

Seasonal occurrence. Limited records show that nymphs occur in April (11-IV-2007, DB Weissman, CAS) and adults are active by mid-July (19-VII-2015, JA Cole and DB Weissman, CAS) into August (5-VIII-2014, JA Cole, DB Weissman, CAS).

Stridulatory file. (n = 3), length 3.2–3.5 mm, 190–219 teeth, tooth density 60.9 ± 3.1 (58.9–64.4) teeth/mm.

Song. (n = 4) Similar to *N. sierranus* in consisting of several OPT (10.6 ± 3.7 (5.0–15.3)) that are interspersed between MPT. The PTR of 1.20 ± 0.03 is intermediate: slower than *N. sierranus*, faster than *N. radocantans*, and statistically indistinguishable from *N. inversa*. PTF is 16.9 ± 0.5 kHz.

Karyotype. (n = 3) Unique. $2n\delta = 19$ (16t + XmXtYm). JCT14-06, S14-61, paratotype.

Recognition. Both sexes have the largest body size (pronotum length more than 10 mm) of any Sierranus Group species and are noticeably robust in comparison with the typical fusiform shape of *Neduba*. The male pronotum is weakly constricted as in *N. prorocantans* and *N. sierranus*, but not only is *N. arborea* larger than those species but the stridulatory file tooth density is greater (59–62 teeth/mm) than the former (47–52 teeth/mm) and less than the latter (62–70 teeth/mm). *N. inversa* is also separated from this species by a higher tooth density (64–68 teeth/mm) and a strong pronotum constriction. The oval, highly convex female subgenital plate is distinctive. Song PTR will separate this species from all others in the Sierranus Group, but not from *N. inversa* in the Sequoia Group, a smaller species with a strong pronotum constriction. The karyotype is unique. This is the only extant Sierranus or Sequoia Group species known from the Coast Ranges of California.

Etymology. *l. arborea* “of the trees” in reference to the male habit of singing from oak branches above the understory.

Notes. The discovery of a member of the Sierranus Group in the Coast Ranges is significant as *N. extincta*, the only other species in either the Sierranus or the Sequoia Group distributed west of the Central Valley is, as the name suggests, extinct (Rentz 1977). Female nymphs were the first individuals of this species to be encountered. DNA from these females indicated that the population was distinct from known Sierranus Group taxa. Once males were collected the unique karyotype provided more evidence for specific distinction. Further investigation of the North Coast Ranges should be undertaken as the Sierranus Group may have crossed the Central Valley on multiple occasions.

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

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

Fig. 19 (distribution), Fig. 26 (male and female habitus, calling song, male and female terminalia, karyotype), Plate 3A (live habitus), Plate 5E (male calling song), Plate 8B (male ventral sclerite), Plate 10F (male titillators), Plate 12D (female subgenital plate).

Common name. Raspy Shieldback.

History of recognition. None.

Type material. HOLOTYPE MALE: USA, CA, El Dorado Co., Finnon Reservoir, 5 mi. NE Placerville, 38.780862N, 120.732843W, 790 m, 5-6-VIII-1995, DB Weissman, S95-62 [stop], R95-49 [recording], T95-21 [testes], tegmen in gelcap and genitalia in vial below insect, deposited in CAS, Entomology type #19680.

PARATYPES (n = 17): USA, CA, El Dorado Co., 1♂, 2♀, same data as holotype; 4♂, 2♀, Finnon Reservoir, 5 mi. NE Placerville, 38.79978N, 120.74947W, 740 m, 8-9-VIII-2014, JA Cole, DB Weissman, LACM; 8♂, US50 3.7 mi. W Kyburz, 38.76427N, 120.35897W, 1112 m, 19-VII-2015, JA Cole, DB Weissman, LACM.

Measurements. (mm, ♂n = 12, ♀n = 4) Hind femur ♂18.26–20.50, ♀19.48–21.29, pronotum total length ♂7.96–9.70, ♀7.85–8.85, prozona length ♂3.46–5.07, ♀3.89–5.08, metazona dorsal length ♂3.92–5.50, ♀3.32–4.25, pronotum constriction width ♂2.20–2.63, ♀2.35–2.80, metazona dorsal width ♂5.47–6.41, ♀4.92–5.62, head width ♂4.40–4.75, ♀4.60–5.23, ovipositor length ♀13.45–18.05.

Habitat. Oak woodland understory and riparian. In tangles, leaf litter, and bunch grass under oaks. This species inhabits mixed conifer forests at lower elevations than does *N. radicata*, but the two overlap at the extremes of their elevational distributions.

Seasonal occurrence. Midsummer as indicated by scant records: July (19-VII-2015, JA Cole & DB Weissman, LACM) into August (9-VIII-2014, JA Cole, D.B. Weissman, LACM).

Distribution. West slope of the Sierra Nevada in the vicinity of the American River watershed.

male HOLOTYPE CA: El Dorado Co. S95-62



female PARATYPE CA: El Dorado Co. S95-62



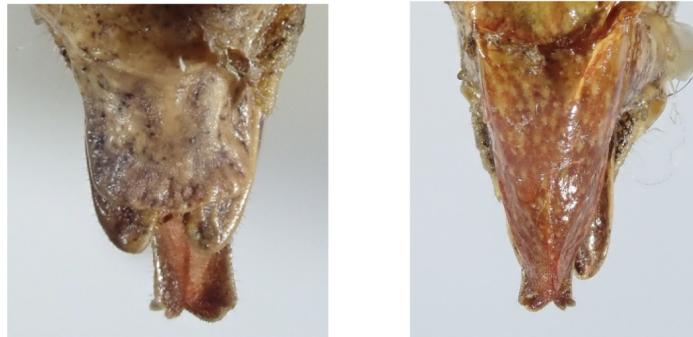
female terminalia PARATOPOTYPE CA: El Dorado Co. JAC000002307



calling song PARATOPOTYPE CA: El Dorado Co. 25.0°C JCR150804_01



male terminalia PARATYPE CA: El Dorado Co. JAC000002308



ventral sclerite
HOLOTYPE



karyotype PARATOPOTYPE CA: El Dorado Co. S95-62 T95-20

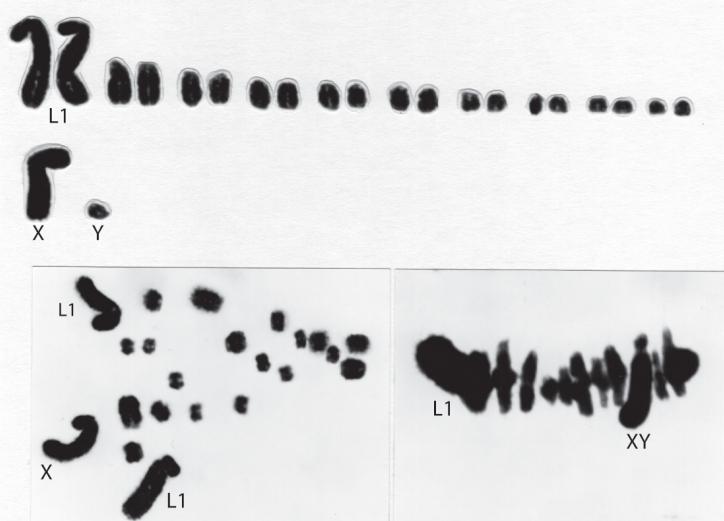


FIGURE 26. *N. radocantans* male and female habitus, calling song, male and female terminalia, karyotype.

Stridulatory file. ($n = 5$) length 3.2–3.4 mm, 200–250 teeth, tooth density 70.6 ± 5.5 (62.5–76.9) teeth/mm.

Song. ($n = 19$) Unique in the high PTN of 19.9 ± 3.9 (two-way ANOVA, $P = 1.93 \times 10^{-15}$). The greater portion of airtime spent producing OPT makes the PTR slower (0.8 ± 0.3 s $^{-1}$, ANCOVA, $P = 3.96 \times 10^{-9}$) than that of other Sierranus Group species. PTF is 16.2 ± 1.2 kHz.

Karyotype. ($n = 6$) Unique. $2n\delta = 22$ ($2m + 18t + XmYt$), T95-20, S95-62, paratopotype.

Recognition. Males have both a high stridulatory file tooth density (68–73 teeth/mm) and a strongly constricted pronotum. Male *N. sierranus* have a similar high tooth density but the pronotum constriction is weak. *N. inversa* is difficult to separate but tends to have a lower stridulatory file tooth density. Female hind femora are shorter than other Sierranus and Sequoia group species. The song has the slowest PTR and highest PTN of the Sierranus Group. The latter song feature is temperature-invariate and distinct to a human listener, and thus may be used to identify this species in song surveys that lack temperature correction. Inhabiting the vicinity of the American River drainage, this species ranges the farthest north of any in the Sierranus Group (Fig. 19).

Etymology. *l. rado* “scrape” + *cantans* “singing”. Refers to the rasping, abrasive sound quality of the numerous minor PT in the male song.

Notes. Distributed at the northern limit of the Sierranus Group, *N. radocantans* is sympatric with *N. radicata*, the species with the most southerly distribution in the Carinata Group where their elevational distributions overlap. Selection for mate recognition at a contact zone could have driven the evolution of the distinctive, elaborate song with numerous OPT in this species. The population near Kyburz, California was located with a bat detector while night driving. Males were common but no females could be found, even after trampling vegetation. *N. radicata* songs were heard in trees at this locality. The type locality of Finnon Lake is private property that is owned and managed by the Mosquito Volunteer Fire Association (www.gomvfa.org). The conservation prospectus of this area is unknown.

Material examined. Type series only, see Type material above.

Sequoia Group

The phylogenetically defined Sequoia Group includes the species *extincta*, *inversa*, *sequoia*, *prorocantans*, and *duplocantans*. Males of all but one of the four species are morphologically separated from the Sierranus Group by the lower stridulatory file tooth density (46–62 teeth/mm). Like the Sierranus Group, the species are diagnosed by song and karyotype and are morphologically cryptic; only measurements of body parts and stridulatory file tooth density differ. As in the Sierranus Group, each species occupies distinct watersheds in the Sierra Nevada, albeit farther south (Fig. 8). This group contains the only pair of fully sympatric *Neduba* species within the same species Group.

Neduba extincta Rentz, 1977

Fig. 19 (distribution).

Common name. Extinct Shieldback.

History of recognition. Described from a single male museum specimen deposited at CAS (Rentz 1977).

Type material. The holotype male is the only specimen known. Images of the holotype are available at OSFO (Cigliano *et al.* 2020).

Measurements. See Rentz (1977).

Distribution. Antioch Sand Dunes, Contra Costa County, California, on the western edge of the Central Valley.

Habitat. Historically known from the sandy banks of the San Joaquin River, elevation 9 m. The 55 acre Antioch Dunes National Wildlife Refuge is the only National Wildlife Refuge in the country established to protect endangered plants and insects.

Seasonal occurrence. The only known specimen was collected 1-VII-1937 (ES Ross, CAS).

Stridulatory file. ($n = 1$) length 3.2 mm, 167 teeth, tooth density 52.2 teeth/mm,

Song. Unknown.