

other *Neduba* except *N. diabolica*. Females have a pentagonal subgenital plate without sinuous distal margins and no medial groove, characters shared only with *N. oblongata*.

Notes. This is a common species in California Coast Range woodlands throughout summer and fall. The proximity of the range to the heavily populated San Francisco Bay Area and the low frequency calling song that many people can hear makes this one of the most commonly encountered species. Considerable variation exists in the male internal genitalia, which we attribute to historical episodes of population isolation and contact as the California coastline and Coast Ranges changed repeatedly and dramatically over the Cenozoic Era. The Santa Lucia Range and portions of the Santa Cruz Mountains have changed between islands, peninsulas, and broad mainland connections (Bartow 1991). A distinct ventral sclerite shape is found in the Santa Lucia Range (Fig. 10, Plate 6B), which may reflect separation from the Coast Ranges north of Monterey Bay by a marine embayment that lasted from 18 to 2 Ma (Hall 2002). Santa Cruz Mountains *N. carinata* have ventral sclerites with long lateral processes (Fig. 10, Plate 6D) that resemble those of several Convexa Clade taxa (Plates 6–7). The Carinata and Convexa Clades meet geographically in the San Francisco Bay Area, where mtDNA introgression (Fig. 4) suggests gene flow as the explanation for shared ventral sclerite morphology despite distinct calling song differences.

Material examined (n = 116). All USA, CA, Monterey Co., 1♂, 1.5 mi. N of Carmel, 36.58N, 121.92W, 213 m, 23-VI-1957, TJ Cohn, CAS; 1♂, 1♀, 11.2 mi. N Pfeiffer Big Sur State Park off Hwy 1, 36.411288N, 121.782732W, 5-VII-1986, DB & BI Weissman, CAS; 1♀, Asilomar, 1.3 mi. W of Pacific Grove, 36.617735N, 121.94011W, 10-VII-1957, TJ Cohn, CAS; 1♀ nymph, Big Sur River Trail, 36.280942N, 121.860028W, 21–23-V-1971, FS Bartholomew, CAS; 6♂, 1♀, Big Sur, SR1, 36.3547N, 121.8136W, 685 m, 20-VIII-2012, JA Cole, LACM; 2♂, Bottcher's Gap, Los Padres National Forest, 19 miles north of Big Sur off SR1 on Palo Colorado Road, 36.355N, 121.8138W, 652 m, 20-VIII-2012, JA Cole, LACM; 2♂, same data except 7-IX-2002, JA Cole, LACM; 1♂, 1♀, same data except JAC; 1♂, Nacimiento-Ferguson Rd., at bridge of Nacimiento R., 8.4 mi. E of SR1, 36.0135N, 121.4216W, 587 m, 19–20-VIII-2012, JA Cole, JAC sound record; 2♂, 1♀, Pacific Grove, 36.617738N, 121.916622W, 4-VII-1925, HH Keifer, CAS; 1♂, Palo Colorado Rd., 3 mi. E of SR1, 36.3864N, 121.8687W, 327 m, 20-VIII-2012, JA Cole, JAC sound record; 1♂ nymph, Pebble Beach, 36.56635N, 121.946622W, 18-V-1969, RP Allen, CSCA; 1♀ nymph, same data except 27-V-1921, EC VanDyke, CAS; 1♂, Pfeiffer Big Sur State Park, 36.248852N, 121.782732W, 60 m, 23-IX-1995, DB Weissman, CAS; 3♂, same data except 27-IX-1985, DB Weissman, CAS; 4♂, 3♀, same data except 5-VII-1986, DB & BI Weissman, CAS; **San Benito Co.**, see Type material above; **San Francisco Co.**, 1♂, San Francisco, 37.77493N, 122.419416W, 24-X-1909, FX Williams, CAS; **San Mateo Co.**, 2♂, Jasper Ridge, 37.407995N, 122.22691W, 12-VII-1982, DB Weissman, CAS; 1♂, Kings Mount, 37.44083N, 122.32333W, 14-X-1946, ES Ross, CAS; 1♂, 1♀, same data except 17-VIII-1946, ES Ross, CAS; 1♂, Portola State Park, 37.2527N, 122.21854W, 8-VIII-1962, RP Allen, CSCA; **Santa Clara Co.**, 1♀, Los Gatos, 12-XII-1965, J Harville, CAS; 2♂, Los Gatos, 15431 Francis Oaks Way, 37.22661N, 121.97468W, 22-VIII-2013, DB Weissman, CAS; 1♂, same data except VI-1986, DB Weissman, CAS; 7♂, 2♀, Los Gatos, Francis Oaks Way, 37.226611N, 121.97468W, 120 m, 6-VII-1987, DB Weissman, CAS; 2♂, Uvas Canyon County Park, 15 miles west of Morgan Hill on Croy Road, 37.0855N, 121.7954W, 349 m, 19-20-VII-2005, JA Cole, JF Eguizabal, JAC; 6♂, 1♀, same data except LACM; 1♂, 2♀, same data except 2-3-VII-2003, JA Cole, LACM; 2♂, 2♀, same data except 22-VIII-2014, DB & DW Weissman, CAS; 1♂, same data except 6-IX-2002, JA Cole, JAC; 2♂, same data except LACM; 1♂, Mount Umunhum, 37.15255N, 121.89897W, 1008 m, 5-VII-2018, DW & DB Weissman, CAS; **Santa Cruz Co.**, 1♀, Loma Prieta, 37.110781N, 121.844676W, 2-VIII-1959, CAS; 1♀, Santa Cruz, 36.974117N, 122.030796W, 25-XI-1955, RL Lewis, CSCA; 1♂, Soquel, 36.98801N, 121.95663W, 18-XII-2016, DW Weissman, CAS; 4♂, same data except 9-IX-2014, DW Weissman, CAS; 1♂, Summit above Saratoga, 37.263832N, 122.023015W, 26-VIII-1968, J Smith, BMED; 6♂, 1♀, U.C. Santa Cruz Campus, 36.974117N, 122.030796W, 25-VI-1982, SI Weissman, CAS.

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

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

Common name. Mount Hamilton Shieldback.

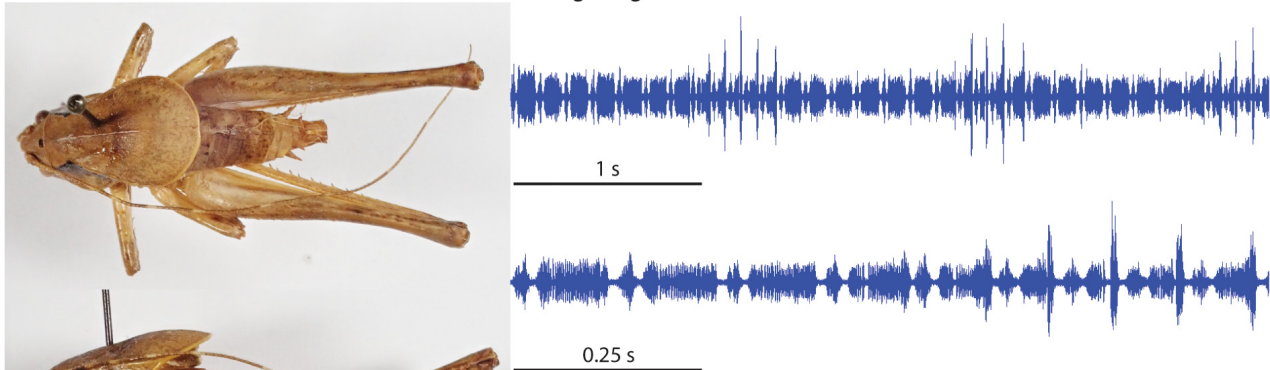
History of recognition. None.

Type material. HOLOTYPE MALE: USA, CA, Santa Clara Co., Mount Hamilton, 2.6 road mi. W observatory, 37.341883N, 121.643002W, 1036 m, 12-VI-1982, DB Weissman, S82-23 [stop], R82-47 [recording], T82-2 [karyotype], 127 [teeth] 3.5 [mm stridulatory file length], deposited at CAS, Entomology type #19713.

PARATYPES (n=10): USA, CA, Santa Clara Co., 1♂, Mount Hamilton, 0.3 mi. W observatory, 37.341883N, 121.643002W, 1260 m, 6-VII-1997, DB Weissman, CAS; 3♂, Mount Hamilton, 15 mi. W observatory, 37.341883N, 121.643002W, 488 m, 12-VI-1982, DB Weissman, CAS; 3♂, 1♀, Mount Hamilton, 2.6 mi. W observatory, 37.341883N, 121.643002W, 1036 m, 12-VI-1982, DB Weissman, CAS; 2♂, Mount Hamilton, 6.5 mi. W observatory, 37.32864N, 121.65729W, 686 m, 8-VIII-2015, DB & DW Weissman, LACM

Measurements. (mm, ♂n = 8, ♀n = 1) Hind femur ♂18.44–20.61, ♀22.01, pronotum total length ♂8.65–11.01, ♀9.66, prozona length ♂3.65–5.21, ♀4.95, metazona dorsal length ♂4.80–6.27, ♀4.71, pronotum constriction width ♂2.50–3.14, ♀3.55, metazona dorsal width ♂6.00–7.39, ♀6.43, head width ♂4.26–4.85, ♀5.18, ovipositor length ♀18.58.

male HOLOTYPE CA: Santa Clara Co. S82-23 calling song PARATOPOTYPE CA: Santa Clara Co. 26.0°C R82-55



male terminalia PARATOPOTYPE CA: Santa Clara Co. JAC000002252



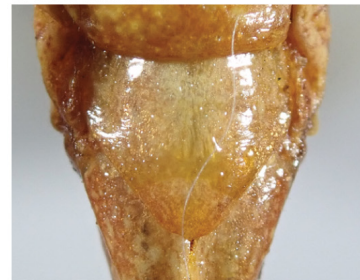
female PARATOPOTYPE CA: Santa Clara Co. S82-23



ventral sclerite HOLOTYPE



female terminalia PARATOPOTYPE JAC000002253



karyotype PARATOPOTYPE CA: Santa Clara Co. S82-23 T82-2

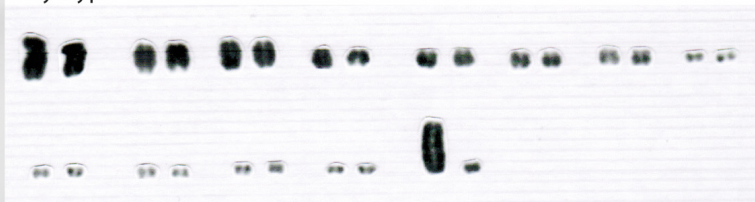


FIGURE 11. *N. oblongata* male and female habitus, calling song, male and female terminalia, karyotype.

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,