

## *Neduba carinata* Walker, 1869

Figure 9 (distribution), Fig. 10 (male and female habitus, calling song, male and female terminalia, karyotype), Plate 1A (live habitus), Plate 4A (male calling song), Plate 6A–D (ventral sclerites), Plate 9A–C (male titillators), Plate 11A (female subgenital plate).

**Common name.** Carinate Shieldback.

**History of recognition.** As the type species of *Neduba*, establishing the identity of *N. carinata* is of central taxonomic importance. In a situation resembling that of *Gryllus assimilis* (Rehn & Hebard 1915), *N. carinata* was at times used as a “trash can” taxon (Rentz & Birchim 1968), into which multiple species were binned (e.g. Tinkham 1944). The broad type locality of “California” was narrowed to Fremont Peak, San Benito County, California, USA (Rentz & Birchim 1968). We accepted this type locality designation and determined taxonomic and geographic relationships relative to this locality. The Fremont Peak type locality is in the Gabilan Range of the South Coast Ranges of California. In over 40 years of fieldwork by orthopterists at Fremont Peak (e.g. Helfer 1987; Rentz & Birchim 1968; Strohecker *et al.* 1968), sympatric *Neduba* species have not been found at this locality; however, the correct assignment of the name *N. carinata* requires that all other possibilities are eliminated. This is a valid concern considering that an additional *Neduba* species occurs in the South Coast Ranges (see *N. lucubrata*). Images of the *N. carinata* holotype show a subgenital plate with parallel lateral carinae and long, articulate styli (Cigliano *et al.* 2020), a condition that is found in all topotypic males that we have examined. In contrast, the subgenital plate of *N. lucubrata* has lateral carinae that converge to the apex and terminate in rudimentary knob-like styli. Thus, we conclude that the name *N. carinata* indeed belongs to our topotypic series. Variety *picturata* (Scudder 1899) was synonymized under *N. diabolica* (Rentz & Birchim 1968).

**Type material.** F. Walker’s male holotype of *N. carinata* resides in the British Museum. Type not examined by us but images available at OSFO (Cigliano *et al.* 2020). TOPOTYPES EXAMINED (n = 25): **USA, CA, San Benito Co.**, 2♂, Fremont Peak State Park, peak area, 36.760793N, 121.502442W, 457 m, 25-VI-1982, DB Weissman, CAS; 6♂, 1♀, same data except 762 m, 25-VI-1982, DB Weissman, CAS; 14♂, 1♀, Fremont Peak State Park, Valley View Campground, 11 mi. S of San Juan Bautista on County Road G1, 36.7597N, 121.505W, 829 m, 18–19-VII-2005, JA Cole, JF Eguizabal, LACM; 1♂, same data except JAC.

**Measurements.** (mm, ♂n = 34, ♀n = 7) Hind femur ♂18.33–28.80, ♀21.55–26.21, pronotum total length ♂8.23–10.72, ♀8.35–10.05, prozona length ♂3.43–4.88, ♀4.02–5.20, metazona dorsal length ♂4.45–6.45, ♀3.67–4.85, pronotum constriction width ♂2.00–2.78, ♀2.35–3.00, metazona dorsal width ♂5.11–7.25, ♀5.18–6.45, head width ♂3.89–4.84, ♀4.60–5.32, ovipositor length ♀16.00–18.27.

**Distribution.** South Coast Ranges of California, from the southern San Francisco Bay Area south along the Santa Lucia Range to Morro Bay.

**Habitat.** Understory vegetation, tangles, and leaf litter in mixed woodland, riparian woodland, and coastal redwood (*Sequoia sempervirens* (Lamb. ex D. Don) Endl.) forest. Males call near the forest floor from plants such as poison oak (*Toxicodendron diversilobum* (Torr. & A. Gray)), introduced Mediterranean grasses, and peavines (*Lathyrus* sp.).

**Seasonal occurrence.** Adults from late June (23-VI-1957, TJ Cohn, CAS) through December (18-XII-2016, DW Weissman, CAS). Nymphs collected in May and alongside adults in late June (CAS).

**Stridulatory file.** (n = 24) length 2.4–3.4 mm, 115–159 teeth, tooth density  $44.7 \pm 3.9$  (38.5–55.3) teeth/mm.

**Song.** (n = 52) Frequent sustained bouts of low frequency lisping. Males call incessantly at night and sometimes during the afternoon. PTR  $10.9 \pm 2.1$  s<sup>-1</sup>. The MPT and OPT are subequal in length. Males spend a lot of time singing with PTdc  $73.1 \pm 9.7\%$  (calculated by combining both MPT and OPT). PTF  $11.4 \pm 1.7$  kHz is among the lowest carrier frequencies in the genus.

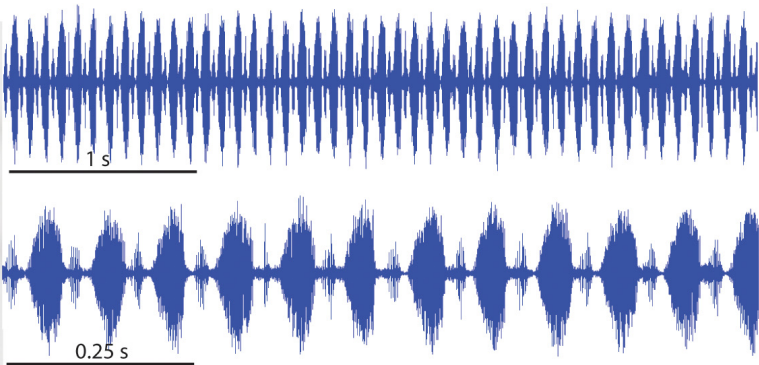
**Karyotype.** (n = 22)  $2n♂ = 26$  (2m + 22t + XtYt). T82-6, S82-26, topotype.

**Recognition.** This species is separated morphologically from all other species in the Carinata Group except *N. diabolica* by the high stridulatory file tooth density (38–55 teeth/mm). The male ventral sclerite throughout most of the range has the shaft broad and straight (narrow, curved shaft in Convexa Clade), the apex broad and convex to subconical covered with tubercles of large size, and a short lateral process (often long and shelf-like in the Convexa Clade). In *N. carinata* populations found near the Convexa Clade in the South Bay Area, the ventral sclerite of the former species resembles the latter and is an unreliable diagnostic feature; songs remain diagnostic. Acoustically, the low frequency, rasping or lisping bouts of song with a fast uniform PTR (~11 s<sup>-1</sup>) separate this species from all

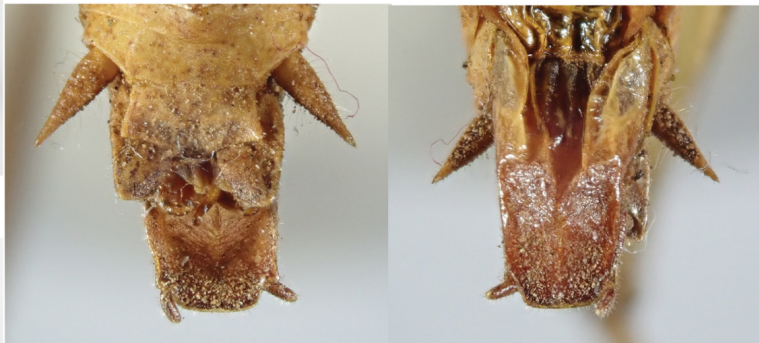
male TOPOTYPE CA: San Benito Co.  
S82-25 R82-56



calling song TOPOTYPE CA: San Benito Co. 23.5°C JCR050718\_00



male terminalia TOPOTYPE CA: San Benito Co. JAC000001966



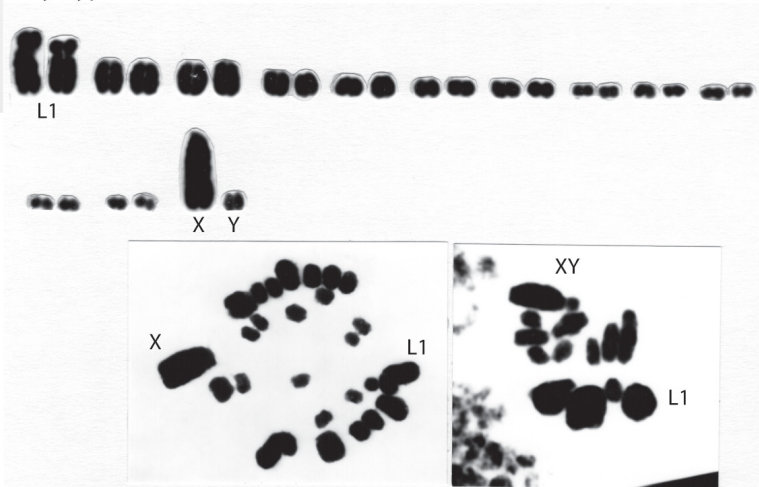
female CA: Santa Cruz Co. JAC000001984



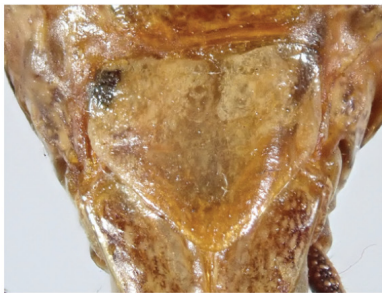
ventral sclerites	CA:	CA: Santa	CA:
TOPOTYPE	Monterey Co.	Clara Co.	Santa Cruz Co.
S82-25 R82-71	S86-74, R86-146	S87-78, R87-82	S82-29, R82-99



karyotype TOPOTYPE CA: San Benito Co. S82-26 T82-6



female terminalia CA: Monterey Co.  
JAC000001991



**FIGURE 10.** *N. carinata* male and female habitus, calling song, male and female terminalia, karyotype.

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.