* and discuss their differences.

L.T. Green apparently made the first collection of *Nama arizonica* in 1976 (*Green G-359*). It was not collected again until 2012 when G. Goodwin reconnoitered the botanical resources of the CO Bar Ranch (*Goodwin 3882, 5902, 5907, 5979*). Crawford (2015) added many collections of *N. arizonica* during his thesis work.

## TAXONOMIC TREATMENT

***Nama arizonica*** R.A. Crawford & G. Rink, **sp. nov.** (Fig. 1A–G). TYPE: U.S.A. ARIZONA. Coconino Co.: Babbitt Ranches, N of Wupatki National Monument, 35.59116, -111.37683, 1545 m, 04 Sep 2023, *Rink 17732* (HOLOTYPE: ASC!; ISOTYPES: ARIZ!, ASU!, BRY!, DES!, MNA!, MO!, NAVA!, NY!, UT!).

**Diagnosis.**—Similar to *Nama dichotoma*, however, *Nama arizonica* differs in having corollas with glands on the abaxial surface, while those of *N. dichotoma* lack such glands. Also, *N. arizonica* has prevalingly sessile glands, while those of *N. dichotoma* are prevalingly pedicellate. The stem hairs of *N. arizonica* are stiff, straight, and spreading ascending while those of *N. dichotoma* are more randomly oriented. The leaves of *N. arizonica* tend to be scattered along the stem like those of *N. hispida*, though they can be basally disposed like those of *N. dichotoma*.

Specimens examined: **All specimens in ASC: U.S.A. ARIZONA. Coconino Co.:** east rim of the Little Colorado River gorge, 17 mi W of Cameron, 1.5 mi NE of the terminus of Lee Canyon, Navajo Nation, 21 Aug 2012, *Crawford 527*; Little Colorado River gorge, east rim, river mile 23.5 from the confluence, Navajo Nation, 22 Aug 2012, *Crawford 571*; south rim of Big Canyon 15 km E of its confluence with the Little Colorado River gorge, Navajo Nation, 16 Aug 2013, *Crawford 1085*; Little Colorado River Gorge, northeast rim, river mile 26.8 from confluence, Navajo Nation, 20 Sep 2013, *Crawford 1090*; Little Colorado River gorge, Hellhole Bend, northeast rim, River mile 35.5 from the confluence, Navajo Nation, 20 Sep 2013, *Crawford 1089*; Little Colorado River gorge, N of Straight Canyon, southwest rim, river mile 16.0 from confluence, Navajo Nation, 21 Sep 2013, *Crawford 1099*; Cedar Wash, 2 mi E of Mesa Butte and 3 mi NW of SP Crater, CO Bar Ranch, 8 Sep 2012, *Goodwin 3882*; Citadel Wash, N of Wupatki, CO Bar Ranch, 1 Sep 2013, *Goodwin 5902*; Savage Well near the Wupatki boundary and 0.2 mi N of Citadel Wash, CO Bar Ranch, 1 Sep 2017, *Goodwin 5907*; ca. 4 mi S of Hwy 87, E of Blue Ridge Range Station and W of East Clear Creek, 14 Aug 2018, *Goodwin 5989*; ca. 4 mi S of Hwy 87, E of Blue Ridge Ranger Station along the west rim of East Clear Creek, 14 Aug 2018, *Goodwin 5991* (mixed specimen); Wupatki National Monument, 12 Aug 1976, *Green G359*; Hot Na Na Wash, Marble Canyon, Navajo Nation, 13 Oct 2013, *Rink 12411*; Babbitt Ranches, N of Wupatki National Monument, 29 Sep 2021, *Rink 17121*; Babbitt Ranches, N of Wupatki National Monument, 4 Sep 2021, *Rink 17732*; MNA, CO Bar Ranch, ca. 0.25 mi NE of the jct of Hwy 89 and the Wupatki loop road, 11 Aug 2018, *Goodwin 5979*; Red Gap Ranch, 26 Aug 2006, *Stiversson 43*. **Navajo Co.:** S of Holbrook, 1 mi W of the Hutch Road Crossing of Black Canyon, 24 Sep 2013, *Goodwin 4393*.

**Distribution and habitat.**—*Nama arizonica* is known only from Coconino and Navajo cos., Arizona; 1400–1900 m (4600–6250 ft). It appears to be an edaphic endemic, restricted to limestone and limestone-derived substrates (often with overlying loose volcanic cinders) in north central Arizona. It seems to be most prevalent along Marble Canyon and Little Colorado River gorge rims, but is found south toward the Mogollon Rim as well. It occurs in grassland and sparse pinon juniper woodland.

**Taxonomic discussion.**—When Crawford encountered sympatric occurrences of *Nama arizonica* and *N. dichotoma*, the flowers of *N. arizonica* opened earlier in the morning than those of *N. dichotoma*. In those sympatric populations, no intermediates were found; *N. arizonica* flowers were always pink (Fig. 1A), while *N. dichotoma* flowers were always white. Throughout its range, *N. dichotoma* has flowers that vary from white to lavender (Fig. 1B). Though *N. arizonica* has some similarities in vestiture with *N. hispida*, the flowers are much smaller (Fig. 1C).

Stacked microscope images of the seed coats and scanning electron microscope (SEM) images of vestiture, of both *Nama arizonica* and *N. dichotoma*, exhibit further differences. The ridges separating the alveoli on the surface of *N. dichotoma* seeds tend to be strongly wavy, while those of *N. arizonica* are not wavy, or less so (Figs. 1D and 1E). Seed coat indentations in *N. arizonica* are fewer and shallower than those of *N. dichotoma*. The leaf hairs of *N. arizonica* are broad based, narrowing abruptly and remaining narrow upwards (Figs. 1F and 1G), while those of *N. dichotomum* are broad based, narrowing gradually to the tip (Figs. 1H and 1I). The hairs of both species have small protuberances along the shaft. The protuberances on the hair shafts of *N. dichotoma* are shorter and fewer in number than those on *N. arizonica* hair shafts.

Chromosome numbers from mitotic root tips of *Nama arizonica* are  $2n=14$  (Fig. 1J). *Nama arizonica* is diploid, matching other *Nama* species, but not *N. dichotoma*, which is  $n=14$  (Bacon 1974, 1984).

**Etymology.**—The epithet “*arizonica*” denotes endemism to the State of Arizona.



FIG. 1. **A.** *Nama arizonica* R.A. Crawford & G. Rink, sp. nov. Photo: R. Crawford. **B.** *Nama dichotoma* (Ruiz & Pav.) Choisy. Photo: G. Clifton. **C.** *Nama hispida* A. Gray. Photo: G. Clifton. **D.** *Nama arizonica* seed. Photo: Z. Holditch. **E.** *Nama dichotoma* seed. Photo: Z. Holditch. **F.** Scanning electron microscope (SEM) image of the leaf hairs of *Nama arizonica*. Photo: Ayers and Crawford. **G.** SEM image of the leaf hairs of *Nama arizonica*. Photo: Ayers and Crawford.

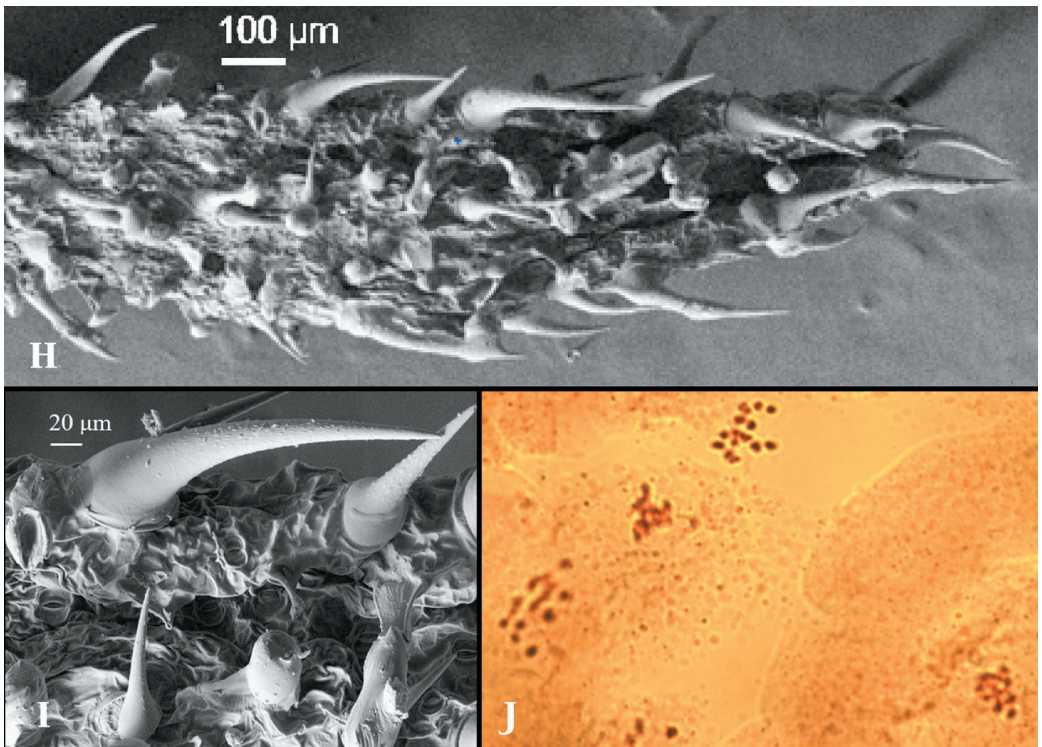


FIG. 1. **H.** SEM image of the leaf vestiture of *Nama dichotoma* (Ruiz & Pav.) Choisy. Photo: Ayers and Crawford. **I.** SEM image of the vestiture of *Nama dichotoma*. Photo: Ayers and Crawford. **J.** Chromosomes from root tips of *Nama arizonica*. Photo: Ayers and Crawford.

#### KEY TO THE NAMA OF NORTHERN ARIZONA

1. Corolla relatively large and showy, 6–18 mm long.
  2. Plants often sprawling, sometimes ascending; leaves disposed basally and in the inflorescence such that the stems are easily visible; leaves flat; seeds cross-alveolate; mostly low desert \_\_\_\_\_ **N. demissa**
  2. Plants ascending; leaves well-disposed along the stems such that the stems can be hidden; leaves often inrolled at the margins; seeds tending to be longitudinally alveolate; mostly high desert \_\_\_\_\_ **N. hispida**
1. Corolla relatively small and inconspicuous, 3–8 mm long.
  3. Stems often not readily visible due to abundant stem leaves; stem hair orientations: longer ones ascending-spreading, underlayerment usually dense, retrorse; leaves strongly inrolled; capsule short, ovate \_\_\_\_\_ **N. retrorsa**
  3. Stem usually readily visible with longer internodes between the stem leaves; stem hair orientations various, but without an underlayerment of dense retrorse hairs; leaves flat or inrolled only at the edges; capsule lanæolate to ovate.
    4. Stems sprawling; leaves spatulate to ovate, 2–10 mm long \_\_\_\_\_ **N. pusilla**
    4. Stems ascending; leaves linear elliptic to oblanceolate, (3–)6–40 mm long.
      5. Stems, leaves, and calyx segments with prevailing pedicellate glands; hairs slightly curved; corolla limb projecting to slightly spreading; widespread \_\_\_\_\_ **N. dichotoma**
      5. Stems, leaves, and calyx segments with prevailing sessile glands, sometimes a few pedicellate glands present; hairs stiff, straight; corolla limb flared; restricted to Coconino and Navajo cos. \_\_\_\_\_ **N. arizonica**

#### ACKNOWLEDGMENTS

Gary Alpert and Zane Holditch of Northern Arizona University generously donated their time, expertise, and photography equipment for Figs. 1D and 1E. Tina Ayers, ASC curator, and Toni Jageri (ASC) donated various images including SEM images. Thanks to Glenn Clifton for the use of his images. We appreciate that the Navajo Nation facilitated permits for research and collecting on their lands. We could not have done this work without the services and collections of the Deaver Herbarium (ASC), Northern Arizona University, Flagstaff,

Arizona. We appreciate that Richard Halse and Sarah Taylor thoroughly reviewed this ms, providing many helpful comments.

## REFERENCES

- BACON, J.D. 1974. Chromosome numbers and taxonomic notes in the genus *Nama* (Hydrophyllaceae) Brittonia 26(2):101–105.
- BACON, J.D. 1984. Chromosome numbers and taxonomic notes in the genus *Nama* (Hydrophyllaceae) II. Sida 10:269–275.
- BRAND, A. 1913. Hydrophyllaceae. In A. Engler, Das Pflanzenreich, IV. 25:1–210.
- CHANCE, G.D. & J.D. BACON. 1984. Systematic implications of seed coat morphology in *Nama* (Hydrophyllaceae). Amer. J. Bot. 71:829–842.
- CRAWFORD, R. 2015. A flora of the Little Colorado River Gorge, 2015. M.S. Thesis, Northern Arizona University, Flagstaff, U.S.A.
- HITCHCOCK, C.L. 1933. A taxonomic study of the genus *Nama*. Amer. J. Bot. 20(6):415–430; 518–534.
- LINNAEUS, C. 1753. Species plantarum. Laurentius Salvius, Stockholm, Sweden.
- TAYLOR, S.E. 2012. Molecular systematics and the origins of gypsophily in *Nama* L. (Boraginaceae). Ph.D. diss. University of Texas at Austin, U.S.A.