

**Distribution.** Restricted to Santa Catalina Island, Los Angeles County, California, USA. Probably found throughout the island in suitable habitat.

**Habitat.** Dense chaparral vegetation, often on steep hillsides and in canyon bottoms. Individuals prefer to sit on the inner twigs of tangles. Also, in gardens on non-native vegetation. One individual taken from ornamental eucalyptus (JAC, pers. obs.).

**Seasonal occurrence.** Adult records from mid-June (14-VI-1985, S Bennett, CAS) through July (28-VII-1981 DB Weissman, CAS).

**Stridulatory file.** ( $n = 5$ ) length 3.2–3.9 mm, 94–111 teeth, tooth density  $30.4 \pm 2.1$  (28.2–33.0) teeth/mm.

**Song.** ( $n = 10$ ) Continuous 200 ms MPTL at a brisk PTR of  $4.4 \pm 0.4$  s<sup>-1</sup>. PT consist of the least amount of pulses (toothstrikes) of any species (~20). PTF approaches the ultrasonic at  $18.5 \pm 3.5$  kHz. A captive male drummed at irregular intervals while stridulating (Fig. 20); the drums were audible and induced considerable substrate vibration in the cage.

**Karyotype.** ( $n = 4$ ) Unique.  $2n\delta = 24$  ( $4m + 18t + XmYt$ ). T85-12, S85-70, topotype.

**Recognition.** Shares the following morphological characters with *N. lucubrata*: a single apical spine on the fore tibiae, prosternal spines, and tegmina darkened apically. The stridulatory file has a lower tooth density (28–33 teeth/mm) than any other species except those of the Castanea Group. Male genitalia of *N. propsti* are similar to those of *N. castanea* and *N. macneilli*, but the arms of the titillators of *N. propsti* have a shaft that is straight and not swollen at a distance of 1/6 from the base as in the latter two species (Plate 10). The song is unique in having short MPTL produced continually at a rapid PTR. Females have the longest subgenital plate of any species, approximately 1.5 times longer than wide. This is the only nedubine on Santa Catalina Island (Figs. 8, 19) with the most southerly distribution of any *Neduba*.

**Notes.** *N. propsti* is an early branching lineage (Figs. 3–5) that has apparently been isolated on Santa Catalina Island for a long time. The island has never been connected to mainland California (Legg *et al.* 2004) being the product of tectonic uplift. Males may be wary and cease calling at the slightest disturbance, as much as a single leaf falling, and jump with little provocation (JAC pers. obs.). This is one of a handful of *Neduba* species that drum (Weissman 2001; see also *N. castanea*, *N. macneilli*, and *N. lucubrata* below). Drumming was observed in captivity by a single male without a female present (JAC pers. obs) and not in the field; the context of drumming in the mating system is not known in this species.

**Material examined.** ( $n = 14$ ) All USA, CA, Los Angeles Co.: 3♂, Hermit Gulch Campground, Avalon Canyon, Santa Catalina Island, 33.38265N, 118.33951W, 91 m, 9-10-VII-2013, JA Cole, LACM; 1♂ same data except JAC; 2♀, Santa Catalina Island, 33.383361N, 118.417576W, 1-VII-1983, DB Weissman, CAS; 1♀, same data except 20-VII-1982, S Bennett, CAS; 1♀, same data except 28-VII-1981, S Bennett, LACM; 1♂, same data except 30-VI-1973, DB Weissman, CAS; 4♂, Santa Catalina Island, Toyon Bay, 33.383N, 118.416W, 14-VI-1985, S Bennett, CAS; 1♀, same data except 5-VII-1986, S Bennett, CAS.

## Castanea Group

The Castanea Group is readily recognizable on account of the robust habitus, the short hind femora, by having only one spine on the anterior margin of the fore tibiae, and by the lack of prosternal spines. The lateral carinae of the male subgenital plate converge apically, although not as dramatically as in the Sierranus and Sequoia Groups, and the styli vary from articulate to rudimentary to absent. The posterior margins of the abdominal tergites have only slight crenulations. Superficially the species of this group resemble sympatric *Aglaothorax ovata*. Karyotypes also separate the two species in this group from all other *Neduba*. Castanea Group species occupy the dry slopes of central and southern California mountain ranges (Fig. 8).

### *Neduba castanea* (Scudder, 1899)

Fig. 19 (distribution), Fig. 21 (male and female habitus, calling song, drumming, male and female tremulation karyotype), Plate 2B–C (live habitus), Plate 5A (male calling song), Plate 7I (male ventral sclerite), Plate 10B (male titillators), Plate 11K (female subgenital plate).

**Common name.** Chestnut Shieldback.

**History of recognition.** Scudder (1899) described *Tropizaspis castanea* from Los Angeles County, California. Caudell (1907) transferred this species to *Aglaothorax* based on habitus, in particular the pronotal shape, but the species was moved to *Neduba* once the male genitalia were examined (Rentz 1988; Rentz & Birchim 1968). Our fieldwork shows that *N. castanea* is the only *Neduba* species found in mainland Los Angeles County (i.e. exclusive of the Channel Islands), where it is limited to the fringes of the Mojave Desert.

**Type material.** The holotype male is housed at ANSP. Images of the type are available at OSFO (Cigliano *et al.* 2020). PARATYPE (n = 1): USA, CA, Los Angeles Co., 1♀, Los Angeles Co., VII, Coquillett, USNM; TOPOTYPES EXAMINED (n = 26): USA, CA, Los Angeles Co., 2♂, County road N4 near Llano, 34.505828N, 117.817841W, 1280 m, 6-VIII-1988, DB Weissman & DC Lightfoot, CAS; 1♂, County Road N6, 2 mi. NW of Devil's Punchbowl, 34.4267N, 117.8697W, 1250 m, 6-VIII-1988, DB Weissman & DC Lightfoot, CAS; 1♂, Devil's Punchbowl County Park, 34.4138N, 117.8587W, 1445 m, 17-VIII-1982, DB Weissman, CAS; 1♂, Devil's Punchbowl County Park, 34.4138N, 117.8587W, 1445 m, 30-VIII-1975, PH Sullivan, CAS; 1♂, Devil's Punchbowl Road 1 mi. NW of Devil's Punchbowl, 34.42382N, 117.86816W, 1341 m, 20-VI-2018, JA Cole, JAC; 1♂, Juniper Hills, Devil's Punchbowl Road (County Road N6), 2 miles east of Longview Road, 34.4267N, 117.8697W, 1316 m, 2005, JA Cole, LACM; 3♂, 1♀ nymph, same data except 13-VI-2003, JA Cole, JN Hogue, LACM; 1♂, same data except JAC; 2♂, same data except 14-VI-2015, JA Cole, GE Bell, T Farwell, LACM; 1♂, same data except JAC; 2♂, same data except 14-VI-2017, JA Cole, LACM; 3♂, 1♀, same data except 18-VI-2008, JA Cole, LACM; 1♀ nymph, same data except 20-VI-2003, JA Cole, JN Hogue, LACM; 1♂, same data except 7-VII-2004, JA Cole, LACM; 1♂, 1♀, Largo Vista Rd. (county Road N4), 1 mi. S of Fort Tejon Rd., 34.4530N, 117.7649W, 1277 m, 22-VI-2008, JA Cole, LACM; 1♀, same data except 22-VI-2008, JA Cole, JAC.

**Measurements.** (mm, ♂n = 14, ♀n = 6) Hind femur ♂16.99–21.20, ♀18.50–23.87, pronotum total length ♂9.90–13.20, ♀10.08–13.20, prozona length ♂3.84–5.69, ♀4.83–6.92, metazona dorsal length ♂5.60–8.67 ♀4.72–6.76, pronotum constriction width ♂2.70–3.68, ♀2.95–3.85, metazona dorsal width ♂7.24–8.49 ♀6.75–8.25, head width ♂4.94–5.85, ♀5.05–6.81, ovipositor length ♀14.92–20.25.

**Habitat.** Pinyon-juniper (*Juniperus* spp.-*Pinus monophylla* Torr & Frém.), Joshua tree (*Yucca brevifolia* Engelm.) woodlands, *Ceanothus* scrub, and yellow pine forest. Specimens were taken from pinyon pine, juniper, mountain mahogany (*Cercocarpus* sp.), and Joshua tree.

**Distribution.** Dry north slope of Transverse Ranges of California including the San Gabriel, San Bernardino, Liebre, and San Emigdio Mountains.

**Seasonal occurrence.** Adult specimens have been taken from mid-June in foothill regions (13-VI-2003, JA Cole & JN Hogue, LACM) into September at high elevation (12-IX-2015, DA Gray, CAS). Females were last instar nymphs at the earliest date of occurrence listed above.

**Stridulatory file.** (n = 5), length 3.7–4.6 mm, 79–99 teeth, tooth density  $21.6 \pm 1.1$  (19.8–22.7) teeth/mm.

**Song.** (n = 24) A continuous series of long MPTL ( $373.1 \pm 51.5$  ms) with widely spaced toothstrikes delivered at PTR of  $2.6 \pm 0.7$  s<sup>-1</sup>. The sound resembles a finger running along the teeth of a comb. The PTF of  $13.7 \pm 2.1$  kHz extends comfortably into the audible range. There is a significant high frequency component, however, with 18.7 kHz PTF measured in one high frequency laboratory recording. Males begin calling at sunset. The population from McGill Campground on Mount Pinos, Ventura County, California has a significantly slower PTR than that of the type locality (2-sample t-test, *P* = 0.002). Males may also produce audible substrate vibrations via drumming. Drums precede bouts of stridulation (Fig. 21).

**Karyotype.** (n = 5) 2n♂ = 22 (4m + 16t + XmYt), shared only with *N. macneilli*. T88-69, S88-72, topotype.

**Recognition.** Morphological and color pattern differences thought to separate *N. castanea* from *N. macneilli* (per Rentz & Birchim 1968) are unreliable. The development of the styli on the subgenital plate, from absent to slight swellings to articulated, may vary within a population and even between the left and right sides of a single specimen. Both species exhibit the full range of variation in color patterns. Female *N. castanea* have round, highly convex subgenital plates, whereas those of *N. macneilli* are subtriangular with a bluntly pointed apex. Geographically *N. castanea* replaces *N. macneilli*, which is a Sierra Nevada species, in the Transverse Ranges of southern California.

**Notes.** We treat *N. castanea* and *N. macneilli* as closely related sister species based on reproductive isolation via allopatry. Both inhabit the same life zone in different geographic regions of California. *N. castanea* and *N. macneilli* are sympatric with *Aglaothorax ovata*, and all three species share a similar robust habitus suggesting convergent evolution of body form in their habitat. Enlarged pronotal size may be adaptive for signal transmission in open

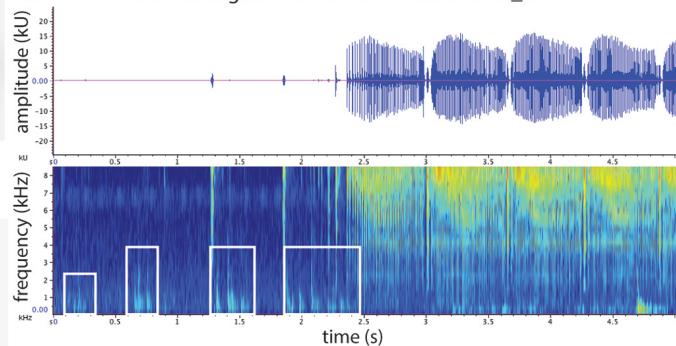
male TOPOTYPE CA: Los Angeles Co.  
JAC000002043



calling song TOPOTYPE CA: Los Angeles Co. 25.8°C JCR150614\_02



calling song with drumming (white boxes)  
TOPOTYPE CA: Los Angeles Co. 23.3°C JCR171002\_00



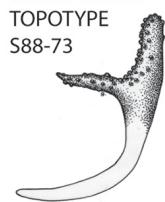
female TOPOTYPE CA: Los Angeles Co.  
JAC000002036



male terminalia TOPOTYPE CA: Los Angeles Co. JAC000002041



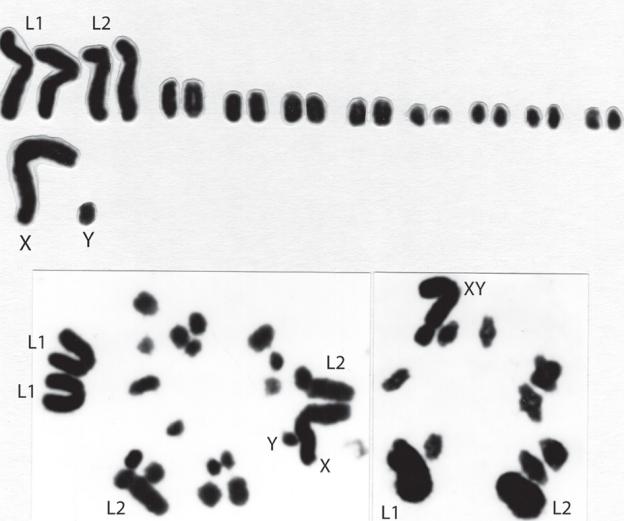
ventral sclerite  
TOPOTYPE  
S88-73



female terminalia TOPOTYPE  
JAC000002038



karyotype TOPOTYPE CA: Los Angeles Co. S88-72 T88-69



**FIGURE 21.** *N. castanea* male and female habitus, calling song, male and female terminalia, karyotype.

habitats such as pinyon-juniper and Joshua tree woodlands, where trees and bushes are widely spaced, compared with the dense forest understories inhabited by other *Neduba* species Groups. Drumming was observed during courtship in the field at the Largo Vista Road locality (see Type material above), during which a male alternated drumming and stridulating. The signaling did not result in copulation in this observed instance (JAC pers. obs.).

**Material examined.** (n = 26) All USA, CA, Kern Co., 3♀, McGill Campground, Los Padres National Forest, 34.82539N, 119.09791W, 12-IX-2015, DA Gray, LACM; 11♂, 1♀, McGill Campground, Los Padres National Forest, 34.81505N, 119.10014W, 2271 m, 8-9-VIII-2017, JA Cole, LACM; 1♂, 1♀, same data except JAC; Los Angeles Co., in addition to type material (above), 5♂, Sierra Highway, 0.6 miles west of Crown Valley Road, Acton, 34.4936N, 118.1834W, 929 m, 17-VI-2003, JA Cole, JN Hogue, LACM; 1♂, same data except 18-19-VI-2008, JA Cole, JAC sound record; 1♂, Spunky Canyon, 2 mi. SW of Green Valley, 34.6023N, 118.3863W, 1047 m, 16-VI-2012, JA Cole, LACM; 2♂, same data except 26-VII-2001, JA Cole, LACM.

### ***Neduba macneilli* Rentz & Birchim, 1968**

Fig. 19 (distribution), Fig. 22 (male and female habitus, calling song, male and female terminalia, karyotype), Plate 2D (live habitus), Plate 5B (male calling song), Plate 7J–K (male ventral sclerites), Plate 10C (male titillators), Plate 11L (female subgenital plate).

**Common name.** MacNeill's Shieldback.

**History of recognition.** *N. macneilli* was described from the eastern Sierra Nevada mountains of California by Rentz & Birchim (1968). The type locality is 1 mile west of Tom's Place, Mono County, California. Tinkham (1944) referred to this species under the name *carinata*.

**Type material.** The male holotype is housed at ANSP. Images of the holotype are available at OSFO (Cigliano *et al.* 2020). PARATYPES (n = 2): USA, CA, Mono Co., 2♂, Rock Creek, 1 mi. W Tom's Place, 37.5586N, 118.7025W, 2143 m, 10-IX-1966, DC & KA Rentz, CAS;

TOPOTYPES (n = 16): 4♂, 1♀, Tom's Place, 37.5586N, 118.7025W, 2143 m, 28-VIII-1986, DB & BI Weissman, DCF Rentz, CAS; 8♂, 1♀, Tom's Place, 1 mi. W, 37.5586N, 118.7025W, 2143 m, 15-16-VII-2012, JA Cole, LACM; 2♂, same data except JAC.

**Measurements.** (mm, ♂n = 19, ♀n = 4) Hind femur ♂16.35–21.50, ♀22.55–28.10, pronotum total length ♂9.89–11.85, ♀10.15–12.13, prozona length ♂4.59–6.30, ♀4.61–6.68, metazona dorsal length ♂4.90–6.20, ♀4.78–5.54, pronotum constriction width ♂2.58–3.85, ♀3.15–3.42, metazona dorsal width ♂6.65–7.81, ♀6.96–7.55, head width ♂4.13–5.83, ♀5.93–6.25, ovipositor length ♀17.14–19.35.

**Distribution.** Eastern slope of the Sierra Nevada Mountains of California.

**Habitat.** Yellow pine forest and pinyon-juniper woodlands. Specimens were taken from *Purshia tridentata* Pursh (DC) and *Pinus monophylla*.

**Seasonal occurrence.** Adult specimens have been taken from mid-July (10-VII-2003, JA Cole & JF Eguizabal, LACM) through October (22-X-1939, ER Tinkham, CAS).

**Stridulatory file.** (n = 19) length 3.4–4.4 mm, 71–99 teeth, tooth density  $23.1 \pm 1.8$  (19.8–26.4) teeth/mm.

**Song.** (n = 43) The song of this species was published in Morris *et al.* (1975). The calling song of *N. macneilli* is not distinguishable from that of *N. castanea* (see discussion under the former species). In addition to calling song, 2 of 5 recorded males of *N. macneilli* (identified as *N. castanea* in Weissman (2001)) from 1.3 m E Walker Pass, Kern Co. (S88-68), produced an audible drumming by visibly tapping the substrate in the laboratory simultaneously with both hind legs. Of many males recorded from various populations, these were the only males of *N. macneilli* ever heard drumming. A courting topotypic male produced short PT accompanied by obvious body movements (tremulations) that could have caused substrate vibration. This male was displaying to a female nymph (JAC, pers. obs., 15-VII-2012).

**Karyotype.** (n = 14)  $2n\delta = 22$  (4m + 16t + XmYt), identical to that of *N. castanea*, and corrects the result of Ueshima and Rentz (1979). T86-83, S86-98, topotype.

**Recognition.** Males are indistinguishable from *N. castanea*. The female subgenital plate is subtriangular, in contrast to the rounded plate of *N. castanea*. This species inhabits the southeastern Sierra Nevada, whereas *N. castanea* inhabits the Transverse Ranges.