

Distribution. Known only from Mount Hamilton in the Diablo Range, Santa Clara County, California.

Habitat. Oak woodland and chaparral.

Seasonal occurrence. Available records indicate adult activity extends throughout the summer from mid-June (12-VI-1982, DB Weissman, CAS) through mid-August (8-VIII-2015, DB & DW Weissman, CAS).

Stridulatory file. (n = 4) length 2.8–3.5 mm, 114–134 teeth, tooth density 39.1 ± 2.3 (36.3–41.3) teeth/mm.

Song. (n = 9) Unique. PTR is bimodal and switches between a slow rate $7.45 \pm 0.59 \text{ s}^{-1}$ and a fast rate of $11.2 \pm 1.28 \text{ s}^{-1}$.

Karyotype. (n = 4) $2n_{\text{♂}} = 26$ (2m + 22t + XtYt), S82-23, T82-2, paratopotype.

Recognition. Stridulatory file, male genitalia, song, and geography. A low stridulatory file tooth density separates this species (36–41 teeth/mm) from *N. carinata*, which has a significantly higher density (38–55 teeth/mm; two-sample *t*-test, $P = 0.007$). The ventral sclerite is robust with a straight shaft, low convex apex, and a minute lateral process. Other Carinata Group species have a longer lateral process, and the shaft of Convexa Clade species is curved. Santa Lucia Mountains *N. carinata* males may have a minute lateral process but the whole sclerite is not as robust as in *N. oblongata*. The ventral sclerite of *N. diabolica*, which inhabits the same mountain range, has a more conical apex, a longer lateral process, and a curved shaft. The calling song is unique among Carinata Group species in having a bimodal PTR. The female subgenital plate is pentagonal and flat, identical to *N. carinata*, both of which are separated from *N. diabolica* by the lack of a medial groove. This species is geographically restricted to the Mount Hamilton vicinity in the Diablo Range of California.

Etymology. *l. oblongata* oblong, referring to the fusiform habitus and enlarged, oval pronotum.

Notes. The two highest peaks in the Diablo Range, Mount Hamilton (1284 m) and Mount Diablo (1173 m) are mountain habitat islands separated by a mere 67 km, yet each harbors a distinct Carinata Group species (see *N. diabolica* below). This contrasts with a single (albeit variable) species, *N. carinata*, distributed across 200 km of the South Coast Ranges. The Santa Clara Valley is thus implicated as an isolating barrier between the Diablo Range and the Coast Ranges, while the Vallecitos Valley is a potential biogeographic break between populations in the north and south of the Diablo Range. The bimodal PTR in the male calling song is reminiscent of the songs of Sierranus Group species (see below). Given the evolutionary distance between the Carinata Group and the Sierranus Group (Figs. 3–5), the mostly likely explanation for shared bimodal PTR is convergent evolution. A preexisting receiver response may exist in *Neduba* females (e.g. Basolo 1996; Ryan & Rand 1999) that selects for male songs with an elaborate pattern or additional OPT.

Material examined. Type series only. See Type material above.

Neduba ambagiosa Cole, Weissman, & Lightfoot sp. n.

Fig. 9 (distribution), Fig. 12 (male and female habitus, calling song, male and female terminalia, karyotype), Plate 1B–C (live habitus), Plate 4C (male calling song), Plate 6I (male ventral sclerite), Plate 6G–H (male ventral sclerites, *ambagiosa* x *carinata* hybrids), Plate 9D (male titillators), Plate 11C (female subgenital plate).

Common name. Ambiguous Shieldback.

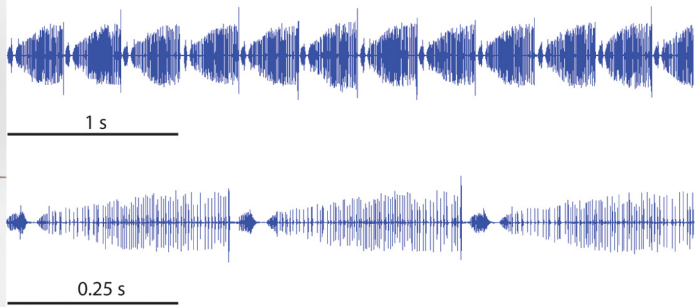
History of recognition. Individuals of this species were encompassed in the type series of *N. convexa* (Caudell 1907).

Type material. HOLOTYPE MALE: USA, CA, Lake Co., Middle Creek, 2.7 mi. S of Middle Creek Campground on Elk Mountain Road, 39.21569N, 122.93381W, 430 m, 6-VIII-2014, JA Cole, DB Weissman, JAC000001944 [specimen barcode], S14-64 [stop], JCR140918_00 [recording], 110T [teeth] 3.4 [mm stridulatory file length], genitalia extracted and cleared in vial and excised tegmen in gelcap below specimen, deposited at CAS, Entomology type #19706.

PARATYPES (n = 27): USA, CA, Lake Co., 6♂, 3♀, Middle Creek Campground, 7 miles northwest of Upper Lake on Elk Mountain Road, 39.2537N, 122.9502W, 610 m, 3-6-VII-2003, JA Cole, LACM; 1♂, 1♀, same data except JAC; 5♂, 4♀, Middle Creek, 2.7 miles south of Middle Creek Campground on Elk Mountain Road, 39.21569N, 122.93381W, 430 m, 6-VIII-2014, JA Cole, DB Weissman, LACM; Mendocino Co., 4♂, 3♀, Tranquility, 1 mile south of Caspar, 39.349009N, 123.815849W, 7-VII-1982, JR Helfer, CAS.

Measurements. (mm, ♂n = 16, ♀n = 9) Hind femur ♂17.59–22.4, ♀19.95–22.36, pronotum total length ♂7.82–11.14, ♀6.90–8.84, prozona length ♂3.26–4.91, ♀3.75–5.12, metazona dorsal length ♂4.35–6.23, ♀2.93–3.87,

male HOLOTYPE CA: Lake Co. JAC000001944 calling song PARATOPOTYPE CA: Lake Co. 24.5°C JCR140816_01



male terminalia PARATOPOTYPE CA: Lake Co. JAC000001947



female PARATOPOTYPE CA: Lake Co. JAC000001952



ventral sclerite
HOLOTYPE



subgenital plate PARATOPOTYPE
CA: Lake Co. JAC000001950



male PARATOPOTYPE CA: Lake Co. JAC000001938



karyotype PARATOPOTYPE CA: Lake Co. S14-64 T14-24 JAC000001949



FIGURE 12. *N. ambagiosa* male and female habitus, calling song, male and female terminalia, and karyotype.

pronotum constriction width ♂1.55–2.93, ♀2.30–3.15, metazona dorsal width ♂5.43–7.00, ♀4.20–6.15, head width ♂3.75–4.80, ♀4.42–5.10, ovipositor length ♀13.43–18.81.

Distribution. North Coast Ranges of California. The type locality is in the vicinity of Clear Lake.

Habitat. Understory of chaparral and mixed conifer forests, riparian corridors, and canyon bottoms. On leaf litter, poison oak, and on tree trunks.

Seasonal occurrence. mid-June (16-VI-1978, DB Weissman, CAS) through November (15-XI-1953 JR Helfer, CAS). Nymphs from December through July.

Stridulatory file. (n = 13) length 2.6–3.9 mm, 94–139 teeth, tooth density 34.2 ± 2.6 (30.8–40.9) teeth/mm.

Song. (n = 11) PTR 2.9 ± 0.3 s⁻¹, identical to topotype *N. convexa*. PTF 13.0 ± 0.9 kHz. Males are nocturnal singers. A genetically identified hybrid population (Fig. 4; see also Notes under *N. carinata*) from Solano County, California has a significantly faster pulse rate of 3.1 ± 0.2 s⁻¹ (ANCOVA, $P = 1.08 \times 10^{-5}$).

Karyotype. (n = 9) $2n\♂ = 26$ (2m + 22t + XtYt). T14-24, S14-64, paratopotype.

Recognition. A low stridulatory file tooth density (30–40) will separate this species from *N. carinata* and *N. diabolica* distributed to the south. The ventral sclerite apex is usually conical to pyramidal, rarely flat, with a short to medium-length lateral process. The length of the lateral process is shorter than most *N. convexa*, a species of the Sierra Nevada, northern Central Valley and Cascade Range, but is longer than that of *N. oblongata* in the Diablo Range. The lateral process is shorter than the shaft, separating this taxon morphologically from *N. longiplutea* distributed farther north in the North Coast Ranges. Curved apical margins and a distinct central groove on the triangular subgenital plate will separate females of this species from *N. carinata*, *N. diabolica*, and *N. oblongata* which are pentagonal with straight apical margins. The subgenital plate of *N. longiplutea* to the north is longer than wide with a bifurcate apex in contrast to the subequal length and width and entire, acute apex of this species. Calling song will separate this species from *N. carinata*, *N. oblongata*, and *N. diabolica* as all are species with similar length MPT and OPT and fast PTR.

Etymology. *l. ambagiosa* circuitous, indirect, roundabout, referring to the distribution being the southwestern extent of a ring of Convexa Clade taxa around the Central Valley (Fig. 8).

Notes. This species has exchanged genes with populations of *N. carinata* (see also Notes section under *N. carinata* species account). In addition to DNA evidence (Fig. 4), males from a population along Putah Creek in Solano County have a high stridulatory file tooth density as in *N. carinata* but sing with *N. convexa* song, albeit with a faster PTR that may be influenced by *N. carinata* alleles. The geography of this hybrid population suggests that other populations from the northern and eastern Bay Area may also have hybrid characteristics. Stridulatory files from north Bay Area populations that we have examined are within the range for this species. Populations in inland locations such as Solano County may experience gene flow that is otherwise prevented across the Coast Ranges by San Francisco Bay. A precopulatory pair was observed (JAC pers. obs.) at the type locality (Fig. 2G, Plate 1B). After phonotaxis the female oriented directly behind the male and palpated the male with her antennae.

Material examined. DETERMINED (n = 51): **All USA, CA, Alameda Co.,** 1♂, Berkeley, Strawberry Canyon, 37.871593N, 122.272747W, 4-VII-1959, RW Thorp, CAS; **Humboldt Co.,** 1♂, Scotia, 40.482357N, 124.100881W, 18-VII-1958, JR Helfer, CAS; **Lake Co.,** in addition to type material (above), 2♂, 1♀, Anderson Springs, 38.775N, 122.69194W, 29-VII-1961, JS Buckett, BMED; 1♀, Anderson Springs, 38.775N, 122.69194W, 7-VIII-1955, JS Buckett, BMED; 1♂, Blue Lakes, 39.17111N, 123.01111W, 414 m, 30-VII-1949, HA Hurt, BMED; 1♂, SR20, mile marker 114, 39.01101N, 122.4908W, 423 m, 5-VIII-2014, JA Cole, DB Weissman, JAC sound record; **Marin Co.,** 1♂, 2.9 km Samuel P Taylor State Park, 38.02583N, 122.72667W, 61 m, 27-IX-1981, VF Lee, CAS; 1♂, Lagunitas, 38.011312N, 122.702208W, 5-VII-2009, EC VanDyke, CAS; 1♂, 1♀, Lake Lagunitas, 37.946869N, 122.594742W, 24-VI-1958, DC Rentz, CAS; 1♂, McClures Beach, 38.187421N, 122.965276W, 15-VII-1960, JS Buckett, BMED; 1♂, same data except CAS; 1♂, same data except 2-X-1960, JS Buckett, BMED; 1♂, same data except 6-VIII-1964, JS Buckett, BMED; 2♂, Tomales Bay State Park, beach area, 38.166667N, 122.916667W, 16-VI-1978, DB Weissman, CAS; **Mendocino Co.,** 5♂, Mendocino, 39.307674N, 123.799459W, 37 m, 1960, ER Tinkham, CAS; 1♀, same data except 10-XI-1959, JR Helfer, CAS; 1♂, same data except, 10-XI-1961, JR Helfer, CAS; 1♂, same data except 15-X-1959, JR Helfer, CAS; 1♀, same data except 15-XI-1953, JR Helfer, CAS; 1♂, 1♀, same data except 20-X-1962, JR Helfer, CAS; 1♀, same data except 22-X-1961, JR Helfer, CAS; 1♀, same data except, 3-X-1958, JR Helfer, CAS; 1♂, same data except 3-XI-1959, JR Helfer, CAS; 1♂, same data except 3-XI-1961, JR Helfer, CAS; 1♂, same data except 30-X-1959, JR Helfer, CAS; 1♀, same data except 5-XII-1958, JR Helfer, CAS; 3♂, Ukiah, 39.15017N, 123.20778W, 196 m, 2014, JN Hogue, CSUN; 1♂, 3♀, Mendocino Co., 20-VII-1923, ER Leach, CAS;

Napa Co., 1♂, end of Atlas Peak Road 10 mi. airline N of Napa, 38.450743N, 122.262753W, 6-VII-1973, JA Sutro, CAS; 1♀, north side Howell Mountain, 2 miles NNE Angwin, 38.602527N, 122.435787W, 396 m, 18-X-1974, HB Leech, CAS; **San Francisco Co.**, 5♂, Lands End, 37.787707N, 122.505528W, 17-X-1909, FX Williams, CAS; **Solano Co.**, 1♀ nymph, Green Valley, 38.227515N, 122.151579W, 34 m, 16-VI-1953, AA Grigarick, BMED; **Sonoma Co.**, 1♂, Bodega Bay, 38.33325N, 123.048057W, 20-VII-1974, LD & MD Anderson, UCR; QUESTIONABLE PLACEMENT (n = 20): **Alameda Co.**, 1♀, Oakland Hills, 37.804372N, 122.270803W, 6-IX-1948, CD MacNeill, CAS; **Marin Co.**, 1♂, McClures Beach, Pt. Reyes Peninsula, 38.187421N, 122.965276W, 2-X-1960, JS Buckett, CAS; 1♀, Mill Valley, 37.89076N, 122.523586W, 2-VIII-1925, EP VanDuzee, CAS; 1♀ nymph, same data except 24-VI-1923, EP VanDuzee, CAS; 1♀ nymph, same data except 25-VI-1925, EP VanDuzee, CAS; 1♀, same data except 26-VII-1926, EP VanDuzee, CAS; 1♀, same data except 27-VI-1925, EP VanDuzee, CAS; 1♀, same data except 5-VII-1925, EP VanDuzee, CAS; 1♀, same data except 7-XI-1925, EP VanDuzee, CAS; 2♂, Mount Tamalpais, NE slope, 37.927425N, 122.591924W, 700 m, R Hunt, BMED; **Mendocino Co.**, 1♀, Navarro, 39.151843N, 123.541956W, 18-XII-1973, DO Clark, CSCA; 1♂, VanDamme State Park, 39.27639N, 123.77333W, 13-X-1979, T Tyler, CSCA; **Napa Co.**, 1♀, Hwy 121, 6 mi. NW of Napa, 38.403064N, 122.4184W, no collector, CSCA; 1♀ nymph, Lake Berryessa, 38.58903N, 122.229496W, 20-V-1961, CD MacNeill, CAS; **Solano Co.**, 1♂, Vallejo, 38.104086N, 122.256637W, 18 m, 6-VIII-1956, D Haug, CSCA; **Sonoma Co.**, 1♂ nymph, Cazadero, 38.533246N, 123.08528W, 36 m, 5-VII-1962, R Bartges, BMED; 1♀, Jenner, 38.449636N, 123.115559W, 17-X-1937, no collector, BMED; 1♀ nymph, Kenwood, 38.4138N, 122.546094W, 126 m, 14-V-1960, TH Gantenbein, BMED; 1♀ nymph, Stillwater Cove, 38.545833N, 123.298611W, 23-V-1954, EI Schlinger, BMED; HYBRIDS WITH *N. CARINATA*: **Napa Co.**, 1♀, Monticello Dam, 38.513394N, 122.104351W, 8-X-1969, F Andrews, CSCA; **Solano Co.**, 3♂, Lake Solano County Park, 5 mi. SW of Winters off SR128, 38.49576N, 122.03399W, 51 m, 30-VII-2016, JA Cole, LACM; 12♂, 3♀, same data except 31-VII-1-VIII-2013, JA Cole, LACM; 7♂, same data except 31-VII-2014, JA Cole, DB Weissman, LACM; 2♂, 1♀, same data except 31-VII-1-VIII-2013, JA Cole, JAC; 1♀, same data except 25-VII-2019, JA Cole, JAC

***Neduba diabolica* (Scudder, 1899)**

Fig. 9 (distribution), Fig. 13 (male and female habitus, calling song, male and female terminalia, karyotype), Plate 4D (male calling song), Plate 6F (male ventral sclerite), Plate 9E (male titillators), Plate 11D (female subgenital plate).

Common name. Mount Diablo Shieldback.

History of recognition. Originally described in *Tropizaspis* from a female taken at “Monte Diablo, California” (Scudder 1899). Rentz & Birchim (1968) assigned the majority of South Coast Range *Neduba* populations to this species and synonymized variety *picturata* (Scudder 1899) under this name. We reassign all other South Coast Range populations to *N. carinata*. The type of *picturata* was collected during the Northwestern Boundary Survey (Caudell 1907), which makes *picturata* a synonym of *N. steindachneri* (see discussion under that species) and not *N. diabolica*.

Type material. The female holotype is housed in ANSP. Type not examined by us but images available at OSFO (Cigliano *et al.* 2020). **TOPOTYPES EXAMINED** (n = 23): **USA, CA, Contra Costa Co.**, 1♀, Mount Diablo State Park, 37.862703N, 121.93107W, 1021 m, 1-IX-2002, DB Weissman, CAS; 3♂, Mount Diablo State Park, 37.862703N, 121.93107W, 670-1160 m, 30-VI-1990, DB & DD Weissman, CAS; 3♂, Mount Diablo State Park, Fire Interpretive Trail, 37.8807N, 121.9172W, 1131 m, 20-21-VII-2005, JA Cole, JF Eguizabal, LACM; 1♂, Mount Diablo State Park, Juniper Camp, 37.8785N, 121.9339W, 886 m, 27-28-VI-2008, JA Cole, W Chatfield-Taylor, W Ericson, JAC; 1♂, 1♀, same data except LACM; 1♂, Mount Diablo State Park, Juniper Camp, 37.862703N, 121.93107W, 886 m, 28-VIII-1982, DB Weissman, CAS; 1♂, 1♀, Mount Diablo State Park, Lookout Point, 37.862703N, 121.93107W, 7-VI-1967, DC & KA Rentz, CAS; 2♂, Mount Diablo State Park, near North Gate Entrance, 37.862703N, 121.93107W, 229 m, 13-VII-1982, DB Weissman, CAS; 1♂, 2♀, Mount Diablo State Park, summit, 37.862703N, 121.93107W, 1021 m, 11-VIII-1990, DB Weissman & DW Weissman, CAS; 1♂, same data except 13-VII-1982, DB Weissman, CAS; 2♂ nymphs, 1♀ nymph, Russelman Park, Mount Diablo East Slope, 19-IV-1931, EP VanDuzee, CAS; 1♂ nymph, same data except 24-IV-1932, EC VanDyke, CAS.

Measurements. (mm, ♂n = 8, ♀n = 3) Hind femur ♂20.09–22.49, ♀21.80–23.09, pronotum total length ♂9.50–