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A New and Endemic Species of *Nebria* Latreille (Insecta: Coleoptera: Carabidae: Nebriini), Threatened by Climate Change in the Trinity Alps of Northern California

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Nebria praedicta, new species, is described from the highest elevations of the Trinity Alps of northern California (type locality = U.S.A., California, Trinity County, north by northwest slope of Thompson Peak in upper Grizzly Lake Basin). Based on collection records, this species is endemic to the region and now probably restricted to northern slopes of this single high massif, where it has been found only at and below the toe of a catastrophically receding glacier. This species is most closely related to *Nebria vandykei* of the Cascade Range in Washington and Oregon, based on characters of external and male and female genitalic form and structure and on preliminary DNA sequence comparisons. Its existence was predicted from the Cascade-Trinity Alps vicariant distribution of the species pair, *Nebria paradisi* Van Dyke and *Nebria turmaduodecima* Kavanaugh, which occupy the same habitats in the respective regions, and the widespread co-occurrence of *N. paradisi* with *N. vandykei*. Characteristics are provided for distinguishing *N. praedicta* adults from those of closely related species; and the imminent threat to the survival of the species from climatic change is discussed.

KEYWORDS: Coleoptera, Carabidae, Nebriini, *Nebria*, California, Trinity Alps, catastrophic glacial recession, climate change

In 1981, *Nebria turmaduodecima* Kavanaugh was described from upper Caribou Basin in the Trinity Alps of northwestern California, where adults were found at the margins of a persistent snowfield at an elevation of 2380 m (Kavanaugh 1981). This species, endemic to the Trinity Alps, is most closely related to *Nebria paradisi* Darlington (1930, 1931) (Kavanaugh 1985), which is restricted to the Cascade Range, from northern Washington south to Mt. Hood in northern Oregon. Members of *N. paradisi* live in the same habitat as *N. turmaduodecima* members; and wherever they occur in that habitat, they are found with members of another species, *Nebria vandykei* Bänninger (1928). Because of this widespread habitat association of *N. paradisi* with *N. vandykei*, the senior author (DHK) expected that, eventually, either *N. vandykei* itself or a closely related species would be found in the Trinity Alps associated with *N. turmaduodecima*. The most likely place to find this predicted species was high on the northern slopes of Thompson Peak, the highest peak in the Trinity Alps, at or near the glaciers and persistent snowfields on that slope. When the junior author (SDS) visited Grizzly Lake Basin, on the northern slope of Thompson Peak, on 13 September 2008, he looked for and found very large, black *Nebria* adults among the smaller, faintly metallic green adults of *N. turmaduodecima*.

Our subsequent study of external and genitalia morphology and preliminary DNA sequence data for these specimens has convinced us that they indeed represent a new and distinct species. The purpose of this paper is to describe this new species and distinguish its members from those of the two *Nebria vandykei* taxa, which are currently ranked as subspecies but may, in fact, represent distinct species—namely, *Nebria vandykei vandykei* Bänninger, from the Olympic Mountains and the Cascade Range of Washington, and *Nebria vandykei wyeast* Kavanaugh (1979), from volcanoes of the Cascade Range in northern to central Oregon. We also discuss our concern for the future survival of this species in the face of the current climatic warming trend.

MATERIALS AND METHODS

This report is based on study of the 23 specimens from the Trinity Alps, described here as representing a new species, and additional specimens representing all previously described Nearctic *Nebria* species. All but two of the specimens in the type series were collected directly into 95% ethanol to preserve them suitably for DNA sequencing and analysis. Institutional codons cited in the text:

CAS — California Academy of Sciences, San Francisco, California, USA

EMEC — Essig Museum of Entomology, University of California, Berkeley, California, USA

Methods used in the present study, including dissection techniques and criteria for ranking taxa as distinct species, were as described in Kavanaugh (1979). The only measurement used is standardized body length (SBL), which equals the sum of the lengths of the head (measured from apex of clypeus to a point on midline at level of posterior margin of compound eye), pronotum (measured from apical margin to basal margin along midline), and elytra (measured along midline from apex of scutellum to apex of the longer elytron). Following dissection, preparations of female genitalic structures were stained with Chlorosol Black E and digitally photographed using an Auto-montage imaging system by Syncroscopy with a Leica M420 dissecting microscope. Digital photographs of dorsal habitus, pronotum, and male and female genitalia were also taken with the auto-montage system.

DESCRIPTION

Nebria praedicta Kavanaugh and Schoville, sp. nov.

Figures 1-2, 5, 8-9, 11, 13, 16.

TYPES.—Holotype, a pinned male, deposited in CAS, labeled: “CASENT1039942”/ “U.S.A., California, Trinity County, Trinity Alps, NNW slope of Thompson Peak below glacier in upper Grizzly Lake Basin, N41.00458°W/123.04799° to N41.00301°W/123.04807°, 2411–2470 m, 13 September 2008, S. D. Schoville collector”/ “IMAGE” [pale blue label]/ “HOLOTYPE *Nebria praedicta* Kavanaugh & Schoville n. sp. designated. by D.H. Kavanaugh & S. D. Schoville 2009” [red label]/ “California Academy of Sciences Type No. 18447”. A total of 22 paratypes (10 males and 12 females) are deposited in CAS and EMEC, each with same locality label as holotype, but labeled: “PARATYPE *Nebria praedicta* Kavanaugh & Schoville n. sp. designated. by D.H. Kavanaugh & S.D. Schoville 2009” [yellow label].

TYPE LOCALITY.—North by northwest slope of Thompson Peak in upper Grizzly Lake Basin, 41.00458°N, 123.04799°W to 41.00301°N, 123.04807°W, Trinity County, California, U.S.A.

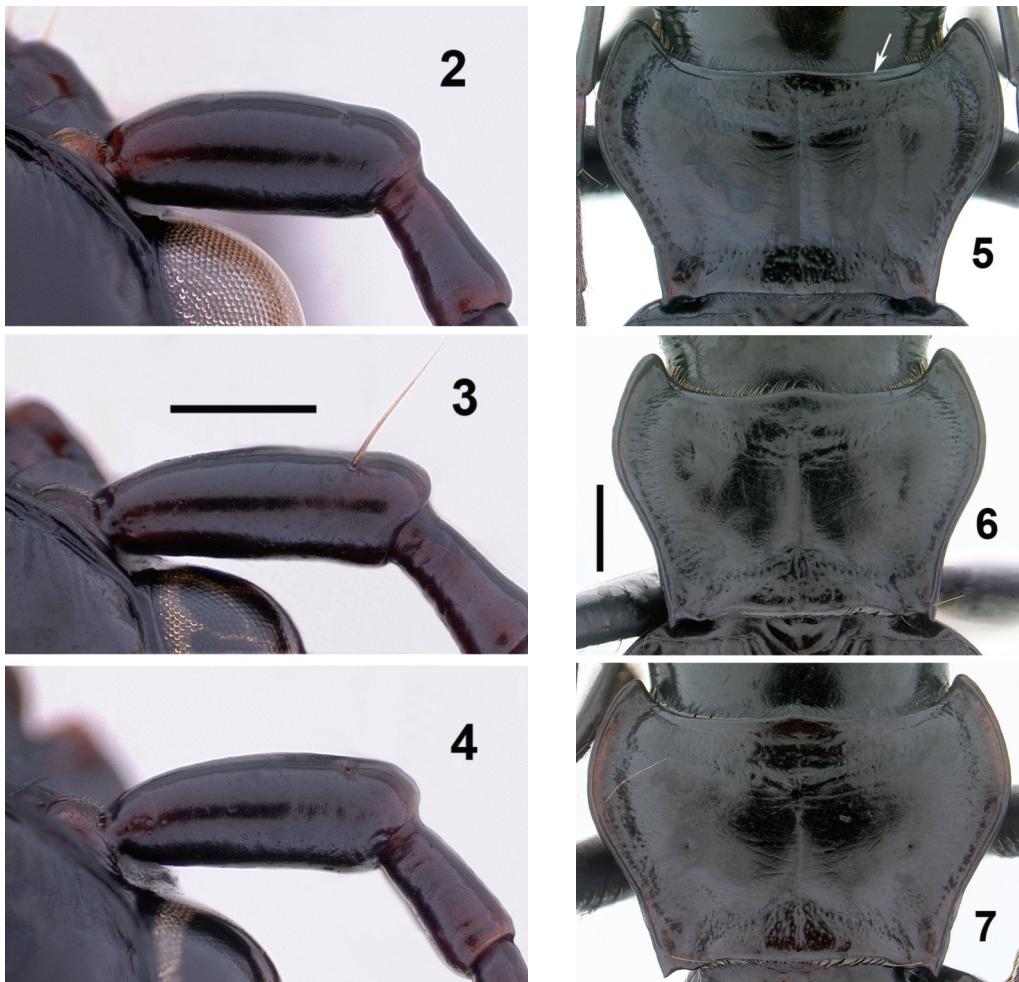
ETYMOLOGY.—The specific epithet, *praedicta*, is the perfect participle of the Latin verb, *praedico* (meaning, to predict), used as an adjective in the nominative singular, in reference to the predicted occurrence of a member of the *vandykei* species-subgroup in the Trinity Alps.

DIAGNOSIS.—Adults of this species can be distinguished from those of all other Nearctic *Nebria* species by the following combination of character states: both males and females with SBL greater than 12.0 mm; body (Fig. 1) and appendages black or piceous, vertex with pair of paramedial pale spots; dorsal body surface without metallic reflection; elytral microsculpture comprised of moderately deeply impressed isodiametric meshes; antennal scape (Fig. 2) symmetrical or slightly swollen sub-basally, straight, medium-length; pronotum (Fig. 5) with basal sinuation of lateral margins distinct, moderately deep and long, midlateral and basolateral setae present; elytral silhouette distinctly and symmetrically ovoid, elytra markedly flattened (especially at lateral declivity), intervals only moderately convex, striae moderately punctate; female genitalia with lateral lobe of basal apodeme of sternite VIII (Fig. 9) extremely short, bursa copulatrix (Fig. 11) without sclerites, spermathecal duct straight or slightly arcuate and deflected moderately right of midline proximally and irregularly convoluted distally; specimen from Trinity Alps of northwestern California.

Comparisons. Members of this species are most similar, in external and genitalia morphology, to those of both subspecies of *Nebria vandykei* Bänninger, with which they share large size, dark, non-metallic body and appendage color, markedly ovoid elytra, distinctly catenate elytral intervals 3, 5, and 7, virtually identical male genitalia, and female genitalia without sclerites on the bursa copulatrix. *Nebria praedicta* adults differ with those of both *N. vandykei* subspecies in the following traits: antennae very long (with the scape extended laterally at 90° to the longitudinal body axis, the distal two antennomeres extend posteriorly beyond elytral mid-length) (at most only the distal-most [eleventh] antennomere extends beyond elytral mid-length in members of either *N. vandykei* subspecies), the antennal scape nearly straight, medium-length, and slightly swollen sub-basally or symmetrical (Fig. 2) (slightly arcuate and narrowed basally in both *N. vandykei* subspecies, medium-length in *N. v. vandykei* (Fig. 3) and more elongate in *N. v. wyeast* (Fig. 4)); pronotum (Fig. 5) with basal sinuation of the lateral margin long and moderately deep (shallower and shorter in both *N. vandykei* subspecies (Figs. 6 and 7)), anterior margination more nearly complete medially and distinctly divided into two parallel beads by a finely impressed secondary transverse sulcus paramedially (Fig. 5) (anterior margination restricted to lateral thirds and without or with only a faint median sulcus dividing the margination into parallel beads (Fig. 6 or 7) in *N. vandykei* subspecies); elytral silhouette (Fig. 1) symmetrically ovoid (very slightly narrower basally than apically in the *N. vandykei* subspecies), elytra markedly flattened, especially at the lateral declivity (most noticeably just anterior to the subhumeral sinuation) (slightly more convex



FIGURE 1. Digital image of holotype, *Nebria praedicta* new species; habitus, dorsal aspect; scale line = 1.0 mm.



FIGURES 2-4. Digital images of right antennal scape, dorsal aspect; scale line = 0.5 mm. Fig. 2. *Nebria praedicta* new species. Fig. 3. *Nebria vandykei vandykei* Bänninger. Fig. 4. *Nebria vandykei wyeast* Kavanaugh.

Figures 5-7. Digital images of pronotum, dorsal aspect; scale line = 1.0 mm; white arrow = secondary transverse sulcus within anterior margination. Fig. 5. *Nebria praedicta* new species. Fig. 6. *Nebria vandykei vandykei* Bänninger. Fig. 7. *Nebria vandykei wyeast* Kavanaugh.

overall and especially at the lateral declivity in both *N. vandykei* subspecies), elytral striae moderately punctate (only slightly punctate in *N. vandykei* subspecies), elytral intervals only moderately convex (markedly in *N. vandykei* subspecies); lateral lobe of the basal apodeme of abdominal sternite VIII in females (Fig. 9) extremely short (longer and more similar in length to the medial lobe in *N. vandykei* subspecies (Fig. 10)); spermathecal duct of females (Fig. 11) with a longer, straighter, and more distinctly deflected right proximal section (proximal section shorter, more arcuate than straight, and less distinctly deflected right in *N. vandykei* subspecies (Fig. 12)). Additionally, the following trends separate many or most adults of *N. praedicta* from those of *N. vandykei* subspecies: the smallest males and females of *N. praedicta* are larger (13.0 mm and 13.4 mm, respectively) than the smallest males and females of the *N. vandykei* subspecies (12.0 mm and 12.6 mm, respectively); *N. praedicta* adults have fewer catenations on elytral intervals 3

(two to six catenations), 5 (zero to six catenations), and 9 (11 to 16 catenations in the umbilicate series) than adults of *N. vandykei* subspecies (with four to seven, three to seven, and 14 to 19 catenations on intervals 3, 5, and 9, respectively). In addition, *N. praedicta* is a species apparently restricted to the highest elevations of the Trinity Alps in northwestern California, whereas the *N. vandykei* subspecies occur only in the Cascade Range of Oregon (*N. v. wyeast*) and the Cascade Range and Olympic Mountains of Washington (*N. v. vandykei*) (Fig. 13).

DESCRIPTION.—Body size large for *Nebria*, SBL males 13.0–14.2 mm, SBL females 13.4–14.8 mm; head black or piceous, with pair of paramedial pale spots present on vertex; pronotum, elytra, and legs black or piceous; dorsum and venter without metallic reflection; frons and vertex smooth or nearly so; microsculpture with sculpticells regularly isodiametric, flat, faintly impressed on frons, moderately impressed on pronotum and elytra.

Head.—Size and width relative to pronotum greater than average for genus, slightly greater in females than males; genae and occiput moderately inflated, slightly more inflated in females than males. Eyes slightly reduced in diameter, moderately convex. Antennae moderately elongate; scape (Fig. 2) medium-length, slightly arcuate, slightly swollen anterobasally, with one anterodorsal seta subapically; pedicel with one ventral seta subapically; flagellar antennomeres moderately elongate, slender. Labrum with apical margin slightly to moderately bisinuate. Clypeus with apical margin truncate or slightly concave and slightly emarginate. Mentum with pair of M2 setae (setal nomenclature as in Kavanaugh 1979) long and slightly to moderately far removed from basal margin. Submentum with three or four pairs of lateral setae (five setae unilaterally in a few individuals) and one pair of medial setae (absent or with two setae unilaterally in a few individuals).

Pronotum.—Size and width relative to elytra average for genus; shape (Fig. 5) moderately cordate and slightly convex, basal margin distinctly narrower than apical margin; lateral margins moderately arcuate, with basal sinuation long and moderately deep; lateral explanation present throughout pronotal length, moderately broad at middle and basally and slightly broader apically; basal margin markedly bisinuate; apical angles moderately long, slightly narrow, and moderately rounded; basal angles slightly obtuse, projected posteriorly, distinctly dentate apicoposteriorly; lateral margination (“lateral bead”) present throughout, widened apically, slightly narrowed and more faintly impressed at middle; anterior margination complete or incomplete only near midline, moderately to markedly impressed, divided into two thin beads paramedially by a finer secondary transverse sulcus, anterior transverse impression narrow and moderately deep; posterior transverse impression narrow and deep; basal foveae deep, moderately broad, and moderately divergent basally; midlateral and basolateral setae present.

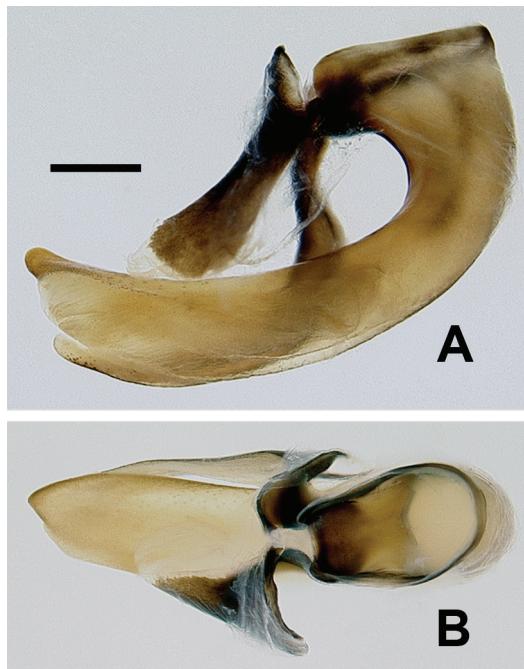
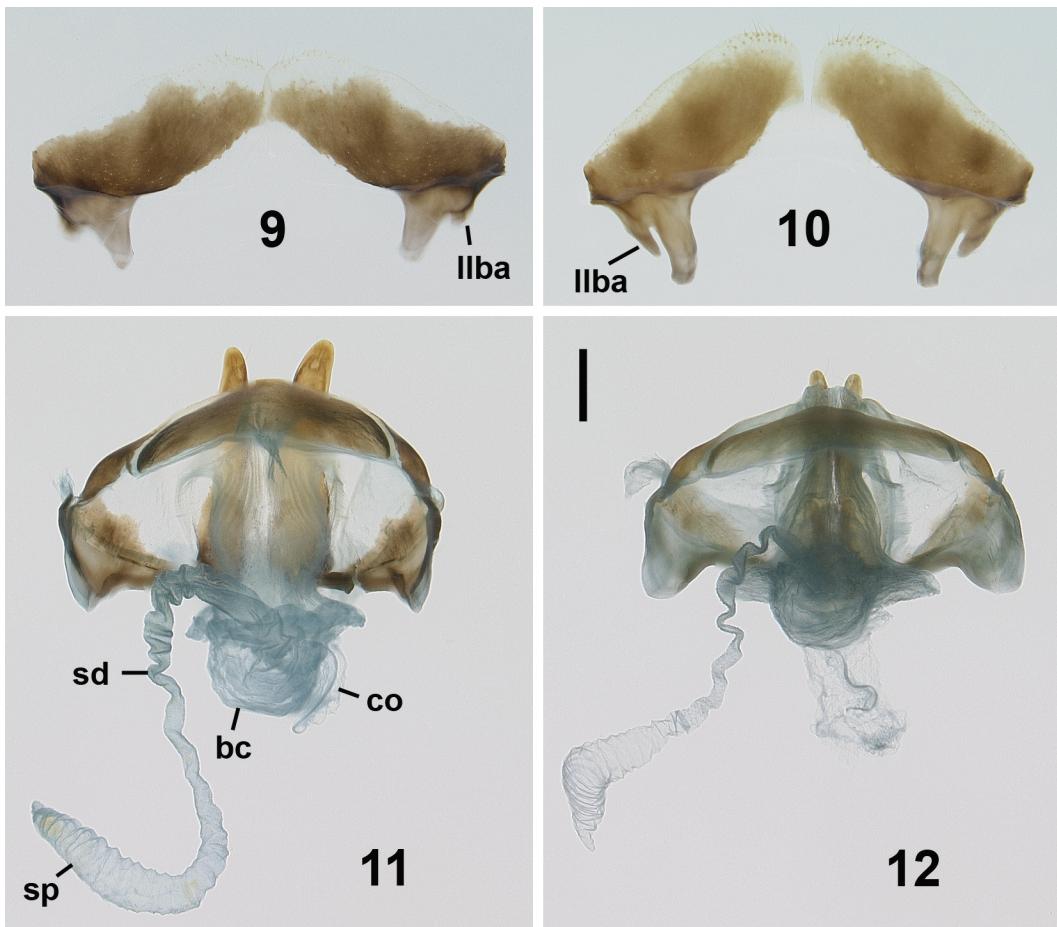


FIGURE 8. Digital image of male median lobe of aedeagus, *Nebria praedicta* new species; A = left lateral aspect; B = ventral aspect; scale line = 0.5 mm.



FIGURES 9–12. Digital images of female genitalia and reproductive system. Figs. 9–10. Sternite VIII, ventral aspect; llba = lateral lobe of basal apodeme; scale line = 0.5 mm. Fig. 9. *Nebria praedicta* new species. Fig. 10. *Nebria vandykei* wyeast Kavanaugh. Figs. 11–12. Female reproductive system, dorsal aspect; bc = bursa copulatrix; co = common oviduct; sd = spermathecal duct; sp = spermathecal reservoir; scale line = 0.5 mm. Fig. 11. *Nebria praedicta* new species. Fig. 12. *Nebria vandykei* vandykei Bänninger.

Thoracic venter.—Prosternal intercoxal process moderately lanceolate, smooth with margination intercoxal process present laterally only, from base to slightly posterior to coxa. Mesosternum smooth. Mesepisternum faintly punctulate. Metasternum smooth throughout, moderately shortened; margination of anterior intercoxal process absent or only vaguely impressed medially. Metepisternum smooth.

Elytra.—Slightly shorter in relation to length of forebody than average for genus, slightly longer in most females than in males, moderately wide and markedly flattened; elytral silhouette (Fig. 1) symmetrically ovoid; basal marginations slightly shortened, straight or slightly concave; humeri markedly rounded, humeral carina distinct and sharp but not projected, humeral teeth absent; subhumeral sinuation shallow; elytral apices moderately divergent from midline, apices obliquely angulate medially and rounded apically; elytral striae markedly deep, moderately punctate; intervals slightly to moderately convex and smooth, intervals 3, 5, 7, and 9 markedly crenate, interval 3 with two to six setiferous catenations (only three or four in most individuals), inter-

val 5 with zero to six setiferous catenations (one to three in most individuals), interval 7 with three to seven setiferous catenations (three to five in most individuals), and interval 9 with 11 to 16 setiferous catenations; basal setiferous pore absent.

Hind wings.—Short and narrow, stigma reduced.

Legs.—Markedly long; hind coxae with two or three setae basally (four unilaterally in a few individuals) and one seta apically. Hind trochanter kidney-shaped, medium length, truncate or broadly rounded apically. Middle tibiae with dorsal sulcus present in middle third, with moderately dense setal brush present dorsosubapically. Tarsi without pubescence dorsally; protarsi of males with basal three tarsomeres broadened and with pads of adhesive setae ventrally; hind tarsi with ventroapical margin of tarsomere 4 slightly to moderately lobed laterally.

Abdomen.—Sternite II (first visible sternite) smooth; sternite III without setae; sternites IV to VI with three to seven pairs of posterior paramedial setae and two to eight pairs of paralateral setae (present on sternite IV in all specimens examined, absent from sternites V and VI in a few specimens examined); sternum VII of males with two posterior paramedial (“anal”) setae (some individuals with one or three setae unilaterally), of females with two or three pairs of setae (some individuals with four setae unilaterally).

Male genitalia.—Median lobe of aedeagus (Fig. 8) with mid-shaft slightly thickened, moderately narrowed basally, with its axis bent to a slightly acute (< 90 degrees) angle (in lateral aspect), moderately compressed (in cross-section), right face of mid-shaft unmodified; preapical-shaft markedly broad and moderately tapered apically, ventral margin slightly deflected ventrally (in lateral aspect), broad, moderately tapered, and moderately deflected right (in dorsal aspect); apical orifice markedly deflected right; apical lamella connected slightly right of center on preapical shaft, moderately deflected right, and with bluntly pointed apex (in ventral aspect), plane of lamellar face markedly twisted left (in apical aspect), lamellar apex moderate in length and broadly blunt, with axis slight-

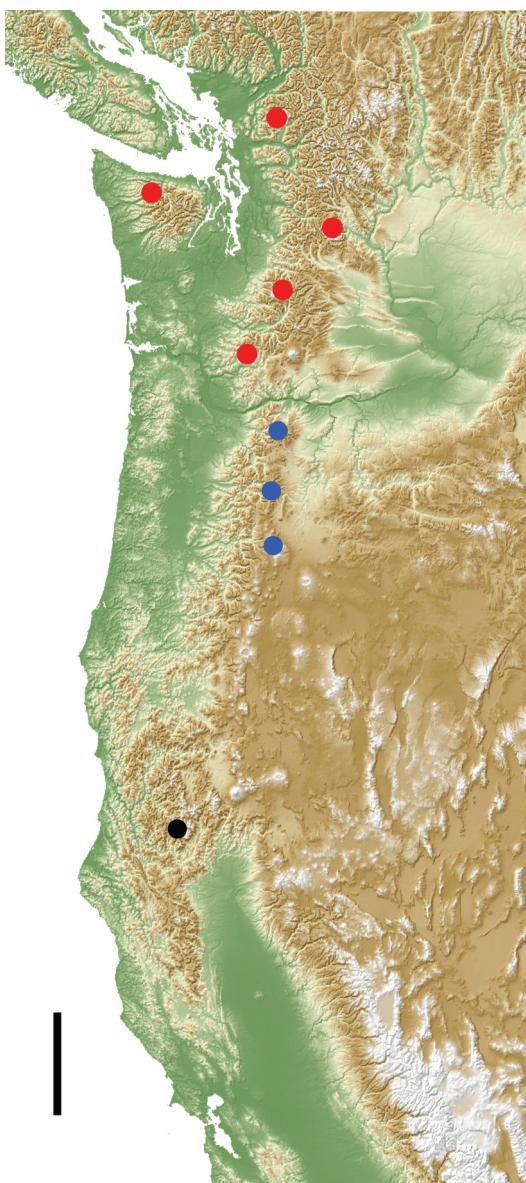


FIGURE 13. Map of the west coast of North America, from southern British Columbia to northern California (California Albers projection), showing the known geographical distributions of *Nebria praedicta* new species (black dots), *Nebria vandykei vandykei* Bänninger (red dots), and *Nebria vandykei wyeast* Kavanaugh (blue dots); scale lines = 100 km.

ly deflected ventrally (in lateral aspect). Parameres asymmetrical, with right much longer than left; left paramere short, broad, slightly narrowed basally; right paramere slender, moderately long, with right medial parametric sclerite present, distinct.

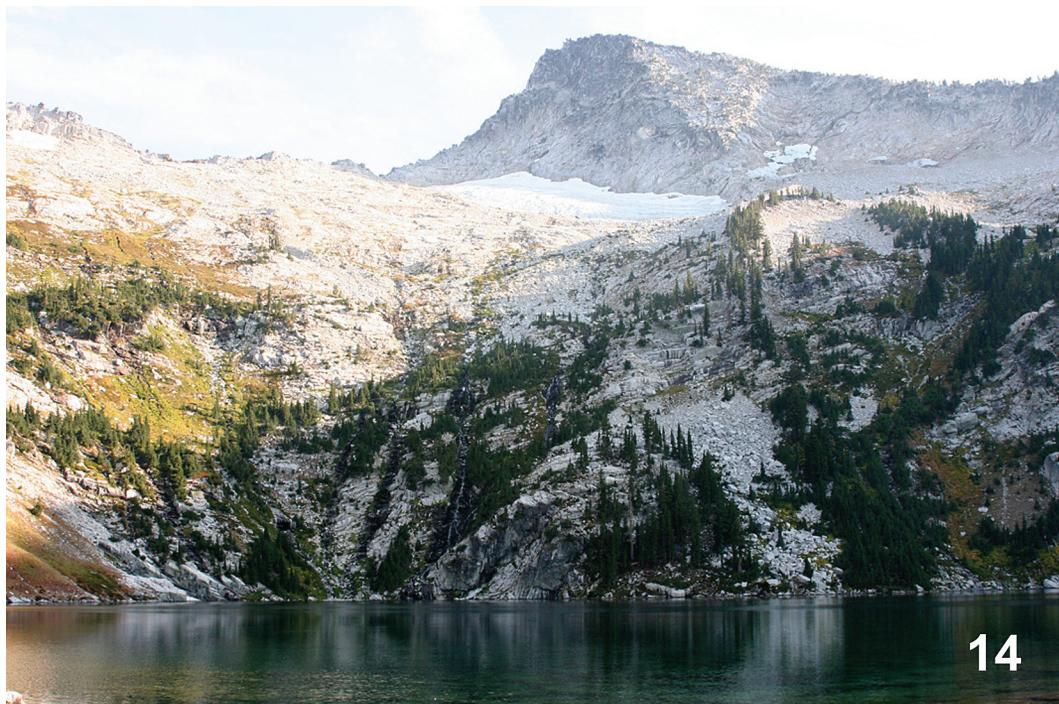
Female genitalia.—Hemisternites of segment VIII (Fig. 9) with a fringe of short and medium-length setae medially on the apical margin, otherwise glabrous; basal apodemes wide, markedly emarginate, with lateral lobes much shorter than medial lobes. Ovipositor with gonocoxite I and gonocoxite II fused medially, moderately broadly separate laterally; gonocoxite I not or only faintly sclerotized ventrally apicomediad to basolaterally, fully sclerotized medially, with a diagonal (basolateral to apicomedial) row of four to six medium-length setiform setae ventrally; gonocoxite II slightly shortened and of moderate width, bluntly rounded apically and moderately bent ventrolaterally (in lateral aspect), with three or four short or medium-length setiform mediodorsal setae in a longitudinal row; both gonocoxites with moderately dense vestiture on medial surface. Bursa copulatrix (Fig. 11) with longitudinal axis moderately sigmoid (in lateral aspect); spermathecal chamber medium-length, broadly cordate and symmetrical (in dorsal aspect), without accessory lobes or sclerites; spermathecal reservoir arcuate, simple, medium-length; spermathecal duct medium-length, moderately thick, straight, and moderately deflected right proximally, irregularly convoluted distally, inserted at posterior end of spermathecal chamber at base of vertical (posterior) face of chamber in midline.

SEXUAL DIMORPHISM.—The smallest *N. praedicta* males are slightly smaller than the smallest females and the largest females are slightly larger than the largest males, but the sexes overlap broadly in overall body length. The basal three tarsomeres of the male protarsi are broad and have dense pads of adhesive setae ventrally. These tarsomeres are slender and without such setal pads in females. In most males, abdominal sternite VII has two pair of posterior paramedial setae (one or three setae unilaterally in a few individuals); in females, either two or three pairs of posterior paramedial setae are present (four setae unilaterally in a few individuals).

GEOGRAPHICAL DISTRIBUTION.—This species is known only from the type locality in upper Grizzly Lake Basin, at 2410 to 2470 m elevation, on the north by northwest slope of Thompson Peak in the Trinity Alps of the Klamath Mountains System, Trinity County, California (Fig. 13). The north-facing slopes of Thompson Peak are probably the only sites in the Trinity Alps where this species occurs, and it is most likely endemic to this area.

HABITAT DISTRIBUTION.—The specimens that form the type series of *N. praedicta* were collected in an area of smooth, sloped, unvegetated granitic bedrock, with abundant loose rockfall scattered on the bedrock surface, below the lower edge of the glacier in the head of Grizzly Lake Basin (Fig. 14). In daytime, beetles were found hiding under stones around seeps and glacial meltwater flowing over the bedrock (Fig. 15). Beetles were found in the same habitat at night, actively foraging along the water edges (Fig. 16). One individual was observed emerging from underneath the glacier's lower edge, and another was seen walking in the water against the current up a 15° slope, the latter behavior previously observed among *Nebria* species only for *Nebria ingens* Horn (Kavanaugh 1971). Numerous specimens of *Nebria turmaduodecima* were also found, both day and night, in the same habitat, together with *N. praedicta* specimens. Viewed from the bedrock periphery of the glacier, no *Nebria* were observed on the glacial ice at night, although numerous staphylinid beetles were seen foraging on horizontal and vertical surfaces along the glacial margins. A visual survey on the glacier itself was not conducted because of dangerous ice conditions (see Discussion below).

PHYLOGENETIC RELATIONSHIPS.—Based on characters of external morphology and form and structure of both male and female genitalia, *N. praedicta* is most closely related to *Nebria vandykei* Bänninger, members of which share the following synapomorphies: large body size, dark, non-



FIGURES 14–15. Fig. 14. View of the NNE face of Thompson Peak, taken from the N shore of Grizzly Lake, type locality for *Nebria praedicta*, sp. nov. The small, remnant glacier is clearly visible at the base of the face at the upper edge of the basin. Fig. 15. View of lower edge of the glacier in upper Grizzly Lake Basin, 2490 m elevation, showing granitic bedrock, loose rockfall cover, and meltwater seep areas where *Nebria praedicta* adults are found.



FIGURE 16. Photograph of a *Nebria praedicta* adult male actively foraging at night over granitic bedrock along a small meltwater trickle.

metallic body and appendage color, markedly ovoid elytra, and distinctly catenate elytral intervals 3, 5, and 7.

Results from a preliminary analysis of DNA sequence data also support a close relationship between *N. praedicta* and *N. vandykei*, with *N. praedicta* recognized as a distinct species. We amplified approximately 1690 base pairs of mitochondrial DNA spanning part of cytochrome oxidase subunit I, all of tRNA Leucine, and part of cytochrome oxidase subunit II (positions 1709–3400 in *Drosophila yakuba*). A combination of universal primers (C1-J1709 with C1-N2353 & C1-J2183 with C2-J3400) was used to amplify two overlapping regions under standard PCR conditions, and an additional internal primer (C1-N2776) was used in DNA sequencing (Simon et al. 1994 and 2006). We calculated the number of uncorrected pairwise differences between multiple individual sequences of *N. v. vandykei* (2 individuals from Mt. Rainier), *N. v. wyeast* (5 individuals from Middle Sister Peak), and *N. praedicta* (15 individuals from the type locality). The average pairwise differences between these taxa are as shown in Table 1. The program MRBAYES v3.1.2 (Ronquist, Huelsenbeck, 2003) was used to estimate a Bayesian phylogeny to assess the monophyly of each species. Samples of *Nebria ingens*, as well as *N. sierrae* and *N. meanyi lamarckensis* from the Sierra Nevada Mountains were used as outgroup taxa. All specimens included in the analysis were shown to be monophyletic genetically for their respective populations.

GEOGRAPHICAL RELATIONS WITH MOST CLOSELY RELATED SPECIES.—The known geographical range of *N. praedicta* is allopatric with respect to those of *N. v. vandykei* and *N. v. wyeast* (Fig. 13). *Nebria v. vandykei* is confined to the Olympic Mountains of westcentral Washington and the Cascade Range from Mount Baker in the north to Mount St. Helens in the south, at elevations between 1190 and 2040 m. The known range of *N. v. wyeast* is confined to the Cascade Range in Oregon, from Mount Hood south to the Three Sisters, at elevations from 1680 to 2190 m. The closest known localities for *N. praedicta* and *N. vandykei* are separated by 356 kilometers linear dis-

TABLE 1. Percent uncorrected pairwise difference of 1639 base pairs of cytochrome oxidase subunit I, tRNA-Leucine, and cytochrome oxidase subunit II.

	<i>N. v. vandykei</i>	<i>N. v. wyeast</i>	<i>N. praedicta</i>
<i>N. v. vandykei</i>	—	0.24%	1.46%
<i>N. v. wyeast</i>	0.24%	—	1.37%
<i>N. praedicta</i>	1.46%	1.37%	—

tance and an intervening area of relatively low elevation (including areas below 1000 m elevation) and unsuitable habitat.

The only other areas in northwestern or northcentral California with similar elevation and habitat to that found high in the Trinity Alps are the north slope of Mount Eddy (on the border of Trinity and Siskiyou Counties) and Mount Shasta (Siskiyou County), 62 and 83 km NE of Thompson Peak, respectively. Although slightly higher than Thompson Peak, Mount Eddy is more inland, hotter and drier, and with very porous substrate; so it is likely too warm and dry for survival of *N. praedicta*. Mount Shasta, like Mount Eddy, is more inland and has very porous volcanic substrate; but it is much taller and bears several glaciers and many large perennial snowfields, particularly high on its northern slope, which may afford suitable habitat for this species (see above). Collecting on the southern and eastern slopes (to 3500 m) and in the summit areas of Mount Shasta by one of us (DHK) and numerous amateur collectors over many years has failed to discover specimens of this species or of *N. vandykei*, which might also (but less likely) occur there.

DISCUSSION.—We are delighted to have discovered this elegant new species and pleased to be able to describe it. However, we have serious concerns about the prospects for its continued survival. As reported by Stone (2008), the large snowfield found at the type locality for *N. turmaduodecima* in upper Caribou Basin (at 2400 meters) on 12 August 1980 (when the type series was collected) had disappeared completely by the same date in 2007; and no individuals of that species were found at that site on the latter date. We are pleased to record that this species is still extant in upper Grizzly Lake Basin at elevations above 2400 meters. At the time that the type series of *N. praedicta* was collected, on 13 September 2008, glacial ice was calving audibly and visibly in large chunks (pieces two to three meters across) along the lower edge of the glacier in upper Grizzly Basin, with a seeping outflow from the melting ice along the entire edge. Based on the extent of collapsed ice within a four-meter margin of the glacier's edge, it was clear that the glacier was retreating rapidly. With no more than an estimated 30 meters of ice remaining between the glacier's lower and upper edges, it's difficult to imagine this ice mass, the largest in the Trinity Alps, persisting under current warming trends.

Without doubt, *Nebria praedicta* depends on persistent snow and ice to provide a microclimate cool enough through the warm months of the year for its members to survive. The glacier in upper Grizzly Basin and the even smaller glaciers or snowfields in adjacent cirques on the north side of Thompson Peak probably represent the only sites where *N. praedicta* survives today in the Trinity Alps and, as far as is known at present, anywhere. The disappearance of these temperature moderating bodies, which is virtually certain to occur with the current climatic warming trend, would be catastrophic for this species, as well as for *N. turmaduodecima*, and likely lead to their quick extinction.

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