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New synonymies in the bee genus *Nomada* from North America (Hymenoptera: Apidae)

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Abstract

We provide diagnostic morphological characters to help distinguish males and females of the following species of *Nomada*: *N. augustiana* Mitchell, *N. bethunei* Cockerell, *N. fervida* Smith, *N. fragariae* Mitchell, *N. lehighensis* Cockerell, *N. texana* Cresson, and *N. tiftonensis* Cockerell. Based on morphological and DNA barcoding evidence we newly synonymize the following species: *N. heligbrodtii* Cresson (under *N. texana*), *N. indusata* Mitchell (under *N. augustiana*), *N. kingstonensis* Mitchell (under *N. lehighensis*), *N. pseudops* Cockerell (under *N. bethunei*), and *N. wisconsinensis* Graenicher (under *N. fervida*). We provide full descriptions of the female of *N. fragariae* and the male of *N. lehighensis*, both of which were not previously known, and newly designate the lectotype of *N. wisconsinensis*. We additionally provide comments on the distribution, flight times, and host associations for the treated species.

Key words: Nomadinae, Nomadini, DNA barcoding, taxonomy

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Introduction

Herein we diagnose seven species and provide five new synonymies for North American *Nomada*, a genus of cleptoparasitic bees that has a world-wide (excluding Antarctica) but predominantly Holarctic distribution (Alexander 1994; Michener 2007). *Nomada* mainly parasitizes the bee genus *Andrena* (Andrenidae), although certain species are known to be parasitic on other andrenid genera as well as bees in the families Melittidae, and Halictidae, and probably in the families Colletidae and Apidae (Snelling 1986; Alexander 1994; Michener 2007). *Nomada* is the largest cleptoparasitic genus of bees, with 795 species described at the time it was last cataloged over its entire geographical distribution (Alexander & Schwarz 1994). Since that catalog was published, notable taxonomic work on the genus has been undertaken (e.g., Schwarz 1999; Schwarz *et al*. 1999; Schwarz & Gusenleitner 2002, 2003, 2004a and b; Hirashima & Tadauchi 2002; Mitai *et al*. 2003, 2008; Mitai & Tadauchi 2004, 2005, 2006, 2007, the latter six papers of which have comprehensively revised the entire *Nomada* fauna of Japan; Standfuss & Schwarz 2007; Proshchalykin & Lelej 2010). There are currently 702 valid species of *Nomada* recognized in the Discover Life Bee species guide (Ascher & Pickering 2010).

The species treated herein belong to two different species groups recognized by Alexander (1994), the ruficornis and vegana species groups. The vegana species group (here represented by *N. fervida*, *N. texana*, and *N. tiftonensis*) is found throughout much of the New World, and is the only group of *Nomada* found in the Neotropics; in addition, it is one of the most morphologically distinct groups within *Nomada*, characterized by features of the male mandible, female paraocular area, postocciput, dorsal and lateral surfaces of the pronotal collar, sculpturing of the propodeal triangle, and male subgenital brush and genital capsule (Alexander 1994). Unlike most *Nomada*, members of the vegana species group are not known to parasitize *Andrena*, and instead have been recorded on *Exomalopsis* (Apidae) or the halictid genera *Agapostemon* and *Nomia* (Alexander 1991).

The ruficornis species group (i.e., *Nomada* s. str.) has long been considered an unnatural assemblage of species that have been lumped together due to their shared lack of synapomorphies uniting other groups (Alexander 1994; Michener 2007). This species group contains nearly half of the described species within the genus, many of them known only from a single gender (Alexander & Schwarz 1994). As many of the strongest characters uniting species into a certain species group are found in males, the ruficornis species group also appears to be the *de facto* placement for many species known only from females.

Our interest in this work was motivated by a broad-scale initiative to create survey guidelines and monitoring protocols for native bees. During tests of survey techniques (primarily bowl and pan traps plus some netting) many *Nomada* specimens were collected. Development and testing of on-line diagnostic keys to all bees found in North America east of the Mississippi River (http://www.discoverlife.org/mp/20q?search=Apoidea) exposed a long series of problems with existing *Nomada* keys, misdiagnosed specimens in collections and difficulty in associating genders due to sexual dimorphism, and a long series of species described from a single sex. In addition, many of the species with strong yellow-red integumental maculations vary greatly in the ratios of red to yellow and in some species maculations vary from completely black to nearly all red with strong yellow markings (this is particularly noticeable on the mesoscutum and mesepisternum).

To supplement this morphological work, we also obtained DNA barcode data from the mitochondrial gene cytochrome oxidase I (COI) representing many *Nomada* species from throughout their ranges, particularly within eastern North America. This ongoing work has resulted in molecular barcoding data from over 1200 individual *Nomada* specimens to date (unpublished data). We were able to apply these molecular data to provide further support for some species synonymies inferred from morphological study. This combination of renewed exploration of morphological character sets, DNA barcode data, and examination of the relevant primary type material has allowed us to formulate new diagnoses of several species and propose new synonymies within the genus.

Material and methods

We examined approximately 232 specimens during the course of this study, including relevant type material. Detailed information about the material examined can be found in the Appendix.

We also obtained molecular barcoding data from selected specimens (Table 1). Approximately half of the sequences in this study were generated by MGR at the Laboratories of Analytical Biology (National Museum of Natural History, Smithsonian Institution). This work entailed extracting genomic DNA by removing a single leg from each specimen, crushing the leg in liquid nitrogen, and performing either phenol-chloroform or Qiagen kit extraction. We amplified a fragment of the mitochondrial gene COI using standard PCR techniques with the following primers: LepF1 (5'-ATTCAACCAATCATAAAGATAT-3') and LepR1 (5'-TAAACTTCTGGATGTCCAAAAA-3') (Hebert *et al*. 2004). In a few cases, we used the following alternative primer with LepR1 to amplify a shorter fragment: MLepF1 (5′-GCTTTCCCACGAATAAATAATA-3′) (Hajibabaei *et al*. 2005). PCR products were submitted for automated sequencing using the same primers used for amplification. We assembled contigs and edited sequences using Sequencher. Barcoded material from York University was generated by CSS using a leg stored in alcohol and sent to the University of Guelph where it was processed as per Hajibabaei et al. (2005). We pooled all sequences generated by both institutions and created an aligned matrix using MacClade (Maddison and Maddison, 2000). All sequences were checked against the occurrence of indels, stop codons, or length discrepancies (the presence of which could indicate accidental amplification of nuclear copies). Pairwise sequence divergence values using Kimura 2-parameter corrected distances were calculated using PAUP* (Swofford 2002). Vouchers are housed at the institutions listed in Table 1.

TABLE 1. Specimens for which DNA barcoding data were obtained.

Species	Extraction Code	Gender	State or Province	Voucher Location	Sequence length (bp)	GenBank No.
N. bethunei	N09B2	Female	Connecticut	UCON	664	HQ204761
	N09D4	Female	Ontario	DEBU	664	HQ204762
	N17F3	Female	New York	AMNH	407	HQ204763
	BEECA4590606	Female	Ontario	PCYU	592	HQ204764
	BEECA5690606	Male	Ontario	PCYU	650	HQ204765
N. fragariae	N09B4	Female	Maryland	USNM	664	HQ204766
	N17C11	Male	Maryland	USNM	664	HQ204767
N. fervida	N08H3	Male	Ontario	DEBU	664	HQ204768
	N16A2	Female	Florida	GHPC	658	HQ204769
	N16B2	Male	Florida	GHPC	664	HQ204770
	N16C2	Male	Florida	GHPC	664	HQ204771
	N16D2	Male	Florida	GHPC	664	HQ204772
	N16E2	Female	Florida	GHPC	407	HQ204773
N. tiftonensis	N08A1	Female	South Carolina	USNM	407	HQ204774
	N08B1	Male	South Carolina	USNM	664	HQ204775
	N08F3	Female	Ontario	DEBU	664	HQ204776
	N09H1	Female	Maryland	USNM	664	HQ204777
	N11G2	Male	Maryland	USNM	419	HQ204778
	N13A3	Female	South Carolina	USNM	664	HQ204779
	N13B3	Female	South Carolina	USNM	664	HQ204780

.....continued on the next page

TABLE 1. (continued)

Species	Extraction Code	Gender	State or Province	Voucher Location	Sequence length (bp)	GenBank No.
N. lehighensis	BEECB7730707	Male	Alberta	PCYU	658	HQ204781
	BEECA0600605	Female	Ontario	PCYU	628	HQ204782
	BEECA0590605	Female	Ontario	PCYU	617	HQ204783
	BEECB0220704	Male	Ontario	PCYU	658	HQ204784
	BEECB0280704	Male	Ontario	PCYU	658	HQ204785
	N20G4	Female	Pennsylvania	USNM	429	HQ204786
	BEECC1530807	Female	California	PCYU	658	HQ204787
	BEECB0250704	Female	Ontario	PCYU	658	HQ204788
	BEECC1940807	Female	Washington	PCYU	658	HQ204789
	BEECB8510707	Female	British Columbia	PCYU	657	HQ204790
	BEECB5210707	Female	British Columbia	PCYU	658	HQ204791
	BEECA0620605	Female	Nova Scotia	PCYU	658	FJ582362
	BEECA0610605	Male	Nova Scotia	PCYU	617	FJ582363
	HDBNS14703	Female	Nova Scotia	PCYU	621	FJ582364
	BEECA0630605	Female	Nova Scotia	PCYU	658	FJ582372
	HDBNS11203	Female	Nova Scotia	PCYU	397	FJ582373
	HDBNS11303	Female	Nova Scotia	PCYU	394	FJ582374
	HDBNS13603	Female	Nova Scotia	PCYU	394	FJ582375
	HDBNS13803	Female	Nova Scotia	PCYU	428	FJ582376
	HDBNS13703	Female	Nova Scotia	PCYU	626	FJ582379

Specimens included in this study were contributed or loaned from the following individuals and institutional collections: Glenn Hall, personal collection (GHPC); Robert Jean, Indiana Dunes National Lakeshore (INDL); Robert Jean, Various Indiana Collections (RJRJ); Smithsonian National Museum of Natural History (USNM); Virginia Scott, University of Colorado Museum of Natural History (UCMC); Jason Weintraub, Academy of Natural Sciences, Philadelphia (ANSP); Packer Collection at York University (PCYU); Jerome Rozen, Jr. and John Ascher, American Museum of Natural History (AMNH); Terry Griswold and Harold Ikerd, USDA Bee Biology and Systematics Laboratory, Logan (BBSL); Ian Stocks, Great Smokies National Park (GRSM); USDA SEL Hymenoptera Group (USNM); David Notton, Natural History Museum, London (BMNH); Gerald Noonan, Milwaukee Public Museum (MWPM); David Wagner, University of Connecticut (UCON); Matthias Buck, University of Guelph (DEBU); Sam Droege, USGS, Bee Inventory and Monitoring Lab (BIML); Brent Steury, George Washington Memorial Parkway (GWMP).

Taxonomy

Nomada augustiana Mitchell

Figures 1–3, 13, 14, 23

Nomada augustiana Mitchell 1962: 402–403. [Holotype: U.S. National Museum of Natural History (on indefinite loan from North Carolina State University), ♀; label data: "[USA] Augusta, Georgia, Richmond Co., Apr [April] 1 1959/ / *Salix*// HOLOTYPE *Nomada augustiana* Mitchell [red label]// USNM ENT 00533881 [yellow barcode label]"].

Nomada indusata Mitchell 1962: 418–419. [Holotype: U.S. National Museum of Natural History (on indefinite loan from North Carolina State University, ♂; label data: "[USA] Wendell NC [North Carolina], TB Mitchell, III 26 '25

[26 March 1925]// *Amelanchier*// HOLOTYPE *Nomada indusata* Mitchell [red label]// Type No. 75220 U.S.N.M. [red label]// USNM ENT 00533936 [yellow barcode label]"] **new synonymy.**

Diagnosis. Females can be differentiated from other North American *Nomada* by the following combination of characters: head and mesosoma with limited amounts of black integumental color (Fig. 1); scutellum entirely yellow on its dorsal surface (shading to orange near metanotum) (Fig. 1); hind tibia at outer apical margin with three to four long, red, stout spine-like hairs that clearly extend beyond the surrounding finer white hairs (three present on one hind leg, four on the other leg in the holotype specimen—based on trends in other *Nomada*, it is likely that other specimens of this species could have a slightly greater number of such stout red spine-like hairs present) (Fig. 13); and T2–T3 each with transverse, medially-interrupted, yellow maculations (Fig. 3). Females of *N. obliterata* Cresson have a similar integumental color pattern, but are readily separated from *N. augustiana* by the extensive black integumental color on the median portion of the propodeal triangle; shorter stout, red spine-like hairs on hind tibia (about the same length as the surrounding white hairs); and only two submarginal cells in the forewing (rarely, some specimens of *N. obliterata* have three). *Nomada armatella* Cockerell can be differentiated from *N. augustiana* by the black median longitudinal stripe present on the mesoscutum and propodeum; very thin white spine-like hairs on the outer apical margin of the hind tibia; and uninterrupted maculations of T2 and T3 (or, if medially-interrupted, then this interruption is extremely narrow, forming a thin longitudinal, linear gap). *Nomada bethunei* is also somewhat similar in the color pattern of its integument, but lacks the clear yellow integument on the scutellum (however, some individuals of *N. bethunei* have an ill-defined orangish area on this sclerite) (Fig. 5); also, T1 usually lacks yellow maculations (Fig. 5), although the holotype of *N. bethunei* from Wisconsin has broadly-interrupted, narrow yellow maculations (*N. augustiana* with relatively broad, medially-interrupted yellow maculations). *Nomada bethunei* additionally has only very short (far shorter than the surrounding white hairs), stout, red, spine-like hairs on the outer apical margin of the hind tibia (Fig. 15).

Males of *N. augustiana* are differentiated by the following combination of characters: mesoscutum with integument more than fifty percent red (Fig. 2); scutellum integument almost entirely yellow (Fig. 2); and hind tibia at outer apical margin with three to five white or transparent, long, stout, spine-like hairs (clearly longer than the surrounding white hairs) (Fig. 14). Males of *N. obliterata* have a similar color pattern on their integument but can be differentiated from *N. augustiana* by the color of the mesoscutum (entirely black or only with two short, red, submedian longitudinal maculations). In addition, in *N. obliterata* the hind tibia has reddish, stout, spine-like hairs that are only about the same length as the surrounding white hairs. Males of *N. bethunei* have a similar color pattern as *N. augustiana*, but in the former species the scutellum integument usually lacks any yellow color (a few specimens have a diffuse orange patch) (Fig. 6), and the flagellar segments lack or only have limited patches of minute hairs present on the anterior surface (when antenna positioned dorsally). In *N. augustiana*, the flagellar segments are densely covered with short hairs that are clearly visible at 40–60X magnification (Fig. 23).

Distribution. *Nomada augustiana* is a rare southern species.

Variation. The only female known to us is the holotype specimen.

Material examined. We examined 10 specimens from GA and NC (Appendix).

Comments. We did not obtain DNA barcoding data for this species. While Mitchell only lists the holotype in his original description and we have seen no other similar specimens, the gender association seems relatively straightforward; in fact, both the holotype of *N. augustiana* and a specimen of *N. indusata* were collected on the same date, genus of tree (*Salix*), and locality by the same collector. Even prior to this realization it was clear from inspection that the hair pattern of the male hind tibia was simply a paler version of the long, evenly-spaced, spine-like hairs of the female, and we found other similarities between the two sexes in their body size, vase-shaped scape, relatively hairy flagellar segments of the antenna, and relative lengths of F1 and F2. Interestingly, despite the low number of specimens available for this species it seems fairly reasonable to assume that it is associated with wetland areas. Labels on the Thomasville, Georgia specimens indicate they were collected in a marsh and the Augusta, Georgia specimens were collected off of *Salix*, a wetland tree. A search for more specimens of this species may be rewarded by collecting near blooming *Salix* or around the nest sites of southern coastal plain *Andrena* species who favor *Salix* pollen (e.g., *Andrena macoupinensis* Robertson).

FIGURES 1–3. *Nomada augustiana*. Fig. 1. Dorsal habitus of female holotype. Fig. 2. Dorsal habitus of male. Fig. 3. Metasoma of female holotype.
FIGURES 4–6. *Nomada bethunei*. Fig. 4. Female face. Fig. 5. Dorsal habitus of female. Fig. 6. Dorsal habitus of male.

Nomada bethunei **Cockerell**
Figures 4–6, 15, 16, 21

Nomada bethunei Cockerell 1903: 607 [Holotype: U.S. National Museum of Natural History, ♂; label data: "Cana [Canada] 2174 [Baker collection No. 2,174]// N. M. 3// TYPE No. 13159 U.S.N.M. [red label]// *Nomada bethunei* Ckll TYPE// USNM ENT 00533894 [yellow barcode label]"].

Nomada (*Xanthidium*) *pseudops* Cockerell 1905: 189–190 [Holotype: University of Colorado, Boulder, ♀, label data: "Collected by S. Graenicher, [USA] Milwaukee, Wis [Wisconsin], 6-8-03 [8 June 1903]// Holotype [red label]// Type 1. *pseudops*, Ckll// FROM COLLS UNIV OF COLO MUSEUM [blue label]// UCMC 0000107 [barcode label]"] **new synonymy**.

Diagnosis. *Nomada bethunei* has more prominent yellow and red integument than in many other species, particularly in the males (Figs. 5, 6). Females are differentiated by the following combination of characters: face with integument color pattern grading from red near the vertex to orange-yellow near the mandible except for restricted black regions immediately surrounding the ocelli and between the antennal bases (Fig. 4); preoccipital margin carinate on gena; mesoscutum with integument more than fifty percent red (Fig. 5); posterior surface of propodeum midlaterally with large yellow maculation extending from ventral margin dorsally, either joining or not joining yellow maculation laterally on propodeal triangle (Fig. 21); hind tibia with four to eight short, thick, red, spine-like hairs that line the outer apical margin (these hairs often difficult to detect as they are shorter than the surrounding white hairs) (Fig. 15); for specimens from the eastern part of the species' distribution, the scutellum is red; the propodeal triangle is red with two round, yellow, lateral spots; and T2–T3 have transverse yellow maculations that are clearly medially-interrupted (specimens from the midwestern part of the species' distribution with the scutellum yellow to orange, propodeal triangle with a lateral, quadrate, yellow maculation; and T2–T3 each with a solid, or rarely medially-interrupted, transverse maculation). *Nomada bethunei* is similar to *N. augustiana*, but can be differentiated from that species by the long, white, spine-like hairs on the outer apical margin of the hind tibia that clearly extend beyond the surrounding white hairs in *N. augustiana* (Fig. 13). It is also similar to *N. obliterata*, but in that species there are only two submarginal cells on the forewing (rarely three, but in such cases, usually only one wing with three cells), and the hind tibia has usually three to four, relatively long, stout setae on the outer apical margin, these setae clearly bent posteriorly at their apical tips. Finally, *N. armatella* differs from *N. bethunei* by the presence of long, thin, white or transparent, stout, spine-like hairs on the outer apical margin of the hind tibia. Males of *N. bethunei* are among the few species of *Nomada*, of this sex, with greater than fifty percent red on the integument of the mesoscutum (Fig. 6). Males are differentiated from *N. articulata* Smith and *N. australis* Mitchell by the lack of a small spine present on the posterior surface (when the antennae is projected dorsally) of the third flagellar segment in both those species; it is separated from all other species by the combination of extensive red integument on the mesoscutum and by the very short, spine-like hairs on the outer apical margin of the hind tibia: these hairs are white, clear, or pinkish and are difficult to see among the surrounding white hairs in this region (Fig. 16) (often most visible when the specimen is inverted and the tibia is examined from underneath). Other species have stout spine-like hairs on the hind tibia that project beyond or are level with the surrounding white hairs in this area.

Molecular results. We obtained DNA barcoding data from four female specimens and one male specimen (Table 1) that were morphologically similar to the two holotypes representing each gender. The sequences from all five specimens were completely identical (0% sequence divergence), even though they were sampled from several different localities (e.g., Ontario, Connecticut, New York), further supporting the synonymy of *N. pseudops* with *N. bethunei*.

Variation. Both males and females have greater amounts of yellow on the propodeum and metasoma in the Midwest than the East. The metasomal terga have transverse yellow maculations that vary from medially-interrupted to complete.

Distribution. *Nomada pseudops*, as previously understood, is an uncommon, northern species, flying in late spring (most specimens from late May to Early June). Mitchell lists Michigan and Ohio for *N. bethunei* and Wisconsin to Massachusetts under *N. pseudops*. Based on Mitchell's records and personal observation, *N. bethunei* ranges from Virginia north to Massachusetts, west to Kansas and Ontario.

Material examined. We examined 23 specimens from ON, CT, NY, NJ, VA, MI, PA, IA, WI, KS, and IL (Appendix).

Comments. *Nomada bethunei*, while uncommon, appears to be regularly collected throughout its range.

FIGURES 7, 8. *Nomada fragariae*. Fig. 7. Dorsal habitus of female. Fig. 8. Head and mesosoma of male.
FIGURES 9–12. *Nomada lehighensis*. Fig. 9. Dorsal habitus of female. Fig. 10. Dorsal habitus of male. Fig. 11. Female metasoma, lateral view. Fig. 12. Female T5.

***Nomada fervida* Smith**

Figures 27, 28, 33, 34

Nomada fervida Smith 1854: 247 [Holotype: Natural History Museum, London, ♀; label data: "Type H.T// B.M. Type Hym 17B.580// *Nomada fervida* Type Sm.// *fervida* Type Sm.// [USA] Georgia"].

Nomada wisconsinensis Graenicher 1911: 239–240 [Lectotype: Milwaukee Public Museum, ♀; label data: "[USA] Randall, Wis. [Wisconsin] Burnett Co., Aug. 5-7, '09 [5-7 August 1909]// TYPE [pink label]// 29752// *Nomada*

wisconsinensis Graen ♀// Lectotype ♀ *Nomada wisconsinensis* Graenicher des. Droege et al"] **new synonymy, new lectotype designation.**

Diagnosis. A group of *Nomada* species in eastern North America possess a distinct posterior pointing spine on the front coxa; of those, *N. fervida* is the only one whose females have a high number and density of spine-like hairs lining the outer apical margin of the hind tibia (Fig. 33). Unlike the spaced, spine-like hairs of other species that form a single line along the rim, these hairs number over 20 and form a tightly packed group without any spaces, looking a bit like a bundle of tiny pencils with slightly reddish erasers at the top. Also helpful in identifying this species is the yellow integument on the scutellum and the entirely black propodeum and propodeal triangle.

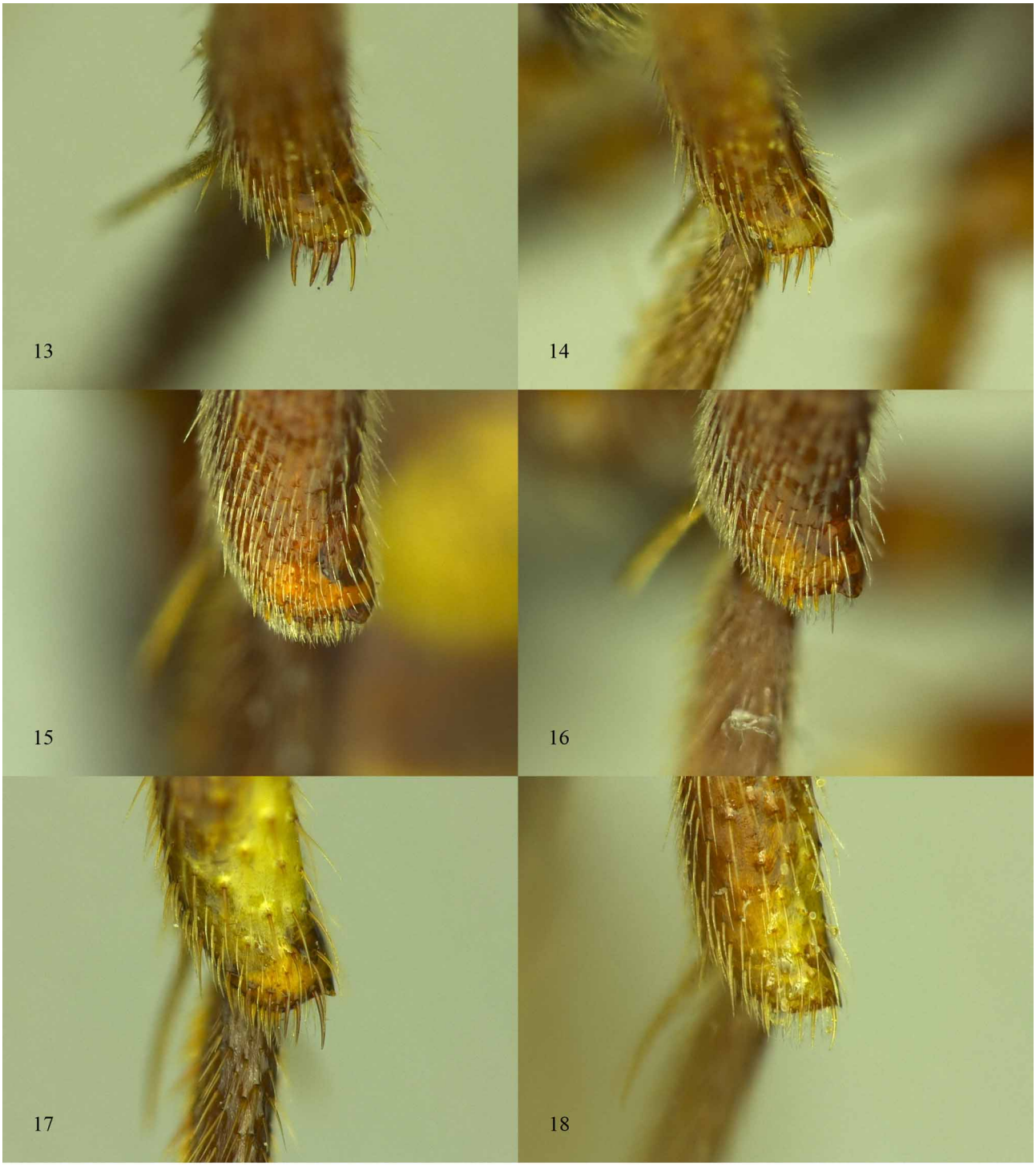
Males of *N. fervida* also are identified by the combination of the spine on the front coxa and extremely dense, numerous, stout, reddish, spine-like hairs on the hind tibia (Fig. 34). However, following the pattern of most *Nomada* species, the spine-like hairs on the hind tibia of the males are not as prominent and consequently must be inspected closely.

Molecular results. We obtained DNA barcoding data from six specimens, three males and two females from Florida and one male from Ontario (Table 1). The sequence divergence among these specimens ranged from 0–0.2% The male from Ontario matches the description of *N. wisconsinensis*, having more extensive yellow maculations on the metasomal terga. All of the specimens from Florida have maculations throughout the terga that are tinged with orange-brown rather than entirely yellow.

Variation. Specimens of *N. fervida* vary primarily in the color and pattern of their maculations. The variability can be roughly characterized according to geographic distribution. There appears to be two main areas where the species has been collected, one centered in the Great Lakes region and one centered in Florida and Georgia. In keeping with the general pattern of many bees and wasps from the Deep South, the southern specimens of *N. fervida* all have burnt orange overtones to the yellow maculations, while in northern specimens those overtones are much less prominent (although still present to varying degrees). On average, southern *N. fervida* tend to have the least extensive maculations, partially reduced on the head, mesepisternum, and metasomal terga and sterna; however, there is extensive overlap and similar maculation patterns can be found in both populations. When present, the placement of these maculations is identical in specimens of *N. fervida* from both geographic locations and there appears to be no significant intraspecific variation in the punctation, body size, relative lengths of the flagellar segments, or number of specialized, spine-like hairs on the outer apical margin of the hind tibia of this distinctive species.

Distribution. *Nomada fervida* is an uncommon sand specialist with two separate populations, one centered on the sand areas of the Great Lakes and the other from the sand areas of Florida and north into Georgia. Database records from a wide variety of specimen records available on the website Discoverlife (www.discoverlife.org) indicate that the species has been collected outside of these main areas, but we have not confirmed any records aside from the ones listed below. Interestingly, all of the southern collection records for *N. fervida* only appear to come from the interior of Florida and none from equally sandy coastal dune systems (with the only possible exception of a single record from St. Petersburg, Florida). As with all uncommonly collected *Nomada*, we would not be surprised if more focused collecting efforts result in additional specimens from similar areas of deep sand, for example in the Sandhills of the Carolinas, New Jersey Pine Barrens, or comparable areas on Long Island and Cape Cod. However, it is interesting to note that T.B. Mitchell (1960, 1962) did not collect this species in North Carolina despite having grown up collecting amidst the large deep sand deposits in the Sandhills and regularly visiting the coastal areas of that state. Similarly, we find it strange that this species appears to be absent from the extensive Nebraska Sand Hills region as well as other interior dunes on the western side of the Great Plains.

Material examined. In addition to the female lectotype designated above, we examined the male lectoallotype which had the following label data: "[USA] Randall, Wis. [Wisconsin] Burnett Co., Aug. 5–7, '09 [5–7 August 1909]// TYPE [pink label]// 29751// *Nomada wisconsinensis* Graen ♂// Lectoallotype ♂ *Nomada wisconsinensis* Graenicher, des. Droege et al." We examined 39 specimens from the following states and provinces: FL, WI, MI, IL, ON, GA, IN (Appendix).



FIGURES 13–18. Outer apical surface of hind tibia. Figs. 13, 14. *Nomada augustiana*. Fig. 13. Female holotype. Fig. 14. Male. Figs. 15, 16. *Nomada bethunei*. Fig. 15 Female. Fig. 16. Male. Figs. 17, 18. *Nomada fragariae*. Fig. 17. Female. Fig. 18. Male.

Comments. We synonymize *N. wisconsinensis* (representing the northern distribution of the species) with *N. fervida* (representing the southern distribution) based on both morphological and DNA barcoding evidence. An examination of the two female primary types showed that diagnostic characters, especially those of the mandibles, labrum, propodeum, hind tibia, and metasoma, are the same between the two specimens (the *N. wisconsinensis* lectotype lacks antennae). The two type specimens appear only to differ in the strength and pattern of yellow maculations, with the *N. wisconsinensis* lectotype a brighter yellow (the *N. fervida* holotype appears to be faded, possibly due to preservation), and with the *N. fervida* holotype having more restricted

maculations on T3–T5. Nonetheless, the maculation patterns on the metasoma are very similar for both types, and are the same on both the head and mesosoma. The color pattern differences used to justify the recognition of two distinct species by previous authors fall well within known patterns of northern and southern populations and intraspecific patterns found in other *Nomada*. Additional support for the synonymy of these two species is provided by the nearly identical DNA sequences from specimens conforming to the type specimens that were caught at both extremes of the species' distribution (i.e., Ontario and Florida, see above).

We encourage researchers to investigate the large sand deposits of central and eastern North America in June and July, a time when these areas are not commonly visited, to look for more specimens of *N. fervida*. Note that populations in Florida are active as adults from March until November. While the host for this species is unknown, we suspect that *Agapostemon splendens* (Lepeletier) may be a good candidate as it is similarly restricted to sandy areas. Similar species of *Nomada* are known to parasitize other *Agapostemon* species (as well as *Nomia* and *Exomalopsis*).

Nomada fragariae **Mitchell**

Figures 7, 8, 17, 18, 22, 24–26

Nomada fragariae Mitchell 1962: 391 [U.S. National Museum of Natural History, ♂; label data: "[USA] Faison N. C. [North Carolina] Apr. [April] 20 1955// T. B. Mitchell, on strawberry// HOLOTYPE *Nomada fragariae* Mitchell [red label]// Type No. 75219 U.S.N.M. [red label]// USNM ENT 00533926 [yellow barcode label]"].

Diagnosis. Females of *N. fragariae* are unique among similar species of *Nomada* in having absolutely no hair on the posterior surface of the propodeum (the other species having copious, long hair) particularly in combination with the uninterrupted bands of yellow maculations on their metasomal terga (Fig. 22). We are aware of only two other eastern species with restricted hair on the propodeum, namely *N. graenicheri* Cockerell and *N. besseyi* Swenk. (While not treated in this paper, these two species are likely to be synonymous). In *N. fragariae*, the hind tibia on the outer apical margin has four to six long, stout, spine-like hairs, of approximately the same length as the surrounding white hairs, and the stout, spine-like hairs are curved ventrally, not posteriorly as in *N. luteoloides* Robertson or *N. imbricata* Smith (Fig. 17). In addition, the flagellar segments (on the posterior surface when the antenna is directed dorsally) have comparatively long, erect hairs in addition to the more commonly found microscopic, more appressed hairs found in this area when compared to similar species (Fig. 24).

Males of *N. fragariae* are unique among similar looking species (*e.g.*, *N. luteoloides*, *N. imbricata*, and *N. annulata* Smith) in the shape, color, and especially pilosity of F11: when the antenna is directed dorsally, the anterior surface (of all flagellar segments including F11) is relatively pale, the apical tip of F11 is located near the midpoint of the flagellar segment or is only slightly shifted laterally (the apical tip is nearly at the lateral edge of F11 in other species, although less extremely so in *N. sulphurata*), and there are three to seven hairs that project out from the apical tip that, while microscopic, are distinctly visible when viewed through a microscope and are much longer than the small, appressed hairs that are scattered over the surface of F11 (there are no hairs projecting beyond apical tip of F11 in the other species) (Fig. 26). Additionally, the entire lateral margin of the mesoscutum usually has a narrow, sometimes faint, border of yellow (Fig. 8). Only *N. imbricata* also has such a yellow lateral maculation on the mesoscutum. In most specimens of *N. imbricata* this border is absent; when present it is restricted to the margin posterior to the tegula (very rarely extending along the entire lateral margin), and the remaining similar species have no known instances of yellow on the mesoscutum. The scutellum of *N. fragariae* has a broad transverse band of yellow present in all examined specimens (Fig. 8), unlike the common occurrence of two distinctly separated, round, yellow circles in similar species. The length of F1 is variable, but is usually about half the length of F2 (Fig. 25). On the outer apical margin of the hind tibia there are four to eight stout, spine-like hairs that are usually difficult to detect as they blend into the white hairs surrounding them; nonetheless these stouter hairs are unique in that they are evenly spaced from each other, are found on the apical margin of the tibia, and are usually just slightly longer than the surrounding white hairs (Fig. 18). The posterior surface of the propodeum is variable in the amount of yellow

maculation present, ranging from absent (rare) to three separate pairs of patches (usually there is one maculation above the hind coxa, one laterally on the propodeal triangle, and often a fainter one in between these two maculations). The hypoepimeron usually has a very faint yellow maculation, and the mesepisternum centrally has a longitudinal yellow stripe extending from the anterior angle to the posterior margin. Finally, the anterior surface of the antenna (when directed dorsally) is yellow-brown.

Description of female. Total length: 9.5–10.5 mm; forewing length: 8.5–9.5 mm.

Color: Figures 7, 22. Head predominantly yellow, with the following areas brownish-red: apical half of mandible, posterior surface of scape, anterior surface of pedicel and flagellar segments, and margins of clypeus and eye; the following areas black to brownish-red at margins: subantennal sulcus, posterior surface of pedicel and flagellar segments, area near antennal socket and ocelli, and preoccipital margin of gena. Mesosoma with the following areas yellow: pronotal collar dorsally, pronotal lobe, most of tegula, mesoscutum along lateral margin (thick band) and medially between center and lateral margin (thin longitudinal stripe), axilla, scutellum, submedially on metanotum, most of posterior surface of propodeum, most of lateral surface of mesepisternum including hypoepimeron, band between midcoxae on ventral surface of mesepisternum, forecoxa and part of hind coxa, apically on all femora, and most of outer surfaces of all tibiae; the following areas reddish-brown: most of mesoscutum, laterally on metanotum, small areas of tegula, anterodorsally, near scrobal groove, and ventrally on lateral surface of mesepisternum, most of ventral surface of mesepisternum, lateral surface of propodeum, most of legs; the following areas black: laterally on pronotum, anteromedially and anteroposteriorly on mesoscutum, medially on propodeal triangle, scrobal pit, anteroventrally on mesepisternum, metepisternum, and anterior margin of lateral surface of propodeum. Forewing weakly infuscate along most of length, more strongly infuscate at apical tip beyond closed cells. Metasoma with the following areas yellow: submedially on T1 (forming wide transverse stripe), most of discs but excluding apical margins on T2–T4, entire T5, small medial spot on S1, and most of discs but excluding apical margins on S2–S4; the following areas reddish-brown: apically on T1–T4, most of S1, apically on S2–S4, and entire S5–S6; with the following areas black: basally on T1 and basolaterally on S1.

Pubescence: Head sparsely covered with short, golden, suberect to appressed, unbranched hairs; in addition, the following areas sparsely covered with long, erect, reddish-golden, unbranched hairs: ventral margin of mandible (ca. 2–3 OD), labrum, clypeus, and anterior and lateral surfaces of scape and pedicel (ca. 1.5 OD), posterior surfaces of flagellar segments (ca. 0.5 OD), and vertex (ca. 1 OD); long, branched hairs on hypostomal area. Mesosoma excluding propodeum largely covered with sparse, short, suberect to appressed, unbranched to minutely-branched hairs; in addition, with long, erect to suberect, simple hairs interspersed on pronotal collar, mesoscutum, scutellum, and outer surfaces of legs; dense, golden, simple, subapressed hairs covering inner surfaces of tarsi. Midtibia with dense patch of golden hairs on anterior surface. Hind tibia on outer apical margin with four to six long, reddish, stout, ventrally-curved, spine-like hairs, about same length as surrounding white hairs (Fig. 17). Propodeum mostly lacking hairs, with sparse, minute, appressed, translucent hairs visible under high magnification (Fig. 22). Entire forewing densely covered with short, brown hairs and lacking visible papillae. Metasoma entirely covered with sparse, short, suberect to appressed, unbranched hairs; in addition, with long, erect to suberect, simple hairs forming weakly defined, transverse row of hairs where basal yellow and apical reddish-brown integument meet on T3–T4 and S1–S4; long simple hairs more densely covering discs of T5 and S5. T5 laterally with very long, simple, white to golden hairs; medially with pseudopygidial area typical for most *Nomada*, subquadrate, wider than long, with dense, medially-parted, flattened, white to silvery-reflecting hairs. S5 sublaterally with dense tuft of long, unbranched, reddish, medially-curved hairs. As typical for *Nomada*, S6 with patch of stout, apically curved, red, spine-like hairs at apicolateral margin.

Punctation: Head with punctures minute and more or less evenly-spaced (ca. 1–2 puncture diameters apart on clypeus, interantennal area, frons, and gena; ca. 3–4 puncture diameters apart on paraocular area, especially near eye, and vertex). Hypostomal area with punctures wider and shallower, separated by 0.5 to 1.0 diameters. Mesosoma with punctures small, separated between 1.0 and 3.0 puncture diameters except as follows: nearly contiguous anteromedially on mesoscutum, on lateral and posterior surfaces of propodeum excluding propodeal triangle (punctures relatively shallow on propodeum), and ventral surface of

mesepisternum; punctures minute and separated by at least three to five puncture diameters on pronotal lobe, tegula, and scutellum. Propodeal triangle with dorsal fourth very weakly reticulate, ventral three-fourths weakly shagreened (more strongly so near ventral margin). Metasomal terga excluding T5 with punctures extremely minute, separated between one and five or more puncture diameters, except apical margins of each tergum with impunctate transverse band about 0.5 OD in length (slightly shorter on T1). T5 subapically near pseudopygidial area with punctures larger, separated between one and two puncture diameters. Sterna basally (on areas with yellow integument) with punctures small, separated by one to three puncture diameters on medial third, grading to punctures minute and in places nearly contiguous on lateral two-thirds; apically (on areas with translucent reddish-brown integument) lacking punctures, with integument weakly shagreened.

Structure: Mandible long, simple, apically pointed. Malar space larger near acetabulum (condyle nearly touching ventral margin of eye). Labrum with apical margin subcarinate, weakly pointed midapically; disc of labrum with central denticle. Pedicel partly enclosed by scape. Flagellar segments excluding F10 subequal, each segment gradually decreasing in length moving apically; F10 longer than more basal segments, about a third longer than F9. Interantennal area with strong longitudinal carina extending posteriorly to midpoint of frons, gradually decreasing in height posteriorly. Preoccipital margin weakly carinate, especially on gena. Pronotal collar in dorsal view with apical margin not distinctly carinate, weakly concave, length at midpoint about 0.3 OD, length laterally about 1.0 OD. Malus with long apical spine distinctly separated from vellum by notch; apical spine with row of small teeth on ventral margin. Hind tibia with small but distinct triangular process on posterior corner of outer apical margin. Hind tibial spurs nearly straight, with outer spur about a fifth shorter than inner. Forewing with three submarginal cells.

Molecular results. We obtained DNA barcode data from one male specimen and one female specimen of *N. fragariae* collected in Calvert Co., Maryland (Table 1). The sequence divergence between these specimens was only 0.3%. These nearly identical sequences provide further evidence that these are different genders of the same species. The description of the female provided herein is based on the specimen included in the molecular analysis.

Variation. In the males, the yellow maculation on T1 varies widely from uninterrupted to constricted to completely interrupted medially. Most individuals have uninterrupted transverse yellow maculations on the remaining metasomal terga; however, in a few individuals the maculation on T2 is constricted medially and, in a few, completely interrupted. All the examined males have a thin, lateral border of yellow on the otherwise black mesoscutum (Fig. 8), although in a few specimens the yellow border does not extend to the anterior margin. The amount of yellow on the posterior surface of the propodeum varies from none to the diagnostic pattern mentioned in the Diagnosis section. Females did not demonstrate any significant variation in structure or color. We examined one male specimen from Talbot County, Maryland that appeared to be a specimen of *N. fragariae* except that the scutum was largely red and the yellow maculations were much greater in extent than in other known specimens of *N. fragariae*.

Distribution. *Nomada fragariae* is known from eastern seaboard states, from Georgia north to the coastal plain of Maryland.

Material examined. 63 specimens were examined from MD, NC, GA (Appendix).

Comments. This is the first description of the female of this species for which we are aware. *Nomada fragariae* is truly an uncommon species; given its unique morphology, surely the female would have been noticed by past taxonomists had they had specimens before them. Hosts have not been mentioned in the past and we have not gathered direct evidence either; however, most of the specimens from Calvert Co., Maryland, came from a month-long project run by taxonomists studying parasitic Hymenoptera at the U. S. Department of Agriculture who were investigating color preferences in bowl traps for various wasp groups. One of us (SD) looked at the approximately 8600 bee specimens collected in Calvert Co., and the only *Andrena* species whose phenology came close to matching that of *N. fragariae* were *A. confederata* Viereck and *A. violae* Robertson. *Andrena confederata* was the only common large species of *Andrena* present on the site (with 18 specimens recorded in total). *Andrena violae* is of moderate size and very common in Mid-Atlantic lawns and fields where violets are present. It would appear unlikely that *A. violae* was the host, as presumably many more specimens of *N. fragariae* would have been captured throughout its range if this were the case. *Andrena*

confederata is uncommon throughout its range and has a largely southern distribution, which fairly well matches the distribution of the known specimens of *N. fragariae*. *Andrena confederata* is also known from the Midwest but it appears to be even less common there, and we are not aware of any *N. fragariae* specimens captured from that region.

Nomada lehighensis **Cockerell**

Figures 9–12, 19, 20, 45–50

Nomada lehighensis Cockerell 1903: 605 [Holotype: Academy of Natural Sciences, Philadelphia, ♀; label data: "[USA] Lehigh Gap, Pa. [Pennsylvania]// 7.1.97 [1 July 1897]// ♀// P43// Type No. 10147 [red label]//*N. lehighensis* Ckll Type"].

Nomada kingstonensis Mitchell 1962: 420 [US National Museum of Natural History, ♀; label data: "[USA] Kingston, R.I. [Rhode Island], Apr. 26 '04 [26 April 1904]// R I College, Lot 80, No.1, Collection// *Nomada perplexa* Cr. ♀// HOLOTYPE *Nomada kingstonensis* Mitchell [red label]// Type No. 75221 U.S.N.M.// USNM ENT 00533940 [yellow barcode label]"] **new synonymy**.

Diagnosis. Females of *N. lehighensis* are likely to be confused with eastern North American *Nomada* species that possess thin, white to reddish, spine-like hairs on the outer apical margin of the hind tibia (e.g., *N. pygmaea* Cresson, *N. sayi* Robertson, and *N. illinoensis* Robertson) due to a very similar appearance of their general habitus. However, *N. lehighensis* can be differentiated from those species by the presence of two to four (typically three) very stout, dark red, spine-like hairs that are evenly spaced along the outer apical margin of the hind tibia, and which do not project beyond the surrounding white hairs (Fig. 19). As is typical of many *Nomada* species, there is a single, long, thin hair between the row of stout, spine-like hairs and a short triangular projection at the outer apical corner of the tibia that is present in nearly all species of *Nomada*. In combination with the hair pattern found on the hind tibia, the pattern of yellow maculations on the metasoma is usually diagnostic (Figs. 10, 11): in a few specimens there are no markings whatsoever, but in the majority, on T2–T5 each terga has a very small yellow dot (at times minute and sometimes with two dots) on the far lateral surface (in fact, so far laterally that they are not visible in dorsal view). The observed variability in maculation pattern progresses from a yellow dot present laterally only on T2 (for lightly-maculated specimens) to yellow dots present on T2 and T3, to yellow dots present on T2, T3 and T5, and finally (for the most heavily-maculated specimens), to yellow dots present on T2–T5 including T4. The dots increase slightly in size with more heavily-maculated individuals; however, as the extent of the maculations increases, the enlargement of the dots occurs medially, creating a more rectangular maculation, progressing to a more broadly transverse set of maculations (these maculations not joining medially and usually absent at the midpoint of the terga), maculation extent finally progressing to T3 possessing a second, sublateral, round, yellow spot similar in size to, but not conjoined with, the far lateral yellow maculation (a second, sublateral yellow spot has not been observed on T2). Unlike many species, in *N. lehighensis* the scutellum is pillow shaped, lacking a median longitudinal depression or furrow. The pseudopygidial area is also diagnostic in this species: compared to other species, it is relatively long, extending basally rather far onto the disc of T5, and is comprised of comparatively long and coarse hairs (Fig. 12). Finally, the preoccipital margin of the gena is carinate to subcarinate.

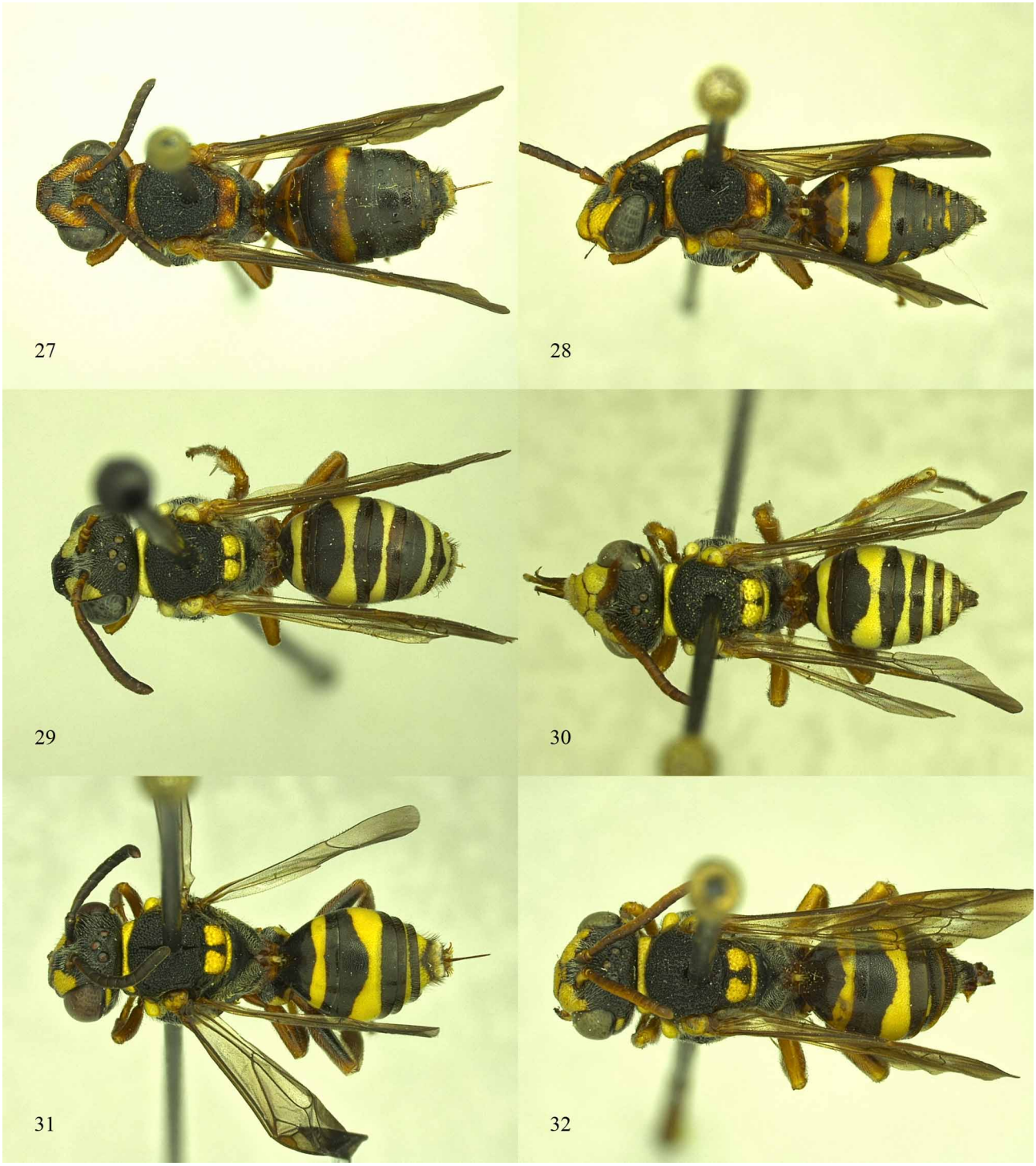
As in females, males of *N. lehighensis* have a similar habitus to species such as *N. sayi*, *N. illinoesnsis*, and *N. pygmaea*. In *N. lehighensis*, both the head and the mesosoma are largely black, with no yellow maculations present on the mesoscutum, propodeum, or mesepisternum (Fig. 10). One individual has small yellow markings on the pronotal collar, and another examined specimen has two large red circles on the scutellum. Males of *N. lehighensis* can be distinguished by the two to four large, stout, spine-like hairs on the outer apical margin of the hind tibia (as with most male *Nomada*, these stout, spine-like hairs are not as large as in the females, and tend toward translucence, making them more difficult to see in the males) (Fig. 20). The yellow maculation pattern found on the metasomal terga is more extensive than that of the females, but follows the general pattern described above. However, in at least one specimen examined the lateral yellow maculations were poorly differentiated from the dark orange background integument of the terga, especially

on T2–T4 (thus these maculations could be described as either complete or medially interrupted). T6 has vague, dark orange to yellow maculations that are poorly differentiated from the background color of the integument.

FIGURES 19, 20. Outer apical surface of hind tibia of *Nomada lehighensis*. Fig. 19. Female. Fig. 20. Male. **FIGURES 21, 22.** Scutellum, metanotum, propodeum, and propodeal triangle of female *Nomada*. Fig. 21. *Nomada bethunei*. Fig. 22. *Nomada fragariae*.

FIGURE 23. *Nomada augustiana* male, outer surfaces of F1–F4.

FIGURES 24–26. *Nomada fragariae*. Fig. 24. Female, lateral surfaces of F9 and F10. Fig. 25. Male, outer view of scape, F1, and F2. Fig. 26. Male, outer view of F10 and F11.



FIGURES 27, 28. *Nomada fervida*, dorsal habitus. Fig. 27. Female. Fig. 28. Male.
FIGURES 29, 30. *Nomada texana*, dorsal habitus. Fig. 29. Female. Fig. 30. Male.
FIGURES 31, 32. *Nomada tiftonensis*, dorsal habitus. Fig. 31. Female. Fig. 32. Male.

Description of male. Total length: 7.5–8.0 mm; forewing length: 6.0–6.5 mm.

Color: Figure 10. Head and mesosoma predominantly black, with the following areas yellow to pale brownish orange: basal two-thirds of mandible, labrum, clypeus, malar space and ventrally on paraocular area, anterior surface of antenna (scape usually yellow, pedicel and flagellar segments often pale brown to orange), sometimes posterior surface of apical flagellar segments, sometimes anteroventral corner of gena near malar space, pronotal lobe, tegula, sometimes entirely or in spots on scutellum, sometimes on anterior surface of

mesepisternum, and most of legs except basally on coxae, posteriorly on trochanters, femora, and sometimes tibiae, reddish brown on entire tarsi. Forewing weakly infuscate to clear along most of length, more strongly infuscate at apical tip beyond closed cells. Metasoma predominantly brownish-red, with the following areas black: basally and sometimes apically on T1, less commonly basally and apically on T2–T6, and basally on S1; the following areas yellow: forming dots or quadrate maculations laterally on T2–T4, sometimes also forming lateral dots on T1 and T5, sometimes forming submedian dot or transverse maculation on median half or third of S2–S4, sometimes forming small dot midapically on T5.

Pubescence: Head and mesosoma (excluding mandible, flagellar segments, tegula, propodeal triangle, and parts of legs) densely covered with white, minutely branched, subappressed to erect hairs intermixed with white to clear, unbranched, erect hairs. Mandible with sparse row of long, unbranched hairs on ventral margin. Flagellar segments densely covered with minute, unbranched, appressed hairs. Tegula, especially near margins, with dense, unbranched, subappressed hairs. Propodeal triangle lacking hairs. Midtibia with dense, golden, simple, subappressed hairs along anterior margin of outer surface. Hind tibia with two to four, stout, reddish, spine-like hairs along outer apical margin and with a single, white to translucent, thin, long hair between spine-like hairs and posterior corner (Fig. 20). Entire forewing (except basally) densely covered with short, brown hairs and lacking visible papillae. Metasoma mostly covered with sparse, short, suberect to appressed, unbranched hairs; in addition, with long, erect to suberect, simple hairs forming weakly defined, transverse row of hairs where basal yellow to orange-brown and apical reddish-brown to black integument meet on T3–T4 and S1–S5 (these hairs restricted more laterally on posterior sterna); long simple hairs more densely covering discs of T6 and T7 (T5–T7 laterally and T7 ventrally on pygidial plate with erect, simple hairs particularly long). S6 with apical tip covered with dense brush of short, unbranched, ventrally directed hairs.

Punctation: Punctures on face below frons largely obscured by hairs, except paraocular area adjacent to eye largely lacking hairs and with sparse, minute punctures. Frons, vertex, and gena with punctures relatively coarse, separated by about a puncture diameter (punctures larger on vertex and gena than on frons). Hypostomal area with punctures relatively wide and shallow. Mesosoma with punctures coarse, deeply impressed, and nearly contiguous to separated by a puncture diameter (especially on mesoscutum and dorsal half of lateral surface of mesepisternum) except as follows: metanotum with punctures fine and nearly contiguous, metespisternum and lateral surface of propodeum immediately above hind coxa with punctures less deeply impressed and less distinct from background integument due to weak striations on these sclerites; propodeal triangle with dorsal fifth very weakly reticulate, ventral fourth-fifths granulose to weakly striate near ventral margin; pronotal lobe and especially tegula with punctures minute, separated by 1 to 3 puncture diameters; legs with punctures less deeply impressed and especially on portions of inner surfaces with punctures absent. T1, T2, and basally on T3 and T4 with punctures minute, nearly contiguous, and weakly impressed; T3 and T4 apically, and T5–T7 with punctures increasingly larger and slightly more deeply impressed, separated by up to a puncture diameter. Sterna excluding very weakly granulose apical margins on S1–S5 with punctures small, weakly impressed, and separated by about a puncture diameter.

Structure: Mandible long, simple, apically pointed. Malar space larger near acetabulum (condyle nearly touching ventral margin of eye). Pedicel partly enclosed by scape. F2 one-third to one-half longer than F1, and one-fourth to one-third larger than F3; remaining flagellar segments subequal, each segment gradually decreasing in length moving apically; F11 nearly twice length of F10. Interantennal area with weak tumescence and moderate longitudinal carina extending posteriorly to midpoint of frons, gradually decreasing in height posteriorly. Preoccipital margin smoothly rounded, not carinate. Pronotal collar in dorsal view with apical margin not distinctly carinate, straight, reduced almost to nothing at midpoint, length laterally about 1.0 OD. Malus with relatively short apical spine distinctly separated from vellum by notch; apical spine with minute hairs on ventral margin. Hind tibia with small but distinct rounded triangular process on posterior corner of outer apical margin. Hind tibial spurs relatively straight, with outer spur nearly one-fourth shorter than inner. Forewing with three submarginal cells. Pygidial plate about a fourth longer than basal width, carinate along margin, and strongly emarginate medially at apex. S7 as in figure 45, S8 as in figures 46 and 47, and genital capsule as in figures 48–50.

Molecular results. We obtained DNA barcoding data from 20 specimens of *N. lehighensis* (16 females and 4 males) sampled from widely separated localities in Canada (Nova Scotia, Ontario, Alberta, British Columbia) and the United States (Pennsylvania, California, Washington) (Table 1). The sequence divergence among these specimens ranged from 0–1.8%. Male specimens possessed sequences identical to that of female specimens in several cases, providing further evidence for the gender association in these species.

We note that our ongoing DNA barcoding work seems to support a cluster of genetically similar specimens that can be categorized into three separate morphological groups with affinities to *N. lehighensis*. Herein we are describing only one of those groups (i.e., the one that most closely matches the holotype specimen of *N. lehighensis*). The remaining morphological groups appear to be distributed in more southern locations throughout the United States, and will be described in a later treatment.

Variation. For both males and females, the extent and pattern of yellow maculations on the metasoma is extremely variable. We have seen a relatively long series of female specimens and the maculation pattern can vary from none to modest amounts on all the terga except T1, which in all cases lacks yellow maculations (see Diagnosis). The amount of black integumental color on the mesoscutum varies progressively from only a small section along the median anterior margin, to a black stripe extending longitudinally along the side, to a stripe extending longitudinally down the middle, to an additional black stripe between the lateral and central areas of black integument. Similarly, and usually corresponding to the degree of black integument on the mesoscutum, the amount of black integument on the face varies from a small patch surrounding the ocelli to a large coalesced patch surrounding both the ocelli and the antennal bases.

The variation in the males of *N. lehighensis* (based only on two individuals) is listed in the Diagnosis, above; however, based on experience with similar species we speculate that there may be individuals of *N. lehighensis* that have extensive areas of red integument, particularly in the Southern Appalachians.

Distribution. *Nomada lehighensis* is a largely northern species that likely is tolerably common but under-reported due to confusion with other species. We have seen specimens from the Maritimes to British Columbia and further south in the East in more mountainous regions. In eastern North America the species ranges as far south as the Great Smoky Mountains, and specimens have been collected from the Fall Line in the Washington, D.C., area, but it is not known from the Atlantic Coastal Plain proper.

Material examined. 31 specimens were examined from ME, BC, WA, RI, DC, PA, NC, VA, NJ, CT, ON, CA, NS, AB (Appendix).

Comments. This is the first description of the male of *N. lehighensis* of which we are aware. As discussed above, this species is likely under-reported due to its similar appearance to other common species. It is perhaps not surprising that the male had not been previously described given the taxonomic uncertainties that have frequently confused identifications in the past. The most important diagnostic character for distinguishing male *N. lehighensis* is the sparse number of stout, spine-like hairs on the hind tibia.

The holotype of *N. kingstonensis* was described based on a single female, and its taxonomic placement was likely complicated by the faded color of the integument. Because the holotype is faded, it is difficult to discern the pattern of the maculations present, particularly on the metasomal terga; however, the holotype appears to have the distinctive small yellow spots at the far lateral surface of T2 along with other diagnostic characters of *N. lehighensis*, including the hair pattern on the hind tibia, the weakly carinate preoccipital margin of the gena, and the general pattern of black integument throughout the body.

Nomada texana Cresson

Figures 29, 30, 35, 36, 39, 41, 43

Nomada texana Cresson 1872: 271 [Lectotype: Academy of Natural Sciences, Philadelphia, ♀; label data: "[USA] Tex. [Texas]// 163// ♀// Lectotype 2567 [red label]"]; Cresson 1916: 132 [lectotype designation].

Nomada heiligbrodtii Cresson 1878: 75 [Lectotype: Academy of Natural Sciences, Philadelphia, ♀; label data: "[USA] Tex. [Texas]// ♀// Lectotype 2598 [red label] // ANSP"]; Cresson 1916: 120 [lectotype designation]. **new synonymy.**

Diagnosis. *Nomada texana* is most similar to *N. tiftonensis*, but can be differentiated from the latter species by the following characters: in both males and females, S3 and S4 each has a narrow, ivory or very pale yellow,

transverse maculation that medially curves slightly anteriorly. The maculations are slightly interrupted medially or nearly so, and one observed specimen from Texas has maculations restricted to small areas laterally on S3 and S4. In contrast, in *N. tiftonensis* there are no maculations on any of the metasomal sterna. Also, in both males and females of *N. texana* on T3 there is an uninterrupted, yellow or ivory, transverse maculation (Fig. 43), while in *N. tiftonensis* the maculation on this tergum is widely medially interrupted (Fig. 44); however, there is often a faint area of paler brown integument connecting the two lateral yellow maculations, and in one specimen from Ontario the maculation is entirely uninterrupted. Females of the two species can be differentiated by characters of the hind tibia (viewed at high magnification): in *N. texana*, there are three to five, very wide and flat, transparent white to brownish, spine-like hairs (depending on the light reflection) whose apical tips are squared-off and extend only to the same length as, or slightly further than, the surrounding finer, white hairs (Fig. 35); while in *N. tiftonensis* these specialized hairs number from seven to ten, increase more dramatically in size posteriorly along the apical margin, and are clearly longer than the surrounding, finer, white hairs; these hairs comparatively thinner than those of *N. texana* (though still thicker than in many other *Nomada* species), round in cross-section, and translucent yellow throughout most of their length but at least a few of the longest and posterior-most hairs have the bases translucent white and the apical tips opaque brown to dark red (Fig. 37). Females of *N. texana* and *N. tiftonensis* can additionally be separated by the punctation of the clypeus relative to the paraocular area: in *N. texana* the punctures on the clypeus are distinctly smaller and denser than those on the paraocular area (punctures ranging in size from relatively small to large, Fig. 39), while in *N. tiftonensis* the punctures are almost exactly the same size and density on the clypeus as in the yellow portion of the paraocular area (punctures uniformly large, Fig. 40). Males of the two species are not as distinctly separated by the punctures of the clypeus, but in general the punctures are denser in *N. texana* than in *N. tiftonensis* (with significant overlap between the two species).

Males and females of *N. texana* and *N. tiftonensis* generally differ, sometimes subtly, in features of the antenna: the antenna (especially the scape, pedicel, and F1) is comparatively brighter yellow-orange in *N. texana* than in *N. tiftonensis*, with the antenna of most *N. tiftonensis* specimens dark brown with black on the posterior surface (when antennae directed dorsally) and dull orange markings on the anterior surfaces of the scape, pedicel and F1 (antenna of *N. texana* with much less contrast between the anterior and posterior surfaces). As discussed above, the density of punctures on the clypeus tends to be much lower in females of *N. tiftonensis* than in *N. texana* (length of space between punctures often greater than one puncture diameter in *N. tiftonensis*, spaces between punctures rarely greater than a puncture diameter in *N. texana*), although in both species there is sometimes an impunctate longitudinal line at the center of the clypeus (this impunctate line sometimes very broad in *N. tiftonensis*). The metasomal maculations of several specimens of *N. texana* are clearly ivory and most are pale yellow to near ivory, while in *N. tiftonensis* the maculations are entirely yellow. All observed specimens of *N. tiftonensis* have extensive amounts of black integument on the hind coxa, while in *N. texana* all but a few lack black integumental color and are instead entirely orange except for a yellow maculation present in both species; however, in a few specimens of *N. texana* there is a limited amount of black at the very base of the hind coxa and in the Maryland specimen the hind coxa is almost entirely black, except for dark orange shadings on the ventral surface.

Molecular results. We do not have molecular data from representatives of *N. texana*. Several specimens were sequenced that had previously been identified as *N. texana*, but upon closer examination they are in fact representatives of *N. tiftonensis* (see below).

Variation. Both of these very similar species have relatively low degrees of variability in most character states. In addition to the information presented in the description section, the extent of yellow/ivory on the male supraclypeal area varies in *N. texana* with all male specimens having pale maculations on the supraclypeal area, although the extent varies to a small degree.

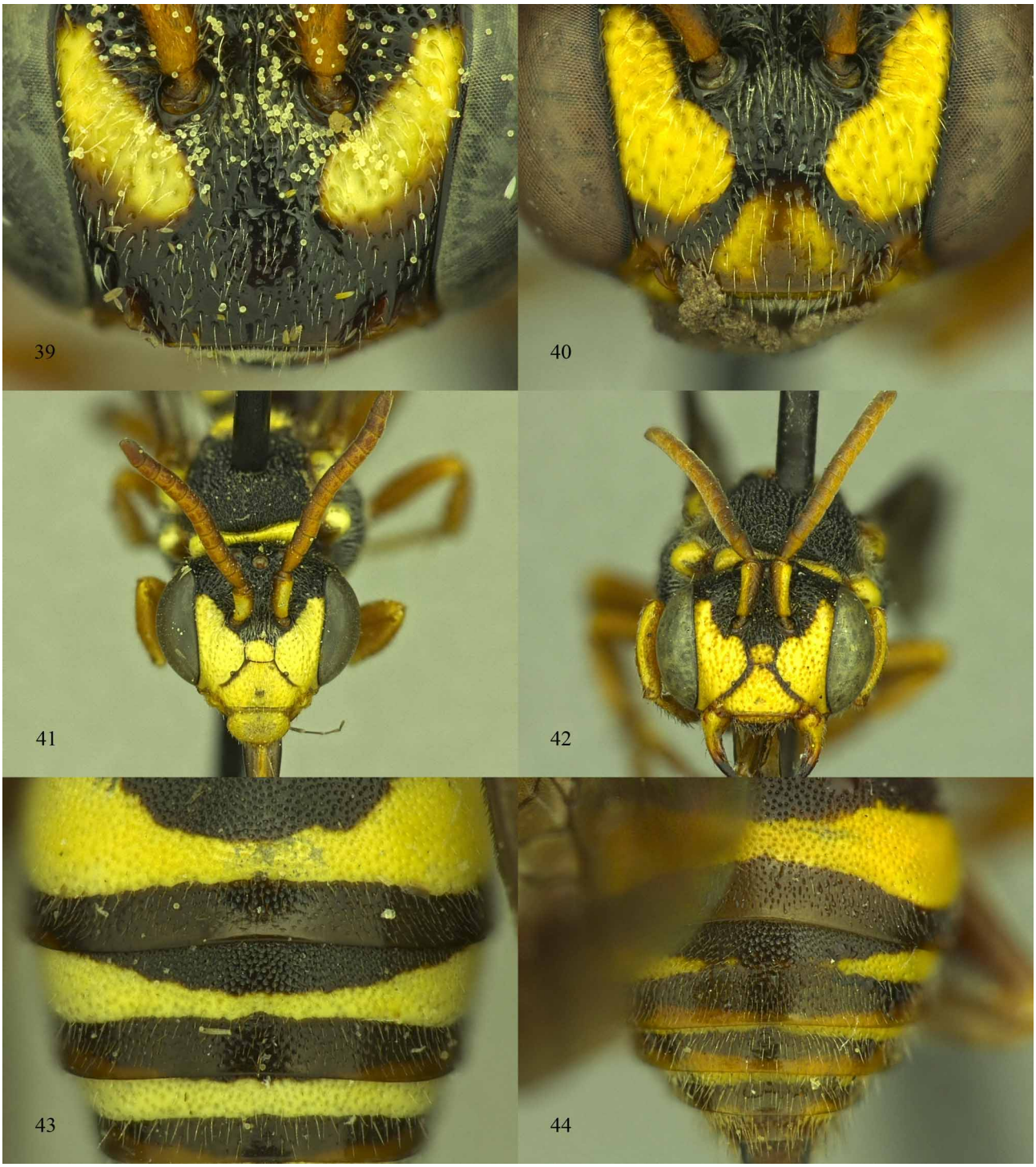
Distribution. *Nomada texana* has a more southern and western distribution relative to *N. tiftonensis*, with specimens seen from Arizona and Idaho east to Texas and Indiana; we have also seen specimens from Georgia, Alabama, and Maryland.

FIGURES 33–38. Outer apical surface of hind tibia. Figs. 33, 34. *Nomada fervida*. Fig. 33. Female. Fig. 34. Male. Figs. 35, 36. *Nomada texana*. Fig. 35. Female. Fig. 36. Male. Figs. 37, 38. *Nomada tiftonensis*. Fig. 37. Female. Fig. 38. Male.

Material examined. 35 specimens were examined from TX, ID, UT, NM, NE, GA, AL, NV, AZ, MD, and IN (Appendix).

Comments. Mitchell (1962) synonymized *N. tiftonensis* and *N. modesta rivertonensis* with *N. heiligbrodtii*, and then separated *N. texana* from *N. heiligbrodtii* based on the maculation pattern of T2 and T3. Based on the characters presented herein we disagree with his conclusions and instead believe that *N. tiftonensis* and *N. modesta rivertonensis* represent males and females of the same species, and that *N. heiligbrodtii* is a junior synonym of *N. texana*. Mitchell's (1962) keys to the males and females of *Nomada*, as

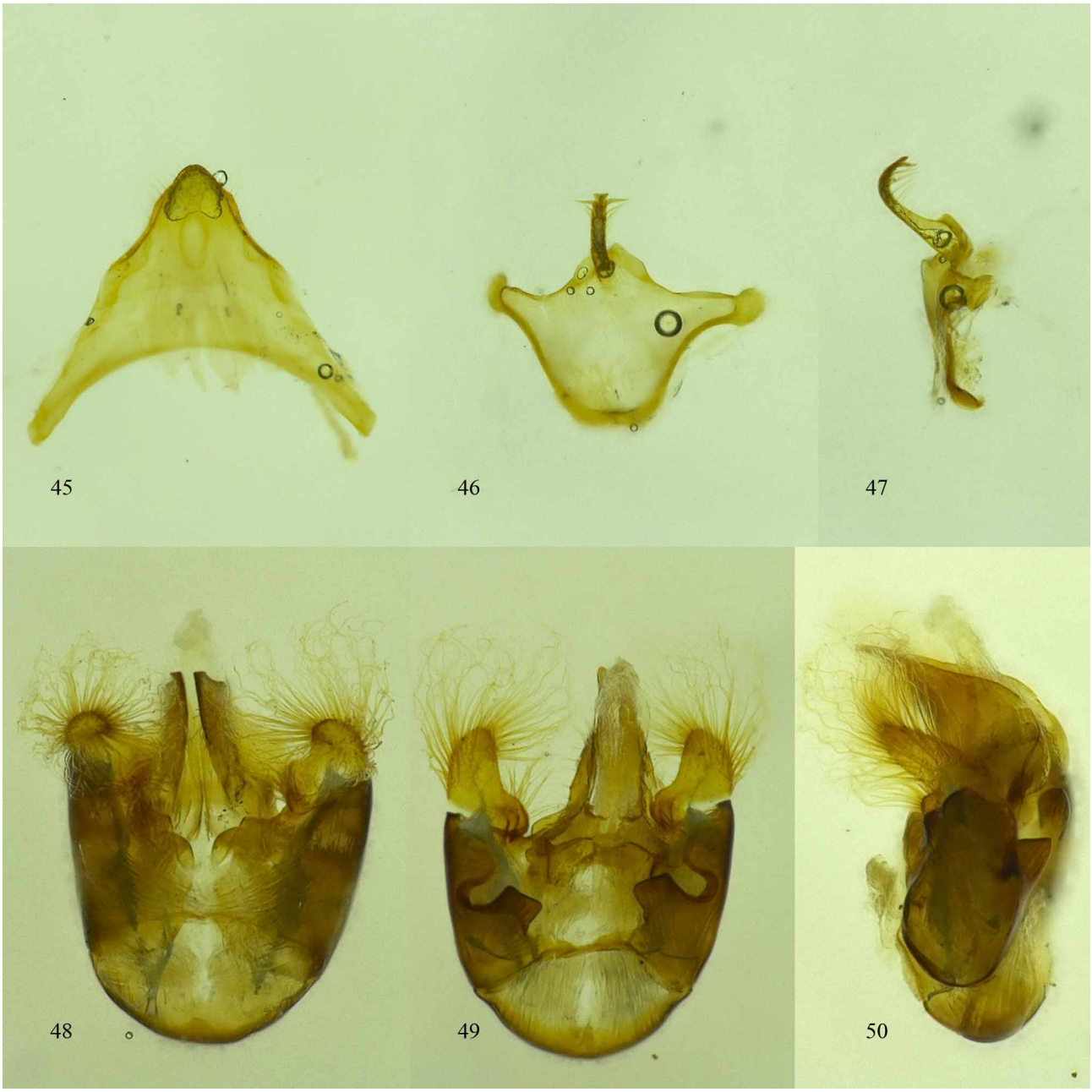
well as diversity of names present on previously identified specimens in collections, reflect the general confusion between these two very similar species.



FIGURES 39, 40. Female clypeus and paraocular area. Fig. 39. *Nomada texana*. Fig. 40. *Nomada tiftonensis*.
FIGURES 41, 42. Male face. Fig. 41. *Nomada texana*. Fig. 42. *Nomada tiftonensis*.
FIGURES 43, 44. Dorsal view of male T2–T4. Fig. 43. *Nomada texana*. Fig. 44. *Nomada tiftonensis*.

Based on the available material, *N. tiftonensis* appears to inhabit eastern sandy areas; all of the collection locales represented by the material, with which we are familiar, meet that general description. With the exception of the Maryland specimen, we are not familiar with the collection locales represented by the examined *N. texana* specimens and are therefore unable to comment upon them. However, the Maryland specimen is perhaps illuminating in that it was captured only a few miles from specimens of *N. tiftonensis.*

The soils of the capture site were silty clay soils (the region is famous for its bricks) while the *N. tiftonensis* specimens were captured in a restricted deep sand area along the Patuxent River (the only source of commercial sand in the region). It would be interesting to investigate the differences in the preferred sites. Hosts for both species are unknown.



FIGURES 45–50. *Nomada lehighensis*, male. Fig. 45. Ventral view of S7. Fig. 46. Ventral view of S8. Fig. 47. Lateral view of S8. Fig. 48. Ventral view of genital capsule. Fig. 49. Dorsal view of genital capsule. Fig. 50. Lateral view of genital capsule.

***Nomada tiftonensis* Cockerell**
Figures 31, 32, 37, 38, 40, 42, 44

Nomada tiftonensis Cockerell 1903: 610 [Holotype: Academy of Natural Sciences, Philadelphia, ♂; label data: "[USA] Tifton, Ga. [Georgia]// P20// Type No. 10165 [red label]// *N. tiftonensis* Ckll Type// ANSP"]; Mitchell 1962: 355 [synonymy with *N. heiligbrodti*].

Nomada modesta rivertonensis Cockerell 1903:610 [Academy of Natural Sciences, Philadelphia, ♀; label data: "[USA] Riverton NJ [New Jersey] viii.31 [31 August]// Type No. 10158 [red label]// *N. modesta* v. *rivertonensis* Ckll Type// 1980 loan to USNM from Acad. of Nat. Sciences at Philadelphia// ANSP"] [head is knocked off]; Mitchell 1962: 355 [synonymy with *N. heiligbrodti*].

Diagnosis. Males and females of *N. tiftonensis* are most similar to *N. texana*. See Diagnosis under that species for identifying characters.

Distribution. Nomada *tiftonensis* is known from Georgia north to Maine and west to Ontario and Wisconsin.

Material examined. 29 specimens were examined from ME, GA, NJ, NH, IN, MD, ON, SC, MI, NY, and WI.

Molecular results. We obtained DNA barcoding data from seven specimens of *N. tiftonensis* (five females and two males) sampled from widely separated localities (Ontario, Maryland, and South Carolina) (Table 1). The sequence divergence among these specimens ranged from 0–0.2%

Variation. In *N. tiftonensis*, most male specimens have a completely black supraclypeal area, while others have vague yellowish patches present, and a few have solid yellow blocks (Fig. 42). In male *N. tiftonensis* the labrum varies from completely yellow to nearly all dark; the labrum in all observed *N. texana* males was completely yellow. See further comments about observed character variation under *N. texana*.

Comments. See Comments under *N. texana*.

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APPENDIX. *Nomada* Specimens.

Species	Sex	Country	State	County	Location	Date	Collectors	Institute
N. augustiana	Female	USA	NC	Richmond	Augusta	April 1, 1959	R. R. Snelling	USNM
N. augustiana	Male	USA	GA	Thomas	Thomasville	March 21, 1904	M. Hebard	ANSP
N. augustiana	Male	USA	GA	Thomas	Thomasville	March 21, 1904	M. Hebard	ANSP
N. augustiana	Male	USA	GA	Thomas	Thomasville	March 21, 1904	M. Hebard	ANSP
N. augustiana	Male	USA	GA	Thomas	Thomasville	March 21, 1904	M. Hebard	ANSP
N. augustiana	Male	USA	GA	Thomas	Thomasville	March 21, 1904	M. Hebard	ANSP
N. augustiana	Male	USA	GA	Thomas	Thomasville	March 21, 1904	M. Hebard	ANSP
N. augustiana	Male	USA	GA	Thomas	Thomasville	March 21, 1904	M. Hebard	ANSP
N. augustiana	Male	USA	GA	Thomas	Thomasville	March 21, 1904	M. Hebard	ANSP
N. augustiana	Male	USA	NC	Wake	Wendell	March 26, 1925	T.B. Mitchell	USNM
N. bethunei	Female	USA	CT	Litchfield	Canaan	May 26-29, 2007	D. Wagner	UCON
N. bethunei	Female	USA	IA		Sioux City	June 26, 1926	C.N. Ainslie	Not Recorded
N. bethunei	Female	USA	KS		Lawrence	June 8, 1952	Michener	BBSL
N. bethunei	Female	USA	KS		Lyndon	June 8, 1952	Wille - Michener	BBSL
N. bethunei	Female	USA	MI	Kalamazoo			H.C. Beckov	Not Recorded
N. bethunei	Female	USA	NJ	Bergen	Norwood	July 6, 1972	R. McGinley	USNM
N. bethunei	Female	USA	NY	Tompkins	Ithaca	June 10, 1985	G.C. Eickwort	AMNH
N. bethunei	Female	USA	NY	Tompkins	Ithaca	June 10, 1985	G.C. Eickwort	AMNH
N. bethunei	Female	USA	NY	Tompkins		June 26, 1959	J. Graham	AMNH
N. bethunei	Female	USA	NY		Batavia	June 18, 1913	H. H. Knight	AMNH
N. bethunei	Female	Canada	ON	Essex	Windsor	May 11-15, 2007	S. Paiero	PCYU
N. bethunei	Female	USA	ON	York	Keele	June 12, 2006	E. Willis	PCYU
N. bethunei	Female	USA	PA	Perry	Newport	18-30 May, 1969	J.W. Adams	Not Recorded
N. bethunei	Female	USA	PA		N. Cumberland	May 29, 1909	P.R. Myers	Not Recorded
N. bethunei	Female	USA	WI		Milwaukee	May 8, 1903	Graenicher	Not Recorded
N. bethunei	Female	Canada						USNM
N. bethunei	Male	USA	IL		Spitner Woods	June 5, 1966	W.J. Knee	BBSL
N. bethunei	Male	USA	KS		Lawrence	June 8, 1952	Michener	BBSL
N. bethunei	Male	USA	NJ		Westfield	June 13, 1984	G. Ferguson	AMNH

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APPENDIX (continued)

Species	Sex	Country	State	County	Location	Date	Collectors	Institute
N. bethunei	Male	Canada	ON	York	Keele	May 19, 2006	E. Willis	PCYU
N. bethunei	Male	USA	VA	Montgomery	Redford	May 25, 1971	J.B. Karren	NMNH
N. bethunei	Male						Baker?	Not Recorded
N. bethunei	Male							Not Recorded
N. fervida	Female	USA	FL	Highlands	Archibold Biological Station	April 4-7, 1980	H.V. Weems, jr.	ANSP
N. fervida	Female	USA	FL	Highlands	Archibold Biological Station	May 12-15, 1978	H.V. Weems, jr. & L. K. Klein	USNM
N. fervida	Female	USA	FL	Lake	Leesburg	May 24, 1961		USNM
N. fervida	Female	USA	FL		Gainesville	March 22, 1968	W.V. Weems	USNM
N. fervida	Female	USA	FL				G. Hall	GHPC
N. fervida	Female	USA	FL				G. Hall	GHPC
N. fervida	Female	USA	IL	Mason	Forest City	August 24, 1967	W.E. LeBerge	BBSL
N. fervida	Female	USA	IN	Gibson		July 14, 1957	Montgomery	RJRJ
N. fervida	Female	USA	IN	Lake	Indiana Dunes	July 21, 2004	R. Grundel	INDL
N. fervida	Female	USA	IN	Lake	Indiana Dunes	July 21, 2004	R. Grundel	INDL
N. fervida	Female	USA	IN	Porter	Indiana Dunes	August 17, 2004	R. Grundel	INDL
N. fervida	Female	USA	MI	Midland		July 25, 1936	R.R. Dreisbach	UCMC
N. fervida	Female	USA	WI	Grant	Rutlege	August 5-10, 1911		UCMC
N. fervida	Female	USA	WI		Two Rivers	June 26, 1911		UCMC
N. fervida	Male	USA	FL	Highlands	Archibold Biological Station	April 3-4, 1978	L. L. Lampert, Jr.	USNM
N. fervida	Male	USA	FL	Highlands	Lake Placid	August 28, 1978	W.V. Weems	USNM
N. fervida	Male	USA	FL		Orlando		R. & G. Bohart	USNM
N. fervida	Male	USA	FL		Orlando		R. & G. Bohart	USNM
N. fervida	Male	USA	FL		St. Petersburg	March 26, 1920	E. Craighead	ANSP
N. fervida	Male	USA	FL				G. Hall	GHPC
N. fervida	Male	USA	FL				G. Hall	GHPC
N. fervida	Male	USA	FL				G. Hall	GHPC
N. fervida	Male	USA	GA		Okefenokee Swamp	July 30, 1934	R. H. Beamer, Jr.	USNM
N. fervida	Male	USA	IL		Havana	August 11, 1930	Frison and Knight	BBSL
N. fervida	Male	USA	IN	Gibson		August 11, 1953		RJRJ

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APPENDIX (continued)

Species	Sex	Country	State	County	Location	Date	Collectors	Institute
N. fervida	Male	USA	IN	Gibson		July 13, 1957	Montgomery	RJRJ
N. fervida	Male	USA	IN	Gibson		July 14, 1957	Montgomery	RJRJ
N. fervida	Male	USA	IN	Gibson		July 14, 1957	Montgomery	RJRJ
N. fervida	Male	USA	IN	Gibson		July 14, 1957	Montgomery	RJRJ
N. fervida	Male	USA	IN	Gibson		August 17, 1958	Montgomery	RJRJ
N. fervida	Male	USA	IN	Gibson		August 14, 1958	Montgomery	RJRJ
N. fervida	Male	USA	IN	Knox		July 9, 1957	Montgomery	RJRJ
N. fervida	Male	USA	IN	Knox		July 9, 1957	Montgomery	RJRJ
N. fervida	Male	USA	IN	Knox		July 9, 1957	Montgomery	RJRJ
N. fervida	Male	USA	MI	Benzie		July 28, 1946	R.R. Dreisbach	UCMC
N. fervida	Male	USA	MI	Midland		June 20, 1942	R.R. Dreisbach	UCMC
N. fervida	Male	Canada	ON	Lambton	Pinery Provincial Park	July 18, 2006	S.M. Piaero	DEBU
N. fervida	Male	USA	WI	Pierce	Prescott	July 13-19, 1910		UCMC
N. fervida	Male	USA	WI		Two Rivers	June 26, 1911		UCMC
N. fragariae	Female	USA	GA					Not Recorded
N. fragariae	Female	USA	MD	Calvert	Chestnut Land Trust	May 8-9, 2008	SEL Hym Group	USNM
N. fragariae	Female	USA	MD	Calvert	Chestnut Land Trust	May 8-9, 2008	SEL Hym Group	USNM
N. fragariae	Female	USA	MD	Calvert	Chestnut Land Trust	May 8-9, 2008	SEL Hym Group	USNM
N. fragariae	Female	USA	MD	Calvert	Chestnut Land Trust	May 8-9, 2008	SEL Hym Group	USNM
N. fragariae	Female	USA	MD	Calvert	Chestnut Land Trust	May 10-11, 2008	SEL Hym Group	USNM
N. fragariae	Female	USA	MD	Calvert	Chestnut Land Trust	May 10-11, 2008	SEL Hym Group	USNM
N. fragariae	Female	USA	MD	Calvert	Chestnut Land Trust	May 10-11, 2008	SEL Hym Group	USNM
N. fragariae	Female	USA	MD	Calvert	Chestnut Land Trust	May 12-13, 2008	SEL Hym Group	USNM
N. fragariae	Female	USA	MD	Calvert	Chestnut Land Trust	May 12-13, 2008	SEL Hym Group	USNM
N. fragariae	Female	USA	MD	Calvert	Chestnut Land Trust	May 12-13, 2008	SEL Hym Group	USNM
N. fragariae	Female	USA	MD	Calvert	Chestnut Land Trust	May 12-13, 2008	SEL Hym Group	USNM
N. fragariae	Female	USA	MD	Calvert	Chestnut Land Trust	May 12-13, 2008	SEL Hym Group	USNM
N. fragariae	Female	USA	MD	Calvert	Chestnut Land Trust	May 12-13, 2008	SEL Hym Group	USNM
N. fragariae	Female	USA	MD	Calvert	Chestnut Land Trust	May 12-13, 2008	SEL Hym Group	USNM

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APPENDIX (continued)

Species	Sex	Country	State	County	Location	Date	Collectors	Institute
N. fragariae	Female	USA	MD	Calvert	Chestnut Land Trust	May 12-13, 2008	SEL Hym Group	USNM
N. fragariae	Female	USA	MD	Calvert	Chestnut Land Trust	May 12-13, 2008	SEL Hym Group	USNM
N. fragariae	Female	USA	MD	Calvert	Chestnut Land Trust	May 12-13, 2008	SEL Hym Group	USNM
N. fragariae	Female	USA	MD	Calvert	Chestnut Land Trust	May 12-13, 2008	SEL Hym Group	USNM
N. fragariae	Female	USA	MD	Calvert	Chestnut Land Trust	May 12-13, 2008	SEL Hym Group	USNM
N. fragariae	Female	USA	MD	Calvert	Chestnut Land Trust	May 12-13, 2008	SEL Hym Group	USNM
N. fragariae	Female	USA	MD	Calvert	Chestnut Land Trust	May 14-15, 2008	SEL Hym Group	USNM
N. fragariae	Female	USA	MD	Calvert	Chestnut Land Trust	May 14-15, 2008	SEL Hym Group	USNM
N. fragariae	Female	USA	MD	Calvert	Chestnut Land Trust	May 14-15, 2008	SEL Hym Group	USNM
N. fragariae	Female	USA	MD	Calvert	Chestnut Land Trust	May 14-15, 2008	SEL Hym Group	USNM
N. fragariae	Female	USA	MD	Calvert	Chestnut Land Trust	May 14-15, 2008	SEL Hym Group	USNM
N. fragariae	Female	USA	MD	Calvert	Chestnut Land Trust	May 16-17, 2008	SEL Hym Group	USNM
N. fragariae	Female	USA	MD	Calvert	Chestnut Land Trust	May 16-17, 2008	SEL Hym Group	USNM
N. fragariae	Female	USA	MD	Calvert	Chestnut Land Trust	May 16-17, 2008	SEL Hym Group	USNM
N. fragariae	Female	USA	MD	Calvert	Chestnut Land Trust	May 16-17, 2008	SEL Hym Group	USNM
N. fragariae	Female	USA	MD	Calvert	Chestnut Land Trust	May 16-17, 2008	SEL Hym Group	USNM
N. fragariae	Female	USA	MD	Calvert	Chestnut Land Trust	May 16-17, 2008	SEL Hym Group	USNM
N. fragariae	Female	USA	MD	Calvert	Chestnut Land Trust	May 20-21, 2008	SEL Hym Group	USNM
N. fragariae	Female	USA	MD	Calvert		May 18-30, 2007	SEL Hym Group	USNM
N. fragariae	Female	USA	MD	Prince George's	Beltsville	June 4, 1991	S. Batra	USNM
N. fragariae	Male	USA	GA		Blood Mountain	May 16, 1951	P.W. Fattig	Not Recorded
N. fragariae	Male	USA	GA					Not Recorded
N. fragariae	Male	USA	GA					Not Recorded
N. fragariae	Male	USA	GA					Not Recorded
N. fragariae	Male	USA	GA					Not Recorded
N. fragariae	Male	USA	GA					Not Recorded
N. fragariae	Male	USA	GA					Not Recorded
N. fragariae	Male	USA	GA					Not Recorded
N. fragariae	Male	USA	GA					Not Recorded

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APPENDIX (continued)

Species	Sex	Country	State	County	Location	Date	Collectors	Institute
N. fragariae	Male	USA	GA					Not Recorded
N. fragariae	Male	USA	GA					Not Recorded
N. fragariae	Male	USA	GA					Not Recorded
N. fragariae	Male	USA	GA					Not Recorded
N. fragariae	Male	USA	GA					Not Recorded
N. fragariae	Male	USA	GA					Not Recorded
N. fragariae	Male	USA	MD	Calvert	Chestnut Land Trust	May 8-9, 2008	SEL Hym Group	USNM
N. fragariae	Male	USA	MD	Calvert	Chestnut Land Trust	May 18-19, 2008	SEL Hym Group	USNM
N. fragariae	Male	USA	MD	Montgomery	Carderock Park	May 18, 1989	M.J. Molineaux	USNM
N. fragariae	Male	USA	MD	Prince George's	Cheverly		M.J. Molineaux	USNM
N. fragariae	Male	USA	MD	Prince George's	PWRC	April 29-May 11, 1986	D.B. Wahl	USNM
N. fragariae	Male	USA	MD	Prince George's			J.F. Reinert	USNM
N. fragariae	Male	USA	MD	Somerset		May 8, 2002	S. Droege	BIML
N. fragariae	Male	USA	NC	Johnston	Clayton	May 6, 1964	G.A. Matuza	Not Recorded
N. fragariae	Male	USA	NC	Johnston	Clayton	May 6, 1964	G.A. Matuza	Not Recorded
N. fragariae	Male	USA	NC	Johnston	Clayton	May 6, 1964	G.A. Matuza	Not Recorded
N. fragariae	Male	USA	NC	Johnston	Clayton	May 6, 1964	G.A. Matuza	Not Recorded
N. fragariae	Male	USA	NC	Johnston	Clayton	May 6, 1964	G.A. Matuza	Not Recorded
N. fragariae	Male	USA	NC		Faison	April 20, 1955	T.B. Mitchell	Not Recorded
N. gracilis	Female	USA	NY	NYC	Inwood Park	April 25, 1942	S.C. Harriot	Not Recorded
N. gracilis	Female	USA	NY	Westchester	Lewisburg	May 9, 1982	M. Favreau	Not Recorded
N. lehighensis	Female	Canada	BC		Midway	June 8, 2007	J. Gibbs and C. Sheffield	PCYU
N. lehighensis	Female	Canada	BC		Midway	June 8, 2007	J. Gibbs and C. Sheffield	PCYU
N. lehighensis	Female	USA	CA	Mendocino		July 5, 2007	J. Gibbs and C. Sheffield	PCYU
N. lehighensis	Female	USA	CT		Hartford	? 1896		UCON
N. lehighensis	Female	USA	DC		Rock Creek	April 8, 2006	D.H. Clemons	Not Recorded
N. lehighensis	Female	USA	ME	Washington	Moosehead Wildlife Preserve	June 1-4, 1983	J.H. Parker	Not Recorded

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APPENDIX (continued)

Species	Sex	Country	State	County	Location	Date	Collectors	Institute
N. lehighensis	Female	USA	NC		Balsam	9-Jul-?		Not Recorded
N. lehighensis	Female	USA	NJ	Bergen	Alpine	April 22, 1965	Favreau and Hamill	Not Recorded
N. lehighensis	Female	USA	NJ	Ocean	Warren Grove	May 19, 1982	J.G. Rozen	ANSP
N. lehighensis	Female	Canada	NS	Hants	Quarry Lake	June 14, 2005	Sheffield/Westby	PCYU
N. lehighensis	Female	Canada	NS	Kings	Avonport	June 9, 2005	C. Sheffield	PCYU
N. lehighensis	Female	Canada	NS	Lunen	Northwest Cove	June 9, 2001		PCYU
N. lehighensis	Female	Canada	NS		Apple	June 10, 2003		PCYU
N. lehighensis	Female	Canada	NS		Avonport	June 23, 2003		PCYU
N. lehighensis	Female	Canada	NS		Gyp Lake	June 27, 2003	?	PCYU
N. lehighensis	Female	Canada	NS		Jack McDougal	June 23, 2005	?	PCYU
N. lehighensis	Female	Canada	NS		NWC	June 25, 2002		PCYU
N. lehighensis	Female	Canada	NS		NWC	June 25, 2002		PCYU
N. lehighensis	Female	Canada	ON		Bill Masteres	July 3, 2003	?	PCYU
N. lehighensis	Female	Canada	ON		Gower to Smiths Falls	June 15-30, 2004	Bennett and Barnes	PCYU
N. lehighensis	Female	USA	PA	Adams	Pine Grove Furnace State Park	June 10-12, 1988	T.G. Spanton	Not Recorded
N. lehighensis	Female	USA	PA		Heckton Mills	April 22, 1910	H.B. Kirk	Not Recorded
N. lehighensis	Female	USA	PA		Lehigh Gap	April 1, 1889		Not Recorded
N. lehighensis	Female	USA	PA		Presque Isle State Park	June 4, 1966	E.J. Kurezewski	Not Recorded
N. lehighensis	Female	USA	RI		Kingston	April 26, 1904	RI College Collection	USNM
N. lehighensis	Female	USA	VA		Mount Vernon	March 31, 1917	W.L. McAtee	Not Recorded
N. lehighensis	Female	USA	WA	Whitman	Clarkston	May 29, 2007	J. Gibbs and C. Sheffield	PCYU
N. lehighensis	Male	Canada	AB		Stafford Lake Park	June 12, 2007	J. Gibbs and C. Sheffield	PCYU
N. lehighensis	Male	Canada	NS	Kings		May 5, 2005	C. Sheffield	PCYU
N. lehighensis	Male	Canada	ON		Gower to Smiths Falls	May 14-31, 2004	Bennett and Barnes	PCYU
N. lehighensis	Male	Canada	ON		Gower to Smiths Falls	May 14-31, 2004	Bennett and Barnes	PCYU
N. texana	Female	USA	AL		Decatur	August, 1944	G.E. Bohart	BBSL
N. texana	Female	USA	AZ		Portal	September 14, 1955	G.E. Bohart	BBSL
N. texana	Female	USA	GA		Carrollton	July 27, 1938	P.W. Fattig	UCMC
N. texana	Female	USA	NM	Ana	Mesilla	September 23, 1965	G.E. Bohart	BBSL

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APPENDIX (continued)

Species	Sex	Country	State	County	Location	Date	Collectors	Institute
N. texana	Female	USA	TX	El Paso	Yslota	July 20, 1955	G.R. Ferguson	BBSL
N. texana	Female	USA	TX		Kerrville	April 7, 1907	P. Durham	UCMC
N. texana	Female	USA	TX		Kerrville	April, 1907	P. Durham	USNM
N. texana	Female	USA	TX		nr. Forestburg	? 1940	L.H. Bridwell	UCMC
N. texana	Female	USA	TX					USNM
N. texana	Male	USA	AL		Decatur	August, 1944	G.E. Bohart	BBSL
N. texana	Male	USA	AZ	Cochise	San Simon	August 31, 2001	O. Messinger	BBSL
N. texana	Male	USA	AZ		Portal	September 16, 1955	G.E. Bohart	BBSL
N. texana	Male	USA	ID	Canyon	Marsing	August 7, 1979	Packer/Viers	BBSL
N. texana	Male	USA	ID	Gooding	Hagerman	July 13, 1966	G.E. Bohart	BBSL
N. texana	Male	USA	IN		Etna Green	August 20, 1936	F.D. Minor	UCMC
N. texana	Male	USA	NE	Buffalo	Ravenna	August 24, 1958	Atyeo and Anderson	BBSL
N. texana	Male	USA	NE		Omaha	August 26, 1913	L.T. Williams	UCMC
N. texana	Male	USA	NM		Las Cruces	June 18, 1942	E.O. Van Dyke	BBSL
N. texana	Male	USA	NV	Clark	St. Thomas Gap	June 7, 1998	T. Griswold	BBSL
N. texana	Male	USA	TX	Ward	Barstow	July 22, 1984	G.F. and J.F. Hevel	USNM
N. texana	Male	USA	TX	Ward	Barstow	July 22, 1984	G.F. and J.F. Hevel	USNM
N. texana	Male	USA	TX	Ward	Barstow	July 22, 1984	G.F. and J.F. Hevel	USNM
N. texana	Male	USA	TX	Ward	Barstow	July 22, 1984	G.F. and J.F. Hevel	USNM
N. texana	Male	USA	TX	Ward	Barstow	July 22, 1984	G.F. and J.F. Hevel	USNM
N. texana	Male	USA	TX	Ward	Barstow	July 22, 1984	G.F. and J.F. Hevel	USNM
N. texana	Male	USA	TX	Ward	Barstow	July 22, 1984	G.F. and J.F. Hevel	USNM
N. texana	Male	USA	TX	Ward	Barstow	July 22, 1984	G.F. and J.F. Hevel	USNM
N. texana	Male	USA	TX		Beeville	June 5, 2006	C.R. Jones	UCMC
N. texana	Male	USA	TX		Devil's River	May 6, 1907	F.C. Bishopp	UCMC
N. texana	Male	USA	TX		Devil's River	May 3, 1907	F.C. Pratt	USNM
N. texana	Male	USA	TX		Plainview	August 13, 1979	G.E. Bohart	BBSL
N. texana	Male	USA	TX		Plano	July, 1907	E.S. Tucker	UCMC
N. texana	Male	USA	UT		Lakepoint	July 22, 1952	G.F. Knowlton	BBSL
N. texana	Male	USA	UT		Tremonton	July 27, 1960	G.E. Bohart	BBSL

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APPENDIX (continued)

Species	Sex	Country	State	County	Location	Date	Collectors	Institute
N. texana	Male	USA	MD	Prince George's	Beltsville Agriculture Research Center	August 26, 2010	S. Droege	USNM
N. tiftonensis	Female	USA	MD	Anne Arundel		September 24-25, 2004	R. Andrus	USNM
N. tiftonensis	Female	USA	MI	Cheb. (Cheboygan?)	Nigger Creek	July 21, 1955	W.J. Hanson	BBSL
N. tiftonensis	Female	USA	NJ		Lakewood	September 6, 1954	G.R. Ferguson	BBSL
N. tiftonensis	Female	USA	NJ		Westfield	August 18, 1956	G.R. Ferguson	BBSL
N. tiftonensis	Female	USA	NY	Westchester	Bedford	September 1, 1957	G.R. Ferguson	BBSL
N. tiftonensis	Female	USA	NY	Westchester	Hartsdale	August 18, 1957	G.R. Ferguson	BBSL
N. tiftonensis	Female	Canada	ON	Lambton	Walpole	August 4, 2006	S.M. Piaero	DEBU
N. tiftonensis	Female	USA	SC	Chesterfield	Caroline Sandhills NWR	September 26, 2007	S. Droege	USNM
N. tiftonensis	Female	USA	SC	Chesterfield	Caroline Sandhills NWR	September 26, 2007	S. Droege	USNM
N. tiftonensis	Female	USA	WI	Grant	Rutlege	August 5-10, 1911		UCMC
N. tiftonensis	Female							Not Recorded
N. tiftonensis	Male	USA	GA		Tifton			ANSP
N. tiftonensis	Male	USA	GA		Tifton			ANSP
N. tiftonensis	Male	USA	IN	Gibson		August 14, 1958	Montgomery	USNM
N. tiftonensis	Male	USA	IN	Gibson		July 14, 1957	Montgomery	USNM
N. tiftonensis	Male	USA	MD	Anne Arundel		September 20, 2004	R. Andrus	USNM
N. tiftonensis	Male	USA	MD		Chesapeake Beach	September 24, 1916	W.L. McAtee	USNM
N. tiftonensis	Male	USA	ME					ANSP
N. tiftonensis	Male	USA	NH	Belknap	Gilford-Alton	August 14-15, 1948	Shappirrio	USNM
N. tiftonensis	Male	USA	NJ	Atlantic	Hammontown	September 7, 1979	R. McGinley	USNM
N. tiftonensis	Male	USA	NJ	Atlantic	Hammontown	September 7, 1932		USNM
N. tiftonensis	Male	USA	NJ	Ocean	Whitesville	August 21, 1955	G.R. Ferguson	BBSL
N. tiftonensis	Male	USA	NJ		Cape May	September 9, 1932	W. Stone	ANSP
N. tiftonensis	Male	USA	NJ		Glasboro	July 3, 1955	G.R. Ferguson	BBSL
N. tiftonensis	Male	USA	NJ		Glasboro	September 6, 1954	G.R. Ferguson	BBSL
N. tiftonensis	Male	USA	NY	Westchester	Poundridge	August 15, 1957	G.R. Ferguson	BBSL
N. tiftonensis	Male	Canada	ON		Dorset	August 6, 1964	R. Kilkton	DEBU
N. tiftonensis	Male	USA	SC	Chesterfield			S. Droege	USNM
N. tiftonensis	Male	USA	MD	Anne Arundel	Davidsonville	September 5, 2010	S. Droege	USNM