

of an appropriate intermediate length between bouts to recognize a conspecific male signal (Cole 2016): intermediate length gaps between PT bouts will contrast with the continuous PT production of sympatric *N. carinata* as well and the long periods of silence between pulse production in *Aglaothorax*.

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

## Sierranus Group

The Sierranus Group is composed of 3 species (*sierranus*, *arborea*, and *radocantans*). Like the Sequoia Group, all Sierranus Group species have a single spine on the posterior margin of the forefemur, a pair of prosternal spines, and the entire male tegmen ivory or white. The male subgenital plate has lateral carinae that converge to the apex, which is devoid of styli, petal-like and often reflexed. The stridulatory file tooth density is the highest of all *Neduba* species groups (59–77 teeth/mm), and this character alone separates it from all Sequoia Group species except *N. inversa*. The Sierranus Group is distributed in the central and northern Sierra Nevada while the Sequoia Group occupies the southern portions of that mountain range (Figs. 8, 19). Within this Group are morphologically cryptic species defined by song and/or karyotype. Body part measurements and stridulatory files offer the only means to identify males that lack song data. Females may also be identified by body part measurements and sometimes the shape of the subgenital plate. Species are parapatric in the Sierra Nevada (Fig. 19) and thus geography will serve to narrow species possibilities. Molecular data show hybridization (Fig. 4) between species with adjacent ranges.

### *Neduba sierranus* (Rehn & Hebard, 1910)

Fig. 19 (distribution), Fig. 24 (male and female habitus, calling song, male and female terminalia, karyotype), Plate 2F–G (live habitus), Plate 5D (male calling song), Plate 8A (male ventral sclerite), Plate 10E (male titillators), Plate 12B (female subgenital plate).

**Common name.** Yosemite Shieldback.

**History of recognition.** Described in *Aglaothorax* from Yosemite Valley (Rehn & Hebard 1910) and transferred to *Neduba* (Rehn & Hebard 1912). The Tulare and Kern County records in Rentz and Birchim (1968) belong to Sequoia Group species that are described in this work (*N. sequoia* and *N. prorocantans*).

**Type material.** The holotype male is in ANSP. Images of the holotype are available at OSFO (Cigliano *et al.* 2020). **TOPOTYPES:** All USA, CA, Mariposa Co., 2♂, Carl Inn, Yosemite, 12-VIII-1938, ER Tinkham, CAS; 4♂, Yosemite National Park, Wawona, 37.53694N, 119.65528W, 1223 m, 27-VIII-1982, DB & BI Weissman, CAS; 4♂, 4♀, Yosemite National Park, Wawona Area, Redwood Estates, 37.53694N, 119.65528W, 1250 m, 23-25-VI-1989, DB Weissman, CAS.

**Measurements.** (mm, ♂<sub>n</sub> = 14, ♀<sub>n</sub> = 5) Hind femur ♂18.11–22.25, ♀21.92–23.60, pronotum total length ♂7.87–9.90, ♀8.54–9.00, prozona length ♂3.80–4.99, ♀4.35–4.91, metazona dorsal length ♂4.01–5.45, ♀3.83–4.50, pronotum constriction width ♂2.60–3.23, ♀2.85–3.20, metazona dorsal width ♂5.47–6.67, ♀5.64–6.05, head width ♂4.50–5.40, ♀5.20–5.65, ovipositor length ♀13.75–14.84.

**Distribution.** Western slope of the Central Sierra Nevada of California, distributed between the Merced and Mokelumne River watersheds in the vicinity of Yosemite National Park.

**Habitat.** Mixed conifer forests. Males call from dense understory vegetation and from pine needle litter, most commonly 15 cm or less from the ground but occasionally as high as 3 m above the ground in conifers. This species is associated with mountain misery (*Chamaebatia foliosa* Benth.), incense cedar (*Calocedrus decurrens* (Torr.) Florin), western bracken fern (*Pteridium aquilinum* (L.) Kuhn), and white fir (*Abies concolor* (Gord. & Glend.) Lindl. ex Hildebr.).

**Seasonal occurrence.** Adults have been taken from early July (9-VII-1968, TR Haig, CSCA) into mid-September (12-IX-2015, JA Cole, LACM). Last instar nymphs from late June into early July.

**Stridulatory file.** (n = 7) length 2.9–3.6 mm, 196–234 teeth, tooth density  $66.1 \pm 5.9$  (58.8–75.5) teeth/mm.

**Song.** (n = 14) The calling song of this species was published in Morris *et al.* (1975). The song of *N. sierranus*, like all other species in the Sierranus Group, has a complex pattern of several OPT between MPT, and gives the song a “fluttering” quality as perceived by a human listener. The PTF is  $16.2 \pm 1.2$  kHz, and at this high carrier

frequency the songs of these insects are difficult for many humans to hear, and a listener must be in close proximity to the singing male to detect him. The PTR of  $1.7 \pm 0.3 \text{ s}^{-1}$  is the fastest rate among the *Sierranus* Group (ANCOVA,  $P = 3.96 \times 10^{-9}$ ).

**Karyotype.** ( $n = 9$ )  $2n_{\text{♂}} = 21$  (18t + XtXtYm), shared only with *N. duplocantans*. T89-20, S89-47, topotype.

male TOPOTYPE CA: Mariposa Co.  
S82-110 R82-160



calling song TOPOTYPE CA: Mariposa Co. 25.0°C S89-47 R89-59



female TOPOTYPE CA: Mariposa Co. S89-47



male terminalia CA: Madera Co. JAC000002360



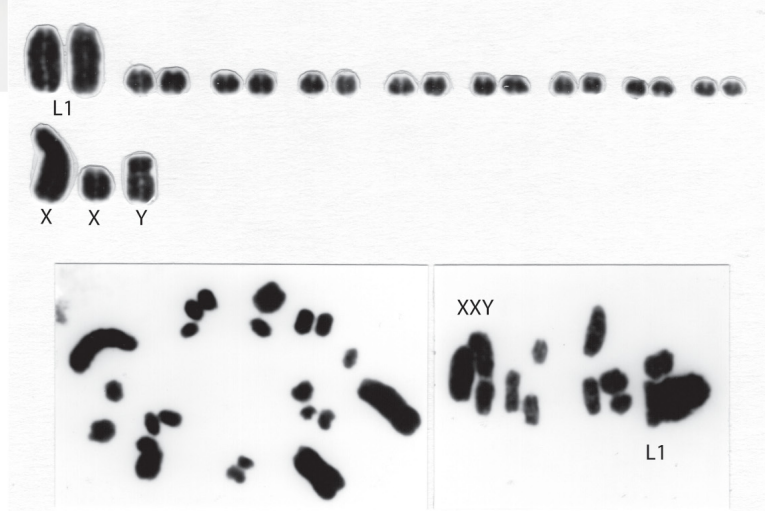
ventral sclerite  
TOPOTYPE  
S89-47, R89-59



female CA: Madera Co. JAC000002360



karyotype TOPOTYPE CA: Mariposa Co. S89-47 T89-20



**FIGURE 24.** *N. sierranus* male and female habitus, calling song, male and female terminalia, karyotype.

**Recognition.** Males may be identified by the combination of a high stridulatory file tooth density (62–70 teeth/mm) and a pronotum that is not strongly constricted. *N. sierranus* has two parapatric neighbors that also have high tooth densities: *N. inversa* to the south and *N. radocantans* to the north, but those species have stronger pronotum constrictions. The PTR is faster than all other species with multiple OPT (*N. arborea*, *N. radocantans*, and *N. inversa*). Karyotype also separates this species from *N. radocantans* and *N. inversa*. The subtriangular subgenital plate that is longer than wide is unique among the Sierranus and Sequoia groups.

**Notes.** Based on comparison of rDNA and mtDNA topologies (Fig. 4), this species has hybridized with its parapatric neighbors to the south and north: *N. inversa* and *N. radocantans*, respectively. The three species are morphologically cryptic. Species status for Sierranus Group lineages is based on song and karyotype. Song differences between these three species may reinforce prezygotic isolation if hybrids between species that differ in chromosome arrangement suffer reduced fitness.

**Material examined.** DETERMINED (n = 23): **Calaveras Co.**, 1♂, 1♀, Golden Pines RV Resort and Campground, 38.29808N, 120.28773W, 1570 m, 14-15-VIII-2015, JA Cole, LACM; **Madera Co.**, 4♂, 2♀, Narrow Gauge Inn, Fish Camp, 37.45506N, 119.64345W, 1435 m, 11-12-IX-2015, JA Cole, LACM; 1♀, Narrow Gauge Inn, Fish Camp, 37.45506N, 119.64345W, 1435 m, 11-12-IX-2015, JA Cole, JAC; **Mariposa Co.**, in addition to type material (above), 1♂, 1 mi. W El Portal, 37.67465N, 119.80238W, 29-VII-1965, RP Allen, CSCA; 1♀, Hites Cove, 37.64083N, 119.84806W, 9-VII-1968, TR Haig, CSCA; 1♂, Jerseydale Campground, Sierra National Forest, 13.5 miles northeast of Mariposa, 37.5451N, 119.8386W, 1131 m, 10-11-VIII-2002, JA Cole, LACM; 1♂, 1♀, same data except JAC; 3♂, same data except 28-29-VII-2012, JA Cole, LACM; **Tuolumne Co.**, 3♂, Mill Creek Campground, Stanislaus National Forest, FR5N21 off Mono Way (SR108), 38.30168N, 119.93763W, 1918 m, 23-24-VIII-2019, JA Cole, J Bailey, SA Downing, LACM; 2♂, same data except JAC; QUESTIONABLE PLACEMENT (n = 5): **Amador Co.**, 1♀, Ponderosa Rd., 1.5 mi. N of Mokelumne River, 38.34889N, 120.77306W, 21-VIII-1984, RW, BMED; **Calaveras Co.**, 1♀, West Point, 38.399079N, 120.527426W, 18-VIII-1929, CAS; **Madera Co.**, 1♀, Bass Lake, 37.324666N, 119.566254W, 20-VII-1934, FE Blaisdell, CAS; 1♀, Oakhurst, 37.328N, 119.649315W, 914 m, 29-VI-1946, HP Chandler, CAS; **Tuolumne Co.**, 1♀, Jamestown, 37.953258N, 120.422695W, 429 m, 1978, Schultz, CSCA.

### *Neduba arborea* Cole, Weissman, & Lightfoot sp. n.

Fig. 19 (distribution), Fig. 25 (male and female habitus, calling song, male and female terminalia, karyotype), Plate 3B (live habitus), Plate 5F (male calling song), Plate 8C (male ventral sclerite), Plate 12C (female subgenital plate).

**Common name.** Arboreal Shieldback.

**History of recognition.** None.

**Type material.** HOLOTYPE MALE: USA, CA, Colusa Co., SR20, mile marker 11.36, 39.1056N, 122.31903W, 129 m, 19-VII-2015, JA Cole, DB Weissman, JAC000001958 [specimen barcode], JCR150803\_01 [recording], DNA159 [tissue], SING0501 [extraction], JCT15-05 [karyotype], tegmen removed in gelcap below specimen, 219 [tooth count], 3.4 mm [file length], genitalia in vial below specimen, deposited in CAS, Entomology type #19707.

PARATYPES (n = 6): **Colusa Co.**, 2♀, SR20, 11.5 miles west of I-5 at mile post 11.22., 39.10567N, 122.32102W, 150 m, 22-IV-2007, DB Weissman, LACM; 1♂, 1♀, SR20, mile marker 11.36, 39.1056N, 122.31903W, 129 m, 19-VII-2015, JA Cole, DB Weissman, CAS; 1♂, SR20, mile marker 11.4, 39.10547N, 122.31759W, 423 m, 5-VIII-2014, JA Cole, DB Weissman, LACM; 1♀, same data except CAS.

**Measurements.** (mm, ♂n = 3, ♀n = 2) Hind femur ♂22.23–23.27, ♀22.44–24.09, pronotum total length ♂10.54–11.60, ♀10.09–10.49, prozona length ♂4.55–5.19, ♀4.94–5.76, metazona dorsal length ♂5.58–6.41, ♀4.33–5.55, pronotum constriction width ♂3.10–3.56, ♀3.08–3.58, metazona dorsal width ♂7.00–7.35, ♀6.72–6.80, head width ♂5.87–6.08, ♀5.72–5.87, ovipositor length ♀16.40–16.60.

**Distribution.** East slopes of the North Coast Ranges bordering the California Central Valley. The type locality is along the Cortina Ridge.

**Habitat.** Oak woodland. Topotype males sang from ground level or from oak branches 1 m or more above the ground.