



<https://doi.org/10.12976/jib/2020.17.2.1>

<http://zoobank.org/urn:lsid:zoobank.org:pub:0B6ED543-EB48-4FFC-9847-E07D9A74C866>

A new species of melolonthine chafer in the endemic Californian genus *Dinacoma* Casey (Coleoptera: Scarabaeidae)

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Abstract

We describe *Dinacoma sanfelipe* **sp. nov.** from southern California, the first new species belonging to the melolonthine scarab beetle genus *Dinacoma* Casey, 1889 (Scarabaeidae: Melolonthinae: Melolonthini) to be described in 90 years, based upon examination of 141 specimens of that genus. Diagnostic comments, a dichotomous key, photographs of all species of *Dinacoma*, and a distribution map are presented to facilitate the identification of adult male specimens. One species in the genus is federally listed under the United States Endangered Species act, and all known species may be of conservation concern.

Key words: Scarabaeoidea, Melolonthini, scarab beetle, insect conservation, cryptic species

Introduction

The melolonthine scarab beetle genus *Dinacoma* Casey, 1889, belonging to the tribe Melolonthini, hitherto consisted of two species restricted to highly localized populations occurring in xeric habitats of southern California: the type species *Dinacoma marginata* (Casey, 1887), described from “California (San Diego Co.)”, and the federally listed *Dinacoma caseyi* Blaisdell, 1930, described from “Palm Springs, Imperial County, California”. Beyond the original generic description by Casey (1889), diagnostic characters distinguishing *Dinacoma*, together with keys to the two known species, were published by Blaisdell (1930) and Hardy (1974), who also each discussed the taxonomic history of the genus. Keys to distinguish *Dinacoma* from related Melolonthini genera were presented by Hardy (1974) and Evans (2002), and the genus was catalogued by Evans (2003) and Evans & Smith (2005).

Due to widespread human-induced degradation of their highly localized and restricted habitats, conservation of these endemic Californian chafers is of serious and ongoing concern, which is only exacerbated by the fact that female *Dinacoma* are fossorial and flightless, limiting their dispersal ability and hence capacity to respond to environmental modification (Wright *et al.* 2004, Rubinoff *et al.* 2020).

Recent phylogenomic analysis of *Dinacoma* concluded that the observed divergence between three extant populations is consistent with the existence of three species-level taxa: *D. caseyi*, *D. marginata*, and a third, cryptic species, occurring in the San Felipe Valley, east of the Laguna mountains in San Diego County, which we describe in this article (Rubinoff *et al.* 2020). We adhere to the Phylogenetic Species Concept, which defines species as the smallest aggregation of populations diagnosable by a unique combination of character states (Wheeler and Platnick 2000).

Material and methods

141 specimens of *Dinacoma* from the following institutional and private collections were studied:

KOCC - Kendall H. Osborne Collection, California, U.S.A.

LACM - Natural History Museum of Los Angeles County, California, U.S.A.

UCRC - Entomology Research Museum, University of California, Riverside, California, U.S.A.

UHIM - University of Hawai'i Insect Museum, Honolulu, Hawai'i, U.S.A.

Body length was measured using a millimeter scale, from the apex of the clypeus to the elytral apices; width was measured across the body at the level of the elytral humeri (i.e. the widest part of the body). Aedeagi were dissected out and the shape of the parameres were compared. Digital photographs of the dorsal and ventral habitus, and lateral and dorsal views of the aedeagi, of the holotype male of *D. sanfelipe* sp. nov., and of representative male specimens of *D. marginata* and *D. caseyi* were taken with a Nikon D-7100 DSLR camera mounted on an Olympus stereomicroscope. The image files were subsequently focus-stacked using Helicon Focus (Helicon Soft Ltd., Kharkiv, Ukraine), and edited on an Apple desktop computer.

Results

Description of new species

Superfamily Scarabaeoidea Latreille, 1802

Family Scarabaeidae Latreille, 1802

Subfamily Melolonthinae Leach, 1819

Genus *Dinacoma* Casey, 1889

***Dinacoma sanfelipe* sp. nov.** Figs 1A–C, M; 2–3.

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Diagnosis

The new species can be distinguished from the two other species of *Dinacoma* by the following combination of morphological characters. Protibia with two distinct external teeth (with third distinctive basal tooth present in *D. marginata*). Anterior margin of clypeus weakly concave (deeply concave to moderately notched in *D. marginata* and *D. caseyi*). Anterior angles of clypeus sharply acute and outwardly divergent (less acute and divergent in *D. marginata* and *D. caseyi*). Scales covering elytra whitish colored medially, becoming yellowish laterally (scales all white in *D. caseyi*). Central elytral longitudinal stripe and juxta-sutural stripe composed of scales distinctly contrasting against remaining elytral ground color (these stripes are less distinct in *D. marginata* and *D. caseyi*). Whitish scales covering ventral surface of abdominal sternites not dense enough to obscure ground color of ventrites (scale covering very dense in *D. caseyi*, largely obscuring the ground color of ventrites except at the base of each ventrite).

Etymology

The new species' epithet is a nominative noun in apposition, indicating the unique locality in San Diego County, California, in which the new species has been collected.

Type Material

Holotype: ♂: UNITED STATES, California, San Diego County, San Felipe Valley; 33.14130°N, 116.54310°W, elev. 2574 ft; 3 June 2016; BL and MV light; Ken H. Osborne/ D. Wikle leg.; UHIM. **Paratypes:** 27 ♂♂: same data as for holotype.

The Holotype bears our red holotype designation label "HOLOTYPE, *Dinacoma sanfelipe* sp. nov., Gillett, Osborne, Reil, & Rubinoff 2020" and is deposited in the University of Hawai'i Insect Museum, Honolulu, Hawai'i. The 27 paratypes each bear our yellow paratype designation label "PARATYPE, *Dinacoma sanfelipe* sp. nov., Gillett, Osborne, Reil, & Rubinoff 2020" and are deposited in the following collections: UHIM (8), KOCC (14), LACM (1),

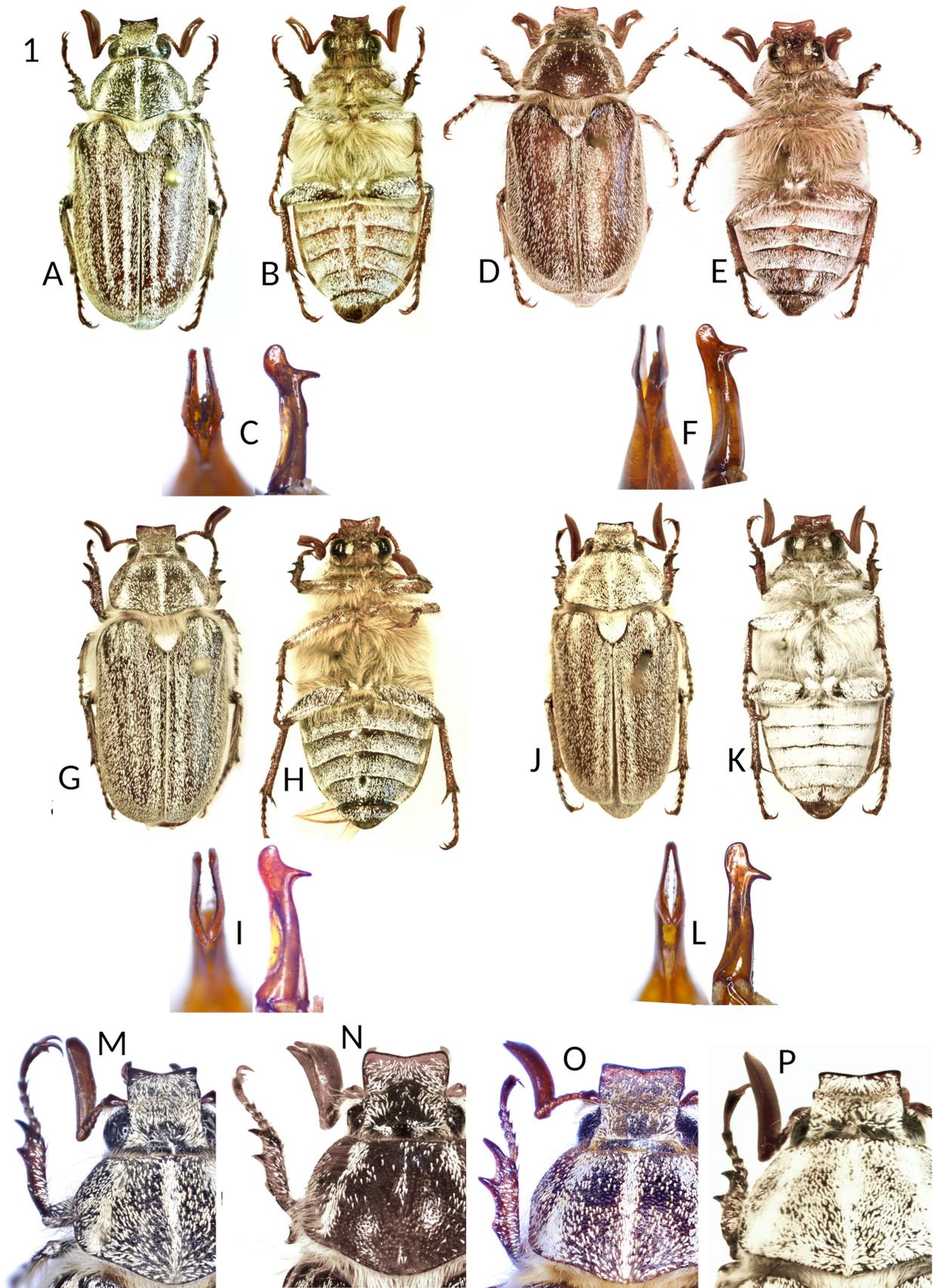


Figure 1. Dorsal and ventral habitus, lateral and dorsal views (showing parameres) of the aedeagus, and dorsal close-up view of right protibia and clypeus of male specimens of *Dinacoma*. A–C, M, Holotype of *Dinacoma sanfelipe* sp. nov. (length 23.0 mm); D–F, N, *D. marginata* (from Del Mar, San Diego) (length 20.0 mm); G–I, O, *D. marginata* (from Bautista Canyon) (length 21.0 mm); J–L, P, *D. caseyi* (length 17.5 mm).

UCRC (1), California Academy of Sciences, San Francisco CA (CAS) (1), Essig Museum of Entomology, Berkeley CA (EMEC) (1), National Museum of Natural History, Washington D.C. (USNM) (1), Muséum d'Histoire Naturelle de Genève, Switzerland (MHNG) (1).

Description of holotype (Figs 1A–C, M).

Dorsal habitus and ventral view shown in Figs 1A and B respectively. Male. Length 23.0 mm; width 10.0 mm. Body robust, elongate, and narrow. Head and pronotum ground color blackish-brown, clothed in long pale yellowish hairs and covered in scattered pale whitish backwardly pointing teardrop-shaped scales. **Thorax:** scales concentrated in three longitudinal stripes on the pronotum; one broad stripe that is narrowed medially on each side, and a narrower stripe along the center, which narrows posteriorly, reaching the base of the pronotum. Ventral surface of prosternum and metasternum clothed in a dense covering of long pale hairs. **Elytra:** lacking long hairs, moderately shining, ground color reddish brown, becoming darker brown basally; covered in scattered pale scales that are white medially and light yellowish-brown laterally. Scales forming a fine (two to three scales wide) sutural border running the length of the inner elytral suture. Each elytron bears a whitish juxta-sutural longitudinal stripe progressively narrowing from behind the scutellum to near the elytral apex. A second similar but slightly narrower longitudinal stripe runs distinctly approximately along the center of each elytron, from the base to about one fifth the elytral length from the elytral apex, where it becomes diffuse. Base of elytral humerus bearing a distinctive patch of whitish scales that largely mask the elytral ground color; the humeral callus itself is less densely clothed in scales, permitting the elytral ground color to show through. Lateral one third of each elytron more or less uniformly clothed in pale scales that reach the external elytral margin without forming further distinctive longitudinal stripe. **Head:** Excluding eyes, approximately as wide as long. Anterior margin of clypeus uniformly shallowly concave medially, lacking emargination, with anterior and lateral borders raised, and the anterior angles sharply acute and directed outwardly. Clypeus and vertex uniformly covered in erect long and pale yellowish-brown pilosity and scattered pale whitish-yellow hair-like recumbent scales. Base of head glabrous medially. Eyes large; interocular width equal to about 3 eye diameters. Antenna 10-segmented; scape equal in length to at least the next three segments combined; antennal club composed of 3 very long subequal segments, longer than all other segments combined. Ventral surface of head clothed in long pale hairs. **Abdomen:** Reddish brown in color. Abdominal ventrites almost uniformly covered in scattered whitish scales that permit the ground color of the ventrites to be clearly visible to the naked eye. A longitudinal area along the midline of the ventrites, and a fine margin along the base of each ventrite are less densely clothed in scales, contrasting against the more uniformly covered areas (Fig 1B). **Legs:** Femora dark brown, somewhat densely covered in whitish scales, but ground color is clearly visible. Tibiae lighter reddish-brown, sparsely covered in long pale hairs and whitish scales, and with a small dense patch of white scales at their base, adjacent to the femoral joint. Meta- and mesotibia bearing a tooth-like ridge a little more than halfway along the external surface; this ridge is fringed with short, stout bristles. Apex of meso and metatibiae each bearing two moderately long apical spurs; mesotibial apical spurs subequal in length, about as long as first tarsomere; metatibial spurs are unequal in length, with innermost spur longer than first tarsomere. Protibia laterally bidentate externally (including apical spur), and sinuous in basal half, but lacking a third distinct basal tooth (Fig 1M). Tarsi reddish brown, claws bearing an acute tooth at their base. **Genitalia:** aedeagus in dorsal view symmetrical, with a broad base and narrowing apically to a convexly rounded tip. In lateral view, the apical third is curved upwards, broadly rounded at the apex, and with ventral teeth almost vertical, only slightly posteriorly curved. Vertical length of teeth about one fifth of total length of aedeagus (Fig 1C).

Variation

The length of specimens in the type series varies between 16.5 – 23.0 mm (mean 19.0 mm; SD 1.36); ground color of pronotum and elytra varies between reddish brown to brownish black. The density of the scale covering varies on the pronotum and elytra such that in some specimens the longitudinal stripes are less discrete, but they are always distinct to the naked eye. The color of scales varies among individual specimens from a distinctly yellowish tone to almost purely white. Depth of clypeal anterior margin concavity is variable, as is the sharpness of the anterior angles of the clypeus and the degree to which they protrude laterally. Density of scale covering on abdominal ventrites variable but the reddish brown ground color of the ventrites is always clearly visible to the naked eye.

Distribution

The new species is known only from the San Felipe Valley in San Diego County, southern California (Figs 2 and 3).

Temporal Distribution

All 28 studied specimens were collected in early June.

Ecology

Nothing is known specifically about the immature biology of the new species. Adults emerge during early summer (late May and June - personal observation, KHO) and males fly about rapidly close to the ground, beginning approximately an hour after sunset, with flight activity tapering off after 2200 hours. They are attracted to electric lights after dark (beginning approximately 2030 hours). Females, which are rarely encountered in this genus, remain undescribed for the new species, but are presumably also flightless. The new species' habitat includes the valley bottom and gentle alluvial slopes, with vegetation ranging from riparian woodland (on San Felipe wash), consisting of Mesquite (*Prosopis glandulosa*), Fremont's cottonwood (*Populus fremontii*), Western willow (*Salix gooddingii*), and Desert willow (*Chilopsis linearis*), grading into desert transitional zone scrub adjacent to the valley bottom, dominated by Catclaw (*Acacia greggii*), Valley cholla (*Opuntia parryi*), and California buckwheat (*Eriogonum fasciculatum*). Photographs of the habitat at the type locality are shown in Fig 3.

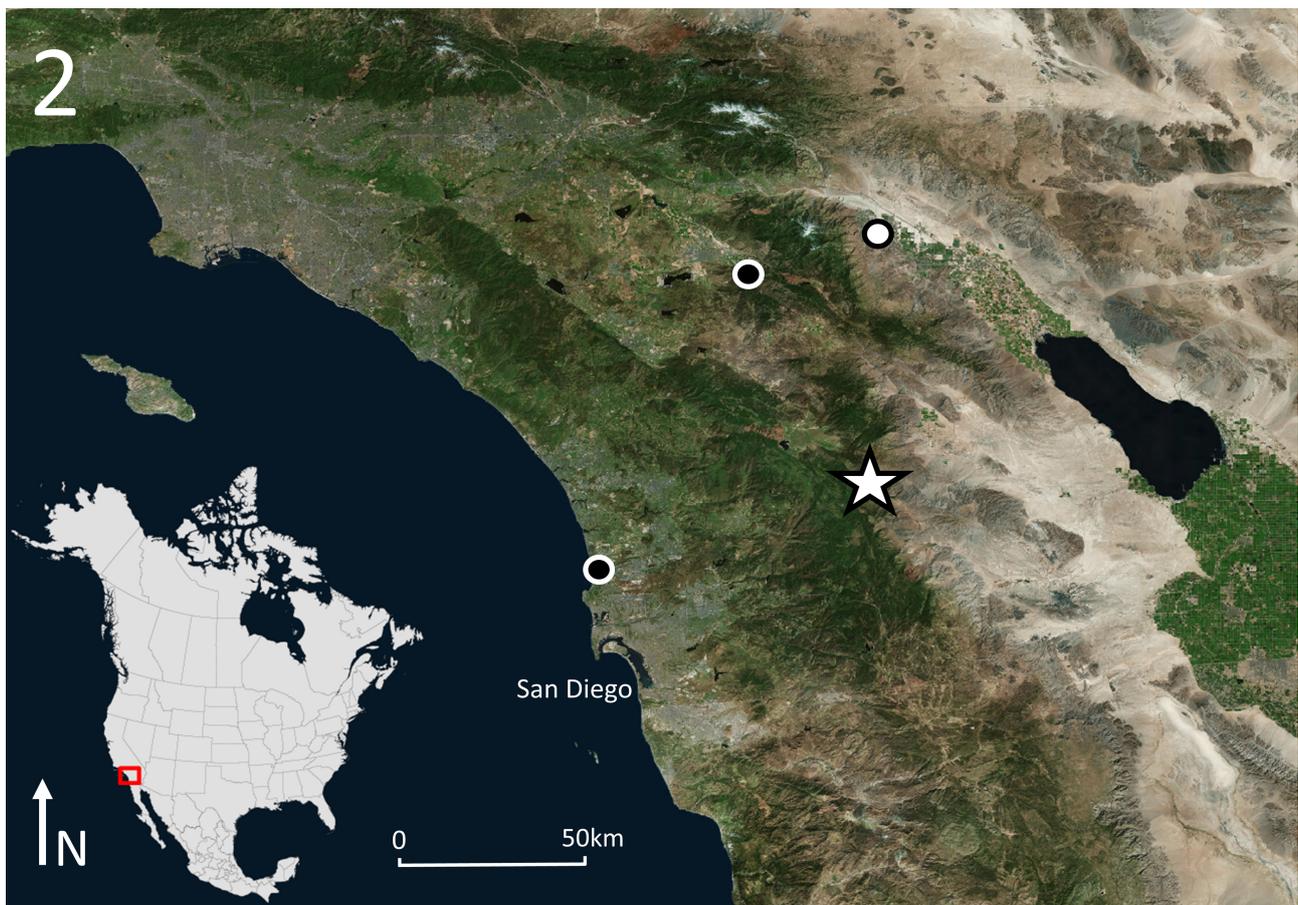


Figure 2. Map of southern California indicating collection localities for *Dinacoma sanfelipe* sp. nov. (white star), *D. marginata* (black-filled circles), and *D. caseyi* (white-filled circle).

Additional material examined

Dinacoma marginata (Casey, 1887) (2 ♀♀, 109 ♂♂). Figs 1D–I, N–O.

3 ♂♂: UNITED STATES, California, San Diego County, Del Mar; 10 August 1946; J. A. Omstook leg.; LACM ENT: 414867; 414869; 414870.

2 ♂♂: same collection data as for preceding, except 1 June 1947; LACM ENT: 414866/414868. 1 ♂: California, San Diego County, San Diego; 9 May 1934; UCRC. 56 ♂♂: California, Riverside County, Bautista Canyon; 33.6948°N, 116.8507°W; elev. 2223 ft; 27 May 2016; BL and MV light; Ken H. Osborne leg.; KOCC. 1 ♀: same collection data as for preceding, except, on ground; KOCC. 19 ♂♂: same collection data as for preceding, except, 29 May 2016; BL and MV light; KOCC. 1 ♀: same collection data as for preceding, except, on ground; KOCC. 8 ♂♂: California, Riverside

County; 33.759722°N, 116.880277°W; 14 June 2003; UCRC ENT 79604-11. 16 ♂♂: California, Riverside County; 33.671944°N, 116.927777°W, 5 July 1990; UCRC ENT 87625-6. 3 ♂♂: California, Riverside County; 33.696111°N, 116.851666°W; 15 June 1985; UCRC. 1 ♂: California, Riverside County; Hemet; 17 May 1984; UCRC.

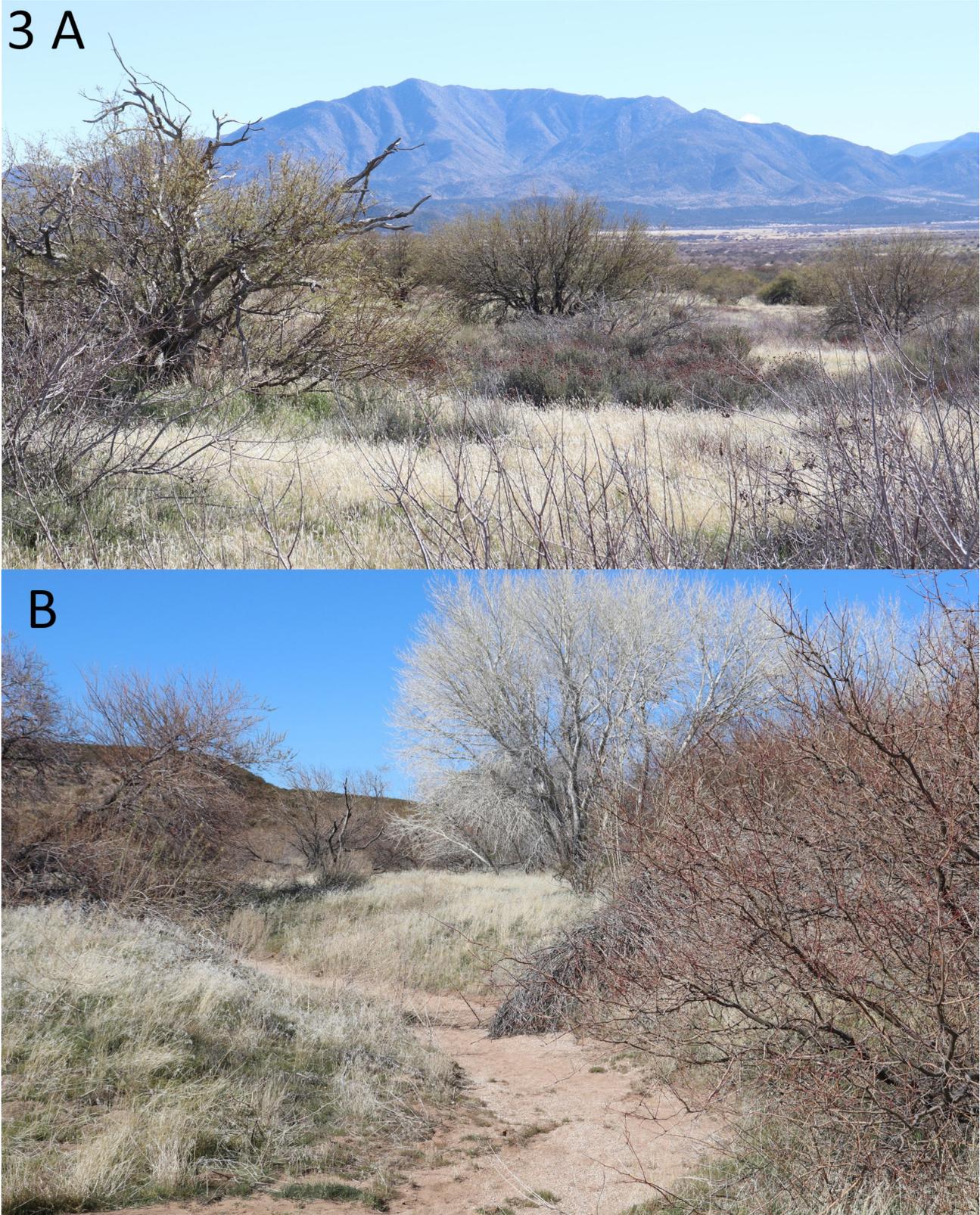


Figure 3. Photographs of the type locality of *Dinacoma sanfelipe* sp. nov. in San Felipe Valley, San Diego County, California, taken in February 2020. **A**, Desert transition scrub at the type locality, with *Prosopis*, *Acacia*, *Eriogonum*, and *Opuntia* (Granite Mountain lies in the far background); **B**, A wash near the collection site of the type series (where adult male *Dinacoma* were also observed in abundance), with *Prosopis*, *Populus*, *Salix*, *Chilopsis*, and *Bacharis*. Photographs by K. H. Osborne.

Dinacoma caseyi Blaisdell, 1930 (2 ♂♂). Figs 1J–L, P.

2 ♂♂: UNITED STATES, California, Riverside County, Palm Canyon Wash; 33.801°N, 116.497°W; at black light; 28 April 2016; K. H. Osborne leg, under USFWS permit #TE-837760; UCRC.

The approximate position of collection localities for examined specimens of all species is indicated in the map in Fig 2.

Key to adult males of *Dinacoma* species

The following dichotomous key is based in part upon that by Hardy (1974).

1. Elytra with all scales uniformly white in color; covering of scales on abdominal sternites extremely dense, obscuring reddish-brown ground color of ventrites (Fig 1K) *D. caseyi* Blaisdell
- Elytra with scales near suture white and those laterally yellowish-white; covering of scales on abdominal sternites less dense, not obscuring reddish-brown ground color of ventrites (Figs 1B, E, H) 2
2. Foretibiae bearing only two distinct external teeth, including apical tooth (Fig 1M). Anterior margin of clypeus weakly and uniformly concave, not weakly notched or with weak emargination. Anterior angles of clypeus distinctly acuminate and outwardly divergent (Fig 1M). Central and juxta-sutural longitudinal elytral squamous stripes distinct, clearly contrasting with remainder of elytral surface (Fig 1A) *D. sanfelipe* Gillett, Osborne, Reil, and Rubinoff sp. nov.
- Foretibiae bearing three distinct external teeth, including apical tooth (Figs 1N–O). Anterior margin of clypeus deeply concave, weakly notched or with weak emargination. Anterior angles of clypeus not so distinctly acuminate and not distinctly outwardly divergent (Figs 1N–O). Central and juxta-sutural longitudinal elytral squamous stripes less distinct, not clearly contrasting with remainder of elytral surface (1D, G) *D. marginata* (Casey)

Discussion

Based upon the specimens we examined, *D. caseyi* males are slightly smaller in mean length than those of the other two *Dinacoma* species (mean length = 17.25 mm; SD = 0.25; n = 2). No noteworthy difference in mean length was noted between males of *D. marginata* (mean length = 18.85 mm; SD = 1.10; n = 82) and *D. sanfelipe* sp. nov. (mean length = 19.0 mm; SD = 1.36; n = 28).

We did not detect any consistent diagnostic characteristics in the shape of the aedeagi or parameres to enable the three species to be distinguished.

When Casey described *D. marginata* (then in the genus *Thyce*), he specifically stated that “In *T. marginata* the anterior tibiae have two teeth exclusive of the exterior apical spur” (Casey 1887). Subsequently, Hardy’s (1974) brief diagnosis of the genus *Dinacoma* stated that the anterior tibiae in that genus are “bidentate, or at most with poorly developed third tooth”. Our study of *D. marginata* specimens from the type locality of San Diego (Figs 1D–F and N) and from Bautista Canyon, Riverside County (Figs 1G–I and O), suggests that there is some variation in the extent of development of the protibial teeth in that species. Specifically, whilst we recognize the basal (third) tooth as being distinctly present in both populations (in disagreement with Hardy’s (1974) statement above), it is clear that this tooth is most well-developed and distinctive in specimens belonging to the Bautista Canyon population. This population may prove to be distinctive from the (likely now extirpated) nominate San Diego population. However, because as yet no molecular sequence data is available for the topotypical San Diego population, we have decided to treat these two populations as conspecific.

In their genomic study, Rubinoff *et al.* (2020) found that each of the populations of *Dinacoma* (which did not include topotypical *D. marginata*) was isolated genetically, suggesting the possibility that *Dinacoma* evolve into extremely isolated and geographically restricted species, as is the situation for *D. caseyi*. Further research on the group may reveal additional populations that confirm the isolated nature of each species, reflecting the importance of incorporating some invertebrate-based research when planning conservation reserves. Further, *Dinacoma* distributions suggest historical dispersal, perhaps during wetter, glacial, periods, followed by isolation and speciation in pockets of suitable alluvial or coastal habitat. Such a distribution could be used to investigate for matching patterns of diversity in other groups, especially other insects, or even amphibians, to identify localized hotspots of species diversity across the southern California desert regions.

Acknowledgments

We gratefully acknowledge the following collection managers for preparing specimen loans, photographing specimens, and providing label data: Weiping Xie (LACM), Doug Yanega (UCRC). Our late friend and colleague, U. S. Fish and Wildlife Service biologist Christopher Gregory, proposed, passionately pursued, and promoted the overarching research initiatives on *Dinacoma*, one of which ultimately exposed through molecular analyses, the species level novelty presented here. Funding was provided by The College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa; USDA Cooperative State Research, Education and Extension (CSREES), Grant/Award Number: HAW00942-H; and by the U. S. Fish and Wildlife Service 15.657 Endangered Species Conservation Recovery Implementation Funds, Cooperative Agreement Awards: F15AC00043 and F15AC00813, project title “Determining and Measuring Environmental Influences on the Distribution and Abundance of Casey’s June Beetles”. The authors also thank two anonymous reviewers for their constructive comments and corrections.

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