

Corrections to the literature: Three recently published records for *Nicrophorus* (Coleoptera: Staphylinidae: Silphinae) deemed erroneous

by Derek S. Sikes²

Abstract

During the last decade three occurrence records for three species of *Nicrophorus*—*N. guttula*, from Sitka Alaska, USA, *N. hebes* from Alaska, and *N. hybridus* from Whitehorse, Yukon, Canada—were published, which are likely erroneous because no reliable evidence suggests these species occur or occurred in these regions. This short note provides details, comments, and species distribution modeling analyses on these records and concludes all three are erroneous.

Introduction

Species of the genus *Nicrophorus*, commonly called burying beetles in North America, are relatively well known, large-bodied beetles (Anderson and Peck 1985) now in the family Staphylinidae (Cai et al. 2022). Despite peer-reviewed publications being the gold standard for reliable scientific information, errors do make it into print and, when found, are best corrected. Herein, three such records are addressed—while admitting the much greater difficulty of demonstrating the absence, relative to the presence, of a species from a region. One approach to this problem is to attempt to answer the question of whether the climate of a region is suitable for a species based on an understanding of the climate from where it is known to occur. Thus, a niche modeling, aka species distribution modeling, analysis was undertaken to help quantify the likelihood of two of these questionable records.

Methods

Species Distribution Modeling

The basics of the protocols in Oliver (2021) and Waraniak (2018) were followed using the 19 bioclimatic variables available from the WorldClim 2.0 database which contain the averages for the years 1970–2000 at 2.5 minutes resolution (~5 km) (Fick and Hijmans 2017). The bioclim (Nix 1986, Booth et al. 2014) model in the dismo 1.3-5 package (Hijmans et al. 2021) for R v.4.0.2 (R Core Team 2020) was used with the presence-only occurrence data for *N. hybridus* and *N. guttula*. The R script for the *N. guttula* analysis is provided as an appendix. The occurrence data files for the R analyses presented herein are available at <https://doi.org/10.6084/m9.figshare.19401131>. These data came from the collections and literature sources listed in Table 1. Those with DSS as the source are available in more complete form at <http://dx.doi.org/10.5061/dryad.mr221> from Sikes and Venables (2013). Those with GBIF as the source are listed below in the literature cited as GBIF.org (2022c) and GBIF.org (2022a).

Table 1: Collections and literature from which data used herein were derived.

Collection or Publication	Source
Albuquerque [MSBA]	GBIF
Anderson & Peck (1985)	literature
Backlund & Marrone (1997)	literature
Berkeley [EMEC]	DSS, GBIF
Boulder [UCM, UCMC]	GBIF

²University of Alaska Museum, 1962 Yukon Dr., University of Alaska Fairbanks, Fairbanks, AK 99775, dssikes@alaska.edu

Collection or Publication	Source
Budapest [HNHM]	DSS
Cambridge [MCZC]	DSS
Chicago [CHAS]	GBIF
Chicago [FMNH]	DSS, GBIF
Cincinnati [CMC]	GBIF
Cochrane [CEIC]	DSS
College Station [TAMU]	DSS, GBIF
Columbus [OSUC]	DSS
Denver [DMNS]	GBIF
Ebina -Nishikawa private coll [MNC]	DSS
Edinburgh [RSME]	DSS
Fairbanks [DSSC]	DSS
Fairbanks [UAM]	GBIF
Flagstaff [NAUF, CPMAB]	GBIF
Fort Collins [CSUC]	GBIF
Frankfurt [SMFD]	DSS
Hatch (1945)	Literature
iNaturalist	GBIF
Jalisco [CZUG]	GBIF
Las Cruces [NMSU]	GBIF
Los Angeles [LACM, IP]	GBIF
Los Angeles [LACM, RLB]	GBIF
Los Angeles [LACM]	DSS
Logan [EMUS]	DSS
New Haven [PMNH]	DSS
New York [AMNH]	DSS
Norman [OMNH, RINVRT]	GBIF
Ohio [OSUC]	GBIF
Peck & Anderson (1985)	Literature
Peck & Kaulbars (1987)	Literature
Philadelphia [ANSP]	DSS
Provo (BYUC)	DSS
San Diego [SDNHM]	GBIF
Santa Barbara [SBMNH]	GBIF
Santa Barbara [UCSB, IZC]	GBIF
St. Paul [UMSP]	DSS
Tempe [ASU, ASUHC]	GBIF
Tempe [ASU, NEON-IV]	GBIF
University Park [PSUC]	GBIF
Vancouver [UBCZ]	GBIF
Washington D.C. [USNM]	DSS, GBIF
Wien [Wolfgang Barries Private Coll.]	DSS

Results

Nicrophorus hebes Kirby

Based on molecular, ecological, breeding trial, and morphological data, Sikes et al. (2016) recognized this species as valid and elevated it to species status from a junior synonym under *Nicrophorus vespilloides* Herbst. *Nicrophorus hebes* is distributed widely within eastern and central Canada and, to date, there is no evidence that *Nicrophorus hebes* occurs west of about 120° longitude or north of about 61° latitude in the Nearctic. It is thus absent from northwestern Canada and Alaska. Nevertheless, this species was

accidentally reported from Alaska by Meeds (2021) who, while reviewing literature relevant to forensic entomology for Alaska, misunderstood the information presented in Sikes et al. (2016).

Nicrophorus hybridus Hatch & Angell

Bygarski and LeBlanc (2013), presenting on forensic entomological research conducted in Whitehorse, Yukon Territory (60° 43' N, 135° 03' W) reported the species *N. hybridus* from their samples. This species has never been confirmed north of 53° latitude and is relatively difficult to distinguish from *Nicrophorus investigator* (magnified lateral and ventral views are needed). *Nicrophorus investigator* is a widespread and common species in northern regions of the Nearctic and Palearctic so any records of *N. hybridus* north of 53° latitude are likely misidentifications of *N. investigator*, as suggested for this case by Sampson and Sikes (2020). There are numerous records of *N. investigator* north of 60° latitude in both the Nearctic and Palearctic, with maximum latitude records at 69°N in Norway and 67°N in Yukon Territory (Anderson and Peck 1985, Sikes and Venables 2013).

Climate change is expected to expand many species' ranges polewards (Stafford et al. 2013) so *N. hybridus* records north of 53° latitude may increase in likelihood as the planet warms. Any such records would need confirmation by careful study of voucher specimens and use of appropriate keys (e.g., Anderson and Peck 1985) by someone experienced with identification of *Nicrophorus*.

Backlund and Marrone (1997) reported *N. hybridus* from sandy grasslands and scattered cottonwood stands in South Dakota. Peck and Kaulbars (1987) reported this species from prairie, sage steppe, and montane meadow. Anderson and Peck (1985) indicated it occurs in prairies and dry inland valleys. The ecoregion data of Olson et al. (2001), as mapped in SimpleMapp (Shorthouse 2010) (data not shown), indicate it occurs primarily in grasslands, shrub steppe, montane and foothills forests and parklands east of the Rocky Mountains but some records are known from west of these mountains in coastal forest ecoregions—presumably in drier inland grassland and shrub valleys. All these habitats and climates are quite different from the subarctic boreal habitats of the Whitehorse region.

Using presence-only data for *N. hybridus* a niche model for this species was estimated which shows Whitehorse to have habitat unsuitable for this species (Figure 1), thus making it far more likely that the specimens in question were actually *N. investigator*.

Nicrophorus guttula Motschulsky

Bousquet et al. (2013) in their checklist of the beetles of Canada and Alaska, reported *N. guttula* from Alaska because the type locality of this species is Sitka, Alaska (57° N). Sikes et al. (2002) had addressed this issue and concluded the type locality was likely based on an error. Aside from the type locality description there have been no other records of this species reported from Sitka or anywhere in southeast Alaska, despite relatively extensive beetle collections having been made there, including 408 records of *Nicrophorus* from southeast Alaska—with the only *Nicrophorus* species being *N. investigator* and *N. defodiens* (GBIF.org 2022c). The northernmost, verified record (specimen identified by S. Peck) for *N. guttula* is from Riske Creek in southern British Columbia at 51.9° (GBIF.org 2022b). However, this northernmost record appears to be an outlier, because 97% of records are south of 50°N (Sikes and Venables 2013 (total $n = 294$), GBIF.org 2022a (total $n = 1328$)). Note that in Sikes and Venables (2013) there is a record from 55°N that, upon inspection, was revealed to be incorrectly georeferenced—its locality data said only “British Columbia” with no further geoprecision and it had thus been georeferenced to the approximate center of the province. I therefore deleted that record's geocoordinates.

Using presence-only data for *N. guttula* a niche model for this species was estimated which shows southeast Alaska to have unsuitable habitat for this species (Figure 2), making the likelihood very low that the type locality of Sitka is correct. The correct type locality is presumably somewhere along the northwestern coast of California, Oregon, or Washington. Many beetle specimens from this coastline, and Alaska, made their way to Europe via Russian naturalists in the mid 1800s and confusion over collection data is quite plausible.

Finally, how is it that this error was published in a work (Bousquet et al. 2013) on which I, a specialist on both the beetles of Alaska and the genus *Nicrophorus*, was a co-author? The answer is that the Alaskan

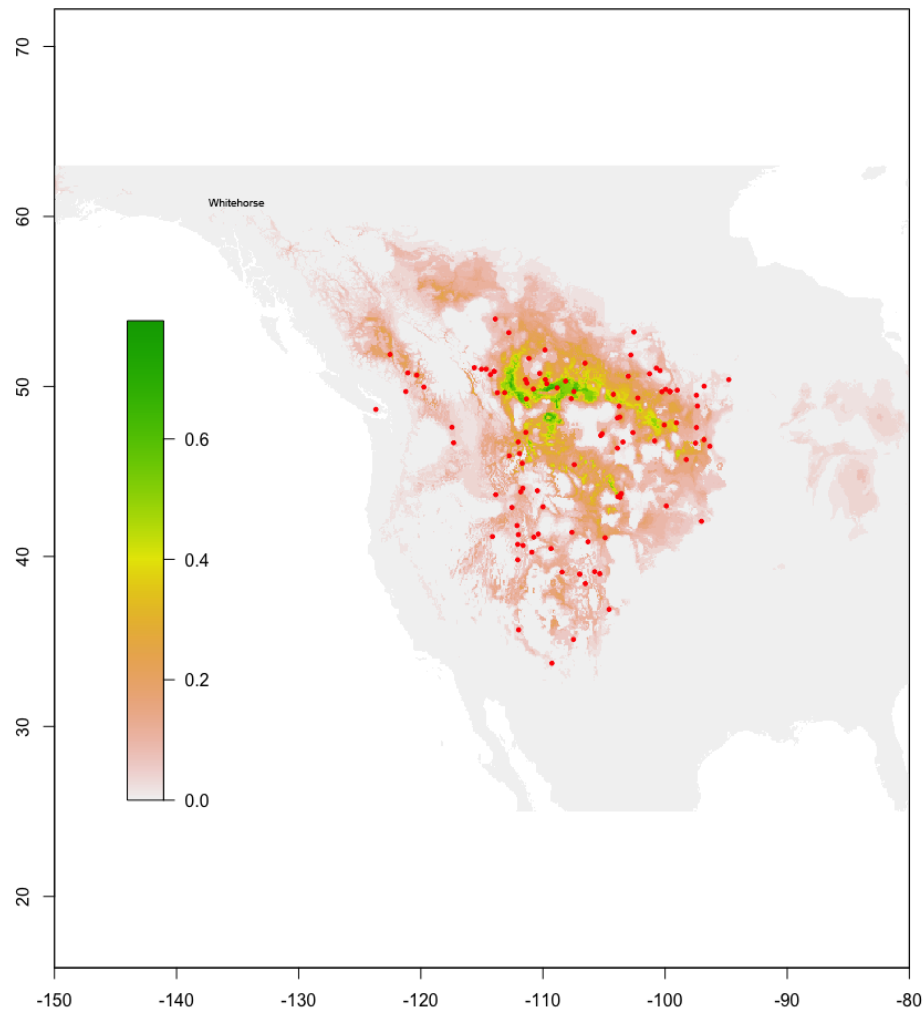


Figure 1: Map of records for *Nicrophorus hybridus* Hatch & Angell showing observations (red dots) and habitat suitability probability (colors, see key) based on presence-only niche modeling using the bioclim algorithm in the dismo package in R.

record for this species was added to the draft, without consulting me, after I had finished and submitted my edits. Nevertheless, I was curious how likely such a record was and these analyses helped lay this question to rest.

Acknowledgments

I thank the curators and collections staff who helped arrange loans of specimens for study from the collections listed in Table 1 and those who helped digitize data shared with GBIF.org, including those who submitted relevant iNaturalist observations.

Appendix: R script for Niche Modeling

```
# Species distribution modeling for Nicrophorus guttula
# Derek Sikes, dssikes@alaska.edu
# 2022-01-17
```

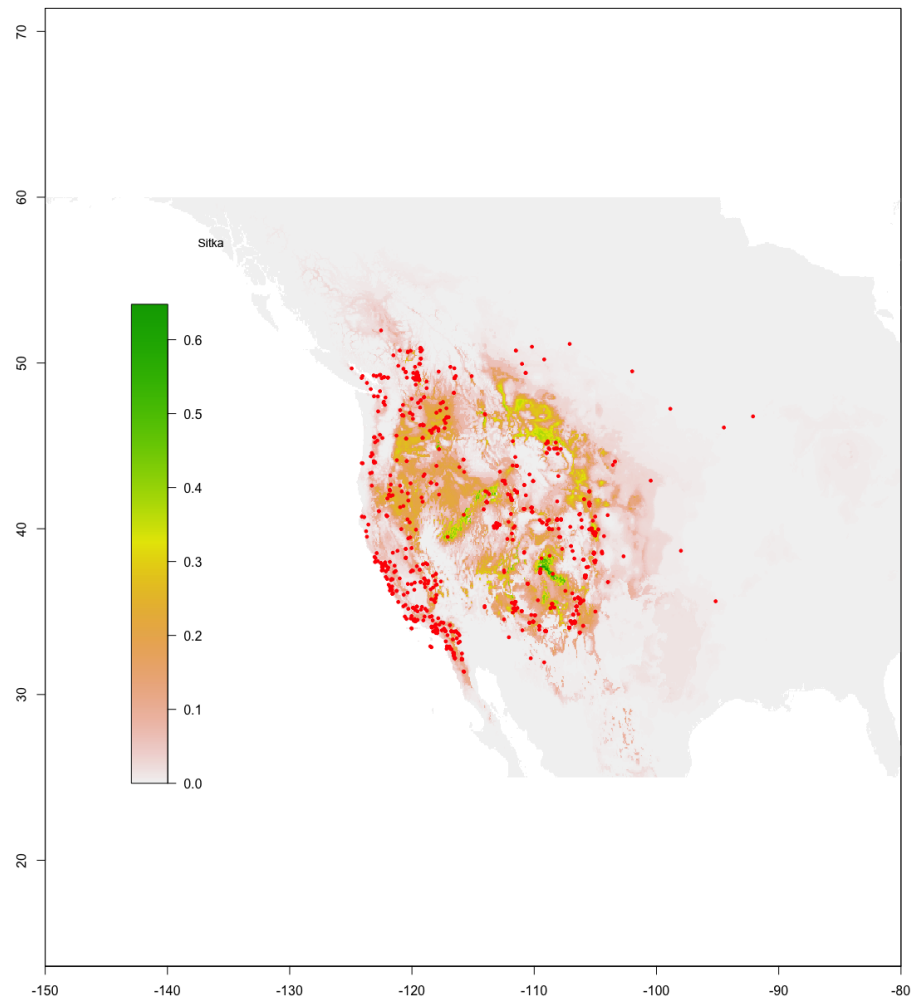


Figure 2: Map of records for *Nicrophorus guttula* Motschulsky showing observations (red dots) and habitat suitability probability (colors, see key) based on presence-only niche modeling using the bioclim algorithm in the dismo package in R.

```
install.packages("dismo")
install.packages("maptools")
install.packages("rgdal")
install.packages("raster")
install.packages("sp")

library("sp")
library("raster")
library("maptools")
library("rgdal")
library("dismo")

# getData did not work to download the bioclimatic data from Worldclim so
# these were downloaded manually from https://www.worldclim.org/data/
# worldclim21.html they appeared in the following directory Users/dssikes
# /Downloads/wc2.1_2.5m_bio
```

```

> path <- file.path("/Users/dssikes/Downloads/wc2.1_2.5m_bio")
> files <- list.files(path, pattern='tif$', full.names=TRUE)
> files
[1] "/Users/dssikes/Downloads/wc2.1_2.5m_bio/wc2.1_2.5m_bio_1.tif"
[2] "/Users/dssikes/Downloads/wc2.1_2.5m_bio/wc2.1_2.5m_bio_10.tif"
[3] "/Users/dssikes/Downloads/wc2.1_2.5m_bio/wc2.1_2.5m_bio_11.tif"
[4] "/Users/dssikes/Downloads/wc2.1_2.5m_bio/wc2.1_2.5m_bio_12.tif"
[5] "/Users/dssikes/Downloads/wc2.1_2.5m_bio/wc2.1_2.5m_bio_13.tif"
[6] "/Users/dssikes/Downloads/wc2.1_2.5m_bio/wc2.1_2.5m_bio_14.tif"
[7] "/Users/dssikes/Downloads/wc2.1_2.5m_bio/wc2.1_2.5m_bio_15.tif"
[8] "/Users/dssikes/Downloads/wc2.1_2.5m_bio/wc2.1_2.5m_bio_16.tif"
[9] "/Users/dssikes/Downloads/wc2.1_2.5m_bio/wc2.1_2.5m_bio_17.tif"
[10] "/Users/dssikes/Downloads/wc2.1_2.5m_bio/wc2.1_2.5m_bio_18.tif"
[11] "/Users/dssikes/Downloads/wc2.1_2.5m_bio/wc2.1_2.5m_bio_19.tif"
[12] "/Users/dssikes/Downloads/wc2.1_2.5m_bio/wc2.1_2.5m_bio_2.tif"
[13] "/Users/dssikes/Downloads/wc2.1_2.5m_bio/wc2.1_2.5m_bio_3.tif"
[14] "/Users/dssikes/Downloads/wc2.1_2.5m_bio/wc2.1_2.5m_bio_4.tif"
[15] "/Users/dssikes/Downloads/wc2.1_2.5m_bio/wc2.1_2.5m_bio_5.tif"
[16] "/Users/dssikes/Downloads/wc2.1_2.5m_bio/wc2.1_2.5m_bio_6.tif"
[17] "/Users/dssikes/Downloads/wc2.1_2.5m_bio/wc2.1_2.5m_bio_7.tif"
[18] "/Users/dssikes/Downloads/wc2.1_2.5m_bio/wc2.1_2.5m_bio_8.tif"
[19] "/Users/dssikes/Downloads/wc2.1_2.5m_bio/wc2.1_2.5m_bio_9.tif"

> predictors <- stack(files)
> predictors
class      : RasterStack
dimensions : 4320, 8640, 37324800, 19  (nrow, ncol, ncell, nlayers)
resolution : 0.04166667, 0.04166667  (x, y)
extent      : -180, 180, -90, 90  (xmin, xmax, ymin, ymax)
crs         : +proj=longlat +datum=WGS84 +no_defs
names       : wc2.1_2.5m_bio_1, wc2.1_2.5m_bio_10, wc2.1_2.5m_bio_11, wc2.1_2.5m_bio_12, wc2.1_2.5m_bio_13, wc2.1_2.5m_bio_14, wc2.1_2.5m_bio_15, wc2.1_2.5m_bio_16, wc2.1_2.5m_bio_17, wc2.1_2.5m_bio_18, wc2.1_2.5m_bio_19, wc2.1_2.5m_bio_2, wc2.1_2.5m_bio_3, wc2.1_2.5m_bio_4, wc2.1_2.5m_bio_5, ...
min values  :      -54.759167,      -38.162666,      -66.380669,
              0.000000,      0.000000,      0.000000,
              0.000000,      0.000000,      0.000000,      0.000000,
              0.000000,      1.000000,      9.063088,
              0.000000,      -30.760000, ...
max values  :      31.16667,      38.50467,      29.29167,
              11246.00000,      2768.00000,      507.00000,
              230.69151,      6174.00000,      1560.00000,      5608.00000,
              5230.00000,      21.97300,      100.00000,
              2377.62402,      48.46000, ...

# the Nicrophorus guttula data were taken from the data prepared for Sikes
  and Venables (2013) and GBIF.org (2022c). These were prepared as a .
  csv file with two columns of data separated by a comma (
  decimalLongitude, decimalLatitude). Note that R will throw an error if
  the first column is latitude and the second is longitude - these must
  be reversed. The following loads the observed data.

```

```

> guttula <- read.csv("~/Documents/ALASKA/PROJECTS/2022-AKES-Nicro_
  corrections/niche_modeling_attempts/GBIFandDSS_guttula_data/guttula.csv
  ")
> View(guttula)

# the following builds the model by using climate data from the observed
  records

> obspred <- extract(predictors, guttula) # extracts bioclim data for
  each of our data points
> bioclim.model <- bioclim(obspred)
> predictions <- predict(predictors, bioclim.model)

# the following makes the map of the modeled expected distribution

> plot(predictions, xlim=c(-150, -80), ylim=c(25, 60))

# the following adds the observed data to the expected on the map
> points(guttula, col = "red", pch = 20, cex = 0.75)

```

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