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Review of *Trechus* Clairville, 1806 (Coleoptera: Carabidae: Trechini) from the coastal Sequoia belt in California

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Abstract

The species of *Trechus* Clairville, 1806 from the Sequoia belt in coastal California are reviewed. Six native and one introduced species are reported. Detailed information on distribution and habitats is provided for the first time. The aedeagus of *Trechus humboldti* Van Dyke, 1945 is described for the first time. One new species is described from the Santa Lucia Mountains (Monterey County): *Trechus santaluciaensis* sp.n.

Key words: Carabidae, Trechinae, Trechini, *Trechus*, new species, taxonomy, key, California.

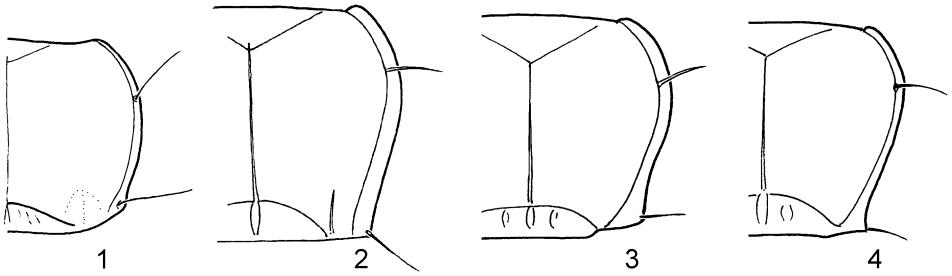
Zusammenfassung

Die Arten der Gattung *Trechus* Clairville, 1806, die entlang der Küste im Verbreitungsgebiet des Küstenmammutbaumes (*Sequoia sempervirens*) in Kalifornien vorkommen, werden besprochen. Über sechs einheimische Arten und eine verschleppte Art wird berichtet. Detaillierte Angaben zur Verbreitung und zu den Lebensräumen werden erstmals geliefert. Der Aedeagus von *Trechus humboldti* Van Dyke, 1945 wird erstmals beschrieben. Eine neue Art wird von den Santa Lucia Mountains (Monterey County) beschrieben: *Trechus santaluciaensis* sp.n.

Introduction

Coastal north-western and central-western California is characterized by a special climate with heavy rainfall in the winter season and frequent fog during the summer, lowering the drought and heat dominating the interior parts of California. This area is covered by forests dominated by the paleoendemic coast redwood, *Sequoia sempervirens*, one of the tallest trees of the world. The distribution of this tree is confined to a narrow belt along the coast, from southernmost Oregon to central-western California (Big Sur).

This Sequoia belt is well known for a remarkably rich fauna of Carabidae including some representatives of the genus *Trechus* Clairville, 1806. The knowledge of these *Trechus* species is rudimentary. Jeannel (1927) described *T. conformis* based on a single male, Van Dyke (1945) added *T. humboldti* based on a single male without description of the aedeagus. Kavanaugh & Erwin (1985) summarized records of *T. obtusus*, a species introduced from Europe. Bousquet (2012: 508) reported *T. coloradensis* from Humboldt County. *Trechus ovipennis* Motschulsky, 1845 was reported from the seashore, from



Figs. 1–4: Pronotum of (1) *Trechus obtusus*, (2) *T. humboldti*, (3) *T. ovipennis*, (4) *T. conformis*.

San Francisco to Alaska (Jeannel 1927, Lindroth 1961), an exceptional habitat and an unusually wide distribution within this genus.

The purpose of this paper is a review of all known *Trechus* from the Sequoia belt, providing a key for determination, detailed distributional and habitat information and the description of one new species. This is my sixth contribution to the Nearctic fauna of *Trechus* (Donabauer 2005a, b, 2009, 2010a, b).

Material and methods

A field trip to this area resulted in more than 1,000 specimens of *Trechus* from more than 20 locations, stored in the author's collection. All previously known species and one species new to science were collected in long series, each from different locations. The "Material examined" sections list only the specimens from the study area.

The stacked photographs (Figs. 14–19) were taken with a Leica DCF490 camera attached to a Leica MZ16 binocular microscope with the help of Leica Application Suite V3 and processed with CombineZM and Adobe Photoshop 7.0 software.

Results

List of *Trechus* from the Sequoia belt in California

Trechus quadristriatus group

1. *Trechus obtusus* Erichson, 1837

Trechus amplicollis group

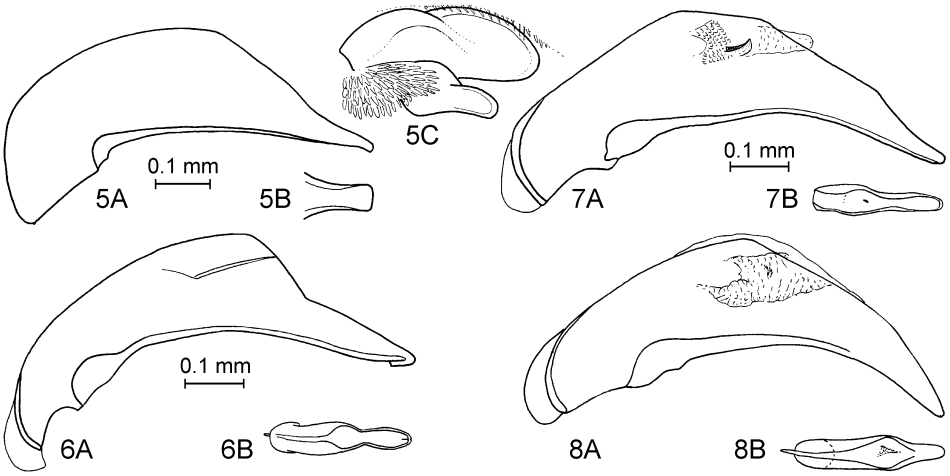
2. *Trechus chalybaeus* Dejean, 1831
3. *Trechus coloradensis* Schaeffer, 1915

Trechus humboldti group

4. *Trechus humboldti* Van Dyke, 1945

Trechus ovipennis group

5. *Trechus santaluciaensis* sp.n.
6. *Trechus ovipennis* Motschulsky, 1845
7. *Trechus conformis* Jeannel, 1927



Figs. 5–8: Aedeagus in lateral (A) and (B) dorsal view, extracted copulatory pieces in lateral view (C): (5) *Trechus obtusus*, (6) *T. chalybaeus*, (7) *T. coloradensis* from northeastern Arizona, (8) *T. coloradensis* from northwestern California.

Determination key to *Trechus* from the Sequoia belt in California

1 Hind margin of pronotum strongly convex (Fig. 1); basal angles not pointed, strongly obtuse. Shape of aedeagus (Fig. 5A–C) highly characteristic: internal sack with two large and complicated copulatory pieces and a dense area of scales, apex elongated and parallel sided in dorsal view. Introduced, in open, rather disturbed areas. Length 3.7 mm. ..... ***T. obtusus***

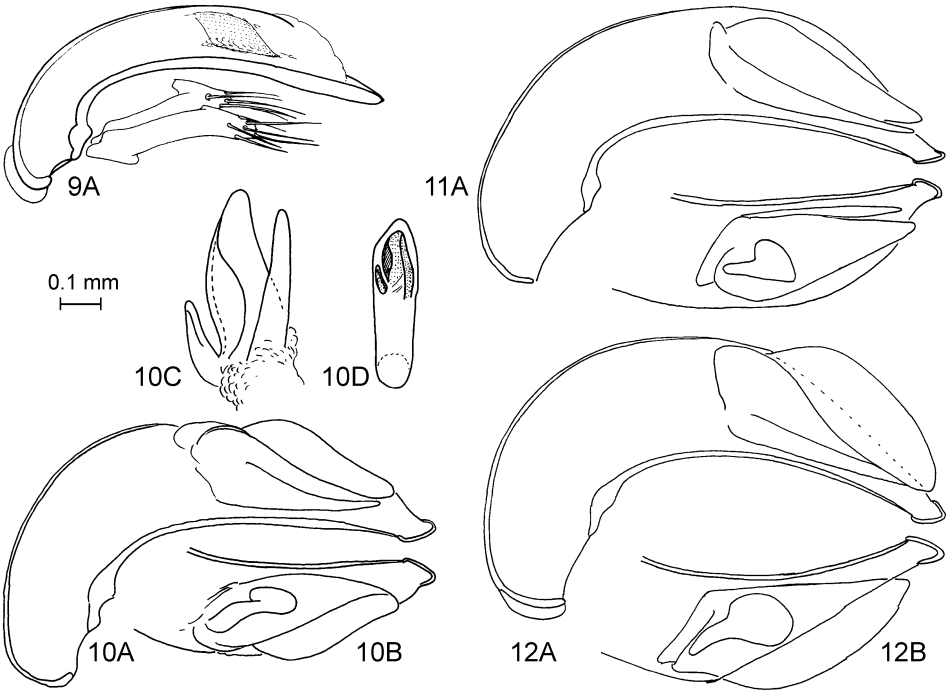
– Hind margin of pronotum more or less straight, basal angles pointed, slightly obtuse at most (Figs. 2–4). Aedeagus different. **2**

2 Striae of elytra deeply impressed, punctured. Elytra of different shape according to development of hind wings. Basal pore in stria 3 in normal position at anterior fourth of elytron length, apical pore in normal position, equally distant to suture and to recurrent striole. Aedeagus (Figs. 6–9) with strongly developed sagittal lamella, copulatory pieces of internal sack small, consisting of less than three parts. **3**

– Striae of elytra shallow at most, hardly impressed on disc, not punctured, lateral striae evanescent. Elytra strongly ovate, shoulders entirely rounded, hind wings strongly reduced. Basal pore in stria 3 shifted forwards, at 15–20 % of elytron length. Apical pore closer to recurrent striole than to suture. Aedeagus (Figs. 10–12) without sagittal lamella, copulatory pieces very large, complicated, consisting of three parts, apex of aedeagus modified into a ring-like knob. (*T. ovipennis* group) **5**

3 Elytra strongly ovoid, shoulders fully rounded and not prominent, strongly convex on disc (Fig. 17). Aedeagus (Fig. 9) slender and comparatively small, equally curved, apex simple and not modified, copulatory piece small, simple, weakly sclerotized, stylomeres with more than the normal four setae. Northernmost section of the Sequoia belt. Length 4.0–4.5 mm. ..... ***T. humboldti***

– Elytra with shoulders more prominent, flatter on disc. Aedeagus distinct (Figs. 6–8), characterized by large dorsal opening. (*T. amplicollis* group) **4**



Figs. 9–12: Aedeagus in lateral (A, B) and in (D) dorsal view, extracted copulatory pieces in approximately dorsal view (C): (9) *Trechus humboldti*, (10) *T. santaluciaensis* sp.n., (11) *T. ovipennis* from Crescent City, (12) *T. conformis* from Fort Bragg.

4 Shoulders more prominent (Fig. 18), hind wings developed although not always functional. Pronotum large and broad. Aedeagus highly characteristic (Fig. 6): in lateral view with pronounced dorsal hump and sharp keel on ventral side of outermost apex, internal sack with elongated spine. Length 4.1–4.5 mm. ..... ***T. chalybaeus***

– Shoulders reduced, rather rounded (Fig. 19), hind wings strongly reduced. Pronotum narrow. Aedeagus without characteristic details (Figs 7, 8): apex simple, internal sack with hyaline structures only. Likely a complex of similar species. Length 4.5–5.0 mm. ..... ***T. coloradensis***

5 Stria 3 of elytra with basal pore only. Elytral striae, except suture, entirely reduced. Aedeagus (Fig. 10) with smallest (= third) copulatory piece relatively small and elongated. Locally endemic south of Monterey in the Santa Lucia Mountains. Length 3.5–4.3 mm. ..... ***T. santaluciaensis* sp.n.**

– Stria 3 with two pores. At least interior three striae slightly impressed. Aedeagus (Fig. 11, 12) with smallest (= third) copulatory piece relatively large and not so elongated. North of Monterey. **6**

6 Basal angles of pronotum not pointed, slightly obtuse (Fig. 3), lateral margin less constricted towards base and less sinuated in front of basal angles. Elytra slightly more flattened on disc. Aedeagus (Fig. 11) slightly more slender, large triangular plate less projecting outside aedeagus, less convex on ventral side, third copulatory piece relatively small. Variable, widespread and common

species in coastal California north of Monterey. Comparatively small, length 3.5–4.2 mm. ..... ***T. ovipennis***

– Basal angles of pronotum more pointed (Fig. 4), lateral margins more constricted towards base and more sinuated in front of basal angles. Elytra slightly more convex on disc. Aedeagus (Fig. 12) slightly thicker, large triangular plate strongly projecting and convex on ventral side, small third piece slightly larger. Locally endemic species north of San Francisco. Comparatively large, length 3.9–4.5 mm. ..... ***T. conformis***

Trechus quadristriatus group

The *T. quadristriatus* group is Palearctic and represented by two introduced species in North America.

***Trechus obtusus* Erichson, 1837** (Figs. 1, 5)

Material examined: San Mateo County: 1 ex.: Pacifica, Mori Point, V.2013, leg. M. Donabauer. – Mendocino County: 2 ex.: Mendocino, Big river / coast, 2.V.2013, leg. M. Donabauer; 1 ex.: Fort Bragg, 10-Mile river beach, 4.V.2013, leg. M. Donabauer. – Humboldt County: Klamath, Klamath river / coast, 5.V.2013, leg. M. Donabauer.

Distribution: *Trechus obtusus* is adventive in western North America, well established and widespread especially along the Pacific coast (Kavanaugh & Erwin 1985, Bousquet 2012: 514). The few specimens were collected at the seashore in dry and open conditions.

Trechus amplicollis group

The *T. amplicollis* group (or *T. chalybaeus* group) is Holarctic and represented by seven species in North America.

***Trechus chalybaeus* Dejean, 1831** (Figs. 6, 13c, 18)

Type locality: Alaska, Aleutian Islands.

Material examined: Humboldt County: 1 ex.: Orick, Redwood Creek, 5.V.2013, leg. M. Donabauer.

Distribution: This species is widespread and common in the mountain ranges of western North America north of Mexico, especially in California (Donabauer 2010a, Bousquet 2012).

***Trechus coloradensis* Schaeffer, 1915** (Figs. 7, 8, 13c, 19)

Type locality: Colorado.

Material examined: Humboldt County: 29 ex.: Prairie Creek State Park, Campground, 8.V.2013, leg. M. Donabauer. – Del Norte County: 42 ex.: Crescent City env., Jedidiah Redwoods State Park, 7.V.2013, leg. M. Donabauer.

Distribution: This species is widespread in the high mountains from northwestern New Mexico and northeastern Arizona northwards to Colorado (Bousquet 2012); these populations are far eastwards of California and separated by the closely related and very similar *T. oregonensis* Hatch, 1951 from the Cascade range. The population in northwestern California is therefore totally isolated and may represent a new species or subspecies; this is indicated by slight aedeagal differences between specimens from California and Arizona (Figs. 7–8). I have not been able to study specimens from the

type area (Colorado) or material of the five available synonyms (see Bousquet 2012). A revision of *T. coloradensis* is required. All specimens were collected on muddy banks of relatively large streams in some distance to the main water body, in dark recesses fully shaded by dense ferns and grasses.

Trechus humboldti group

The *T. humboldti* group (new) is Holarctic and represented by a single, very localized species in northern California and southern Oregon.

***Trechus humboldti* Van Dyke, 1945** (Figs. 2, 9, 13a, 17)

Type locality: California, Humboldt County, Orick.

Material examined: Humboldt County: 62 ex.: Orick, Redwood Creek, 5.V.2013, leg. M. Donabauer; 52 ex.: Prairie Creek State Park, Campground, 8.V.2013, leg. M. Donabauer. – Del Norte County: 3 ex.: Crescent City env., Jedidiah Redwoods State Park, 7.V.2013, leg. M. Donabauer.

Distribution and ecology: This species is endemic in the humid northern part of the Sequoia belt (Fig. 13a) from Lane County in southern Oregon (Bousquet 2012: 513) to Humboldt County in northern California. It was collected syntopic with *T. ovipennis* and *T. coloradensis* in muddy and wet conditions beside small streams, always well-shaded and with rich vegetation of ferns, mosses and grasses. This species is significantly more hygrophilous than *T. ovipennis* and the most specialized *Trechus* of the study area.

Discussion: *Trechus humboldti* was described based on a unique male specimen, without description of the male aedeagus and stated as "probably belongs to the group with *ovipennis*". Subsequently it was included in the *T. ovipennis* group by Bousquet (2012: 513). Beside the ovate shape of the elytra (Fig. 17), *T. humboldti* is well separated from the rest of the *T. ovipennis* group by many characteristics like the position of the dorsal seta of the elytron, the size and shape of aedeagus (Fig. 9), and the configuration of the copulatory pieces.

Trechus ovipennis group

The *T. ovipennis* group is western Nearctic and represented by two species in Arizona, four localized species in California and one widespread species along the Pacific coast (California to Alaska). All species are characterized by strongly oval elytra and uniform aedeagi with three copulatory pieces (instead of two or less in most other Trechini).

***Trechus santaluciaensis* sp.n.** (Figs. 10, 13a, 14)

Type locality: California, Monterey County, Big Sur.

Type material: Holotype (male) and 170 paratypes: Monterey County, Big Sur, 28.IV.2013, leg. M. Donabauer; 44 paratypes: Monterey County, Julia Pfeiffer Burns State Park, 28.IV.2013, leg. M. Donabauer.

Diagnosis: This new species is closely related to *T. ovipennis, T. conformis* Jeannel, 1927, and *T. pomonae* Fall, 1901 (see Donabauer 2010a) in all aspects: habitus, aedeagus, distribution, and mode of life. Therefore this new species belongs to the *T. ovipennis* group sensu Bousquet, 2012. It can be separated from all other species (of this and all other groups) except *T. pomonae* by the lack of the second pore in stria 3. It is characterized by an entirely reduced striation of elytra except stria 1 and the shape and position of the

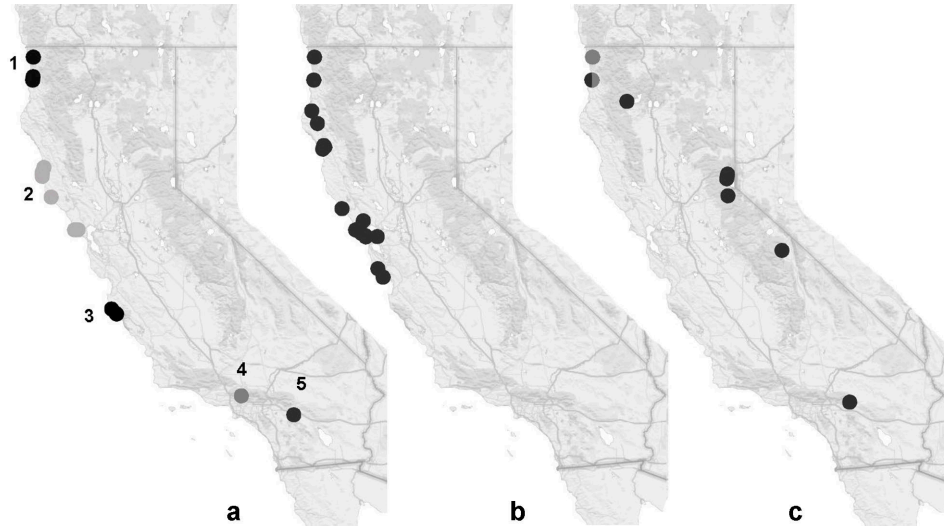


Fig. 13: Distribution of *Trechus* in California: (a) 1 – *Trechus humboldti*, 2 – *T. conformis*, 3 – *T. santaluciaensis* sp.n., 4 – *T. pomonae*, 5 – *T. alinae*. (b) *T. ovipennis*. (c) black – *T. chalybaeus*, grey – *T. coloradensis*.

smallest copulatory piece in the internal sack of the aedeagus (Fig. 10). It is distinguished from *T. pomonae* by significantly darker colour, less shiny elytra, slightly smaller body size, and less impressed elytral striae.

Description: BL 3.5–4.3 mm. Body moderately convex. Body rather dark, entirely reddish piceous, elytra with bluish lustre, margins of elytra paler; appendages entirely pale, contrasting to body. In rare exceptions the basal half of elytra is reddish pale, the apical half significantly darker. Antenna slender, of normal length. Eyes moderately large, slightly reduced in size, length of temples shorter than eye diameter.

Pronotum comparably small, equally rounded laterally, slightly convex on disc, maximal width approximately at anterior third of pronotum length; lateral margins moderately constricted towards base, hardly sinuate before small and slightly projecting basal angles; anterior and posterior margins nearly straight; front angles rounded and not prominent; basal angles right or slightly acute; basal foveae present but weakly impressed; basal furrow strongly impressed; median line distinct, shallow, almost extended to margins.

Elytra strongly ovate, moderately convex, rather flat on disc; shoulders completely rounded and not prominent; stria 1 entirely impressed, all other striae hardly visible, indistinct; stria 3 with basal pore strongly impressed, shifted forwards near base, at 15–20 % of length of elytra; second pore always lacking. Apical pore shifted from normal position, much closer to recurrent striola than to suture (relation 1 : 3).

Aedeagus (Fig. 10) almost identical in general appearance to that of several other species of the *T. ovipennis* group in California (*T. ovipennis*, *T. conformis, T. alinae* Dajoz, 1990, and *T. pomonae*), but characterized by shape of smallest (= third) copulatory piece. Aedeagus normal-sized (37 % of length of elytra); in lateral view basal part without sagittal lamella, equally curved, central part more or less straight, apex short, constantly narrowed, not elongated, slightly knobbed at end; aedeagus in dorsal view symmetric, parallel-sided,

straight with equally narrowed, short and symmetric apex; end broadly rounded. Internal sack without dense field of scales and armed with three complex copulatory pieces; medium copulatory piece well developed, rather large-sized and elongated. Large copulatory piece very similar to that of *T. ovipennis*.

Etymology: This species is named after the Santa Lucia Mountains in coastal central California, running from Monterey County southeast for 169 km into central San Luis Obispo County. These mountains are home to the southernmost native stands of Coast Redwood trees, since the climate gets drier towards the south.

Distribution and ecology: This flightless species was locally common along small creeks in deeply shaded stands of *Sequoia* under stones and detritus in wet or moist conditions. This species is so far known from two places of the northern Santa Lucia Mountains (Fig. 13) and is potentially distributed further southwards along the coast. *Trechus santaluciaensis* sp.n. is likely restricted to the river valleys of the western slopes of the Santa Lucia Mountains along the Pacific coast. It is the vicariant taxon of *T. ovipennis* in the north (Alaska to San Francisco area) and *T. pomonae* in the south (Los Angeles area).

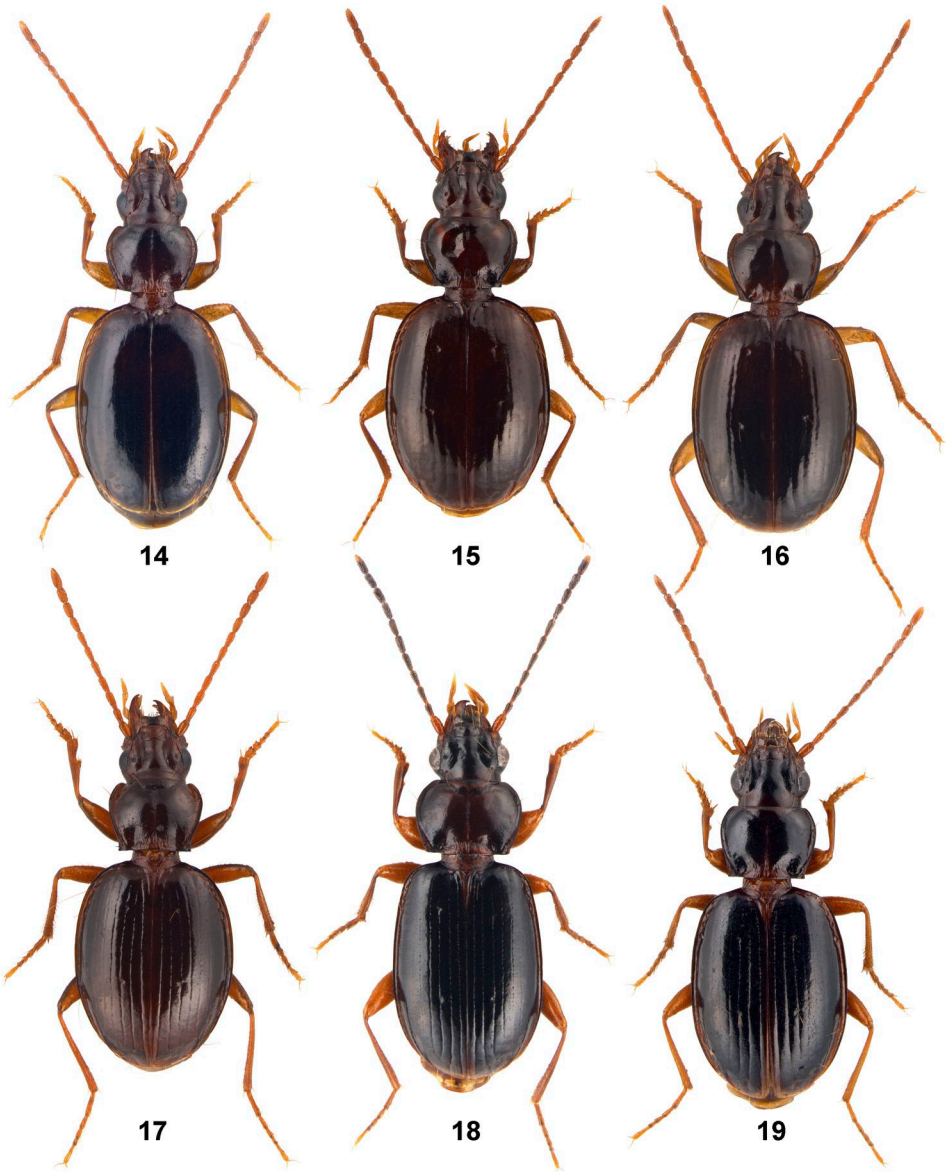
***Trechus ovipennis* Motschulsky, 1845** (Figs. 3, 11, 13b, 16)

Type locality: Alaska: Sitka (discussed by Bousquet 2012: 513).

Material examined: Santa Cruz County: 2 ex.: Santa Cruz, Empire Cave, 22.IV.1979, leg. D.C. Rudolph; 4 ex.: Santa Cruz, Doloff Cave, 22.IV.1979, leg. D.C. Rudolph; 39 ex.: Big Basin Redwoods, 29.IV.2013, leg. M. Donabauer. Alameda County: 2 ex.: Berkeley, 7.X.1936, leg. H.B.Leech. – Marin County: 12 ex.: Mill Valley, Miller Creek, 9.V.2013, leg. M. Donabauer; 56 ex.: Muir Woods, 30.IV.2013, leg. M. Donabauer; 10 ex.: Point Reyes, Inverness Ridge, 30.IV.2013, leg. M. Donabauer; 6 ex.: Point Reyes, W Inverness, 22.III.1983, leg. Smetana; 2 ex.: Bolinas Ridge, Copper Mine Gulch, 22.III.1983, leg. Smetana. – Sonoma County: 2 ex.: Petaluma, 22.III.1983, leg. M. Smetana; 39 ex.: 3 miles SE Fort Ross, 1.V.2013, leg. M. Donabauer. – Mendocino County: 50 ex.: Legett SW, Hales Grove, 4.V.2013, leg. M. Donabauer; 77 ex.: Riverdale env., Smithe Redwoods State Reserve, 4.V.2013, leg. M. Donabauer. – Humboldt County: 7 ex.: Orick, Redwood Creek, 5.V.2013, leg. M. Donabauer; 32 ex.: E of Eureka, Elk River, 4.V.2013, leg. M. Donabauer; 1 ex.: Humboldt Redwoods State Park, Cow Creek, 4.V.2013. – Del Norte County: 55 ex.: Crescent City env., Jedidiah Redwoods State Park, 7.V.2013, leg. M. Donabauer.

Distribution and ecology: *Trechus ovipennis* is reported from a narrow corridor along the Pacific coast from southern Alaska southwards to Santa Cruz County in California. This is an unusually wide distribution for a wingless *Trechus*. This species inhabits a variety of distinct microhabitats, almost always close to water sources and in forests where it can be found in wet detritus and under stones. Only exceptionally this taxon was found at the seashore, under logs, close to the mouth of rivers. Therefore *T. ovipennis* should be classified as hygrophilous and forest dwelling instead of halophilous and coastal as proposed by Lindroth (1961).

Discussion: I could not study specimens from outside California and further investigations are needed to clarify, if this taxon may consist of more than one species or subspecies. The rich material at hand shows a significant variability of characteristics, such as body size, shape of basal angles of pronotum, convexity of elytra and number of impressed elytral striae. In respect of the aedeagus there are slight, but constant differences between populations, unfortunately not intergrading from north to south. In Crescent City (northernmost sampled population) aedeagal characteristics are almost identical to populations around San Francisco (southernmost sampled population). Nevertheless



Figs. 14–19: Habitus of all native taxa of *Trechus* in the Sequoia belt in northwestern California: (14) *T. santaluciaensis* sp.n., (15) *T. conformis*, (16) *T. ovipennis*, (17) *T. humboldti*, (18) *T. chalybaeus*, (19) *T. coloradensis*.

aedeagal characteristics from a population around Legett (just north of *T. conformis*) are intermediate to those seen in *T. conformis*. More southwards *T. conformis* coexists with *T. ovipennis*. Therefore no changes to taxonomy of this complicated species can be proposed and I continue to treat *T. ovipennis* as one variable species.

***Trechus conformis* Jeannel, 1927** (Figs. 4, 12, 13a, 15)

Type locality: California, Marin County, Lagunitas.

Material examined: Marin County: 12 ex.: Point Reyes, Inverness Ridge, 30.IV.2013, leg. M. Donabauer; 9 ex.: Lagunitas Creek, Tocaloma, 18.III.1983, leg. Smetana. – Mendocino County: 3 ex.: Albion env., Navarro river/sea shore, 1.V.2013, leg. M. Donabauer; 95 ex.: Gualale, near campground at Gualale river, 2.V.2013, leg. M. Donabauer; 4 ex.: Mendocino, Big river/coast, 2.V.2013, leg. M. Donabauer; 109 ex.: E of Fort Bragg, Campground I, 3.V.2013, leg. M. Donabauer.

Distribution and ecology: This species is confined to the central part of the Sequoia belt (Fig. 13a). Some specimens were taken at the seashore under deeply embedded logs and stones in shaded position at the base of steep rocks or at the mouth of rivers. Nevertheless this species is not halophilous. All places have been in contact with fresh water dripping down the rocks or from the river. This species was significantly more common along rivers in forests, in shaded and muddy places with rich vegetation or detritus. Possibly the coastal findings are results of flooding during winter seasons. There are no evident differences in habitat preference to *T. ovipennis*.

Discussion: This species was described after a single male specimen by Jeannel (1927). Nothing has been published about taxonomy or distribution since then. The slight but constant differences in shape of pronotum and aedeagus from several well sampled populations and the syntopic coexistence with *T. ovipennis* in two places indicate that *T. conformis* should be interpreted as a valid species.

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