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First record of *Hylaeus pictipes* Nylander, 1852 (Hymenoptera, Colletidae) in Virginia, United States of America

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Abstract

Insect surveys of developed areas can provide important new species records as these areas are often under-surveyed and assumed to have low biodiversity. These surveys are of increasing importance as fragmentation and habitat conversion further alters the biosphere. We report a new state species record from Virginia: five *Hylaeus* (*Paraprosopis*) *pictipes* Nylander, 1852 (Hymenoptera, Colletidae). Field surveys in Richmond and the surrounding areas found this species from 28 April to 5 August 2019. This is the furthest south *H. pictipes* has been recorded on the east coast of the USA.

Keywords

Apoidea, bee, introduced species, *Paraprosopis*, range expansion, state record

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Introduction

As highly degraded and modified habitats, urban areas are often considered lacking in biodiversity and thus are under-researched as ecosystems (Hartop et al. 2015). While the degradation of natural habitats is a primary cause of global biodiversity decline (Haddad et al. 2015), it does not necessarily follow that urban environments have poor local biodiversity and therefore should not be surveyed. Recent efforts to survey urban and suburban areas have revealed that a surprisingly rich diversity of species exists in these habitats, yielding exciting discoveries of rare or unknown species. One urban insect survey in Los Angeles, California produced 43 new species of fly (Hartop et al. 2016). Another survey focused on ants in both forested and urban areas of Rondônia, Brazil resulted in 29 new state records (Santos-Silva et al. 2016). Such studies can also be of medical importance, as another urban survey recently found a kissing bug known to transmit the parasite that causes Chagas disease in Barra do Garças, a Brazilian city (Martins et al. 2018).

While there is concern about Honey Bee (*Apis mellifera* Linnaeus, 1758) die offs in agriculture (Kulhanek et al. 2017), the scientific community is also working to increase knowledge on native bee biodiversity to identify population trends and native bee specific conservation needs (Colla and MacIvor 2017). In addition to bolstering biodiversity, wild pollinators have been shown to increase fruit set of crops regardless of Honey Bee abundance (Garibaldi et al. 2013), and native bees have been shown to provide economically significant pollination services (Mallinger et al. 2018). Whether concern for bee population viability comes from agriculture yields or biodiversity concerns, gathering information about native bees should be a priority. Native bee surveys are important for establishing regional population numbers and generating species checklists. In turn, this knowledge of species distribution informs future conservation initiatives in the area.

Due to the importance of insect surveys in urban/developed habitats, and in an effort to collect more data on native bees, we conducted a bee survey in Richmond, Virginia, USA. We centered our survey around the University of Richmond and its surrounding area, establishing Malaise traps in eight different locations in order to provide baseline data on insect biodiversity across urban and suburban natural areas. The bulk of specimens were donated to the Virginia Museum of Natural History, and a synoptic set of species was left at the University of Richmond. Here we provide information for a new state species record collected during these efforts, *Hylaeus pictipes* Nylander, 1852 (Hymenoptera, Colletidae). *Hylaeus pictipes*, a European cavity nester, has been documented in North America from Ontario, Canada, as well as Pennsylvania, Ohio, and California, USA (Gibbs and Dathe 2017).

Methods

Malaise traps (Malaise 1937) were established in eight locations in both urban and suburban habitats in the City of Richmond and Henrico County. Four traps were placed on the University of Richmond campus in Richmond city. One North of the R45 Parking Lot, 37.5789°N, 077.5371°W, one north of the W86 Parking Lot, 37.5755°N, 077.5459°W, one east of the U12 Parking Lot, 37.5740°N, 077.5368°W, and one east of the U27 Parking Lot, 37.5702°N, 077.5370°W. Outside of the University of Richmond, one trap was placed in Bandy Field Nature Park, Henrico County, 37.5859°N, 077.5338°W, another next to the James River Park System Headquarters at the Reedy Creek Trailhead, Richmond city, 37.5244°N, 077.4683°W, and two in the University of Richmond's Pagebrook Property, Goochland County, 37.5937°N, 077.6680°W and 37.5923°N, 077.6672°W (Fig. 1). Collection permission was acquired before Malaise traps were installed. No permits were necessary.

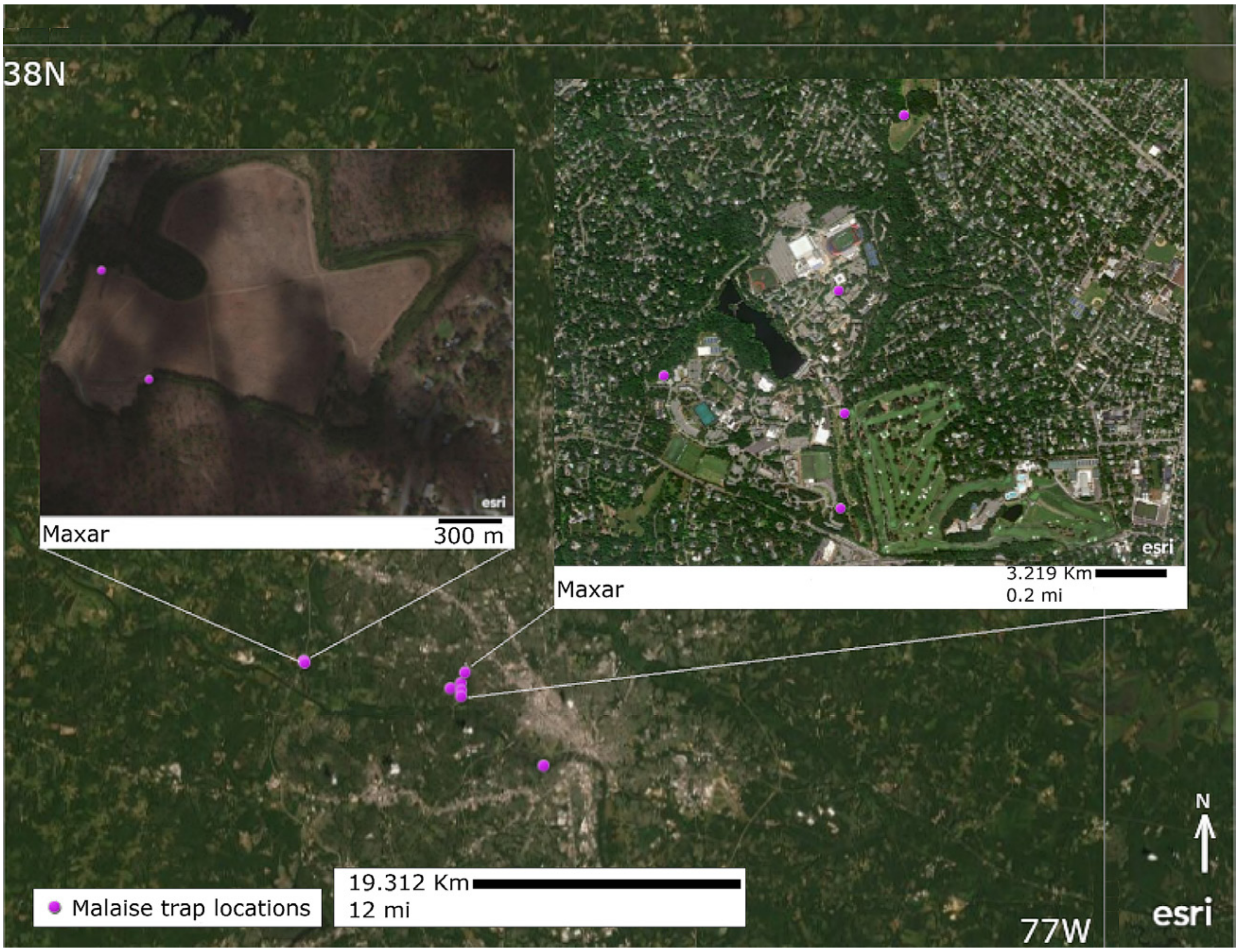

Figure 1. Map of the malaise trap placement throughout Richmond, Virginia, USA (Esri 2021b). Esri.Map data from Esri, Earthstar Geographics, and Maxar.

Traps were placed where floral resources had been seen in prior years. Each trap was serviced about every two weeks and refreshed with a new jar of 200 proof ethanol from 28 April to 5 August 2019 and the bees were removed from each sample for further analysis.

Each bee specimen was washed with dish soap and warm water, then dried with an electric blow dryer, pinned, labeled, and finally sexed before being sorted to morphospecies. Species identifications were provided by Sam Droege at the United States Geological Survey Bee Inventory and Monitoring Lab at the Patuxent Wildlife Research Center, Maryland, USA. Our collected specimens of *Hylaeus pictipes* were identified by comparing them with previously determined specimens of this species collected outside of Virginia. Species determination labels were affixed to each specimen. Select specimens of importance were chosen by Sam Droege, and legs of these specimens were provided to the United States Geological Survey for DNA barcoding. The 1542 bee vouchers (Table 1), and all Malaise trap bycatch was deposited

Table 1. Table of bees collected in survey and donated to the Virginia Museum of Natural History

Family	Subfamily	Tribe	Genus	Subgenus	Species	Authority	Count
Andrenidae	Andreninae	Andrenini	*Andrena*	*Ptilandrena*	*erigeniae*	Robertson, 1891	1
Andrenidae	Andreninae	Andrenini	*Andrena*	*Scrapteropsis*	*fenningeri*	Viereck, 1922	1
Andrenidae	Andreninae	Andrenini	*Andrena*	*Trachandrena*	*hippotes*	Robertson, 1895	1
Andrenidae	Andreninae	Andrenini	*Andrena*	*Scrapteropsis*	*imitarix/morrisonella*		4
Andrenidae	Andreninae	Andrenini	*Andrena*	*Leucandrena*	*macra*	Mitchell, 1951	1
Andrenidae	Andreninae	Andrenini	*Andrena*	*Micrandrena*	*personata*	Robertson, 1897	7
Andrenidae	Andreninae	Andrenini	*Andrena*	*Trachandrena*	sp.		1
Andrenidae	Andreninae	Andrenini	*Andrena*	*Trachandrena*	*spiraeana*	Robertson, 1895	2
Andrenidae	Panurginae	Calliopsini	*Calliopsis*	*Calliopsis*	*andreniformis*	Smith, 1853	3
Apidae	Apinae	Anthophorini	*Anthophora*	*Melea*	*abrupta*	Say, 1837	11
Apidae	Apinae	Apini	*Apis*		*mellifera*	Linnaeus, 1758	17
Apidae	Apinae	Bombini	*Bombus*	*Pyrobombus*	*bimaculatus*	Cresson, 1863	38
Apidae	Apinae	Bombini	*Bombus*	*Cullumanobombus*	*griseocollis*	(DeGeer, 1773)	5
Apidae	Apinae	Bombini	*Bombus*	*Pyrobombus*	*impatiens*	Cresson, 1863	53
Apidae	Nomadinae	Nomadini	*Nomada*		*bidente group*		1
Apidae	Xylocopinae		*Ceratina*	*Zadontomerus*	*calcarata*	Robertson, 1900	69
Apidae	Xylocopinae		*Ceratina*	*Zadontomerus*	*dupla*	Say, 1837	2
Apidae	Xylocopinae		*Ceratina*		sp.		1
Apidae	Xylocopinae		*Ceratina*	*Zadontomerus*	*strenua*	Smith, 1879	62
Apidae	Xylocopinae		*Xylocopa*	*Xylocopoides*	*virginica virginica*	(Linnaeus, 1771)	5
Colletidae	Colletinae		*Colletes*		*thoracicus*	Smith, 1853	4
Colletidae	Hylaeinae		*Hylaeus*	*Prosopis*	*affinis/modestus*		17
Colletidae	Hylaeinae		*Hylaeus*	*Hylaeus*	*leptocephalus*	(Morawitz, 1870)	1
Colletidae	Hylaeinae		*Hylaeus*	*Hylaeus*	*mesillae*	(Cockerell, 1896)	1
Colletidae	Hylaeinae		*Hylaeus*	*Prosopis*	*modestus*	Say, 1837	6
Colletidae	Hylaeinae		*Hylaeus*	*Paraprosopis*	*pictipes*	Nylander, 1852	5
Colletidae	Hylaeinae		*Hylaeus*	*Metziella*	*sparsus*	(Cresson, 1869)	1
Colletidae	Hylaeinae		*Hylaeus*		spp.		1
Halictidae	Halictinae	Augochlorini	*Augochlora*		*pura*	(Say, 1837)	117
Halictidae	Halictinae	Augochlorini	*Augochlorella*		*aurata*	(Smith, 1853)	72
Halictidae	Halictinae	Augochlorini	*Augochloropsis*		*metallica fulgida*	(Smith, 1853)	12
Halictidae	Halictinae	Halictini	*Agapostemon*	*Agapostemon*	*virescens*	(Fabricius, 1775)	1
Halictidae	Halictinae	Halictini	*Halictus*	*Seladonia*	*confusus*	Smith, 1853	1
Halictidae	Halictinae	Halictini	*Halictus*	*Odontalictus*	*ligatus/poeyi*		4
Halictidae	Halictinae	Halictini	*Halictus*	*Protohalictus*	*rubicundus*	(Christ, 1791)	1
Halictidae	Halictinae	Halictini	*Lasioglossum*	*Dialictus*	*admirandum*	(Sandhouse, 1924)	1
Halictidae	Halictinae	Halictini	*Lasioglossum*	*Dialictus*	*bruneri*	(Crawford, 1902)	38
Halictidae	Halictinae	Halictini	*Lasioglossum*	*Dialictus*	*callidum*	(Sandhouse, 1924)	26
Halictidae	Halictinae	Halictini	*Lasioglossum*	*Dialictus*	*coeruleum*	(Robertson, 1893)	8
Halictidae	Halictinae	Halictini	*Lasioglossum*	*Dialictus*	*coreopsis*	(Robertson, 1902)	1
Halictidae	Halictinae	Halictini	*Lasioglossum*	*Dialictus*	*cressonii*	(Robertson, 1890)	17
Halictidae	Halictinae	Halictini	*Lasioglossum*	*Dialictus*	*floridanum*	(Robertson, 1892)	1
Halictidae	Halictinae	Halictini	*Lasioglossum*	*Lasioglossum*	*fuscipenne*	(Smith, 1853)	4
Halictidae	Halictinae	Halictini	*Lasioglossum*	*Dialictus*	*gotham*	(Gibbs, 2011)	121
Halictidae	Halictinae	Halictini	*Lasioglossum*	*Dialictus*	*hitchensi*	Gibbs, 2012	87
Halictidae	Halictinae	Halictini	*Lasioglossum*	*Dialictus*	*illinoense*	(Robertson, 1892)	9
Halictidae	Halictinae	Halictini	*Lasioglossum*	*Dialictus*	*imitatum*	(Smith, 1853)	81
Halictidae	Halictinae	Halictini	*Lasioglossum*	*Dialictus*	*oblongum*	(Lovell, 1905)	1
Halictidae	Halictinae	Halictini	*Lasioglossum*	*Dialictus*	*obscurum*	(Robertson, 1892)	3

Family	Subfamily	Tribe	Genus	Subgenus	Species	Authority	Count
Halictidae	Halictinae	Halictini	*Lasioglossum*	*Dialictus*	*platyparium*	(Robertson, 1895)	10
Halictidae	Halictinae	Halictini	*Lasioglossum*	*Dialictus*	*smilacine*	(Robertson, 1897)	2
Halictidae	Halictinae	Halictini	*Lasioglossum*		spp.		138
Halictidae	Halictinae	Halictini	*Lasioglossum*	*Dialictus*	*tegulare*	(Robertson, 1890)	119
Halictidae	Halictinae	Halictini	*Lasioglossum*	*Dialictus*	*trigeminum*	Gibbs, 2011	1
Halictidae	Halictinae	Halictini	*Lasioglossum*	*Dialictus*	*weemsi*	(Mitchell, 1960)	181
Halictidae	Halictinae	Halictini	*Lasioglossum*	*Dialictus*	*zephyrum*	(Smith, 1853)	50
Halictidae	Halictinae	Halictini	*Sphecodes*		*aroniae*	Mitchell, 1960	1
Halictidae	Halictinae	Halictini	*Sphecodes*		nr. *coronus*		52
Megachilidae	Megachilinae	Anthidiini	*Anthidiellum*	*Loyolanthidium*	*notatum notatum*	(Latreille, 1809)	1
Megachilidae	Megachilinae	Anthidiini	*Anthidium*	*Anthidium*	*manicatum*	(Linnaeus, 1758)	2
Megachilidae	Megachilinae	Megachilini	*Coelioxys*	*Boreocoelioxys*	*sayi*	Robertson, 1897	1
Megachilidae	Megachilinae	Megachilini	*Coelioxys*	*Neocoelioxys*	*dolichos*	Fox, 1890	1
Megachilidae	Megachilinae	Megachilini	*Coelioxys*	*Boreocoelioxys*	*octodentatus*	Say, 1824	1
Megachilidae	Megachilinae	Megachilini	*Megachile*	*Chelostomoides*	*campanulae*	(Robertson, 1903)	4
Megachilidae	Megachilinae	Megachilini	*Megachile*	*Chelostomoides*	*exilis*	Cresson, 1872	1
Megachilidae	Megachilinae	Megachilini	*Megachile*	*Xanthosarus*	*gemula*	Cresson, 1878	1
Megachilidae	Megachilinae	Megachilini	*Megachile*	*Litomegachile*	*mendica*	Cresson, 1878	7
Megachilidae	Megachilinae	Osmiini	*Chelostoma*	*Prochelostoma*	*philadelphi*	(Robertson, 1891)	9
Megachilidae	Megachilinae	Osmiini	*Heriades*	*Neotrypetes*	*carinata*	Cresson, 1864	12
Megachilidae	Megachilinae	Osmiini	*Heriades*	*Neotrypetes*	*leavitti/variolosa*		2
Megachilidae	Megachilinae	Osmiini	*Hoplitis*	*Alcidamea*	*producta*	(Cresson, 1864)	1
Megachilidae	Megachilinae	Osmiini	*Hoplitis*	*Alcidamea*	*truncata*	(Cresson, 1878)	1
Megachilidae	Megachilinae	Osmiini	*Osmia*	*Melanosmia*	*atriventris*	Cresson, 1864	1
Megachilidae	Megachilinae	Osmiini	*Osmia*	*Helicosmia*	*georgica*	Cresson, 1878	1
Megachilidae	Megachilinae	Osmiini	*Osmia*	*Melanosmia*	*pumila*	Cresson, 1864	14
Megachilidae	Megachilinae	Osmiini	*Osmia*	*Diceratosmia*	*subfasciata*	Cresson, 1872	1
Megachilidae	Megachilinae	Osmiini	*Osmia*	*Osmia*	*taurus*	Smith, 1873	1

in the collection of the Department of Recent Invertebrates at the Virginia Museum of Natural History in Martinsville. A synoptic set of identified bees was also deposited in the Department of Biology at the University of Richmond, excluding species for which only one specimen was collected.

Range extension mapping was created using Arc GIS Online, using occurrence data from the Global Biodiversity Information Facility (GBIF.org 2021), graticules from Firefly Gridlines by Nelson (2018), and the Light Gray Canvas Map basemap from ESRI et al. (2021a).

Results

***Hylaeus* (*Paraprosopis*) *pictipes* Nylander, 1852**
Figure 2

New records. UNITED STATES OF AMERICA – **Virginia** • City of Richmond, University of Richmond, north of R45 Parking Lot; 37.5789°N, 077.5371°W; 53 m a.s.l.; 6–15.V.2019; R. Ostrom leg.; Malaise Trap; 1♀, VMNH 110621 • same locality; north of W86 Parking Lot; 37.5755°N, 077.5459°W; 54 m a.s.l.; same collector, collection method, and date range collected as above; 1♀, VMNH 110622 • same locality; east of U12 Parking Lot; 37.5740°N, 077.5368°W; 38 m a.s.l.; same collector and collection method; 15–27.V.2019; 1♀, VMNH 110623 • same locality; east of U27 Parking Lot; 37.5702°N, 077.5370°W; 40 m a.s.l.; same collector, collection method, and date range collected as above; 2♀, VMNH 110624, VMNH 110625.

Identification. Two species of *Hylaeus* Fabricius, 1793 in the subgenus *Paraprosopis* Popov 1939 are known in eastern North America other than *H. pictipes*: *H.* (*P.*) *floridanus* (Robertson, 1893) and *H.* (*P.*) *georgicus* (Cockerell, 1898) (Gibbs and Dathe 2017). Female *H.*

Figure 2. Face of female *Hylaeus* (*Paraprosopis*) *pictipes* head, showing the specimen's paraocular maculation. Note that the paraocular maculation does not extend all the way down the face to the mandibles. From VMNH110623 Face, by Hightower L, and Means J, 2021. Virginia Museum of Natural History, Martinsville, Virginia, United States of America.

(*P.*) *pictipes* are distinguished from *H.* (*P.*) *floridanus* by the following characteristics, compiled and published by Gibbs and Dathe (2017: 3): "paraocular maculation truncated below, not reaching to mandible; mesopleuron and mesoscutellum appearing smoother due to less microsculpture" (Fig. 2). Female *H.* (*P.*) *pictipes* can be distinguished from *H.* (*P.*) *georgicus* by the specimen's clypeus. The clypeus of *H.* (*P.*) *pictipes* is pitted, while that of *H.* (*P.*) *georgicus*' either lacks pits or only contains few obscure pits not visible from most angles (Andrus et al. 2020).

Discussion

Our collection of *Hylaeus pictipes* in Virginia is the furthest south that this species has been found on the east coast of the United States and represents a range extension of 822 km from its previous southern detection in Meadville, Pennsylvania (Choate et al. 2018; Fig. 3). The specimens DNA barcoded as *H. pictipes* from southern California may need additional verification (Gibbs and Dathe 2017), and thus they were not included in the distribution map (Fig. 3).

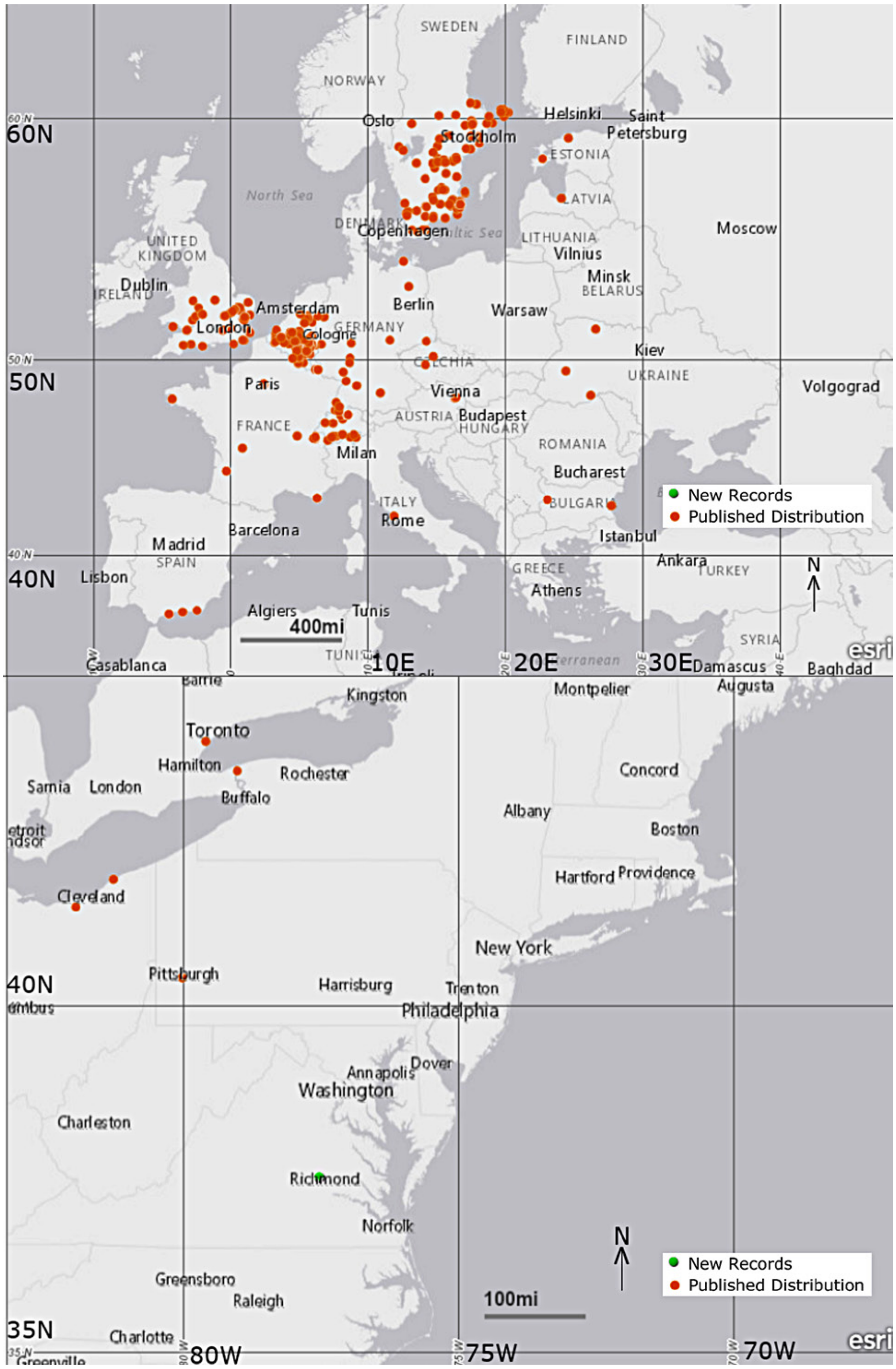

Figure 3. A map of the published records of *Hylaeus* (*Paraprosopis*) *pictipes*. Previous records in both North America and Europe indicated in green. New records in Richmond, Virginia indicated in purple. Map data from Esri, HERE, and NPS (Esri 2021a). Occurrence data from GBIF.org (2021).

Figure 4. Dorsal view of female *Hylaeus* (*Paraprosopis*) *pictipes* head, showing the specimen's facial fovea. Note that the facial fovea curves towards the lateral ocelli, a characteristic of the *Paraprosopis* subgenus. From VMNH110623 Facial Fovea, by Hightower L, and Means J, 2021. Virginia Museum of Natural History, Martinsville, Virginia, United States of America.

Our discovery of a new state species record suggests that additional survey work is needed in other urban areas of Virginia. A new state record, represented by five specimens of *H.* (*P.*) *pictipes* are reported here. This indicates the species is possibly established on the University of Richmond campus and may be found elsewhere in the Richmond area. Further studies will need to be completed in order to find where this species is established, determine the impact of this non-native species on the local ecosystem, and verify what resources it is using. European literature suggests that the species visits a variety of flowers, but particularly those of umbellifers and mignonettes, and nests in pithy stems like roses or hollowed out twigs (Falk 2015). Literature further suggests the most likely negative impact of this species becoming established may be the increased pollination of non-native plants, or the increased chance of disease spread to native species (Russo 2016).

Knowing what species live in our cities is a crucial step towards creating informed conservation policies for native biodiversity. Urban environments continue to be under-sampled, despite recent studies that highlight the biodiversity of developed areas. Evidence of new species records from urban areas justify increases in biodiversity survey efforts, can encourage institutions and individuals to increase native plant diversity in hopes to attract rare or threatened bees, and are vital to the compilation of holistic state bee species checklists.

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Authors' Contributions

Conceptualization: RBJO, KLG. Data curation: RBJO. Funding acquisition: RBJO, KLG. Investigation: RBJO. Methodology: RBJO, KLG. Project administration: KLG. Resources: KLG. Supervision: KLG. Validation: RBJO. Writing – original draft: RBJO. Writing – review and editing: KLG.

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