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## **Revision of the Genus Monatractides (Parasitengona, Torrenticolidae) of the United States and Canada: New Species, Re-descriptions, Phylogenetics, and a Key to Species**

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Revision of the Genus *Monatractides*  
(Parasitengona, Torrenticolidae) of the United States and Canada:  
New Species, Re-descriptions, Phylogenetics, and a Key to Species

A dissertation submitted in partial fulfillment  
of the requirements for the degree of  
Doctor of Philosophy in Entomology

by

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## **Abstract**

The full suite of known *Monatractides* (Parasitengona, Torrenticolidae) taxa of North America (north of Mexico) are investigated herein using integrative methods. Species hypotheses are supported with morphology, geography, and phylogenetic analysis of the barcoding region of COI for 154 individuals from over 100 localities. Relationships between species are examined with a combined analysis of COI and 28S rDNA for 55 specimens. Previously described species are examined and re-described with color images and updated information, where possible. Our results indicate the need to synonymize two species: *M. californica* (Marshall, 1943) is a junior synonym of *M. geographica* (Marshall, 1943). We describe 21 new species and re-describe all previously described species. Overall, diversity of *Monatractides* in the United States and Canada is represented by 27 species, 14 from the east and 13 from the west. These species have been organized into 4 species groups that include 3 smaller groups, separated by morphology for convenience of identification. A key is provided to all described species in the US and Canada.

DISCLAIMER: Pursuant to Article 8.3 of the Fourth Edition of the International Code of Zoological Nomenclature, any names of nomenclatural acts in this work are disclaimed for nomenclatural purposes.

## **Acknowledgements**

Many people have contributed to this dissertation. First, I would like to thank my advisor, Ashley Dowling, for allowing me in his lab to work on these neat little creatures. I would like to thank the other members of my committee, Andy Alverson, Tim Kring, Dan Magoulick and Fred Stephen for their help with questions and reading the dissertation; Ian Smith for allowing the utilization of the extensive collection at the CNC; Danielle Fisher for the invaluable and tireless lab help; and to the invaluable friends I've made in graduate school who supported me along this journey.

Thank you to my dog, Pertussis; you kept me sane during my Masters and we both got fat together during my Ph.D. You're a solid pup in all the ways.

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Lastly, to my family, thank you; I couldn't have asked for a better support system, despite us being widespread during my degree. Dad and Emily, I hope that naming an arachnid after each of you will be some small thanks for the mental fortitude you have offered me. Poppy and Sawyer; never fear, I spared you the embarrassment, as requested.

To all, my heartfelt thanks.

**Dedication**

For Al Steinman, Emily Nelson, Tussy, and John Gilbert.

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## **I Introduction**

There are a large number of physically small, yet incredibly numerous groups of organisms in the world that can vie for the title of “most understudied”: bacteria, algae, nematodes, fungi, and the focus of this work, mites. Despite limited study, mites are known to be one of the most successful groups of invertebrates in the world. Suspected to be at least as specious as insects (if not more so) (Larson et al. 2017), mites already consist of almost 5% of all described species (Wilson & Peter 1988; Halliday et al. 2000; Larson et al. 2017). Mites are found in a diverse range of habitats, including deep soils (Walter & Proctor 1999; Ducarme et al. 2004), vertebrate and invertebrate hosts (Martin 2004; Mullen & OConnor 2002; Larsen et al. 2017), coral reefs (Otto 1999), deep sea trenches (Bartsch 1994), the polar regions (Hawes et al. 2007), and freshwater (Cook 1967, 1986; Prasad & Cook 1972; Di Sabatino et al. 2000).

Like much of Chelicerata, the majority of mites are predacious, but they are unique in the group by their exploitation of many unique food sources, including plants (Karban et al. 1995), fungi (Mitchell & Parkinson 1976; Hallas 1991), bacteria (Kranz & Walter 2009), and scavenging on decaying plant and animal matter (Walter & Proctor 1999; Franklin et al. 2004). In addition to performing ecologically important services like nutrient cycling and decomposition (Kranz & Walter 2009), mites are also economically important as both agricultural pests (Walter & Proctor 2013) and biocontrol agents (Gerson and Smiley 1990), as well as important vectors of human and animal diseases (Water & Proctor 2013, Kranz & Walter 2009).

Currently, around 50 thousand mite species are described (Halliday et al. 2000); yet, estimates of true mite diversity range from 1 million (Ruppert et al. 2004) to 40.8 million (Larson et al. 2017). Despite their diversity and abundance, mites remain relatively poorly

known and largely overlooked by science and the public alike. One reason for this is likely related to the perceived difficulty of the group; a problem that is compounded by an underdeveloped and often confusing taxonomic scheme for these invertebrates. Keys for these groups are not readily accessible or available to a non-specialist, and regional species diversity is poorly known. Information, when available, is often outdated. Additionally, the phylogenetic hypotheses that exist have been tested for only a few groups and may lack some desired rigor.

There are two major radiations of mites – Acariformes and Parasitiformes.

Parasitiformes' most famous members are the ticks, but this group also includes other parasitic mites. *Varroa destructor*, for example, attack honeybees, while mites from the superfamily Dermanyssoidea parasitize all number of vertebrates. This group also contains phytoseiids, which are often utilized as biocontrol agents (McMurty and Croft 1997).

The second radiation, Acariformes, is a larger and more diverse radiation. It's split into two broad groups: Sarcoptiformes and Trombidiformes. Sarcoptiformes consists of the order Orbatida, and the unranked astigmata mites. The astigmatan group specializes in novel exploitation of spatially or temporally restricted habitats, often involving associations with other organisms (OConnor 1982). Some of the better known examples of astigmatans are mites which utilize birds as hosts, different genera of which live on the surface of the skin, on the feather quills, burrow into the skin (e.g. scaly leg or scaly face mites), live in nasal and respiratory tracts, and also can be present as intramuscular parasites (Proctor and Owens 2000). Orbatida is a morphologically diverse group, primarily associated with decomposition and fungivory, However, unlike the other major lineages of mites, are highly conserved biologically, with limited divergence from ancestral traits (Norton 1994). Trombidiformes is also split into two groups: Sphaerolichida and Trombidiformes. Sphaerolichids consists of two recognized

families, Sphaerolichidae and Lordalychidae, and are thought to be ambush predators or fungivores, respectively (Proctor 1998). Prostigmata is the largest, arguably most diverse, of the Acariforms.

Within Prostigmata is the largest radiation of all mites, the Parasitengona, consisting of over 11,000 described species of velvet mites, chiggers, and their aquatic relatives, the aptly named water mites (Zhang et al. 2011). All parasitengone mites are characterized by having a uniquely modified life cycle, almost analogous to holometabolism in insects, where active stages alternate with inactive stages, and larvae and adults utilize different food resources (Belozero 2008, Proctor 1998). Prostigmatid mite larvae are most often ectoparasites, while nymphs and adults are predacious. This life cycle modification is thought to have made synchronizing parasite presence to host availability (e.g. at times of host emergence, in the case of water mites) more feasible, as well as possibly increase dispersal ability (Wholtmann 2001).

While parasitengones have been successful in the terrestrial sphere, within the aquatic realm they have been equally so. In freshwater systems, water mites (Hydrachnidiae) are cosmopolitan and diverse. Currently, water mites represent more than 6,000 described species, representing over 400 different genera, with current estimates of actual species diversity easily over 10,000 worldwide (Di Sabatino et al. 2008; Smith et al. 2010).

As predators and ectoparasites, water mites prey on a wide range of arthropods, including flies, beetles, and copepods (Smith et al., 2010). Parasitization by water mites can reduce overall host fecundity, egg production, mating success, individual size, flight length, and more (Smith et al, 2010, Martin et al., 2010, Nagel et al., 2009).



Preliminary studies suggest that water mites serve as sensitive indicators of habitat and water quality and are highly correlated with levels of organic pollutants in the environment (Cicolani & Di Sabatino, 1991, Smit & van der Hammen 1992, Smith et al., 2010). Aquatic mites have also been found to be sensitive to other types of pollution; Wagnerner and LaPerriere (1985) found that they were the most affected groups of organisms in streams affected by mining for precious metals. There have also been some laboratory toxicological studies on mites, largely examining their sensitivity to iron and pH levels (Rousch et al. 2009); a synthetic pyrethroid (Anderson 1989); heavy metals (Skubala and Zaleski 2012); and arsenic oxide (Kamshilov and Flerov 1976). In each of the aforementioned cases the mite concerned was found to be sensitive to the pollutant and was often one of the more sensitive organisms tested. For this reason, mites represent lots of promise as bioindicators, as the number of individual mites, or the number of taxa collected, would probably be useful indicators when comparing impacted vs. unimpacted sites.

Despite their potential usefulness, water mites, like their terrestrial counterparts, are often overlooked in broader freshwater research and understudied by non-acarologists. This is, again, likely related to a lack of understanding of water mite diversity. The reason they have not been used as biomonitors are trifold. First, they are perceived to not be as abundant as other insect groups, although there have been mites recorded in high densities in both lakes and rivers (Walter and Proctor 1999). Secondly, there is the colloquial belief that there are relatively few studies showing their sensitivity to different types of pollution – although the number of studies mentioned earlier dismiss this claim, the number of studies on mites compared to their insect counterparts is low. Lastly, and most importantly, water mites are perceived as being difficult to identify. Not only do mites need to be slide mounted for species-level identifications, it has been

estimated that over half of the estimated 1,500 species in North America are incorrectly or undescribed, and currently there exist no comprehensive diagnostic tools for use by non-specialists (Smith et al. 2010).

One of the largest groups of fresh water mites in North America is *Torrenticolidae* Piersig, 1902. While widely considered both the most cosmopolitan and diverse, the majority of species remain undescribed, although torrenticolids may be the most abundant arthropods in many small, fast flowing North American streams (Smith et al. 2010, Proctor et al. 2015). Worldwide, *Torrenticolidae* is split into two subfamilies (Wiles 1997); *Testudacarinae* Cook, 1974 and *Torrenticolinae* Piersig, 1902. *Testudacarinae* is comprised of two genera – *Debsacarus* Habeeb, 1961 and *Testudacarus* Walter, 1928; for a detailed and edifying discussion of these genera, see O'Neill et al. 2016. *Torrenticolinae* is comprised of five genera: *Pseudotorrenticola* Walter, 1906; *Neotractides* Lundblad, 1941; *Stygotorrenticola* Pesic & Gerecke, 2014; *Torrenticola* Piersig, 1896; and the focus of this research, *Monatractides* Viets, 1926. For a detailed discussion of the taxonomic history of *Torrenticolidae*, see Fisher et al. 2015.

*Monatractides* contains roughly 160 described species worldwide, and the North American taxonomy is described herein. Like the majority of the genera found in *Torrenticolidae*, species of *Monatractides* are recorded from all continents except Antarctica (Smit et al. 2010). It has been suggested that *Monatractides* may be considered the ancient clade from which other torrenticolid genera evolved, following the break-up of Pangea (Wiles 1997; Pesic and Smit 2011). However, after their original description by Viets in 1926, monatractid mites were demoted to a subgenus under *Torrenticola*, before being restored to generic rank by Wiles in 1997.

Currently, there are 13 described Nearctic species of *Monatractides*, four of which were described by Cook (1980) from Mexico. This leaves 9 species known from North America north of Mexico, all but one of which was described via the efforts of Ruth Marshall (1930, 1933, 1943); six of which are described from California, and are largely the result of specimens collected from single locales. Though thought to be relatively widespread, the descriptions of *Monatractides* in North America have been limited to 5 papers, most of them describing multiple mites, with the last monatractid mite description published in 1955. It is currently thought that this genus is most speciose in Oriental and Afrotropical regions (Di Sabatino et al., 2008), but the Nearctic region remains under-described. Previous to this work, monatractids had only been described from four locations in North America (north of Mexico); California, Wyoming, Wisconsin, and New Jersey. This lack of geographic coverage has made inquiry into the genus problematic.

Additionally, like many of the other species descriptions for torrenticolid genera, *Monatractides* species descriptions leave much to be desired, with some species described without drawings, and measurements proving un-descriptive, misleading, and often based on a single specimen. Multiple species have been described on the basis of a single male. This is particularly distressing, as there are often differences in morphology and size between male and female *Monatractides*, leaving these single-specimen descriptions markedly lacking. The second problem was shared by all torrenticolid taxonomy, which was that species hypotheses had largely been driven by morphological similarities, which leaves species boundaries untested (Fisher et al. 2015). As more species are collected, it is important to have readily-accessible (and understandable) descriptions and identification guides available for these beasts, if they are to be elevated to broader scientific research.

This study is the fifth in a series of descriptions of North American Torrenticolidae (Fisher et al. 2015; Cherri et al. 2016; O' Neill et al 2016, Fisher et al. 2017). The goal of this ongoing taxonomic project is to explore the family and make these mites amenable to other researchers. It is clear that most of the biological diversity on earth is, and will likely remain, undocumented (Wilson 2003). Thus, one of the additional goals of this project is, in the light of the taxonomic impediment, to facilitate the species-discovery process by the use of integrative taxonomy.

An attempt has been made to streamline the descriptions contained herein to include information that can be best used to diagnose a given species. We are following the foundational footsteps of Fisher et al. 2017 and provide micrographs in place of line drawings. Additionally, the ejaculatory complex and legs have been omitted from the depictions and descriptions contained herein, as these structures were not useful in diagnosing similar species.

Herein, we discuss 27 species of *Monatractides* Viets, 1926 (Parasitengona: Torrenticolidae) from North America, north of Mexico, 21 of which are newly described. Species hypotheses are supported with morphology, geography, and phylogenetic analysis of the barcoding region of COI for 154 individuals from over 100 localities. Relationships between species are examined with a combined analysis of COI and 28S rDNA for 55 specimens. Additionally, previously described species are examined and re-described with color images and updated information. Our results indicate the need to synonymize two species: *M. californica* (Marshall, 1943) is a junior synonym of *M. geographica* (Marshall, 1943). We describe 21 new species and re-describe all previously described species.

## II Materials and Methods

**Species Delimitation.** Similar to Fisher et al. (2017) and colleagues (Fisher et al. 2015, Cherrie et al. 2016, O'Neill et al. 2016), a combination of morphological, molecular, and biogeographic characters were used in an integrative approach to species delimitation. De Queiroz (1999, 2005, 2007) suggests, in the unified species concept, that any single line of evidence can be used to hypothesize a species. Integrative taxonomy strengthens species hypotheses by utilizing multiple lines of evidence. Initial morphological hypotheses were created during the sorting stage under a stereoscope by sorting individuals into recognizable groups (i.e. morphotypes). These morphological hypotheses were then tested with a molecular phylogenetic analysis. The results of the phylogenetic analyses were compared to the morphological hypotheses, which served to identify the species groups requiring further phylogenetic and morphological examination. Thus, distinctive morphotypes recovered as monophyletic and with low genetic variability (e.g. less than 1% divergence in COI) were considered well supported species, and additional specimens were not added unless identified outside of the known geographic range. Alternatively, if morphotypes were recovered as non-monophyletic, and/or spanned multiple clades in the COI analysis, additional specimens were included to drive the generation of a new species hypothesis, or add weight to the test of the current species hypotheses. In all instances, biogeography was considered, and attempts were made to include additional samples to recovered lineages with both interesting and widespread distributions.

**Sampling and Specimen Curation.** A large part of the material utilized in this study was housed at the Canadian National Collection of Insects, Arachnids, and Nematodes (CNC) in Ottawa, Canada, with access generously provided by Ian Smith. The CNC houses samples from

over 12,000 water mite collection events from across North America and spans the last century. Additionally, the CNC holds each described North American *Monatractides* type. All available *Monatractides* collections and types were loaned from the CNC and consulted in this study. More than a thousand collection events and tens of thousands of monatractids were examined in this study. The majority of the CNC collection is stored in GAW, so additional collections were taken by the Dowling Lab at the University of Arkansas and stored in ethanol (95%) in order to provide more specimens for molecular analysis. Collecting expeditions to Missouri, Pennsylvania, Alaska, the Rocky Mountain Region, and spanning the Pacific Northwest were taken by the Dowling Lab. The coverage for these combined collections is illustrated in Fig 1.



**Figure 1.** Map of Collection Sites utilized in this study: Canadian National Collection and University of Arkansas Dowling Lab collection sites across North America. Each dot represents a locality and not a specific sample; often multiple samples are taken within a small, localized area, and these multiple samples are represented with a single dot.

Mites utilized in this study were collected using the protocol explained in Fisher et al. (2015); a procedure which is the result of years spent collecting water mites and is detailed in Smith et al. (2010, p. 516-518) and previous water mite studies. Briefly, sampling consists of digging a trench typically 1-2m upstream of a 250 $\mu$ m-mesh collection net. The sediment is disturbed several feet below the surface of the substrate, until the majority of the organic debris in the sampling area has been disturbed. The resulting net “catch” is transferred to a container, which is then filled with water and swirled so that mites and organic debris are suspended in the water column and any sediment remains at the bottom. The top solution is poured through a set of stacked sieves (2mm and 250 $\mu$ m). The addition of water, swirling, and pouring is repeated until all the organic matter has been decanted into the stacked sieves. The coarse sample is then discarded and the fine sample is placed in site-specific container with added water. The container is kept in a cool and dark place until samples can be processed, as mites must be kept alive for processing.

Processing samples is done by consolidating the collected material into a clump by pouring the sample container through a 250 $\mu$ m sieve or net and placing the resulting material into a shallow, water-filled white tray. Most water mites move away from the debris clump and accumulate in the corners of the tray, where they can be collected and transferred to a collection jar. As noted in Fisher et al. (2015), it can take some time for mites to move away from the debris and should be allowed to sit for 8-12 hours with periodic collection of mites from the trays. It should also be stressed that some species of water mites do not readily escape the debris, and the sample clump should also be examined to sample these species. After mites from a sample have been collected, the excess water should be decanted from the collection jar before preservative is added.

Water mite collections were preserved in ethanol or GAW (50% glycerol, 10% glacial acetic acid, and 40% water). Intact specimens were examined under a microscope and representatives of potential morphotypes from across North America were identified. Individuals from each morphotype were dissected and mounted in glycerin jelly or Hoyer's medium. Glycerin jelly mounts were done following protocol from Fisher et al. (2015). Once dissected, slide specimens were examined for additional morphological characters under higher magnification. For molecular analysis, representatives of each morphotype preserved in ethanol underwent DNA extraction. Because DNA extraction is non-destructive for these genera of water mites, extracted morphotypes were slide mounted following extraction. The majority of these mounts were in glycerin jelly, while others were mounted in Hoyer's to better observe fine details under high magnification. Because body coloration can be important in identifying some *Monatractides*, holotypes and allotypes were designated using glycerin jelly slide mounts whenever possible. Species hypotheses were created and additional specimens of each species (when available) were mounted in glycerin jelly and Hoyer's for additional measurements and further morphological study.

**Terminology.** Morphological terminology follows Fisher et al. (2015), which is modified from Proctor et al. (2015), Smith et al. (2010) and Goldshmidt (2007), with the addition of the novel term “anterior venter,” used to describe the distance between the gnathosomal bay to the genital field, introduced by Fisher et al. (2017).

Convention dictates the use of Roman numerals for legs and leg parts (e.g. leg-II, instead of leg-2). The use of the shorthand “palp” is avoided and is instead referred to as “pedipalp” because it is more broadly applicable. To avoid confusion, pedipalp and leg podomeres will be written out: coxa, trochanter, etc.



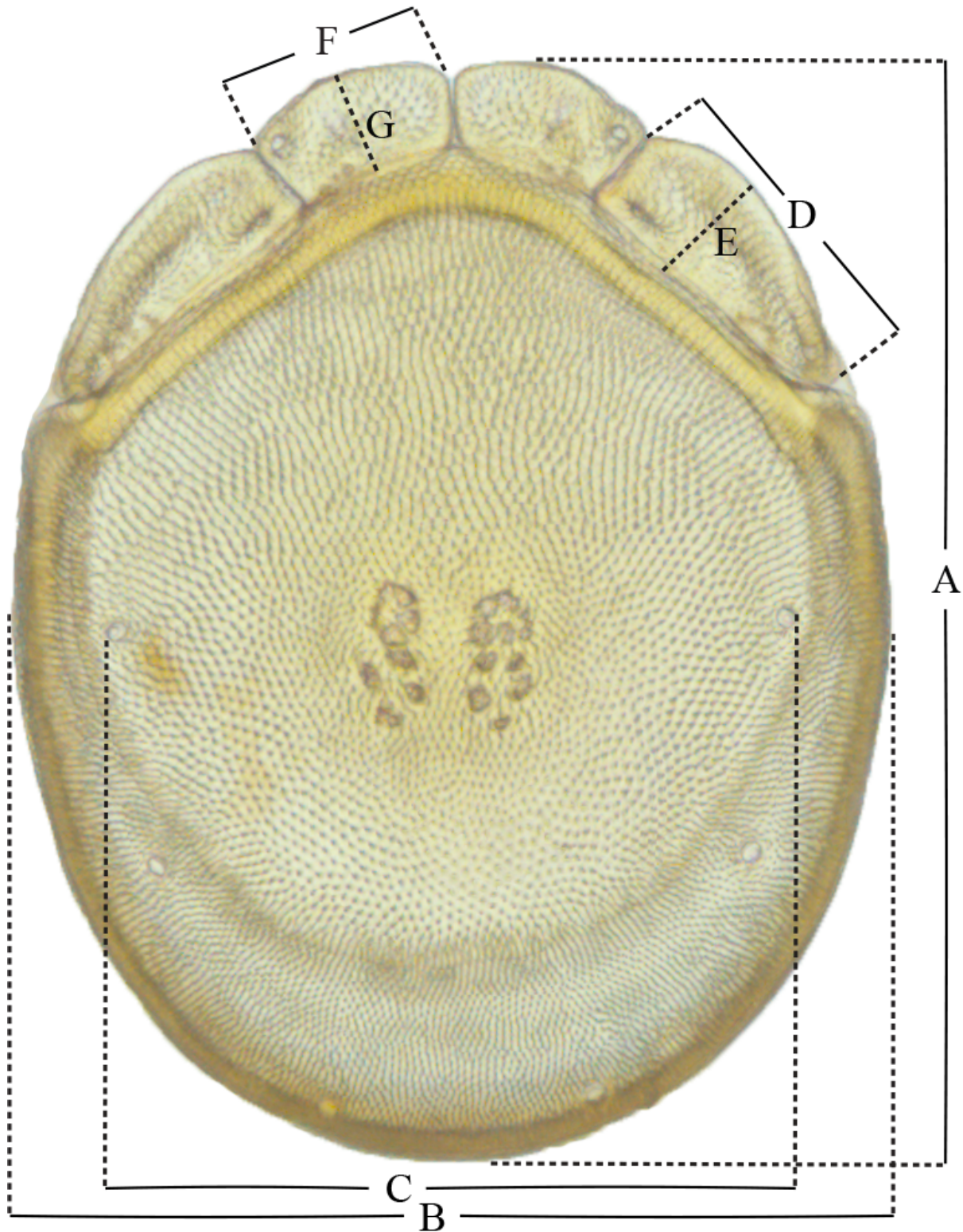
Chaetotaxy of post-larval torrenticolids presents several difficulties, and has been little used by past taxonomists in their descriptions. Pedipalpal setae are generally conserved in torrenticolids and there tends to be very little variance within a species (Fisher et al. 2015). Thus, pedipalpal chaetotaxy is described when of taxonomic interest. Leg setae can vary considerably within a species; thus, leg chaetotaxy is not examined in this study, barring very few appropriate instances where it is noted in a general fashion.

The cuticle of water mites, when unpigmented, has a yellowish, golden, or light orange cast. Thus, we follow O'Neill et al. (2016) when referring to a lack of pigmentation in the cuticle as “colorless.” Colorful species have dorsal coloration ranging from bluish to orangish, with a medial stripe or spots ranging from bluish to reddish or orangeish, with terminology used to describe these shades following Fisher et al. (2017).

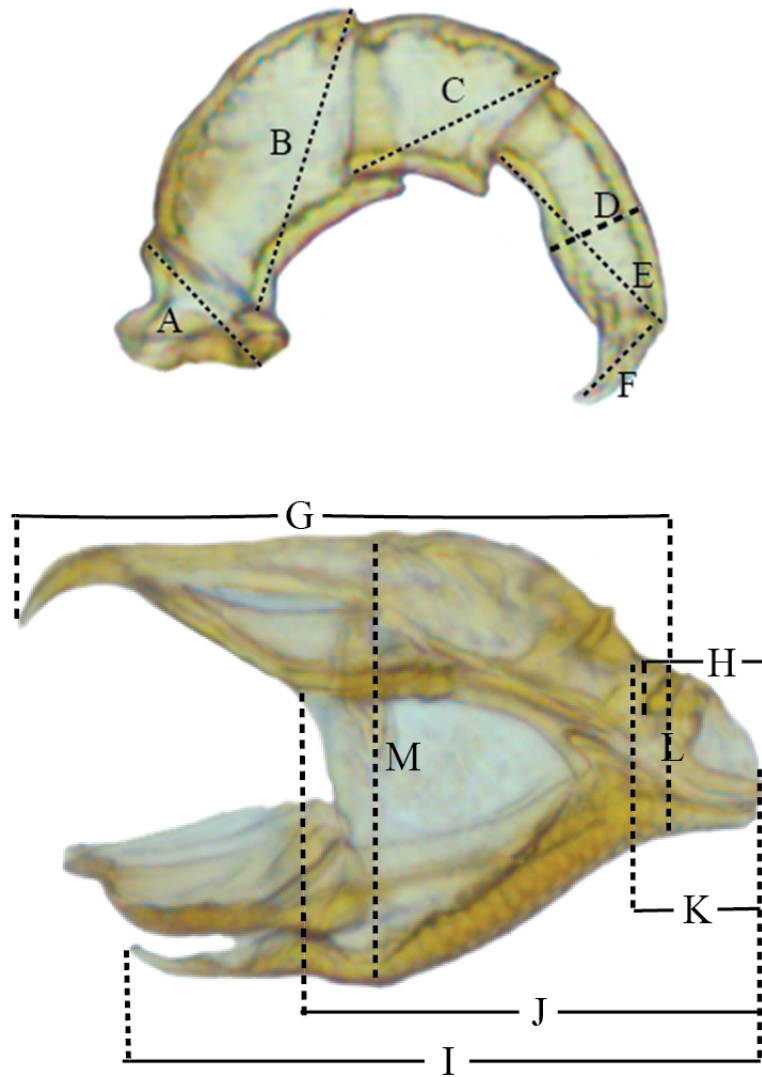
Geographic coverage for this study was limited to North America, north of Mexico; thus, this region is referred to as “North America” (Fig. 1).

**Measurements (Fig. 2-4).** Measurements follow Fisher et al. (2017), with identical measurements excluded and included. For each species, when available, a minimum of five individuals of each sex were measured. Efforts were made to include variability seen in individuals within species across the geographic range.

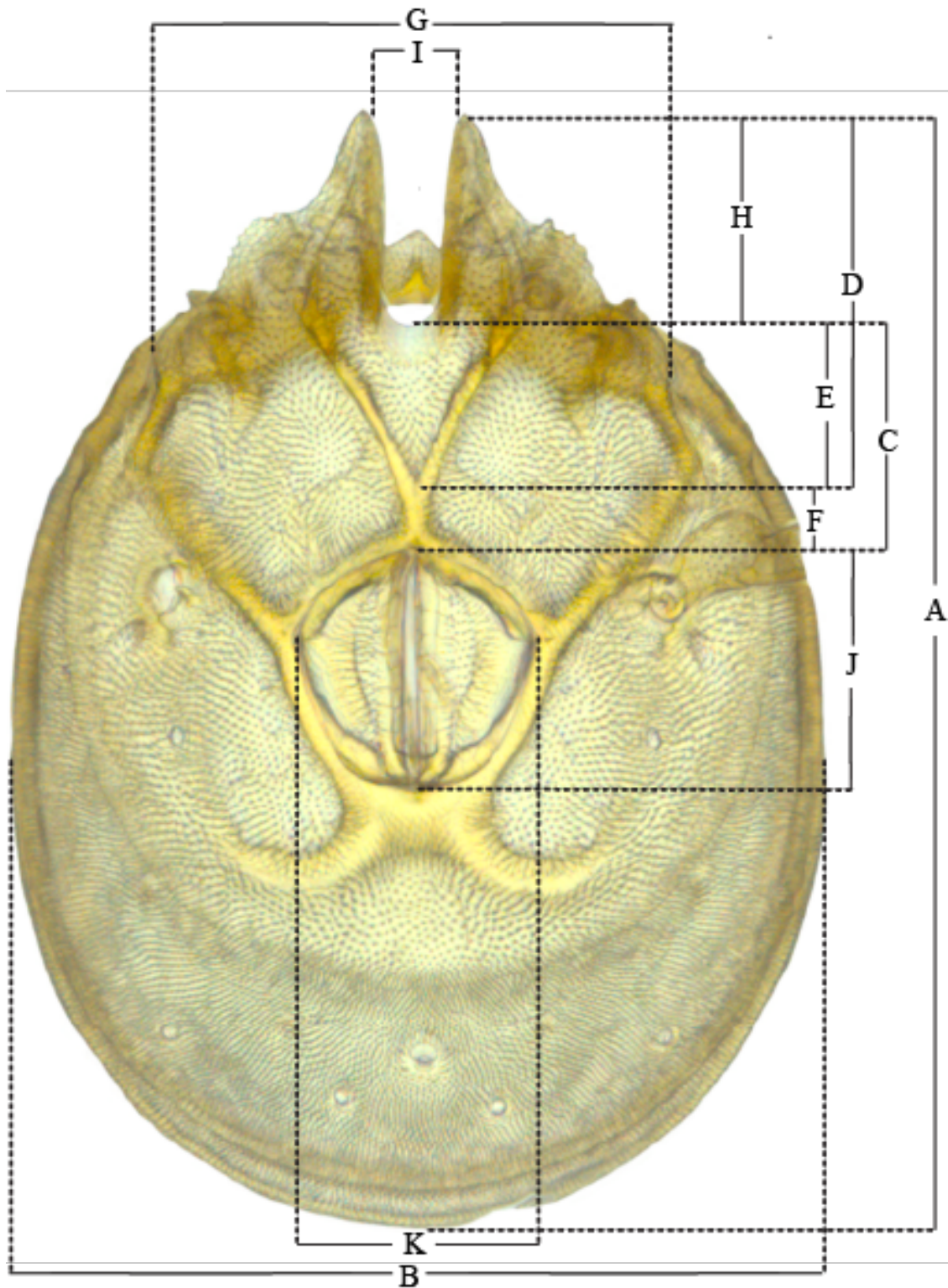
Whenever possible, measurements were taken with an objective micrometer on a Leica DM 2500 compound microscope. However, for some previously described holotype and allotype slide mounts, measurements were taken from high-quality, stacked images, as described in Fisher et al. (2015).



**Figure 2.** Dorsal measurements: **A** dorsal length **B** dorsal width **C** distance between dorsal glandularia, Dgl-4 **D** antero-lateral platelet length **E** antero-lateral platelet width **F** antero-medial platelet length **G** antero-medial platelet width.



**Figure 3.** Gnathosomal measurements: Gnathosomal measurements. Palpomeres – **A** trochanter length **B** femur length **C** genu length **D** tibia length **E** tibia width **F** tarsus length. Chelicerae – **G** cheliceral base length **H** fang length. Subcapitulum – **I** ventral length **J** dorsal length **K** rostrum length **L** rostrum width **M** height.



**Figure 4.** Venter measurements: **A** ventral length **B** ventral width **C** anterior venter **D** coxa-I total length **E** coxa-I medial length **F** medial suture length **G** coxa-III width **H** gnathosomal bay length **I** gnathosomal bay width **J** genital field length **K** genital field width.



**Images.** Color micrographs of slide mounts were taken with a Leica DFC 300x camera using Leica Application Suite software or taken with an iPhone camera mounted to the microscope; all images were then stacked using Helicon Focus 6. The resulting image stacks were edited in Adobe Photoshop CS6 as described in Fisher et al. (2017). Legs were removed from the venter and the majority of setae were removed from the pedipalp, as these structures were neither useful for identification nor accurately depicted in photographs. It must be noted that color micrographs may be a composite of multiple specimens in order to achieve the best representation of specific characters (venter, dorsum, pedipalp, and subcapitulum).

In some cases, specimens preserved in glycerin jelly were not available, and only specimens mounted in Hoyer's solution were available. While Hoyer's solution is the preferred media for mounting terrestrial mites (and other small sclerotized arachnids), due to its superior optical properties, the medium leads to rapid loss of pigmentation (the bright purples, oranges, and blues seen in monatractids), though structural color (often appearing orange or yellow, as mentioned earlier) is retained. For additional discussion of the use of mounting media use in adult water mites, see Fisher et al. (2015). When possible, micrographs were taken of these slides and coloration was added in Photoshop; in instances where very few specimens were collected and no record exists of coloration before images were taken, it is noted in the text.

**Morphological and Distributional Examinations.** Samples from a majority of sites (east, southwest, and Rocky Mountains) were sorted to male and female representative morphotypes per sample locality (when possible) and appropriate representatives were chosen for extraction. Thus, clades containing members from across geographic ranges were created, regardless of the initial morphotype hypotheses. In samples with a high abundance of specimens (i.e. many collections from the Pacific Northwest), samples were scanned for morphotypes rather

than sorting the entire sample. While this effort was presumed to be sufficient to find most species, as Fisher et al. (2017) notes, it does increase the likelihood of missing species present in low abundances, and it would be remiss to not mention this.

The barcoding region of COI was used as an independent test of the species hypotheses created using morphology. The resulting tree was used as a guide to increase molecular sampling in certain geographic regions, or with certain morphotypes. Thus, COI was used to determine if distinct genetic lineages could be determined using morphological characters, conservative or ambiguous, and thus indicate species boundaries. COI was used similarly to test distributional hypotheses, although ethanol collections were limited from Mexico, northern Canada, and the eastern United States, so the full ranges of species may not be represented in the genetic data. However, the majority of species are represented by specimens collected across their presumed geographic distributions and morphological variation.

The D2-3 region of 28S rDNA was analyzed in combination COI to resolve relationships between species. This analysis included representatives of all but one species group. Sequences were deposited in GenBank and accession numbers are located in Table 1. Following recommendations by Chakrabarty et al. (2013), GenSeq nomenclature is used.

Qiagen DNeasy Tissue Kits (Qiagen Inc., Valencia, California) were used for genomic DNA extraction. Target regions of COI (~620 bp) and 28S (~800 bp) were amplified with LOC1490 and HCO2198 (Folmer et al. 1994) and D6R and D23F (Park and Ó Foighill 2000), respectively, and purified with Qiagen QIAquick PCR Purification Kits. PCR product was tested using test gels (1.5% agarose), and purified PCR product was sequenced by MacroGen USA (Rockville, Maryland). DNASTAR© Lasergene SeqMan (Madison, Wisconsin) was used to

reconcile forward and reverse sequences, and the resulting contigs were checked for contamination with GenBank BLAST searches.

Clustal X (Thompson et al. 1997) was used to align COI sequences and 28S sequences were aligned with MAFFT Version 7 (Kato and Standley 2013). All alignments were edited conservatively using BioEdit (Hall 1999). Molecular analyses were performed with the Extreme Science and Engineering Discovery Environment infrastructure through the Cipres Portal (Miller et al. 2010). MrBayes (3.2.2) was used to perform Bayesian analyses over 5 million generations and resulting majority-rule trees were viewed in Dendroscope 3 (v. 3.5.7) (Huson and Scornavacca 2012); tree image files were exported and edited in Adobe Photoshop CS6 to create final images.

**Type Designation.** I have followed the rationale of Fisher et al. (2017) in designating primarily female holotypes, with the argument that females of the North American Torrenticolidae tend to be more distinctive morphologically than their male counterparts. I found this to be true for North American *Monatractides*, and have thus identified female holotypes, when possible. The exception here is with *M. montgomeryae*, for which only a male was found. Wherever possible, allotypes that best represent the proposed species hypotheses were selected from the identified paratypes. Allotypes (a paratypic member of the opposite sex as the holotype) have been chosen via connection to the holotype by sampling location, genetic variation, and character consistency, and are considered to be the best representatives of the paratypic species.

Whenever possible, the entire type series is represented in our phylogenetic analysis. However, in some instances, GAW-preserved material was used for representatives when phylogenetic specimens were preserved in Hoyer's medium, which destroys coloration. While these individuals lack molecular data, specimens were preferred if from the same sample or

region, especially from collections that lacked similar species, and individuals were selected which adhere to the species hypothesis with a high confidence.

**Material Deposition of Nearctic Types.** Material examined for previously described species and those described in this study (holotypes, allotypes, paratypes, and most other examined material) were deposited in the CNC. For all species, when additional specimens were available, representative paratypes and other examined material were also deposited in the Acari Collection at the University of Arkansas.



Table 1. Genbank accession numbers and GenSeq nomenclature for all specimens examined.

Species	Genbank Accession #		DNA #, Specimen Catalog #	GenSeq Nomenclature
	COI	28S		
<i>M. axfordii</i>			DNA1750 ACUA 140808 (non-type voucher)	Genseq-4 COI
<i>M. axfordii</i>			DNA1752 ACUA 140810 (non-type voucher)	Genseq-4 COI
<i>M. axfordii</i>			DNA2421 ACUA 156723 (non-type voucher)	Genseq-4 COI
<i>M. axfordii</i>			DNA2426 ACUA 151481 (holotype)	Genseq-4 COI
<i>M. axfordii</i>			DNA2428 ACUA 151482 (allotype)	Genseq-4 COI
<i>M. banderae</i>			DNA3099 ACUA 151831 (allotype)	Genseq-4 COI, 28S
<i>M. banderae</i>			DNA3097 ACUA 151833 (holotype)	Genseq-4 COI
<i>M. banderae</i>			DNA3098 ACUA 151832 (non-type voucher)	Genseq-4 COI, 28S
<i>M. brewsteri</i>			DNA1559 ACUA 140738 (allotype)	Genseq-4 COI, 28S
<i>M. brewsteri</i>			DNA1560 ACUA 140739 (non-type voucher)	Genseq-4 COI
<i>M. brewsteri</i>			DNA1573 ACUA 138882 (holotype)	Genseq-4 COI, 28S
<i>M. coastalis</i>			DNA2454 ACUA 151494 (holotype)	Genseq-4 COI
<i>M. coastalis</i>			DNA2506 ACUA 151498 (non-type voucher)	Genseq-4 COI, 28S

Table 1. Genbank accession numbers and GenSeq nomenclature for all specimens examined (cont).

Species	Genbank Accession #		DNA #, Specimen Catalog #	GenSeq Nomenclature
	COI	28S		
<i>M. confusica</i>			DNA1329 ACUA 135653 (allotype)	Genseq-4 COI, 28S
<i>M. confusica</i>			DNA1333 ACUA 135548 (holotype)	Genseq-4 COI
<i>M. curva</i>			DNA1317 ACUA 135667 (paratype)	Genseq-4 COI
<i>M. curva</i>			DNA2356 ACUA 151446 (paratype)	Genseq-4 COI
<i>M. curva</i>			DNA2363 ACUA 151447 (non-type voucher)	Genseq-4 COI
<i>M. curva</i>			DNA2433 ACUA 151480 (allotype)	Genseq-4 COI
<i>M. curva</i>			DNA2369 ACUA 151448 (non-type voucher)	Genseq-4 COI
<i>M. curva</i>			DNA2419 ACUA 151465 (non-type voucher)	Genseq-4 COI
<i>M. curva</i>			DNA2374 ACUA 151452 (non-type voucher)	Genseq-4 COI
<i>M. curva</i>			DNA2388 ACUA 151458 (non-type voucher)	Genseq-4 COI
<i>M. curva</i>			DNA1335 ACUA 135546 (non-type voucher)	Genseq-4 COI
<i>M. curva</i>			DNA2351 ACUA 151444 (non-type voucher)	Genseq-4 COI, 28S
<i>M. curva</i>			DNA2353 ACUA 151445 (non-type voucher)	Genseq-4 COI

Table 1. Genbank accession numbers and GenSeq nomenclature for all specimens examined (cont).

Species	Genbank Accession #		DNA #, Specimen Catalog #	GenSeq Nomenclature
	COI	28S		
<i>M. curva</i>			DNA3117 ACUA151860 (non-type voucher)	Genseq-4 COI, 28S
<i>M. curva</i>			DNA2444 ACUA 151478 (non-type voucher)	Genseq-4 COI, 28S
<i>M. curva</i>			DNA2450 ACUA 151476 (non-type voucher)	Genseq-4 COI, 28S
<i>M. curva</i>			DNA2451 ACUA 151477 (holotype)	Genseq-4 COI
<i>M. curva</i>			DNA2477 ACUA 151483 (non-type voucher)	Genseq-4 COI
<i>M. curva</i>			DNA2389 ACUA 151459 (non-type voucher)	Genseq-4 COI
<i>M. emilyae</i>			DNA2382 ACUA 151454 (allotype)	Genseq-4 COI, 28S
<i>M. emilyae</i>			DNA2416 ACUA 151463 (holotype)	Genseq-4 COI
<i>M. geographica</i>			DNA1628 ACUA 140753 (non-type voucher)	Genseq-4 COI
<i>M. geographica</i>			DNA1899 ACUA 139952 (non-type voucher)	Genseq-4 COI, 28S
<i>M. geographica</i>			DNA1953 ACUA 140717 (non-type voucher)	Genseq-4 COI
<i>M. geographica</i>			DNA1900 ACUA 139953 (non-type voucher)	Genseq-4 COI

Table 1. Genbank accession numbers and GenSeq nomenclature for all specimens examined (cont).

Species	Genbank Accession #		DNA #, Specimen Catalog #	GenSeq Nomenclature
	COI	28S		
<i>M. geographica</i>			DNA1945 ACUA 140723 (non-type voucher)	Genseq-4 COI
<i>M. geographica</i>			DNA3143 ACUA 151420 (non-type voucher)	Genseq-4 COI, 28S
<i>M. geographica</i>			DNA3135 ACUA 151392 (non-type voucher)	Genseq-4 COI
<i>M. geographica</i>			DNA1954 ACUA 140733 (non-type voucher)	Genseq-4 COI
<i>M. geographica</i>			DNA1955 ACUA 140734 (non-type voucher)	Genseq-4 COI
<i>M. geographica</i>			DNA2535 ACUA 151429 (holotype)	Genseq-4 COI
<i>M. geographica</i>			DNA2572 ACUA 151514 (non-type voucher)	Genseq-4 COI
<i>M. geographica</i>			DNA3153 ACUA 151425 (non-type voucher)	Genseq-4 COI
<i>M. geographica</i>			DNA3154 ACUA 151426 (allotype)	Genseq-4 COI,
<i>M. geographica</i>			DNA2400 ACUA 151394 (non-type voucher)	Genseq-4 COI
<i>M. geographica</i>			DNA3171 ACUA 151432 (non-type voucher)	Genseq-4 COI
<i>M. geographica</i>			DNA2464 ACUA 151497 (non-type voucher)	Genseq-4 COI

Table 1. Genbank accession numbers and GenSeq nomenclature for all specimens examined (cont).

Species	Genbank Accession #		DNA #, Specimen Catalog #	GenSeq Nomenclature
	COI	28S		
<i>M. geographica</i>			DNA2574 ACUA 151523 (non-type voucher)	Genseq-4 COI
<i>M. geographica</i>			DNA2571 ACUA 151517 (non-type voucher)	Genseq-4 COI
<i>M. geographica</i>			DNA2573 ACUA 151522 (non-type voucher)	Genseq-4 COI
<i>M. geographica</i>			DNA1961 ACUA 140729 (non-type voucher)	Genseq-4 COI
<i>M. geographica</i>			DNA2396 ACUA 151397 (non-type voucher)	Genseq-4 COI, 28S
<i>M. geographica</i>			DNA2409 ACUA 151395 (non-type voucher)	Genseq-4 COI
<i>M. geographica</i>			DNA2448 ACUA 151398 (non-type voucher)	Genseq-4 COI
<i>M. geographica</i>			DNA2580 ACUA 151486 (non-type voucher)	Genseq-4 COI, 28S
<i>M. geographica</i>			DNA2384 ACUA 151456 (non-type voucher)	Genseq-4 COI
<i>M. geographica</i>			DNA2385 ACUA 151457 (non-type voucher)	Genseq-4 COI, 28S
<i>M. geographica</i>			DNA2391 ACUA 151460 (non-type voucher)	Genseq-4 COI
<i>M. geographica</i>			DNA2393 ACUA 151461 (non-type voucher)	Genseq-4 COI

Table 1. Genbank accession numbers and GenSeq nomenclature for all specimens examined (cont).

Species	Genbank Accession #		DNA #, Specimen Catalog #	GenSeq Nomenclature
	COI	28S		
<i>M. geographica</i>			DNA2483 ACUA 151495 (non-type voucher)	Genseq-4 COI, 28S
<i>M. geographica</i>			DNA2488 ACUA 151500 (non-type voucher)	Genseq-4 COI
<i>M. geographica</i>			DNA2548 ACUA 151502 (non-type voucher)	Genseq-4 COI
<i>M. geographica</i>			DNA2581 ACUA 151487 (non-type voucher)	Genseq-4 COI
<i>M. geographica</i>			DNA3107 ACUA 151442 (non-type voucher)	Genseq-4 COI, 28S
<i>M. geographica</i>			DNA3108 ACA 151837 (non-type voucher)	Genseq-4 COI
<i>M. geographica</i>			DNA3116 ACUA 151840 (non-type voucher)	Genseq-4 COI
<i>M. geographica</i>			DNA3106 ACUA 151441 (non-type voucher)	Genseq-4 COI, 28S
<i>M. geographica</i>			DNA3090 ACUA 151436 (non-type voucher)	Genseq-4 COI
<i>M. geographica</i>			DNA2441 ACUA 151504 (non-type voucher)	Genseq-4 COI, 28S
<i>M. geographica</i>			DNA3091 ACUA 151437 (non-type voucher)	Genseq-4 COI
<i>M. geographica</i>			DNA3092 ACUA 151438 (non-type voucher)	Genseq-4 COI, 28S

Table 1. Genbank accession numbers and GenSeq nomenclature for all specimens examined (cont).

Species	Genbank Accession #		DNA #, Specimen Catalog #	GenSeq Nomenclature
	COI	28S		
<i>M. gilbroskii</i>			DNA3093 ACUA 151866 (non-type voucher)	Genseq-4 COI
<i>M. gilbroskii</i>			DNA2582 ACUA 151488 (non-type voucher)	Genseq-4 COI, 28S
<i>M. gilbroskii</i>			DNA2583 ACUA 151489 (allotype)	Genseq-4 COI
<i>M. lynensis</i>			DNA3094 ACUA 151439 (allotype)	Genseq-4 COI
<i>M. lynensis</i>			DNA3095 ACUA 151440 (holotype)	Genseq-4 COI
<i>M. lynensis</i>			DNA1322 ACUA 135661 (non-type voucher)	Genseq-4 COI, 28S
<i>M. montgomeryae</i>			DNA1323 ACUA 135660 (holotype)	Genseq-4 COI
<i>M. oblongata</i>			DNA3087 ACUA 151416 (non-type voucher)	Genseq-4 COI, 28S
<i>M. oblongata</i>			DNA3111 ACUA 151417 (allotype)	Genseq-4 COI, 28S
<i>M. oblongata</i>			DNA2450 ACUA 151476 (non-type voucher)	Genseq-4 COI
<i>M. oblongata</i>			DNA2540 ACUA 151837 (holotype)	Genseq-4 COI
<i>M. oblongata</i>			DNA3085 ACUA 151435 (non-type voucher)	Genseq-4 COI, 28S

Table 1. Genbank accession numbers and GenSeq nomenclature for all specimens examined (cont).

Species	Genbank Accession #		DNA #, Specimen Catalog #	GenSeq Nomenclature
	COI	28S		
<i>M. oblongata</i>			DNA3084 ACUA 151835 (allotype)	Genseq-4 COI
<i>M. oblongata</i>			DNA2586 ACUA 151490 (non-type voucher)	Genseq-4 COI
<i>M. pertussiae</i>			DNA2380 ACUA 151453 (paratype)	Genseq-4 COI
<i>M. purrsiae</i>			DNA2507 ACUA 151492 (non-type voucher)	Genseq-4 COI, 28S
<i>M. purrsiae</i>			DNA2533 ACUA 151424 (non-type voucher)	Genseq-4 COI
<i>M. purrsiae</i>			DNA2546 ACUA 151427 (non-type voucher)	Genseq-4 COI
<i>M. purrsiae</i>			DNA3152 ACUA 151422 (non-type voucher)	Genseq-4 COI, 28S
<i>M. purrsiae</i>			DNA3151 ACUA 151421 (allotype)	Genseq-4 COI
<i>M. purrsiae</i>			DNA2545 ACUA 151865 (non-type voucher)	Genseq-4 COI
<i>M. rosiae</i>			DNA2456 ACUA 151407 (non-type voucher)	Genseq-4 COI, 28S
<i>M. rosiae</i>			DNA2458 ACUA 151401 (allotype)	Genseq-4 COI
<i>M. rosiae</i>			DNA2467 ACUA 151400 (non-type voucher)	Genseq-4 COI



Table 1. Genbank accession numbers and GenSeq nomenclature for all specimens examined (cont).

Species	Genbank Accession #		DNA #, Specimen Catalog #	GenSeq Nomenclature
	COI	28S		
<i>M. rosiae</i>			DNA2459 ACUA 151405 (holotype)	Genseq-4 COI, 28S
<i>M. rosiae</i>			DNA2461 ACUA 151404 (non-type voucher)	Genseq-4 COI
<i>M. rosiae</i>			DNA2457 ACUA 151411 (non-type voucher)	Genseq-4 COI
<i>M. rosiae</i>			DNA2470 ACUA 151408 (non-type voucher)	Genseq-4 COI
<i>M. sevieri</i>			DNA1730 ACUA156722 (non-type voucher)	Genseq-4 COI
<i>M. sevieri</i>			DNA2429 ACUA151479 (holotype)	Genseq-4 COI
<i>M. sevieri</i>			DNA2376 ACUA151451 (non-type voucher)	Genseq-4 COI
<i>M. sevieri</i>			DNA2377 ACUA151472 (non-type voucher)	Genseq-4 COI
<i>M. sevieri</i>			DNA2430 ACUA151473 (allotype)	Genseq-4 COI
<i>M. simulans</i>			DNA2445 ACUA 151496 (non-type voucher)	Genseq-4 COI
<i>M. simulans</i>			DNA2500 ACUA 151470 (non-type voucher)	Genseq-4 COI
<i>M. simulans</i>			DNA2520 ACUA 151503 (non-type voucher)	Genseq-4 COI

Table 1. Genbank accession numbers and GenSeq nomenclature for all specimens examined (cont).

Species	Genbank Accession #		DNA #, Specimen Catalog #	GenSeq Nomenclature
	COI	28S		
<i>M. simulans</i>			DNA2558 ACUA 151525 (non-type voucher)	Genseq-4 COI, 28S
<i>M. simulans</i>			DNA2560 ACUA 151526 (non-type voucher)	Genseq-4 COI
<i>M. simulans</i>			DNA2493 ACUA 151472 (non-type voucher)	Genseq-4 COI, 28S
<i>M. simulans</i>			DNA2523 ACUA 151469 (non-type voucher)	Genseq-4 COI
<i>M. simulans</i>			DNA2527 ACUA 151471 (non-type voucher)	Genseq-4 COI
<i>M. simulans</i>			DNA2562 ACUA 151509 (holotype)	Genseq-4 COI, 28S
<i>M. simulans</i>			DNA2563 ACUA 151510 (non-type voucher)	Genseq-4 COI
<i>M. simulans</i>			DNA2551 ACUA 151423 (non-type voucher)	Genseq-4 COI, 28S
<i>M. simulans</i>			DNA2555 ACUA 151519 (non-type voucher)	Genseq-4 COI
<i>M. simulans</i>			DNA2556 ACUA 151520 (allotype)	Genseq-4 COI, 28S
<i>M. simulans</i>			DNA2557 ACUA 151515 (non-type voucher)	Genseq-4 COI
<i>M. simulans</i>			DNA2564 ACUA 151512 (non-type voucher)	Genseq-4 COI

Table 1. Genbank accession numbers and GenSeq nomenclature for all specimens examined (cont).

Species	Genbank Accession #		DNA #, Specimen Catalog #	GenSeq Nomenclature
	COI	28S		
<i>M. simulans</i>			DNA2566 ACUA 151521 (non-type voucher)	Genseq-4 COI
<i>M. simulans</i>			DNA2568 ACUA 151524 (non-type voucher)	Genseq-4 COI, 28S
<i>M. simulans</i>			DNA2669 ACUA 151852 (non-type voucher)	Genseq-4 COI
<i>M. siskiyouii</i>			DNA3133 ACUA 151853 (non-type voucher)	Genseq-4 COI, 28S
<i>M. siskiyouii</i>			DNA2565 ACUA 151852 (holotype)	Genseq-4 COI
<i>M. vanni</i>			DNA2406 ACUA 151393 (holotype)	Genseq-4 COI, 28S
<i>M. vonnegutii</i>			DNA2534 ACUA 151428 (non-type voucher)	Genseq-4 COI, 28S
<i>M. vonnegutii</i>			DNA2660 ACUA 151851 (non-type voucher)	Genseq-4 COI
<i>M. vonnegutii</i>			DNA2670 ACUA 151560 (allotype)	Genseq-4 COI
<i>M. vonnegutii</i>			DNA2673 ACUA 151508 (holotype)	Genseq-4 COI, 28S
<i>M. waddellica</i>			DNA1620 ACUA 138919 (non-type voucher)	Genseq-4 COI
<i>M. waddellica</i>			DNA1621 ACUA 138920 (non-type voucher)	Genseq-4 COI, 28S

Table 1. Genbank accession numbers and GenSeq nomenclature for all specimens examined (cont).

Species	Genbank Accession #		DNA #, Specimen Catalog #	GenSeq Nomenclature
	COI	28S		
<i>M. waddellica</i>			DNA1629 ACUA 138932 (non-type voucher)	Genseq-4 COI
<i>M. waddellica</i>			DNA1630 ACUA 138933 (non-type voucher)	Genseq-4 COI
<i>M. waddellica</i>			DNA1631 ACIA 138928 (non-type voucher)	Genseq-4 COI
<i>M. waddellica</i>			DNA2661 ACUA 151505 (non-type voucher)	Genseq-4 COI
<i>M. waddellica</i>			DNA3149 ACUA 151419 (non-type voucher)	Genseq-4 COI, 28S
<i>M. williamsis</i>			DNA2423 ACUA 151858 (allotype)	Genseq-4 COI
<i>M. williamsis</i>			DNA2422 ACUA 151467 (holotype)	Genseq-4 COI, 28S
<i>M. wolfendensis</i>			DNA2425 ACUA 151468 (non-type voucher)	Genseq-4 COI
<i>M. wolfendensis</i>			DNA1327 ACUA 135656 (holotype)	Genseq-4 COI
<i>M. wolfendensis</i>			DNA3123 ACUA 151413 (allotype)	Genseq-4 COI, 28S
<i>M. zirkleii</i>			DNA1334 ACUA 135547 (paratype)	Genseq-4 COI, 28S
<i>M. zirkleii</i>			DNA3130 ACUA 151414 (allotype)	Genseq-4 COI, 28S

### III. Results and Discussion

#### Summary of material

Approximately 650 specimens representing 27 species were examined from almost 500 locations across the United States and Southern Canada (Fig. 1). Specimens preserved in ethanol (for morphological and molecular data) and GAW (for morphological analysis alone) were available for most heavily sampled locations across the US and Canada, but only slide-mounted samples were obtained for some type species.

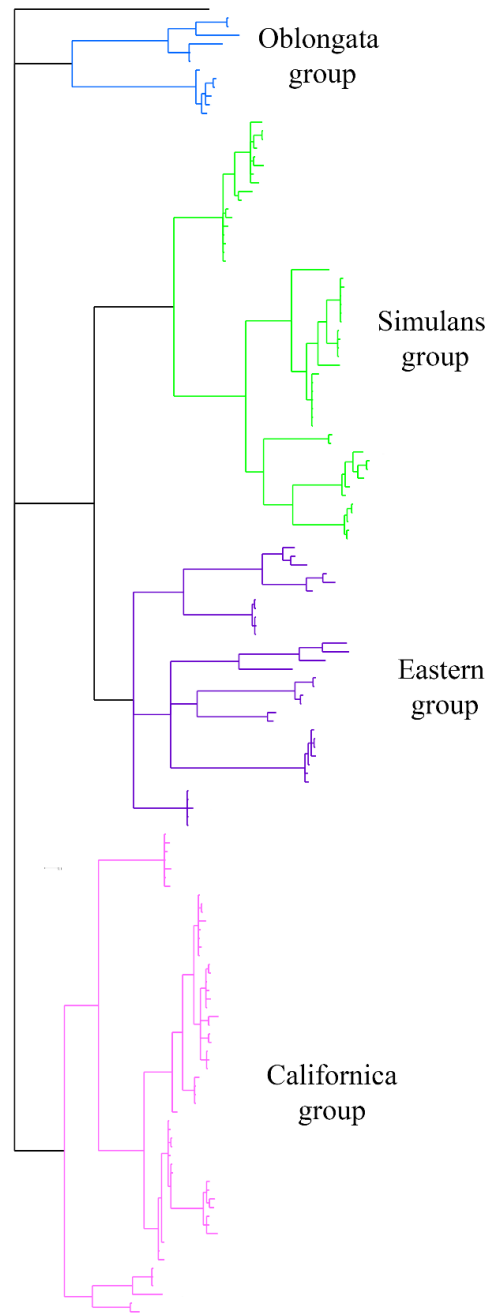
Of the described types utilized in the redescription of North American *Monatractides*, two recognized species were identified as being teneral (*M. compacta*, *M. obovata*). Both of these species were originally described by Marshall in 1943 from Waddell creek, in Santa Cruz, CA. Morphology, including size, is used as a criterion to distinguish species; therefore, using teneral, or immature specimens to create a species hypothesis for adults is problematic. The sclerotization that occurs when an individual moves from an immature to adult stage is not insignificant. While it has been implied that size may not be the most suitable criteria to distinguish species because it may be influenced by environmental factors and nutrition during larval stages (Lundblad 1962), specimen measurements remain an important aspect of creating and testing species hypotheses for water mites. It is for this reason that neither of these species were re-described, as the linkage between adult and larval form was not the focus of this study, and teneral mites were not taken across sampling sites and used to describe species.

#### Summary of phylogenetic analysis

COI sequence data were obtained from 154 taxa from across the United States and Canada (Table 1). These 154 individuals group into 24 clades that represent well-supported species hypotheses (Figs. 5-11). Of these 24 hypotheses, one is represented by a single specimen

(*M. montgomeryae*), and three are represented by a single sex (*M. coastalis*, *M. montgomeryae*, and *M. siskiyouii*). Four clades are identifiable to currently recognized species; one clade represents multiply named species, necessitating the synonymization of two species (see taxonomy section). Ethanol-preserved specimens of two previously described species were not available (*M. cooki*, *M. jordanensis*), but types for each of these were examined morphologically. Of the 24 species in our analysis, 20 represent new species that are herein described. Additionally, one species for which there was no COI sequence data is identified and described. This COI dataset of 154 taxa identified 4 species groups, as well as 3 smaller groups that can be used for identification (described below) (Fig. 5).

A combined dataset of 28S (843 bp) and COI (623 bp) included 55 taxa from all species complexes and groups, and also recovered four species groups (Fig. 6). The species groups identified by the COI-only analyses are outlined in a coordinating color. These complexes were largely determined based off a combination of monophyly, geography, and note-worthy characters, so the fact that the two analyses do not agree on the placement of some species groups (e.g. *M. curva*) is not crippling, but is interesting. While there is poor backbone support seen in the combined tree, the goal of this analysis was to support the identified species hypotheses and grouping therein, and not to identify strong phylogenetic signals and identify genetic divergence.



**Figure 5.** Bayesian inferred cladogram for COI analysis of North American *Monatractides*: species complexes and identification groups. Four complexes have been identified to guide identification.





## Species groups

Considered herein, species groups are monophyletic collections of closely related species recovered by our larger-COI phylogenetic analysis. Species groups proposed should be considered the first step in the journey towards additional exploration of this group, and would benefit from additional sampling and analyses. Relationships between species groups are not recovered with high support, as is evidenced by the disagreement between the COI and combined (COI+28) analyses, and remain unknown. The COI analysis recovered four species groups: Californica; Eastern; Oblongata; and Simulans.

**Californica group (Fig. 7):** This group consists of 4 species, all of which have ranges that include California. Of the species in this group, only one has been collected outside of California (*M. grographica*), though this may change with future sampling. It appears that the Rocky Mountains may be serving as geographic barrier for *M. geographica*, and although its range extends north into Washington and east into Idaho, all collections have occurred on the western side of the mountain range. Members of this group are pigmented orange to colorless, and possess very little dorsal and ventral coloration, which seems to be typical of many Torrenticolidae species recovered from the West (see Fisher et al. 2017 and O'Neill et al. 2016 for discussions of North American of Torrenticolidae and Testudacarinae, respectively).

The Californica group was recovered as monophyletic in the larger-scale COI and the combined analysis (Figs. 5-6) and both the combined and COI-alone analysis agreed in the recovery of *M. waddellica* and *M. geographica* as close relatives, and both species are recovered as monophyletic. The COI analysis supports a sister relationship between *M. vonnegutii* and *M. siskiyouii*, which are grouped together into the Siskiyouii group, based off similar morphology.

*M. geographica* exhibited more intraspecific variation than might be expected, but in this case, this genetic divergence is likely attributed to the wide geographic range across which taxa were collected. In *M. geographica*, variation between geographically close taxa show low levels of intraspecific genetic variation (0-2%), and it is only across the range in its entirety that COI divergence increases (4.1-5.6%). While the presence of cryptic species is always possible, in both cases, these “species” possess no diagnosable morphological variation, despite the intraspecific COI divergence, and are herein considered to be a single species, though may be considered a target of future research to determine if cryptic species do exist.

**Eastern group (Fig. 8):** This group consists of 11 species, grouped by both COI monophyly and geography – as the name suggests, they are primarily found in eastern North America. Members of this group are among the most colorful of the recovered species, which isn’t uncommon in eastern species for all genera of Torrenticolidae. It is only some members of the *Elongatus* group that appear colorless (*M. confusica* and *M. montgomeryae*), although in one case this may be due to loss of coloration as a result of the mounting media used (discussed below in the species description).

Overall relationships within this complex remain unresolved. However, given the agreement between the larger-scale COI analysis and the combined (COI+28S) analysis, a few hypotheses are well supported.

First, it is clear that 3 species are organized into one monophyletic group: the *Elongatus* group (Fig. 9). The three species in this group, *M. confusica*, *M. montgomeryae*, and *M. pertussiae* share the morphologically distinct characteristic of having a relatively elongated subcapitulum for a monatractid mite. The other seven species in the Eastern group have a typically short and stout subcapitulum seen in most *Monatractides*.

*M. emilyae* and *M. williamsis* are recovered as close sister taxa, despite the unresolved nature of their closest sister taxa (*M. zirkleii* or *M. axfordii*). Similarly, *M. lynensis* and *M. wolfendensis* are recovered with strong support as sister groups across analyses, though, again, their relationship with *M. sevieri* and *M. rosiae* remains unresolved.

*M. confusica* exhibited more intraspecific variation than expected, suggesting potential cryptic species. However, in this case, the genetic divergence may be attributed to the relatively wide or complex geographic range between collection sites, and the low number of collected taxa. In the case of *M. confusica* the collection of two specimens for COI analysis doesn't allow for examination of genetic divergence across the full estimated geographic range. In the case of *M. confusica*, there is no diagnosable morphological variability between the two recovered specimens, despite having high intraspecific COI divergence, and should be the target of future research.

**Simulans group (Fig. 10):** This group comprises 6 species (*M. coastalis*, *M. curva*, *M. gilbroskii*, *M. purrsiae*, *M. simulans*, and *M. vanni*) with support for the monophyly of almost all species in the larger-scale COI analysis. One species, *M. coastalis*, is described using a single sex. All members of the Simulans group share the morphologically distinct characteristic of having a relatively elongated subcapitulum for a monatractid mite, which can be used to easily separate members of this group from members in the Californica group, with whom Simulans species may share a geographic range. The Elongatus clade within the Eastern group also shares this elongated subcapitulum, but can be easily separated using size and dorsal coloration.

Overall relationships of this complex remain unresolved. However, given the agreement between the larger-scale COI analysis and the combined (COI+28S) analysis, a few hypotheses are well supported.

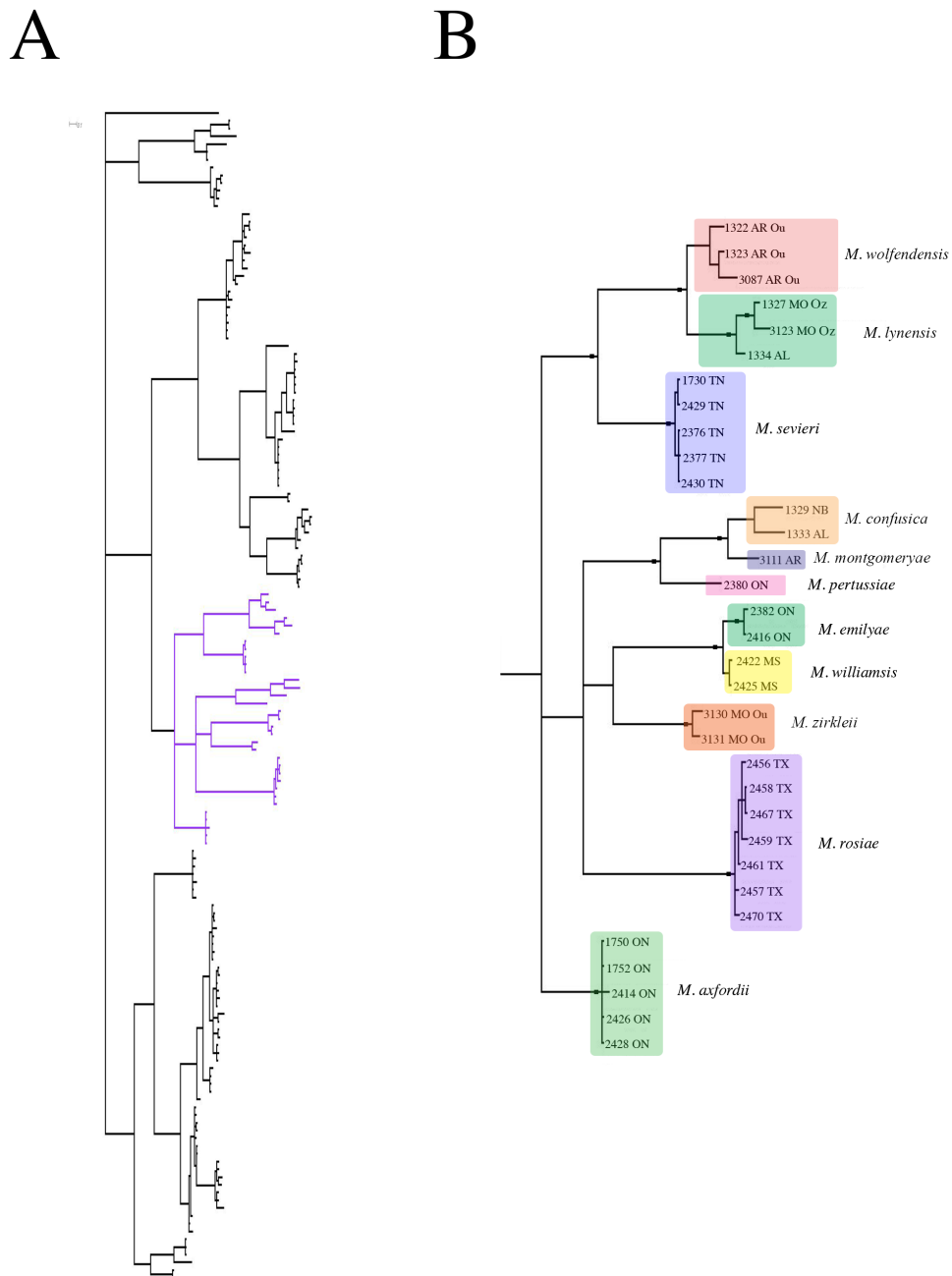
The lineage holding all species in this group excepting *M. curva* has strong support for the relationships among them. This support is intuitive, based off their geographic and morphological similarities when compared to *M. curva*. The sister relationship between *M. gilbroskii* and *M. purrseae* are well supported for both analyses. The monophyly of *M. coastalis* and *M. vanni* lineages are well supported across both analyses.

**Oblongata group (Fig. 11):** Molecular analyses recovered 3 species in this group; *M. brewsterii*, *M. banderae*, and *M. oblongata*. For one additional species, *M. banjoii*, no fresh material for molecular analysis could be obtained, and has been included in this group based on morphology and geography. In total, there are 4 species within the Oblongata group.

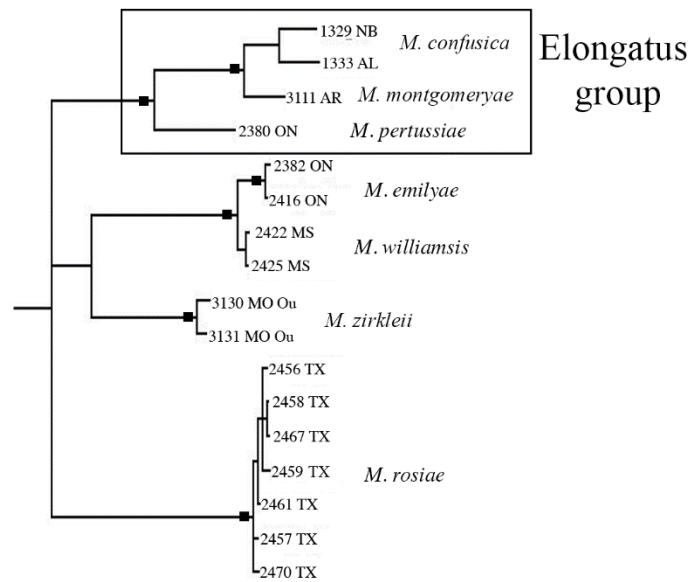
All members of the Oblongata group are western, and range from southern California across to southern Texas, and likely down into Mexico. However, this speculation requires additional sampling for support. The relationships between the Oblongata group and the sister groups remain unresolved, but for the two species within the group for which there is molecular data, there is clear agreement between the combined 28S and COI analysis, and the larger-scale COI analysis that *M. brewsteri*, *M. banderae*, and *M. oblongata* are close relatives, and both analyses have recovered *M. brewsteri* and *M. banderae* as sister species, which have been groups together into the Texas group, based off geography and similar morphological characters. Because of the poor resolution at the base of the combined analysis, there is no additional support for the suggested relationships between the Oblongata and Simulans group, at least in part, seen in the larger-scale COI analysis, and this relationship will remain unresolved until additional sampling can be completed. Additionally, the COI-only and combined analyses disagree on the placement of *M. curva*; further resolution is needed to determine if its proper placement rests with the Oblongata group or the Simulans group. We have chosen to place this

species in the *Simulans* group as advised by the COI-only analysis, though this relationship requires further analysis for full resolution of sister relationships.

**Figure 7.** A) Bayesian inferred phylogenetic hypothesis for COI dataset of North American *Monatractides*. B) Californica group. All species are distributed in the west, primarily California, with the exception of one widespread species (*M. geographica*). Numbers are DNA identification numbers. Black dots denote posterior probability of greater than 95%.

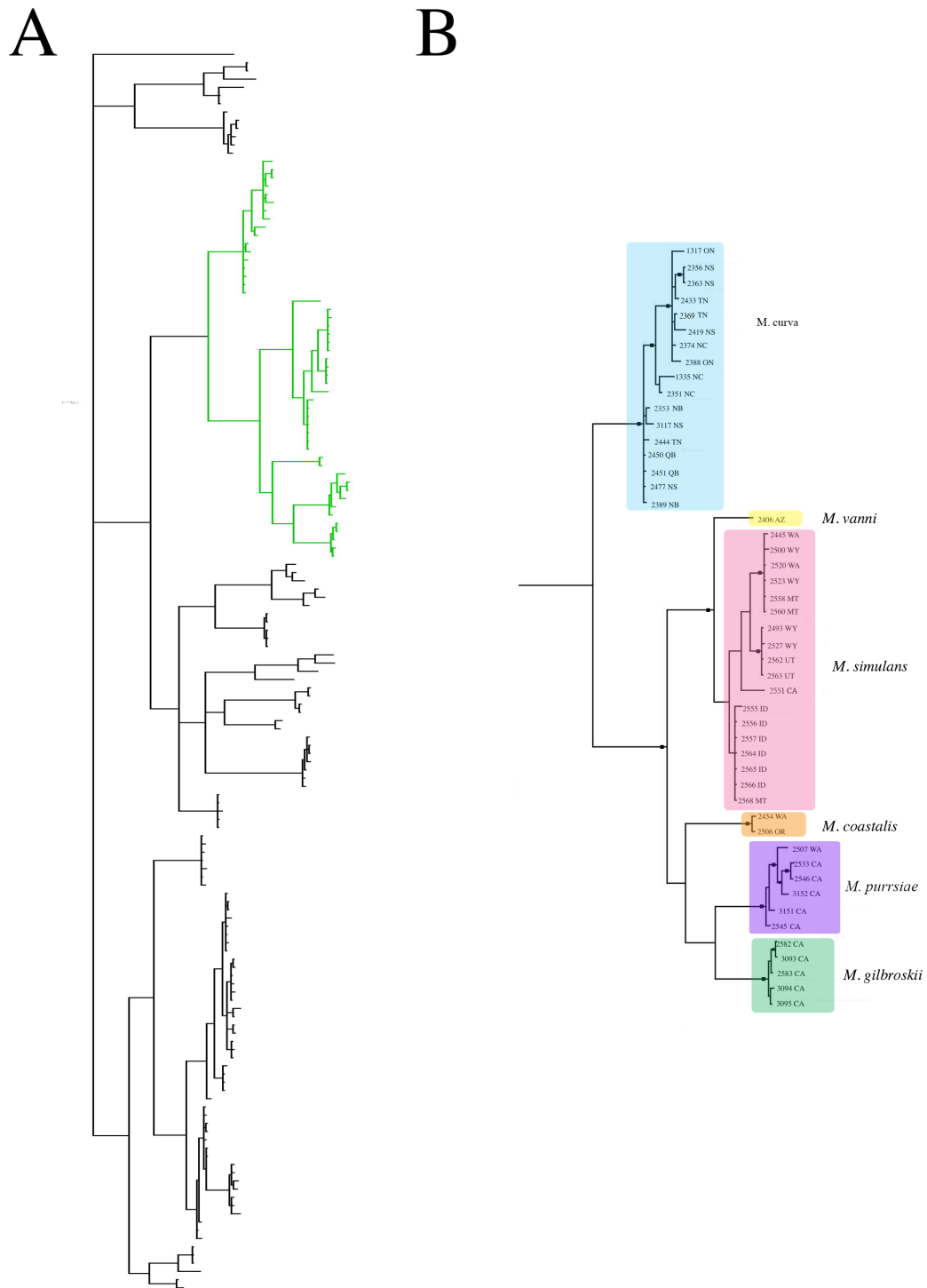


**Figure 8.** A) Bayesian inferred phylogenetic hypothesis for COI dataset of North American *Monatractides*. B) Eastern group; a monophyletic grouping of species primarily found in eastern North America. One species (*M. rosiae*) is from Texas, but that is as far as the known distribution of species in this group extends. Numbers are DNA identification numbers. Black dots denote posterior probability of greater than 95%.

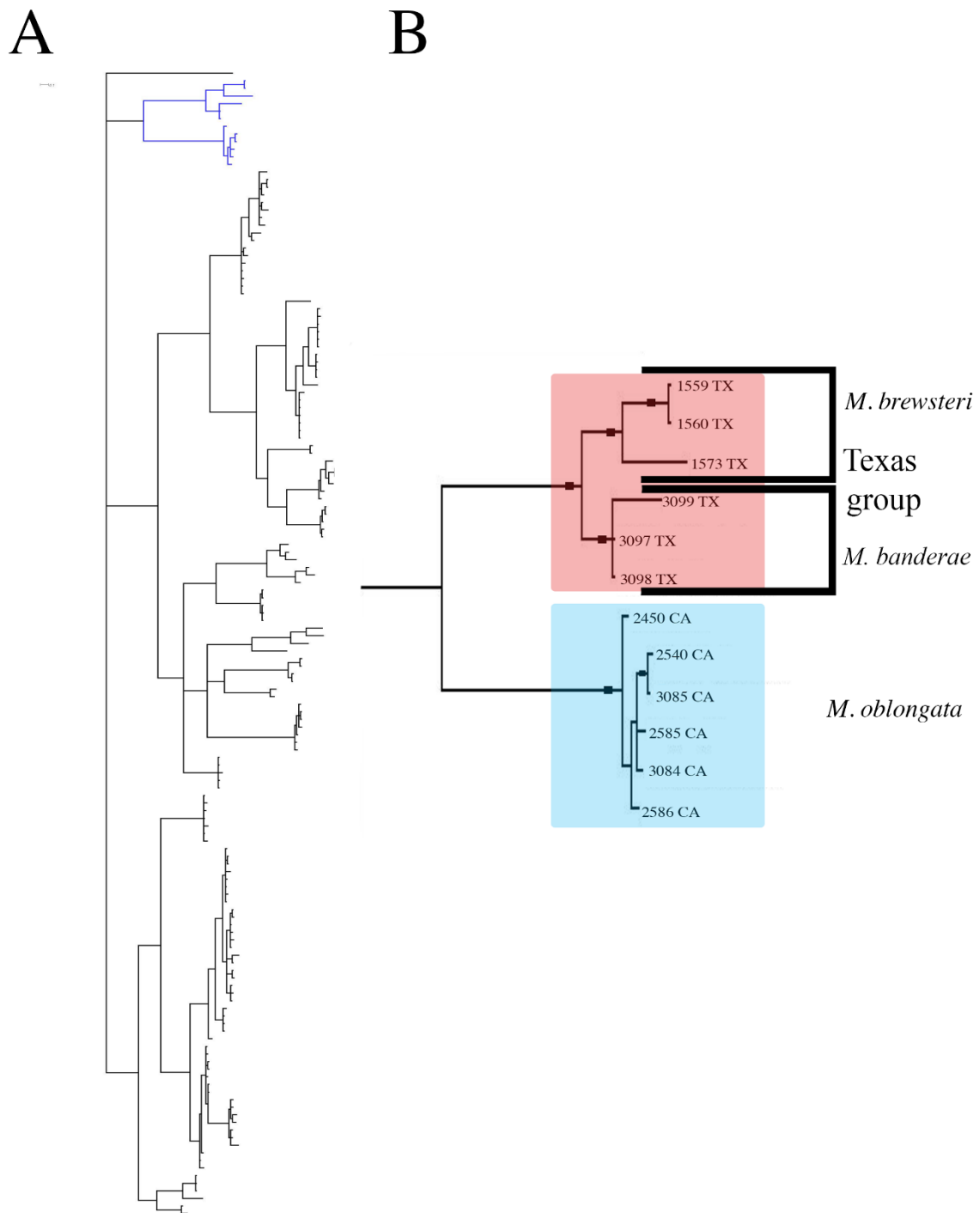


**Figure 9.** Elongatus group; a monophyletic clade of species within the Eastern group with high COI support. Bayesian inferred phylogenetic hypothesis for COI dataset of North American *Monatractides*. Numbers are DNA identification numbers. Black dots denote posterior probability of greater than 95%.





**Figure 10.** A) Bayesian inferred phylogenetic hypothesis for COI dataset of North American *Monatractides*. B) Simulans group. Species are primarily distributed in the west, with the exception of one species (*M. curva*), which is found in Eastern North America. Numbers are DNA identification numbers. Black dots denote posterior probability of greater than 95%.



**Figure 11.** Oblongata group. Both species are distributed in the western to southwestern United States. Bayesian inferred phylogenetic hypothesis for COI dataset of North American *Monatractides*. Numbers are DNA identification numbers. Black dots denote posterior probability of greater than 95%.

## Taxonomy

### Torrenticolidae Piersig, 1902

Familial diagnosis: See Fisher et al. (2015).

### Torrenticolinae Piersig, 1902

Subfamilial diagnosis: See Fisher et al. (2015).

### *Monatractides* Viets 1926

Type species: *M. uniscutatus* Viets 1926 (original designation: *Atractides uniscutatus* Viets 1926)

**Generic diagnosis.** *Monatractides* can be differentiated from other members of the family Torrenticolidae by having long posterior-dorsal subcapitular apodemes (short in *Torrenticola*, the most similar genus to *Monatractides*); a rostrum much narrower than the remainder of the capitulum in the dorsal view (not similarly reduced in *Torrenticola*); the presence of a dorsal shield with no more than two platelets confined to the anterior portion of the dorsum (*Testudacarus* has numerous platelets surrounding the dorsal shield); five palpomeres (four in *Neoatractides*); a gnathosoma that cannot be significantly extended (*Pseudotorrenticola* have an extendable gnathosoma); the presence of a medial suture (absent in *Stygotorrenticola*); no glandularia on the third coxae; and the presence of six genital acetabula.

## Descriptions

### *Monatractides axfordii* Nelson & Dowling, sp. n.

**Material examined.** HOLOTYPE (♀): CANADA, Ontario: 1 ♀ from Hastings Co., Maynooth, Papineau Creek, beside Hwy 127, 1.4 km N of Madawaska Rd, (45°16'16"N, 77°59'59"W), 17 August 2011, by IM Smith, IMS110050.

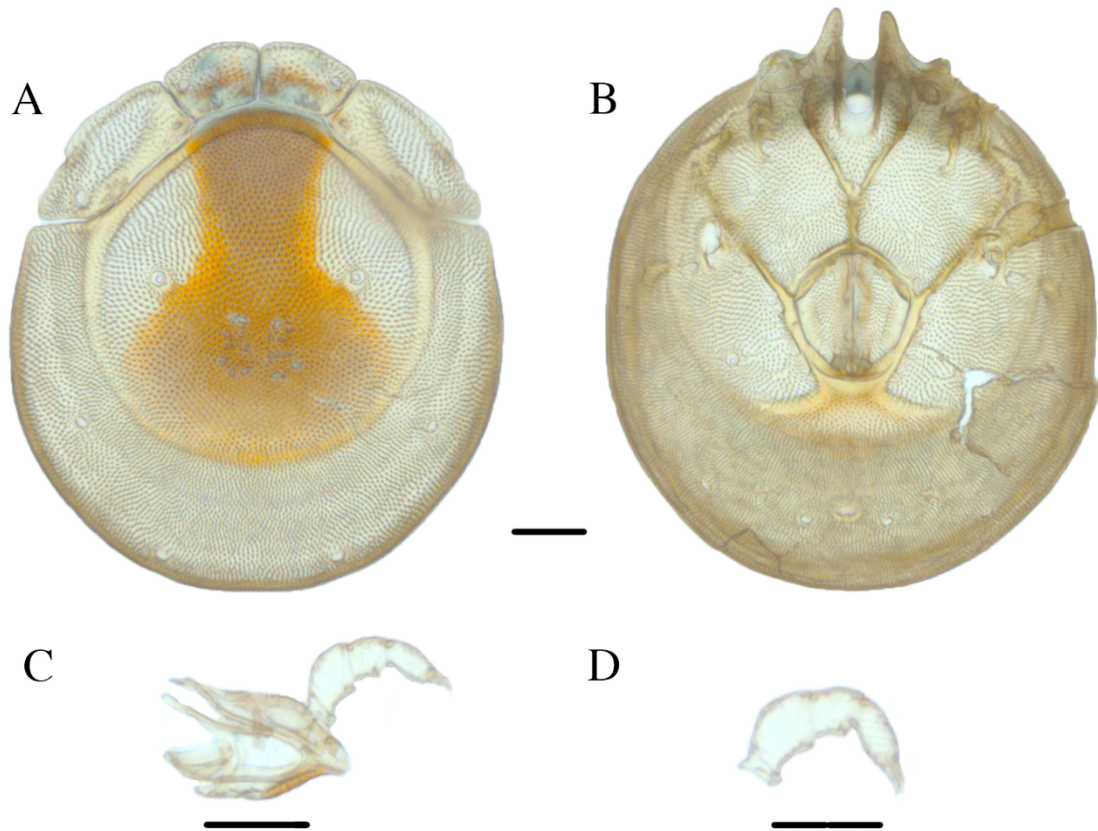
PARATYPES (2 ♀, 2 ♂): Ontario, Canada: (allotype) 1 ♂ from Hastings Co., Maynooth, Papineau Creek, beside Hwy 127, 1.4 km N of Madawaska Rd, (45°16'16"N, 77°59'59"W), 17 August 2011, by IM Smith, IMS110050 • 1 ♀ and 1 ♂ from Hastings Co., Maynooth, Papineau Creek, beside Hwy 127, 1.4 km N of Madawaska Rd, (45°16'16"N, 77°59'59"W), 17 August 2011, by IM Smith, IMS110051 • 1 ♀ from Hastings, Duff Corners; Vanderwater Conservation Area off Vanderwater Road east of Hwy. 37, (44°23'23"N, 77°19'19"W), 13 August 2009, by IM Smith, ML MacKenzie, IMS090089B.

**Type deposition.** Holotype (♀), allotype (♂), and other paratypes (2 ♀; 1 ♂) deposited in the CNC.

**Diagnosis.** *Monatractides axfordii* are similar to other members of the Easterly group by having notable dorsal coloration and patterning; for *M. axfordii*, an orange to dark orange pear-shaped spot on the dorsum, ending at the line of secondary sclerotization. *M. axfordii* is most similar morphologically to *M. emilyae*; they can be differentiated using the anteriomedial platelets (anteriomedial platelet length/width measurement ♀ = 1.3 in *M. emilyae*, 1.44-1.50 in *M. axfordii*; ♂ = 1.88 in *M. emilyae*, 2.3-2.5 in *M. axfordii*). The subcapitulum is wide, differentiating it from all species in the Easterly Elongatus group. *M. axfordii* can be easily differentiated from *M. williamsis*, *M. lynensis*, and *M. zirkleii* by the lack of both purple and

orange dots on the dorsum.

**Description. FEMALE (Fig. 12)** (n=3) (holotype measurements in parentheses when available) with characters of the genus with the following specifications.



**Figure 13.** *Monatractides axfordii* sp. n. female: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum **D** pedipalp (setae not accurately depicted). Scale = 100  $\mu$ m.

**Dorsum** (740-770 (770) long; 630-690 (690) wide) ovoid to round with coloration ranging from orange-brown to pinkish-purple in a pear-shaped blotch on the dorsum. Coloration on antero-medial platelets ranges from orange-brown and bluish-purple to pinkish-purple. Antero-medial platelets (120-130 (130) long; 80-90 (90) wide). Antero-lateral platelets (220-240 (220) long; 80-100 (100) wide), free from dorsal plate. Dgl-4 closer to the muscle scars than

the edge of the dorsum (distance between Dgl-4 290-310 (310)). Dorsal plate proportions: dorsum length/width 1.12-1.17 (1.12); dorsal width/distance between Dgl-4 0.94-1.01 (1.01); antero-medial platelet length/width 1.44-1.50 (1.44); antero-lateral platelet length/width 2.20-2.88 (2.20); antero-lateral/anterio-medial length 1.69-1.92 (1.69).

**Gnathosoma-Subcapitulum** (170-200 (200) long (ventral); 120-140 (135) long (dorsal); 25-35 (35) tall) colorless. Rostrum (85-105 (85) wide) very short and stocky.

Chelicerae (195-215 (215) long with curved fangs (20 long). Subcapitular proportions: ventral length/dorsal length (1.42-1.48 (1.48)). **Pedipalps** short and stocky with small tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (20 (20) long; 30-35 (30) wide); femur (50-55 (50) long; 45-50 (50) wide); genu (30-45 (40) long; 35-40 (40) wide); tibia (50-55 (55) long; 25-30 (25) wide); tarsus (25-30 (25) long).

Palpomere proportions: femur/genu 1.11-1.83 (1.38); tibia/femur 0.91-1.0 (1.0); tibia length/width 1.83-2.0 (1.83).

**Venter** (850-890 (890) long; 690-760 (690) wide) with orange, or pinkish-purple coloration on areas immediately posterior to areas of secondary sclerotization by the genital field. Gnathosomal bay (150-170 (170) long; 50-60 (50) wide. Cxgl-4 subapical. **Medial suture** (60-80 (70) long). **Genital plates** (180-200 (200) long; 170-180 (180) wide). Additional measurements: Cx-1 (260-280 (280) long (total); 120 long (medial); Cx-3 (410-490 (410) wide); anterior venter (190-200 (200) long). Ventral proportions: gnathosomal bay length/width 2.67-3.4 (3.40); anterior venter/genital field length 1.0-1.06 (1.0); anterior venter length/genital field width 1.11-1.12 (1.11).

**MALE (Fig. 13)** (n =2) (allotypic measurements in parentheses when available) with

characters of the genus following specifications.

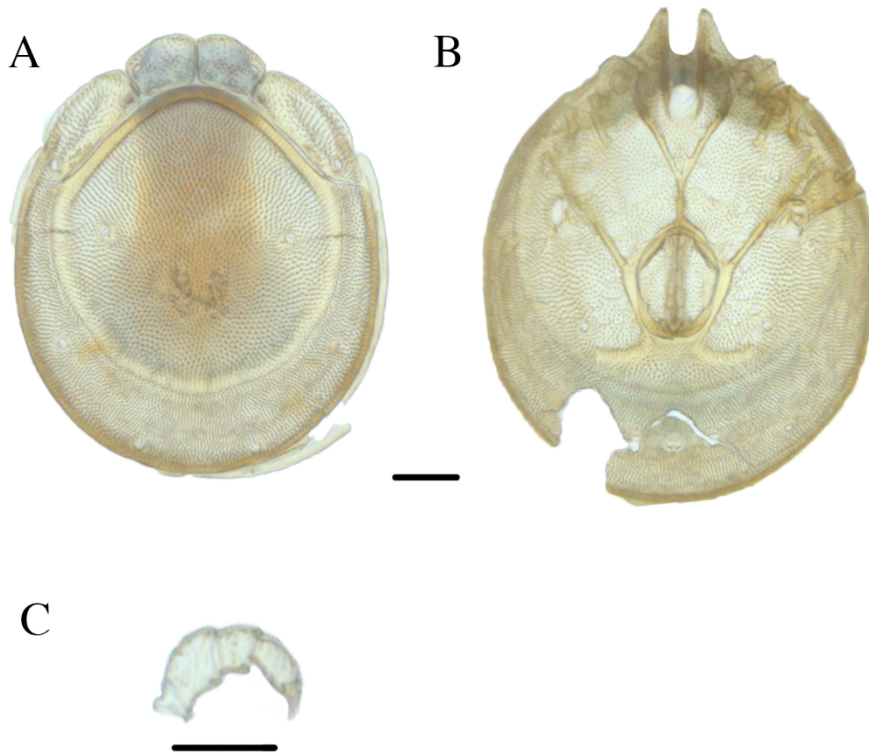
**Dorsum** (650-730 (650) long; 540-530 (540) wide) round with coloration ranging from orange-brown to pinkish-purple in a pear-shaped blotch on the dorsum. Coloration on antero-medial platelets ranges from orange-brown and bluish-purple to pinkish-purple. Antero-medial platelets (110-130 (110) long; 80-90 (80) wide). Antero-lateral platelets (200-230 (200) long; 80-100 (80) wide), free from dorsal plate. Dgl-4 much closer to the edge of the dorsum than to the muscle scars (distance between Dgl-4 280-290 (280)). Dorsal plate proportions: dorsum length/width 1.20-1.24 (1.20); dorsal width/distance between Dgl-4 0.91-0.93 (0.93); antero-medial platelet length/width 1.38-1.44 (1.38); antero-lateral platelet length/width 2.30-2.50 (2.50); antero-lateral/anterio-medial length 1.77-1.82 (1.82).

**Gnathosoma-Subcapitulum** (145-170 (145) long (ventral); 115-120 (115) long (dorsal)) colorless. Rostrum (195 (195) wide) very short and stocky. Chelicerae (185-230 (185) long with curved fangs (25 long). Subcapitular proportions: ventral length/dorsal length (1.26-1.42 (1.26).

**Pedipalps** short and stocky (especially tibiae) with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (20 (20) long; 20-35 (35) wide); femur (35-5- (50) long; 30-45 (55) wide); genu (25-30 (30) long; 30-40 (40) wide); tibia (30-45 (45) long; 25-30 (30) wide); tarsus (25 (25) long; 15 (15) wide). Palpomere proportions: femur/genu 1.40-1.67 (1.67); tibia/femur 0.87-0.90 (0.90); tibia length/width 1.20-1.50 (1.50).

**Venter** (750-760 (760) long; 590-760 (590) wide) with orange, or pinkish-purple coloration on areas immediately posterior to areas of secondary sclerotization by the genital field. Gnathosomal bay (120-140 (140) long; 40-50 (50) wide. Cxgl-4 subapical. **Medial suture** (70-80 (80) long). **Genital plates** (150-170 (170) long; 120-130 (130) wide). Additional measurements: Cx-1 (230-260 (260) long (total); 110-120 (120) long (medial); Cx-3 (390-450

(390) wide); anterior venter (200-210 (200) long). Ventral proportions: gnathosomal bay length/width 2.80-3.00 (2.80); anterior venter/genital field length 1.18-1.40 (1.18); anterior venter length/genital field width 1.54-1.75 (1.54).



**Figure 14.** *Monatractides axfordii* sp. n. male: **A** dorsal plates **B** venter (legs removed) **C** pedipalp (setae not accurately depicted). Scale = 100  $\mu$ m.

**IMMATURES** unknown.

**Etymology.** Specific epithet *axfordii* is in honor of Emily Axford, the actress who voices Moonshine Cybin on Not Another D&D Podcast. This podcast has kept me (WAN) in great spirits over the course of this work, and it seems only fitting that someone playing a Crick Elf so



wonderfully should have the small complement of having an even smaller crick creature named in her honor.

**Distribution.** Currently, *Monatractides axfordii* is known from Eastern Ontario (Fig. 15).

**Remarks.** In COI analyses, *Monatractides axfordii* groups with other members of the Easterly group with high support. This species hypothesis is supported by low COI divergence within the species (less than 1%), and high divergence between species (at least 13% from sister species in the Easterly group), and by the morphological characteristics outlined in the diagnosis.



**Figure 15.** *Monatractides axfordii* distribution.

***Monatractides banderae* Nelson & Dowling, sp. n.**

**Material examined.** HOLOTYPE (♀): **USA, Texas**, Brewster County, Alpine; beside Rt. 118, 32.8 km south of Rt. 67/90, (30°6'6"N, 103°35'35"W), 2 May 2011, by IM Smith, IMS110001.

PARATYPES (7♀; 10♂): **USA, Texas:** (allotype) 1♂ from Bandera County, Lost Maples State Natural Area north of Vanderpool; picnic area, (29°49'49"N, 99°34'34"W), 27 May 2011, by IM Smith, IMS110024 • 1♀ and 4♂ from Bandera County, Lost Maples State Natural Area north of Vanderpool; picnic area, (29°49'49"N, 99°34'34"W), 27 May 2011, by IM Smith, IMS110024 • 1♂ from Brewster County, Alpine; beside Rt. 118, 32.8 km south of Rt. 67/90, (30°6'6"N, 103°35'35"W), 2 May 2011, by IM Smith, IMS110001 • 1♀ from Brewster County, Alpine; beside Rt. 118, 32.8 km south of Rt. 67/90, (30°6'6"N, 103°35'35"W), 2 May 2011, by IM Smith, IMS110002 • 1♂ from Uvalde County, Garner State Park; river crossing site, (29°35'35"N, 99°44'44"W), 28 May 1998, by IM Smith, IMS980027A • **New Mexico, USA:** 1♀ and 1♂ from Catron County, Cottonwood Campground beside Rt. 180 south of Rt. 12, (33°37'37"N, 108°54'54"W), 12 July 1987, by IM Smith, IMS870085 • 2♂ from Catron County, Glenwood; Whitewater Picnic Area 8 km east of Rt. 180, (33°22'22"N, 108°50'50"W), 12 July 1987, by IM Smith, IMS870084 • 3♀ and 2♂ from Catron County, Cottonwood Campground beside Rt. 180 south of Rt. 12, (33°37'37"N, 108°54'54"W), 12 July 1987, by IM Smith, IMS870086.

**Type deposition.** Holotype (♀) and allotype (♂) deposited in the CNC. All other paratypes (7♀; 9♂) deposited in the ACUA.

**Diagnosis.** *Monatractides banderae* are similar to other members of the oblongata

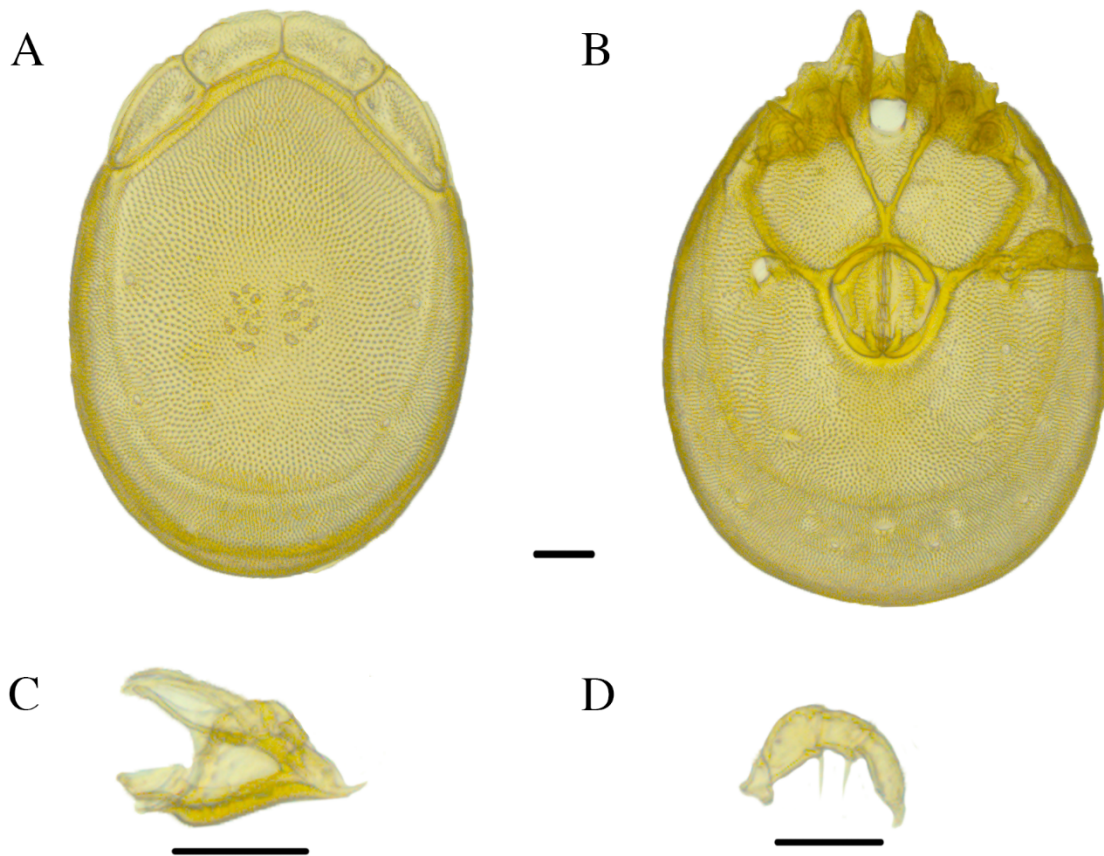
complex (*M. banjoii*, *M. brewsteri*, and *M. oblongata*) in being colorless and ovoid. The Texas group can be easily differentiated from *M. banjoii* by the dorsum width (dorsum width ♀ = 700-1060, ♂ = 665-960 in *M. banjoii*; ♀ = 440-590, ♂ = 345-500 in the Texas group). The Texas group can be differentiated from *M. oblongata* by the width of the gnathosoma (gnathosomal width ♀ = 70-80; ♂ = 65-75 in *M. oblongata*, ♀ = 45-60; ♂ = 40-50 in the Texas group). *M. brewsteri* can be differentiated from *M. banderae* using the anteriomedial platelet measurements for ♀ (anteriomedial platelet length/width measurement ♀ = 1.17-1.88 in *M. brewsteri*, 2.14-2.23 in *M. banderae*), and dorsal measurements for ♂ (dorsum length/width measurements ♂ = 1.16 in *M. brewsteri*, 1.24-1.29 in *M. banderae*).

**Description. FEMALE (Fig. 16)** (n= 8) (holotype measurements in parentheses when available) with characters of the genus with the following specifications.

**Dorsum** (750-760 (750) long; 560-590 (590) wide) ovoid and with no dorsal coloration. Anterio-medial platelets (145-150 (150) long; 65-70 (70) wide). Anterio-lateral platelets (160-165 (165) long; 75-85 (85) wide), free from dorsal plate. Dgl-4 much closer to the edge of the dorsum than to the muscle scars (distance between Dgl-4 390-430 (420)). Dorsal plate proportions: dorsum length/width 1.27-1.36 (1.27); dorsal width/distance between Dgl-4 0.79-0.86 (0.86); anterio-medial platelet length/width 2.14-2.23 (2.14); anterio-lateral platelet length/width 1.94-2.13 (1.94); anterio-lateral/anterio-medial length 1.10 (1.10).

**Gnathosoma-Subcapitulum** (197.5-207.5 (207.5) long (ventral); 135-142.5 (142.5) long (dorsal); 30-42.5 (42.5) tall) colorless. Rostrum (115-125 (125) wide) short and stocky. Chelicerae (180-182.5 (180) long with curved fangs (37.5-42.5 (37.5) long). Subcapitular proportions: ventral length/dorsal length (1.46 (1.46)). **Pedipalps** (especially tibiae) with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (30-32.5 (32.5) long;

27.5 (27.5) wide); femur (47.5-52.5 (47.5) long; 42.5 (42.5) wide); genu (40-42.5 (40) long; 30-32.5 (30) wide); tibia (57.5-60 (60) long; 25 (25) wide); tarsus (21.25-22.5 (22.5) long; 12.5-15 (15) wide). Palpomere proportions: femur/genu 1.19-1.24 (1.19); tibia/femur 1.1-1.26 (1.26); tibia length/width 2.3-2.4 (2.4).

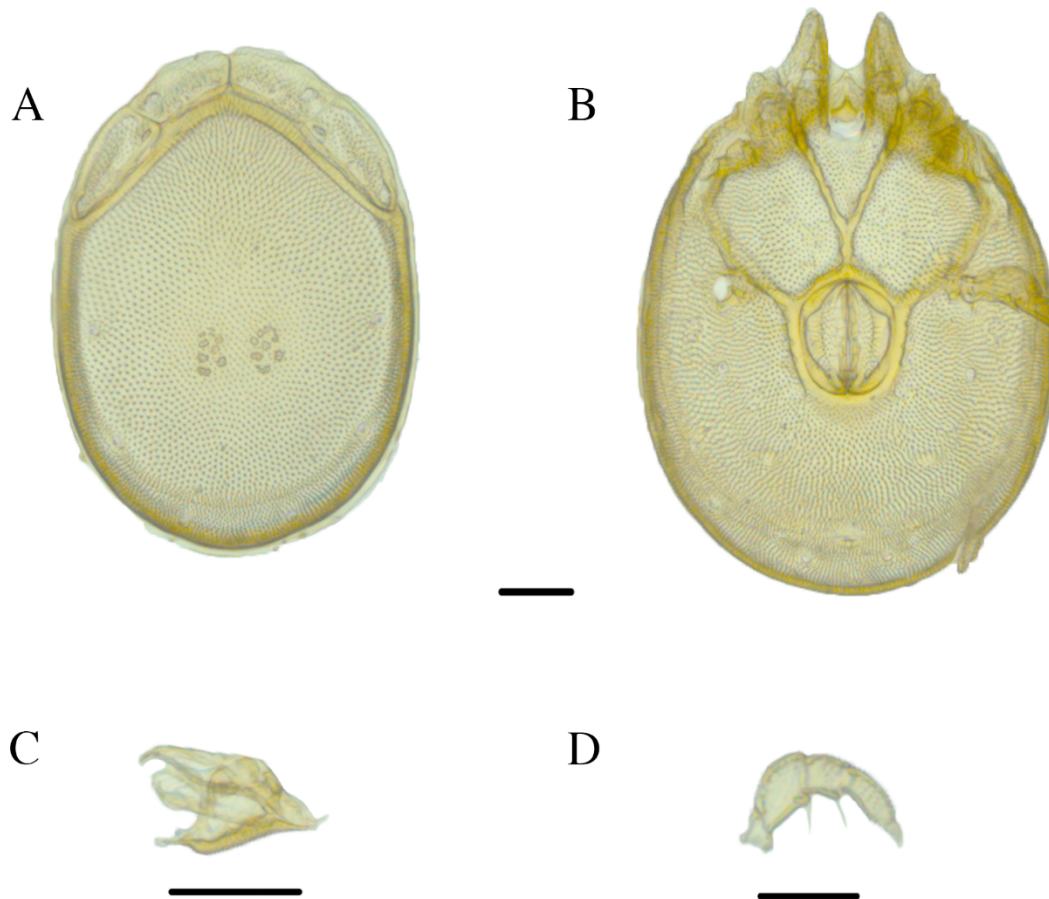


**Figure 16.** *Monatractides banderae* sp. n. female: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum **D** pedipalp (setae not accurately depicted). Scale = 100  $\mu$ m.

**Venter** (830-880 (880) long; 660-680 (660) wide) colorless. Gnathosomal bay (165-170 (165) long; 45-33 (55) wide. Cxgl-4 subapical. **Medial suture** (45-44 (45) long). **Genital plates** (170-180 (180) long; 155-175 (175) wide). Additional measurements: Cx-1 (280-315 (315) long (total); 115-130 (130) long (medial); Cx-3 (400 (400) wide); anterior venter (165-185 (185)

long). Ventral proportions: gnathosomal bay length/width 3.0-3.78 (3.00); anterior venter/genital field length 0.97-1.03 (1.03); anterior venter length/genital field width 1.06 (1.06).

**MALE (Fig. 17)** (n = 10) (allotypic measurements in parentheses when available) with characters of the genus following specifications.



**Figure 17.** *Monatractides banderae* sp. n. male: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum **D** pedipalp (setae not accurately depicted). Scale = 100  $\mu$ m.

**Dorsum** (430-620 (620) long; 345-500 (500) wide) ovoid and with no dorsal coloration. Anterio-medial platelets (100-145 (145) long; 50-70 (70) wide). Anterio-lateral platelets (125-170 (170) long; 60-75 (75) wide), free from dorsal plate. Dgl-4 much closer to the edge of the

dorsum than to the muscle scars (distance between Dgl-4 285-395 (395)). Dorsal plate proportions: dorsum length/width 1.24-1.29 (1.24); dorsal width/distance between Dgl-4 0.86-0.88 (0.86); antero-medial platelet length/width 1.85-2.07 (2.07); antero-lateral platelet length/width 1.87-2.27 (2.27); antero-lateral/anterio-medial length 1.17-1.25 (1.17).

**Gnathosoma-Subcapitulum** (175-185 (182.5) long (ventral); 100-120 (120) long (dorsal); 25-40 (25) tall) colorless. Rostrum (90-112.5 (112.5) wide) short and stocky. Chelicerae (130-167.5 (167.5) long with curved fangs (30-40 (40) long). Subcapitular proportions: ventral length/dorsal length (1.52-1.85 (1.52)). **Pedipalps** with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (20-27.5 (27.5) long; 20-30 (30) wide); femur (40-52.5 (52.5) long; 30-37.5 (37.5) wide); genu (25-37.5 (35) long; 27.5-32.5 (32.5) wide); tibia (40-50 (50) long; 20-22.5 (22.5) wide); tarsus (15-20 (20) long; 12.5-15 (12.5) wide). Palpomere proportions: femur/genu 1.33-1.60 (1.50); tibia/femur 0.95-1.0 (0.95); tibia length/width 2.0-2.38 (2.22).

**Venter** (540-720 (720) long; 395-580 (580) wide) with no ventral coloration. Gnathosomal bay (130-165 (150) long; 45-50 (50) wide. Cxgl-4 subapical. **Medial suture** (50-55 (55) long). **Genital plates** (120-150 (150) long; 100-110 (110) wide). Additional measurements: Cx-1 (265-310 (265) long (total); 100-115 (115) long (medial); Cx-3 (190-330 (190) wide); anterior venter (142.5-175 (175) long). Ventral proportions: gnathosomal bay length/width 2.89-3.67 (3.0); anterior venter/genital field length 1.17-1.19 (1.17); anterior venter length/genital field width 1.43-1.59 (1.59).

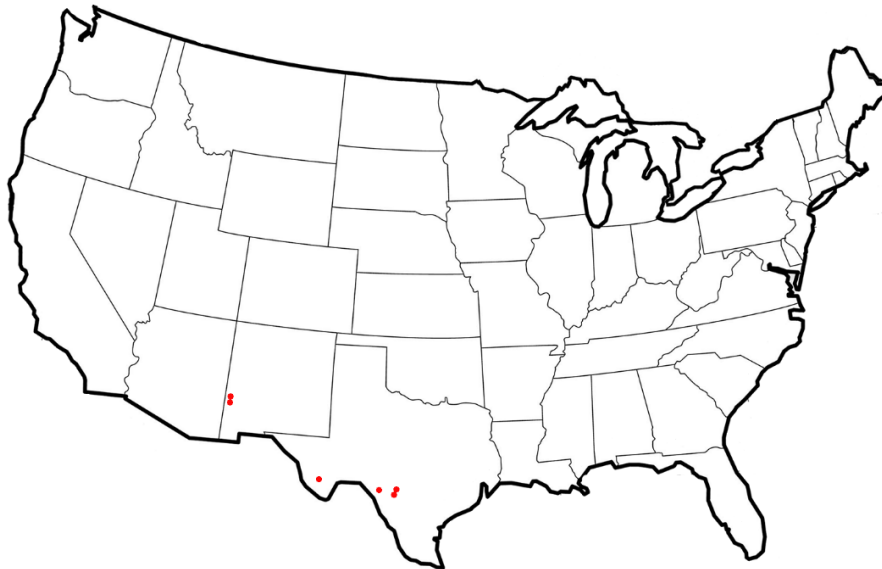
**IMMATURES** unknown.

**Etymology.** Specific epithet *banderae* refers to the county in which the type specimens

were collected; Bandera County, TX.

**Distribution.** South Texas and New Mexico, likely extending west into eastern Arizona and south into north Mexico (Fig. 18).

**Remarks.** *Monatractides banderae* groups with other members of the oblongata complex, *M. oblongata*, *M. banjoi*, and *M. brewsteri* with high geographic and morphological support. Specimens within this group are 0-4.1% different in COI sequence from each other, but over 7% different from the sister species, *M. brewsteri*. Like *M. brewsteri*, there are no currently identified morphological features that can be used to separate members of this group, despite the COI divergence seen within members of the group. Additional sampling will be needed to determine if this is a case of cryptic species or identify other characteristics that may be used to



**Figure 18:** *Monatractides banderae* sp.n. distribution.

***Monatractides banjoi* Nelson & Dowling, sp. n**

**Material examined.** HOLOTYPE (♀): **USA, Arizona:** Coconino County, Oak Creek Canyon; beside Rt. 89A just north of Pine Flat Campground, (35°1'1"N, 111°44'44"W), 21 July 1987, by IM Smith, IMS870099A.

PARATYPES (9♀; 8♂): **USA, Arizona:** (allotype) 1♀ and 1♂ from Coconino County, Oak Creek Canyon; beside Rt. 89A between Bootlegger and Banjo Bill Campgrounds, (34°58'58"N, 111°45'45"W), 21 July 1987, by IM Smith, IMS870100A • 1♀ and 1♂ from Yavapai County, Clear Creek Campground on Forest Service Road #9 east of Camp Verde, (34°31'31"N, 111°46'46"W), 19 July 1987, by IM Smith, IMS870098 • 1♂ from Coconino County, Oak Creek Canyon; beside Rt. 89A just north of Pine Flat Campground, (35°1'1"N, 111°44'44"W), 21 July 1987, by IM Smith, IMS870099A • 1♀ from Coconino County, Oak Creek Canyon; beside Rt. 89A between Bootlegger and Banjo Bill Campgrounds, (34°58'58"N, 111°45'45"W), 21 July 1987, by IM Smith, IMS870100B • 2♀ from Yavapai County, Clear Creek Campground on Forest Rd. #9 east of Camp Verde, (34°31'31"N, 111°46'46"W), 22 July 1987, by IM Smith, IMS870102 • 1♂ from Coconino County, Oak Creek Canyon; beside Rt. 89A between Bootlegger and Banjo Bill Campgrounds, (34°58'58"N, 111°45'45"W), 21 July 1987, by IM Smith, IMS870100A • **New Mexico, United States:** 2♂ from Catron County, Gila Cliff Dwellers National Monument, (33°13'13"N, 108°15'15"W), 10 July 1987, by IM Smith, IMS870080A • 1♀ from Catron, County beside Rt. 15, 65 km north of Rt. 180 (Silver City), (33°12'12"N, 108°13'13"W), 10 July 1987, by IM Smith, IMS870081A • 1♀ from Catron County, beside Rt. 15, 65 km north of Rt. 180 (Silver City), (33°12'12"N, 108°13'13"W), 10 July



1987, by IM Smith, IMS870081B • 1 ♀ and 1 ♂ from Grant County, Gila River Recreation Area beside Rt. 15 at Grapevine Recreation Area north of Silver City, (33°11'11"N, 108°12'12"W), 11 July 1987, by IM Smith, IMS870082B • 1 ♀ and 1 ♂ from Catron County, beside Rt. 180 at campground 9.1 km east of Arizona State line, (33°49'49"N, 108°57'57"W), 13 July 1987, by IM Smith, IMS870088.

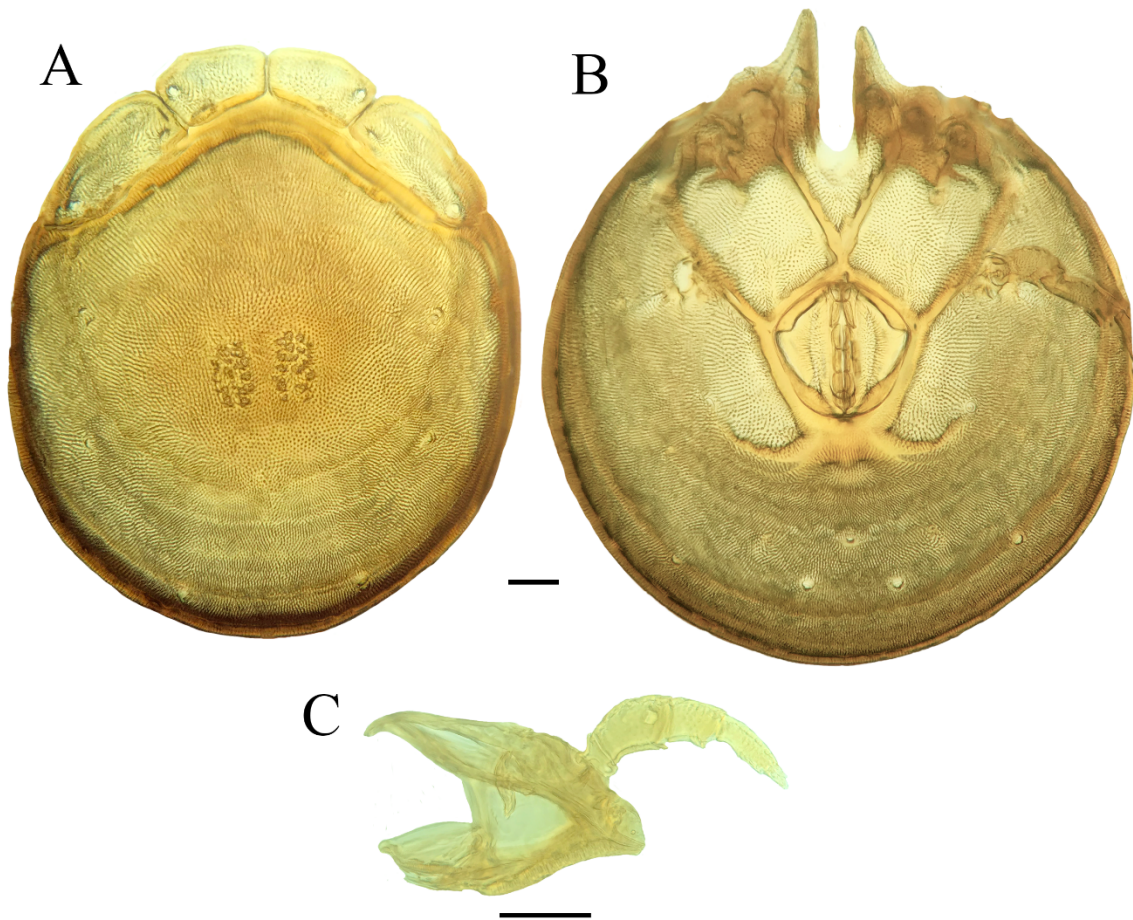
**Type deposition.** Holotype (♀), allotype (♂) deposited in the CNC. All other other paratypes (9♀; 7♂) deposited in the ACUA.

**Diagnosis.** *Monatractides banjoii* are similar to other species found in this western group (*M. oblongata* and *M. brewsteri*) in that they tend to be colorless, and appear, at a glance, much less striking than their colorful eastern counterparts.

*M. banjoii* is also one of the largest mites in western North America (dorsum length ♀ = 840–1210; ♂ = 800–1100), although *M. waddellica* are also large (dorsum length ♀ = 1100–1240; ♂ = 1030–1070), these two species can be distinguished by the elongated dorsum of *M. banjoii* when compared to the more circular (and colorful) *M. waddellica*. In males, the two can be differentiated by the longer genital field length found in *M. waddellica* (♂ = 285–290 in *M. waddellica*; 190–225 in *M. banjoii*). Within the group, *M. banjoii* can be differentiated from *M. oblongata* by being both longer and wider (dorsum width ♀ = 700–1060; ♂ = 665–960 in *M. banjoii*, ♀ = 460–520; ♂ = 420–500 in *M. oblongata*). This measurement can also be used to differentiate *M. brewsterii* from *M. banjoii* (dorsum width ♀ = 440–590; ♂ = 345–500 in *M. brewsterii*).

**Description. FEMALE (Fig. 19)** (n= 10) (holotype measurements in parentheses when available) with characters of the genus with the following specifications.

**Dorsum** (840-1210 (1000) long; 700-1070 (880) wide) elongate ovoid and colorless. Anterio-medial platelets (150-220 (180) long; 90-130 (100) wide). Anterio-lateral platelets (220-340 (240) long; 100-150 (120) wide), free from dorsal plate. Dgl-4 much closer to the edge of the dorsum than to the muscle scars (distance between Dgl-4 480-730 (610)). Dorsal plate proportions: dorsum length/width 1.06-1.20 (1.14); dorsal width/distance between Dgl-4 0.89-0.98 (0.95); anterio-medial platelet length/width 1.62-1.86 (1.80); anterio-lateral platelet length/width 2.00-2.46 (2.00); anterio-lateral/anterio-medial length 1.33-1.61 (1.33).



**Figure 19.** *Monatractides banjoi* sp. n. female: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum and pedipalp (setae not accurately depicted). Scale = 100  $\mu$ m.

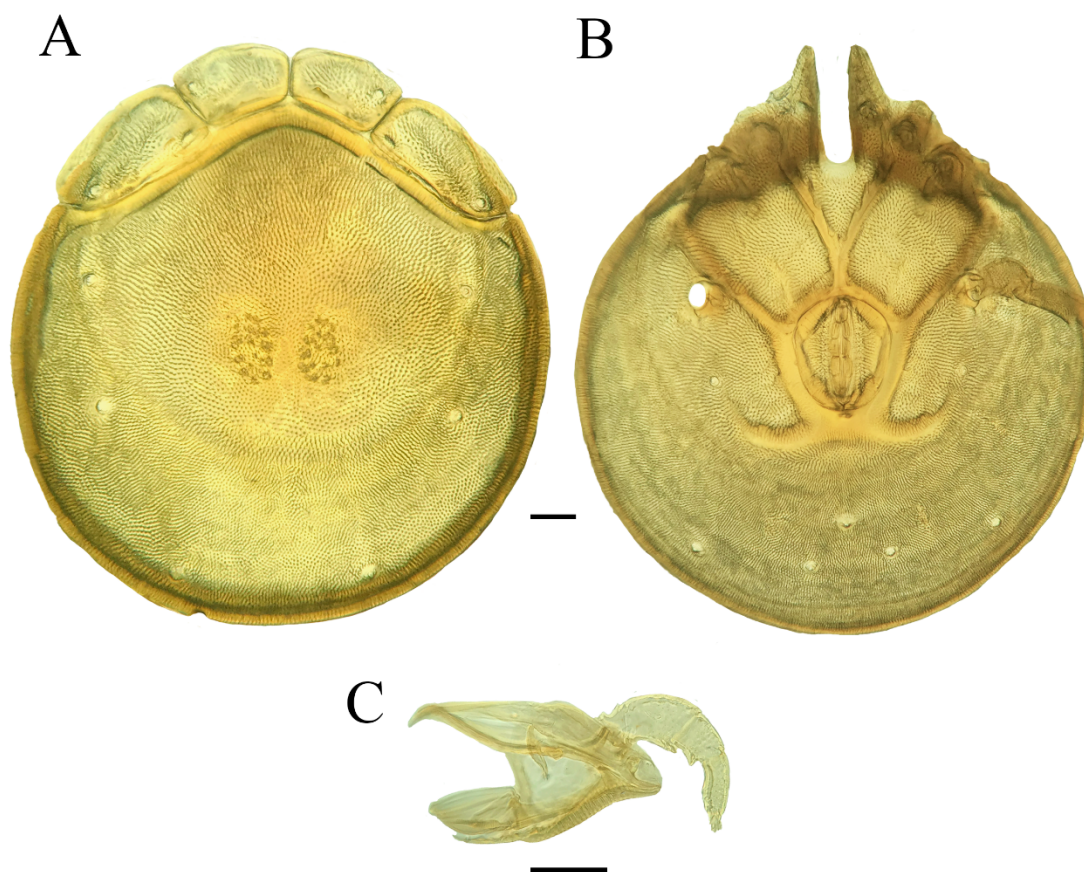
**Gnathosoma-Subcapitulum** (240-310 (265) long (ventral); 155-200 (175) long (dorsal); 35-50 (35) tall) colorless. Rostrum (135-195 (160) wide) short and stocky. Chelicerae (215-280 (250) long with curved fangs (40-65 (40) long). Subcapitular proportions: ventral length/dorsal length (1.43-1.61 (1.51)). **Pedipalps** short and stocky (especially tibiae) with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (30-40 (35) long; 40-50 (40) wide); femur (75-100 (90) long; 50-70 (57.5) wide); genu (40-65 (45) long; 40-55 (45) wide); tibia (55-85 (75) long; 35-40 (30) wide); tarsus (27.5-40 (27.5) long; 15-20 (15) wide). Palpomere proportions: femur/genu 1.46-2.0 (2.0); tibia/femur 0.73-0.89 (0.78); tibia length/width 2.06-2.50 (2.33).

**Venter** (1005-1360 (1145) long; 820-1210 (990) wide), colorless. Gnathosomal bay (190-245 (215) long; 45-75 (60) wide. Cxgl-4 subapical. **Medial suture** (50-80 (67.5) long). **Genital plates** (240-290 (250) long; 230-270 (260) wide). Additional measurements: Cx-1 (390-530 (430) long (total); 130-210 (150) long (medial); Cx-3 (500-720 (600) wide); anterior venter (200-280 (220) long). Ventral proportions: gnathosomal bay length/width 0.85-1.08 (0.85); anterior venter/genital field length 0.83-1.04 (0.88); anterior venter length/genital field width 0.85-1.08 (0.85).

**MALE (Fig. 20)** (n =8) (allotypic measurements in parentheses when available) with characters of the genus following specifications.

**Dorsum** (800-1100 (800) long; 655-960 (655) wide) elongate oval in shape and colorless. Anterio-medial platelets (150-205 (150) long; 110-120 (90) wide). Anterio-lateral platelets (220-310 (220) long; 110-140 (110) wide), free from dorsal plate. Dgl-4 much closer to the edge of the dorsum than to the muscle scars (distance between Dgl-4 485-700 (485)). Dorsal plate proportions: dorsum length/width 1.12-1.22 (1.20); dorsal width/distance between Dgl-4

0.89-0.96 (0.91); antero-medial platelet length/width 1.55-1.86 (1.67); antero-lateral platelet length/width 1.86-2.50 (2.00); antero-lateral/anterio-medial length 1.30-1.65 (1.47).



**Figure 20.** *Monatractides banjoii* sp. n. male: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum and pedipalp (setae not accurately depicted). Scale = 100  $\mu$ m.

**Gnathosoma-Subcapitulum** (230-290 (230) long (ventral); 150-185 (150) long (dorsal); 40-50 (40) tall) colorless. Rostrum (135-175 (135) wide) short and stocky. Chelicerae (215-260 (225) long with curved fangs (45-60 (50) long). Subcapitular proportions: ventral length/dorsal length (1.50-1.63 (1.53). **Pedipalps** short and stocky (especially tibiae) with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (25-40 (25) long; 32.5-50 (32.5) wide);

femur (72.5-140 (140) long; 50-65 (50) wide); genu (47.5-60 (50) long; 40-55 (40) wide); tibia (60-80 (60) long; 25-35 (25) wide); tarsus (25-35 (25) long; 15-20 (15) wide). Palpomere proportions: femur/genu 1.45-2.80 (2.80); tibia/femur 0.43-0.93 (0.43); tibia length/width 2.14-2.80 (2.40).

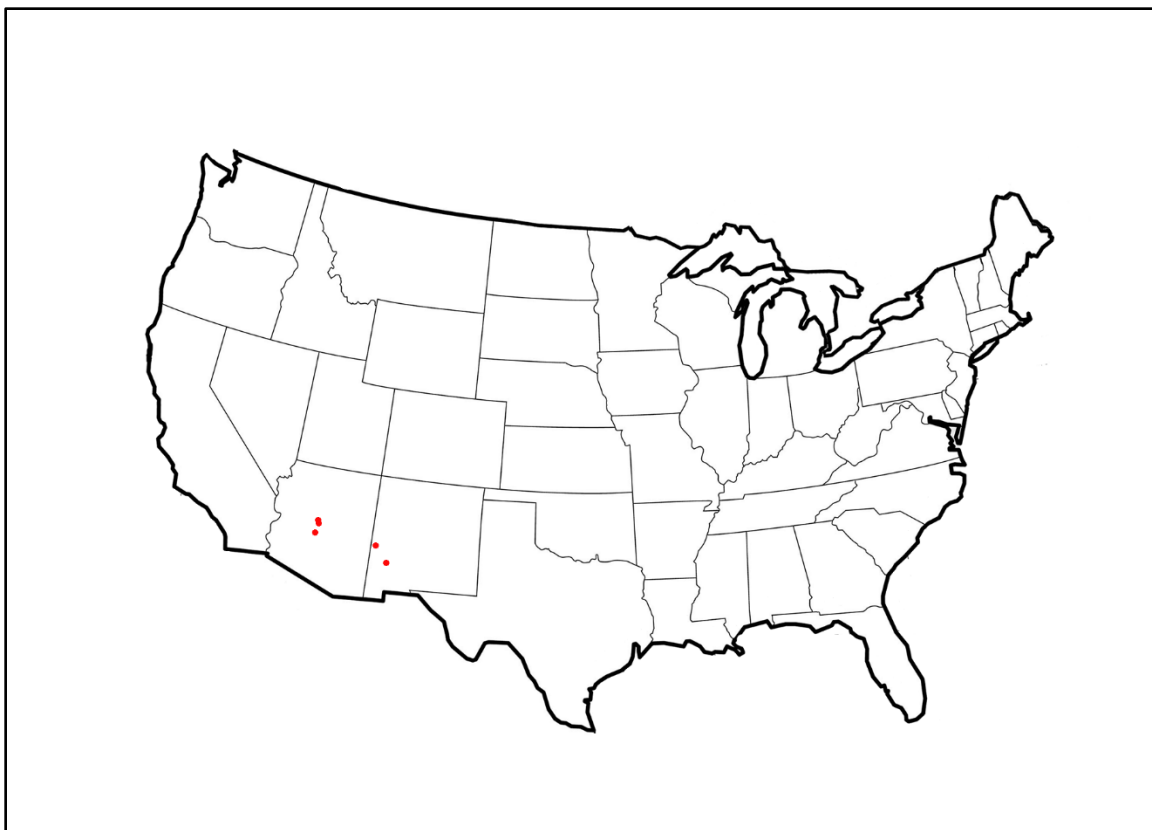
**Venter** (930-1230 (930) long; 790-1090 (790) wide), colorless. Gnathosomal bay (170-310 (190) long; 50-70 (50) wide. Cxgl-4 subapical. **Medial suture** (60-95 (90) long). **Genital plates** (190-260 (190) long; 170-220 (180) wide). Additional measurements: Cx-1 (420-510 (440) long (total); 150-220 (160) long (medial); Cx-3 (530-680 (530) wide); anterior venter (250-310 (250) long). Ventral proportions: gnathosomal bay length/width 2.83-4.43 (3.80); anterior venter/genital field length 1.08-1.32 (1.32); anterior venter length/genital field width 1.23-1.47 (1.39).

**IMMATURES** unknown.

**Etymology.** Specific epithet *banjoii* is from one of the campgrounds from which the allotype was collected (Banjo Bill Campground in Arizona).

**Distribution.** Known from New Mexico and Arizona at this time (Fig. 21).

**Remarks.** Unfortunately, we were unable to acquire fresh material of *Monatractides banjoii*, so this species is not included in our phylogenetic analysis. However, we were able to examine morphology with material mounted in glycerin jelly. The overall appearance, large size, distribution, and dissimilarity to other described species lend confidence that this is a novel western species.



**Figure 21.** *Monatractides banjoii* n. sp. distribution

***Monatractides brewsteri* Nelson & Dowling, sp. n.**

**Material examined.** HOLOTYPE (♀): **USA, Texas**, from Brewster County, Alpine; beside Rt. 118, 32.8 km south of Rt. 67/90, (30°6'6"N, 103°35'35"W), 2 May 2011, by IM Smith, IMS110002.

PARATYPES (2♀; 2♂): **USA, Texas**: (allotype) 1♂ from Val Verde County, Nature Conservancy Dolan Falls Preserve; just above ford through Devils River to campsite, (29°53'53"N, 100°59'59"W), 24 May 2011, by IM Smith, IMS110013 • 1♀ from Brewster County, Alpine; beside Rt. 118, 32.8 km south of Rt. 67/90, (30°6'6"N, 103°35'35"W), 2 May 2011, by IM Smith, IMS110002 • 1♀ and 1♂ from Val Verde County, Nature Conservancy Dolan Falls Preserve; just above ford through Devils River to campsite, (29°53'53"N, 100°59'59"W), 24 May 2011, by IM Smith, IMS110013

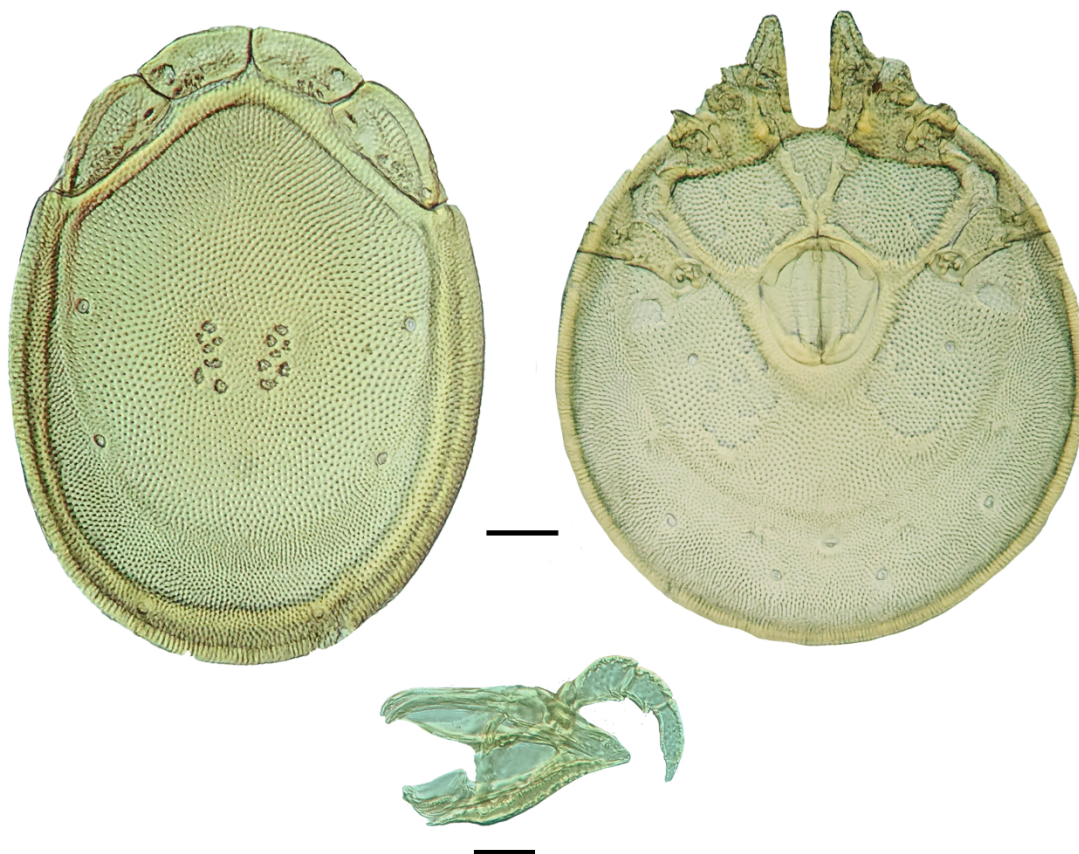
**Type deposition.** Holotype (♀), allotype (♂), and paratypes (2♀; 1♂) deposited in the CNC.

**Diagnosis.** *Monatractides brewsteri* are similar to other members of the oblongata complex (*M. banjoii* and *M. oblongata*) in being colorless and ovoid. The Texas group can be easily differentiated from *M. banjoii* by the dorsum width (dorsum width ♀ = 700-1060, ♂ = 665-960 in *M. banjoii*; ♀ = 440-590, ♂ = 345-500 in the Texas group). The Texas group can be differentiated from *M. oblongata* by the width of the gnathosoma (gnathosomal width ♀ = 70-80; ♂ = 65-75 in *M. oblongata*, ♀ = 45-60; ♂ = 40-50 in the Texas group). *M. brewsteri* can be differentiated from *M. banderae* using the anteriomedial platelet measurements for ♀ (anteriomedial platelet length/width measurement ♀ = 1.17-1.88 in *M. brewsteri*, 2.14-2.23 in *M. banderae*), and dorsal measurements for ♂ (dorsum length/width measurements ♂ = 1.16 in *M.*



*brewsteri*, 1.24-1.29 in *M. banderae*).

**Description. FEMALE (Fig. 22)** (n= 3) (holotype measurements in parentheses when available) with characters of the genus with the following specifications.



**Figure 22.** *Monatractides brewsteri* sp. n. female: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum and pedipalp (setae not accurately depicted). Scale = 100  $\mu$ m.

**Dorsum** (580-770 (770) long; 440-590 (570) wide) ovoid and with no dorsal coloration. Anterio-medial platelets (120-150 (150) long; 70-80 (80) wide). Anterio-lateral platelets (140-175 (175) long; 80 (80) wide), free from dorsal plate. Dgl-4 much closer to the edge of the dorsum than to the muscle scars (distance between Dgl-4 370-430 (410)). Dorsal plate proportions: dorsum length/width 1.32-1.35 (1.35); dorsal width/distance between Dgl-4 0.79-



0.83 (0.79); antero-medial platelet length/width 1.71-1.88 (1.88); antero-lateral platelet length/width 1.75-2.19 (2.19); antero-lateral/antero-medial length 1.17 (1.17).

**Gnathosoma-Subcapitulum** (175-195 (195) long (ventral); 120-182.5 (182.5) long (dorsal); 30-40 (35) tall) colorless. Rostrum (95-120 (12) wide) short and stocky. Chelicerae (165-185 (185) long with curved fangs (35-40 (40) long). Subcapitular proportions: ventral length/dorsal length (1.07-1.46 (1.07)). **Pedipalps** (especially tibiae) with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (25 (25) long; 20-25 (20) wide); femur (50-55 (55) long; 35-40 (40) wide); genu (35 (35) long; 30-35 (30) wide); tibia (40-50 (50) long; 20-25 (25) wide); tarsus (20 (20) long; 10 (10) wide). Palpomere proportions: femur/genu 1.43-1.57 (1.57); tibia/femur 0.91-1.0 (0.91); tibia length/width 2.0-2.5 (2.00).

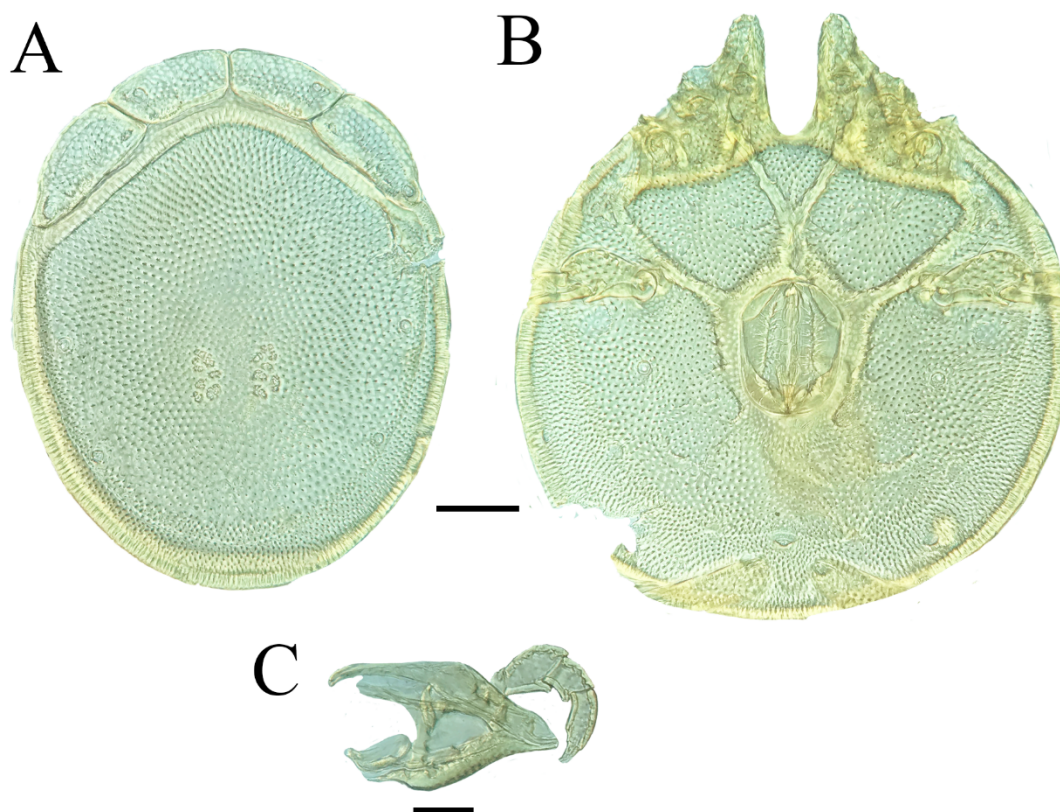
**Venter** (650-865 (840) long; 590-730 (710) wide) colorless. Gnathosomal bay (150-160 (150) long; 50-60 (60) wide. Cxgl-4 subapical. **Medial suture** (25-55 (50) long). **Genital plates** (155-175 (175) long; 145-170 (170) wide). Additional measurements: Cx-1 (270-320 (310) long (total); 100-120 (120) long (medial); Cx-3 (390-450 (450) wide); anterior venter (125-160 (160) long). Ventral proportions: gnathosomal bay length/width 2.50-3.0 (2.50); anterior venter/genital field length 0.81-0.94 (0.91); anterior venter length/genital field width 0.86-0.94 (0.94).

**MALE (Fig. 23)** (n = 2) with characters of the genus following specifications.

**Dorsum** (470 long; 405 wide) round and with no dorsal coloration. Antero-medial platelets (115 long; 60 wide). Antero-lateral platelets (115 long; 60 wide), free from dorsal plate. Dgl-4 much closer to the edge of the dorsum than to the muscle scars (distance between Dgl-4 300-305). Dorsal plate proportions: dorsum length/width 1.16-1.20; dorsal width/distance between Dgl-4 0.94; antero-medial platelet length/width 1.92; antero-lateral platelet

length/width 1.92; antero-lateral/anterio-medial length 1.0.

**Gnathosoma-Subcapitulum** (152.5-155 long (ventral); 100 long (dorsal); 25-27.5 tall) colorless. Rostrum (87.5-90 wide) short and stocky. Chelicerae (127.5 long) with curved fangs (35 long). Subcapitular proportions: ventral length/dorsal length (1.53). **Pedipalps** with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (20 long; 20-22.5 wide); femur (45 long; 30-32.5 wide); genu (30 long; 27.5 wide); tibia (42.5 long; 20 wide); tarsus (15-17.5 long; 12.5- wide). Palpomere proportions: femur/genu 1.50; tibia/femur 0.94; tibia length/width 2.13.



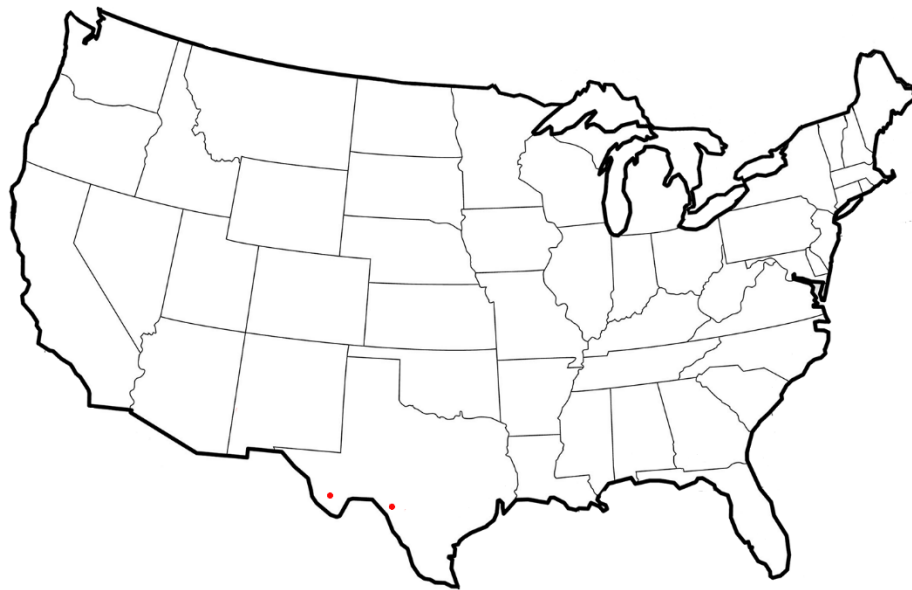
**Figure 23.** *Monatractides brewsteri* sp. n. male: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum and pedipalp (setae not accurately depicted). Scale = 100 μm.

**Venter** (575 long; 470-475 wide) with no ventral coloration. Gnathosomal bay (125 long; 40 wide. Cxgl-4 subapical. **Medial suture** (40 long). **Genital plates** (120-125 long; 100-105 wide). Additional measurements: Cx-1 (270 long (total); 100-110 long (medial); Cx-3 (310 wide); anterior venter (140 long). Ventral proportions: gnathosomal bay length/width 3.13; anterior venter/genital field length 1.12; anterior venter length/genital field width 1.40.

**IMMATURES** unknown.

**Etymology.** Specific epithet (*brewsteri*) refers to the county in which the type specimens were collected; Brewster County, Texas.

**Distribution.** South Texas (Fig. 24).



**Figure 24.** *Monatractides brewsteri* sp. n. distribution.

**Remarks.** *Monatractides brewsteri* group with the other members of the oblongata complex, *M. banderae*, *M. oblongata* and *M. banjoii* with high geographic and morphological support. Additionally, *M. brewsteri* has high group support with *M. oblongata* and *M. banderae* in our 28S analysis; sequencing data is absent for *M. banjoii*. Members of this species groups have high COI divergence from other groups (over 18% from other sister species). However, specimens within this group are have a COI divergence of 4.6% -- while this is higher than other species hypotheses set forth, there are no morphological features currently identified that can separate members of this group; additional sampling will be needed to determine if this is a case of cryptic species or identify other characteristics that may be used to support the separation of this group into two separate species.

***Monatractides coastalis* Nelson & Dowling, sp. n.**

**Material examined.** HOLOTYPE (♀): **USA, Washington**, Grays Harbor County: Capitol State Forest, (46°58'58"N, 123°16'16"W), 25 July 2013, by JC O'Neill, WA Nelson, JNOW 13-0725-005

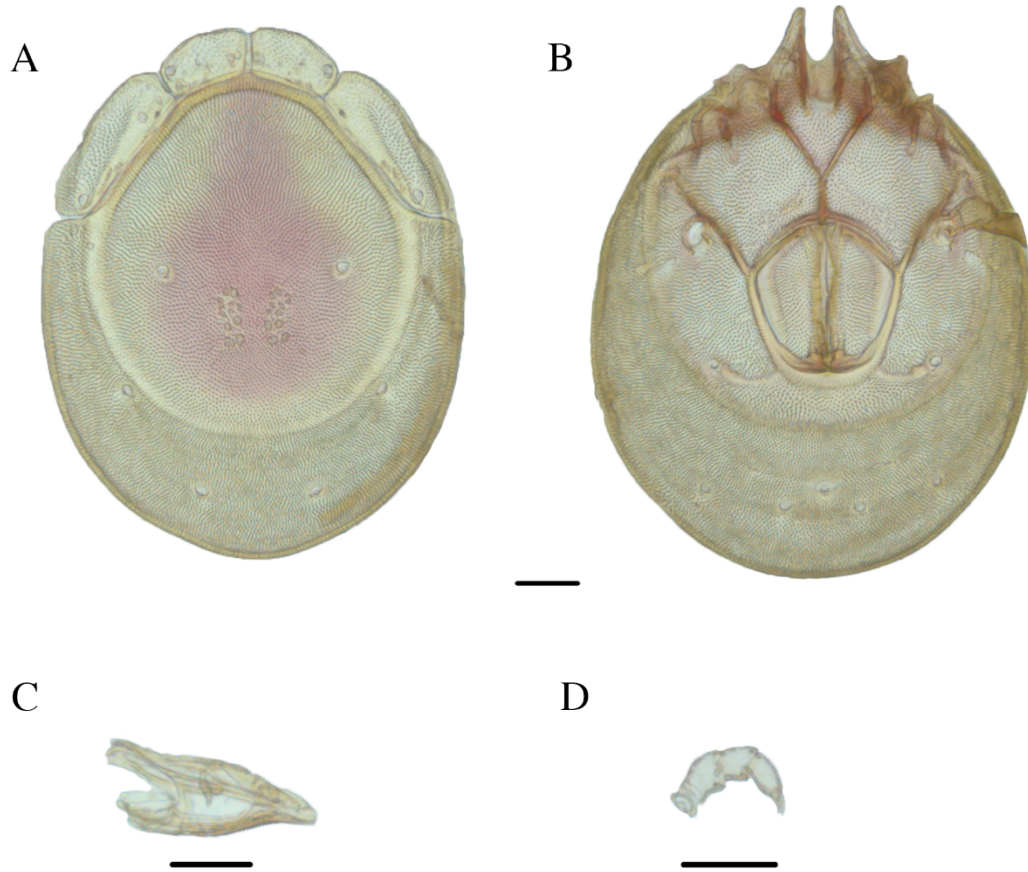
PARATYPES (4♀): **USA, Oregon**: 1♀ from Lane County, Siuslaw National Forest Cummins Creek, (44°15'15"N, 124°6'6"W), 10 August 2013, by JC O'Neill, WA Nelson, JNOW 13-0810-005 • 1♀ from Washington (45°38'38"N, 123°19'19"W), 2 August 2013, by JC O'Neill, WA Nelson, JNOW 13-0802-005 • 1♀ from Lane County, Willamette National Forest Cougar Creek, (44°8'8"N, 122°14'14"W), 11 August 2013, by JC O'Neill, WA Nelson, JNOW 13-0811-003 • **Washington, United States**: 1♀ from Grays Harbor County, Stewarts Creek, (47°15'15"N, 123°55'55"W), 25 July 2013, by JC O'Neill, WA Nelson, JNOW 13-0725-001

**Type deposition.** Holotype (♀) deposited in the CNC. All other paratypes (3♀) deposited in the ACUA.

**Diagnosis.** *Monatractides coastalis* is similar to other members of the Simulans group by having a relatively narrow subcapitulum. Visually similar to other members of the group, *M. coastalis* can be most easily differentiated from *M. curva* by not possessing the downward curved subcapitulum, as well as using the genital field measurements (genital field width ♀ = 240-250 in *M. coastalis*, 200-215 in *M. coastalist*). *M. coastalis* can be differentiated from *M. gilbroskii* using the dorsum width (dorsum width measurement ♀ = 580-705 in *M. coastalis*; 750-820 in *M. gilbroskii*). *M. coastalis* is similar to *M. simulans*, but can be differentiated most easily using the pinkish-purple ventral coloration present in *M. coastalis* and absent in *M. simulans*. Anteriolateral plate measurements can also be used to differentiate these two species

(anteriolateral plate width ♀ = 90-100 in *M. coastalis*, 110-135 in *M. simulans*).

**Description. FEMALE (Fig. 25)** (n= 4) (holotype measurements in parentheses when available) with characters of the genus with the following specifications.



**Figure 25.** *Monatractides coastalis* sp. n. female: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum **D** pedipalp (setae not accurately depicted). Scale = 100 μm.

**Dorsum** (710-880 (880) long; 580-705 (690) wide) round and with a purple-pink dorsal coloration. Anterio-medial platelets (110-160 (150) long; 80-90 (90) wide). Anterio-lateral platelets (230-280 (280) long; 90-100 (100) wide), free from dorsal plate. Dgl-4 equidistant between muscle scars and edge of dorsum (distance between Dgl-4 290-335 (300)). Dorsal plate

proportions: dorsum length/width 1.21-1.28 (1.28); dorsal width/distance between Dgl-4 0.85-0.89 (0.86); antero-medial platelet length/width 1.22-2.0 (1.67); antero-lateral platelet length/width 2.5-3.11 (2.80); antero-lateral/antero-medial length 1.75-2.27 (1.87).

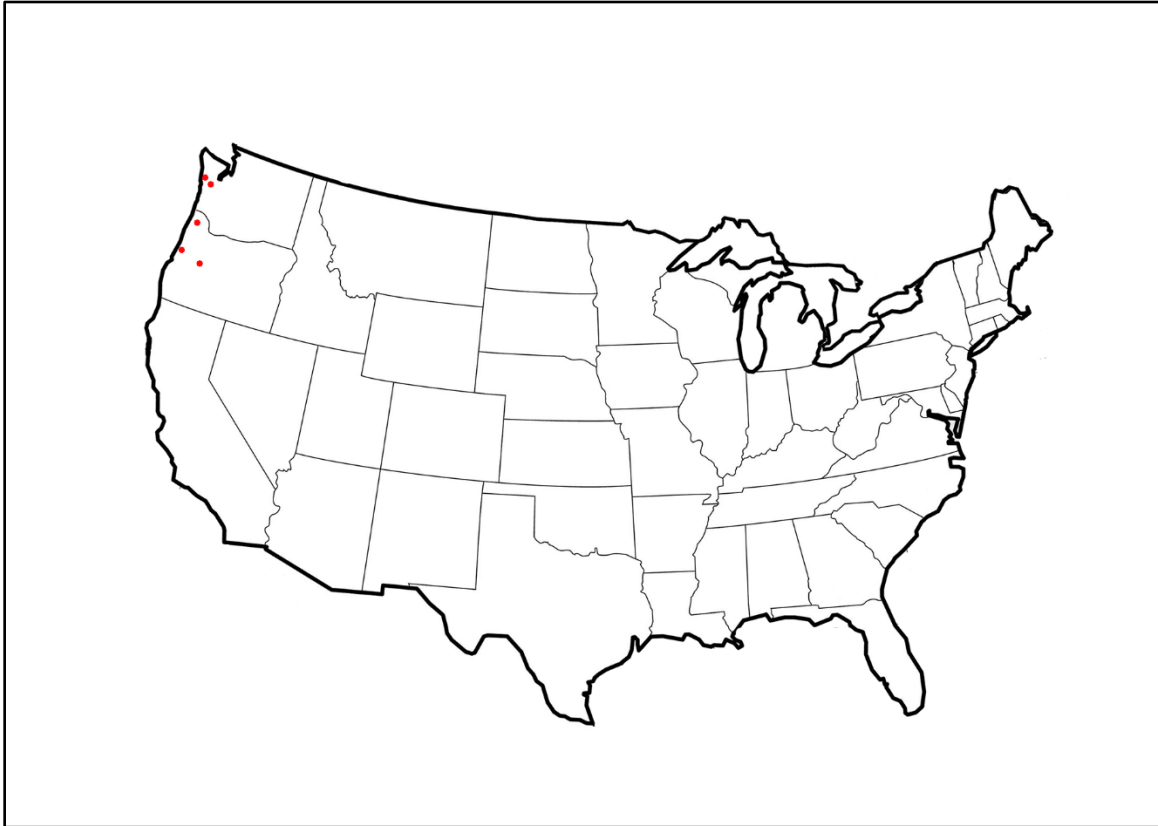
**Gnathosoma-Subcapitulum** (215-245 (235) long (ventral); 150-180 (165) long (dorsal); 45-70 (65) tall) colorless. Rostrum (85-105 (90) wide) long and narrow. Chelicerae (210-270 (255) long with curved fangs 25-35 (35) long). Subcapitular proportions: ventral length/dorsal length (1.36-1.47 (1.42)). **Pedipalps** short and stocky (especially tibiae) with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (15-20 (20) long; 30-35 (35) wide); femur (40-50 (50) long; 35-45 (40) wide); genu (35-40 (40) long; 35-40 (35) wide); tibia (40-45 (45) long; 25-30 (30) wide); tarsus (22.5-25 (25) long; 15-20 (15) wide). Palpomere proportions: femur/genu 1.0-1.43 (1.25); tibia/femur 0.90-1.0 (0.90); tibia length/width 1.5-1.8 (1.5).

**Venter** (750-1000 (980) long; 650-780 (780) wide) with purple coloration on ventral plates (CxI-III). Gnathosomal bay (140-170 (160) long; 50 (50) wide. Cxgl-4 subapical. **Medial suture** (60-80 (60) long). **Genital plates** (250-270 (250) long; 180-200 (180) wide). Additional measurements: Cx-1 (290-375 (300) long (total); 130-140 (140) long (medial); Cx-3 (450-500 (490) wide); anterior venter (200-230 (200) long). Ventral proportions: gnathosomal bay length/width 2.8-2.4 (3.2); anterior venter/genital field length 0.77-0.88 (0.77); anterior venter length/genital field width 0.77-0.92 (0.77).

**MALES** unknown.

**IMMATURES** unknown.

**Etymology.** Specific epithet *coastalis* refers to the western coast, along which this species has been collected.



**Figure 26.** *Monatractides coastalis* distribution.

**Distribution.** Known from Washington and Oregon (Figure 26).

**Remarks.** In all analyses, *Monatractides coastalis* groups with other members of the *Simulans* group, and groups with high support in the COI-only analysis. This species hypothesis is supported by low COI divergence within species (less than 0.5%) and high divergence between species (at least 12% from its sister species), and by the morphological characteristics outlined in the diagnosis.



***Monatractides confusica* Nelson & Dowling, sp. n.**

**Material examined.** HOLOTYPE (♀): **USA, Alabama:** ♀ from Lauderdale, off Natchez Trace Parkway 7.0 km south of Tennessee State Line, (34°56'56"N, 87°49'49"W), 27 September 2010, by IM Smith, IMS100162.

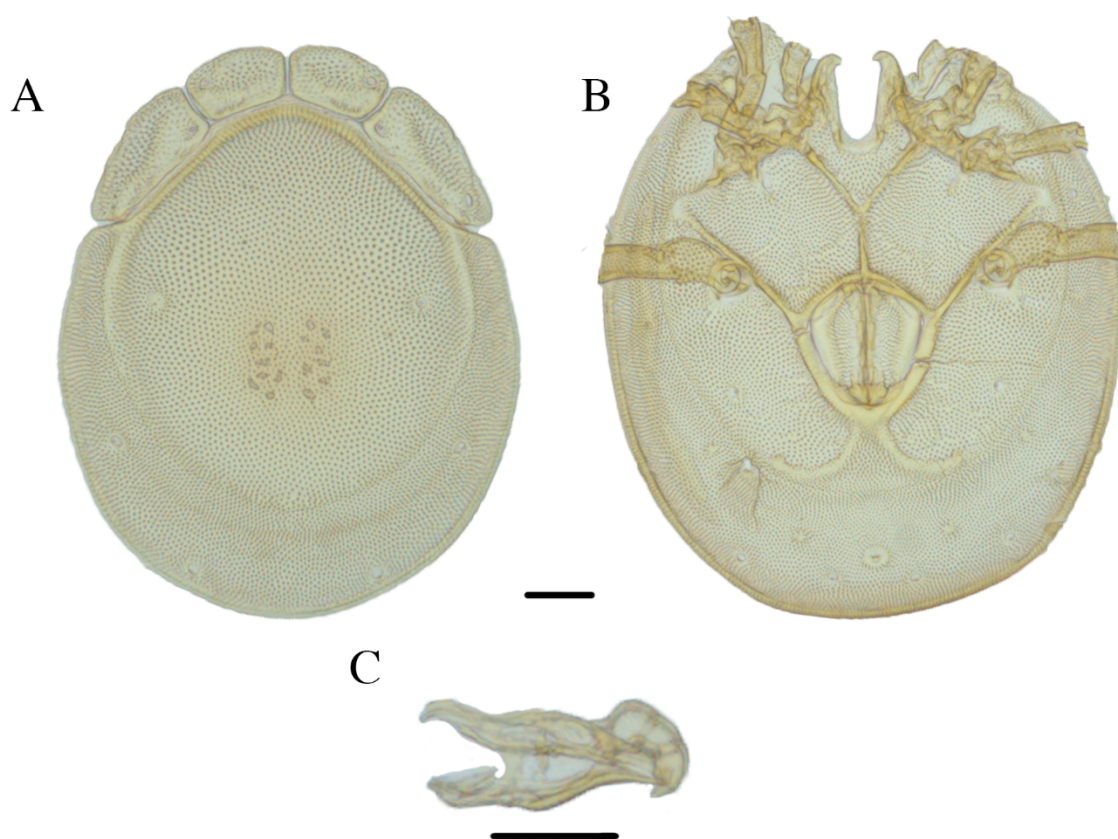
PARATYPES (0♀,1♂): **CANADA, New Brunswick:** (allotype) 1♂ from Charlotte Co; Rollingham, Digdegaush Rv; beside HW 770, (45°18'18"N, 67°4'4"W), 3 October 2011, by IM Smith, IMS110118.

**Type deposition.** Holotype (♀) and allotype (♂) deposited in the CNC.

**Diagnosis.** *Monatractides confusica* are similar to other members of the Eastern group by the smaller size, although is unlike other members in that the two recovered specimens does not have any dorsal coloration, like many other eastern species. However, both of the type specimens for this species were mounted in Hoyer's solution, so coloration may have been lost. Like other members of the Eastern Elongatus group, *M. confusica* has an elongated subcapitulum compared to other known monatractids, which differentiates it from all but its sister species, *M. pertussiae* and *M. montgomeryae*. *M. confusica* can be differentiated from *M. pertussiae* by the dorsal measurements (dorsum width ♀ = 600 in *M. confusica*, 640-690 in *M. pertussiae*; ♂ = 420 in *M. confusica*, 570-680 in *M. pertussiae*), and from *M. montgomeryae* using the anteriomedial platelet length/width measurement measurement (anteriomedial platelet length/width ♀= 1.36-1.44 in *M. pertussiae*, 1.62 in *M. confusica*; ♂=1.43 in in *M. confusica*, 1.22-1.37 in *M. pertussiae* and 2.33 in *M. montgomeryae*).

**Description. FEMALE (Fig. 27)** (n=1) with characters of the genus with the following specifications.

**Dorsum** – (780 long; 600 wide) ovoid, colorless. Anterio-medial platelets (130 long; 80 wide). Anterio-lateral platelets (210 long; 90 wide), free from dorsal plate. Dgl-4 closer or equidistant to the muscle scars than to the edge of the dorsum scars (distance between Dgl-4 360). Dorsal plate proportions: dorsum length/width 1.30; dorsal width/distance between Dgl-4 0.85; anterio-medial platelet length/width 1.63; anterio-lateral platelet length/width 2.33; anterio-lateral/anterio-medial length 1.62.



**Figure 27.** *Monatractides confusica* sp. n. female: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum and palp (setae not accurately depicted). As this specimen was mounted in Hoyer's solution, coloration may not be accurate. Scale = 100  $\mu$ m.

**Gnathosoma-Subcapitulum** (205 long (ventral); 140 long (dorsal); 50 tall) colorless.

Rostrum (90 wide) relatively long and narrow. Chelicerae (210) long with curved fangs (25 long). Subcapitular proportions: ventral length/dorsal length (1.46). **Pedipalps** stocky with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (17.5 long; 25 wide); femur (40 long; 40 wide); genu (30 long; 32.5 wide); tibia (37.5 long; 27.5 wide); tarsus (25 long; 15 wide). Palpomere proportions: femur/genu 1.33; tibia/femur 0.94; tibia length/width 1.36.

**Venter** (840 long; 750 wide) colorless. Gnathosomal bay (130 long; 55 wide). Cxgl-4 subapical. **Medial suture** (100 long). **Genital plates** (180 long; 165 wide). Additional measurements: Cx-1 (330 long (total); 110 long (medial); Cx-3 (255 wide); anterior venter (210 long). Ventral proportions: gnathosomal bay length/width 2.36; anterior venter/genital field length 1.17; anterior venter length/genital field width 1.27.

**MALE (Fig. 28)** (n =1) with characters of the genus following specifications.

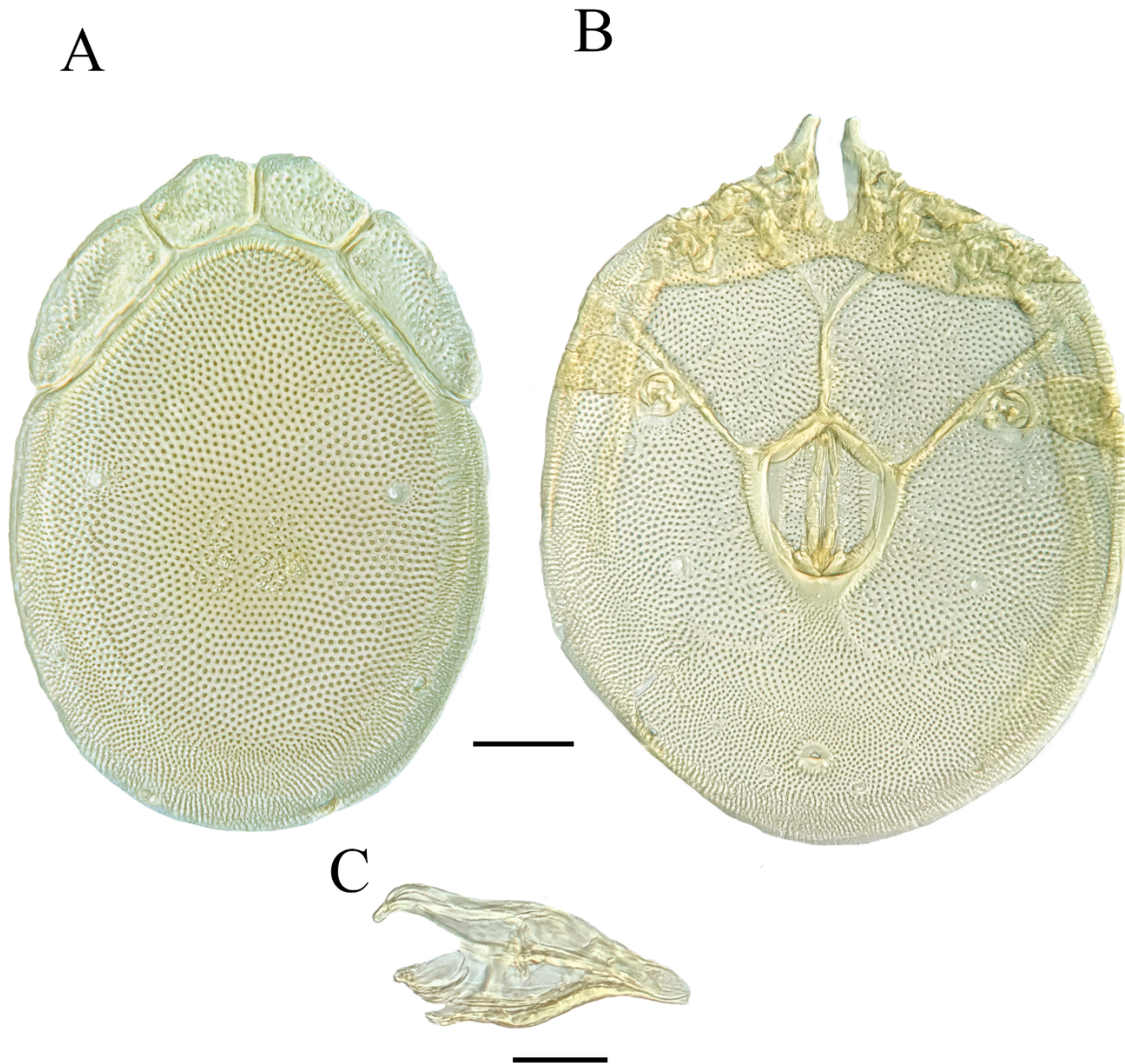
**Dorsum** – (610 long; 420 wide) ovoid, colorless. Anterio-medial platelets (100 long; 70 wide). Anterio-lateral platelets (180 long; 70 wide), free from dorsal plate. Dgl-4 closer or equidistant to the muscle scars than to the edge of the dorsum scars (distance between Dgl-4 270). Dorsal plate proportions: dorsum length/width 1.45; dorsal width/distance between Dgl-4 0.76; anterio-medial platelet length/width 1.43; anterio-lateral platelet length/width 2.57; anterio-lateral/anterio-medial length 1.80.

**Gnathosoma-Subcapitulum** (165 long (ventral); 125 long (dorsal); 30 tall) colorless.

Rostrum (75 wide) relatively long and narrow. Chelicerae (195) long with curved fangs (30 long). Subcapitular proportions: ventral length/dorsal length (1.32). **Pedipalps** stocky with

tuberculate ventral extensions on femora and genua. Palpomeres: trochanter 15 long; 25 wide); femur (25 long; 25 wide); genu (20 long; 20 wide); tibia (30 long; 20 wide); tarsus (10 wide).

Palpomere proportions: femur/genu 1.25; tibia/femur 1.20; tibia length/width 1.50.



**Figure 28.** *Monatractides confusica* sp. n. male: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum. As this specimen was mounted in Hoyer's solution, coloration may not be accurate. Scale = 100  $\mu$ m.

**Venter** (690) long; 550 wide) colorless. Gnathosomal bay (100 long; 40 wide). Cxgl-4

subapical. **Medial suture** (90 long). **Genital plates** (150 long; 115 wide). Additional measurements: Cx-1 (200 long (total); 100 long (medial); Cx-3 (415 wide); anterior venter (190 long). Ventral proportions: gnathosomal bay length/width 2.50; anterior venter/genital field length 1.27; anterior venter length/genital field width 1.65.

**IMMATURES unknown.**



**Figure 29.** *Monatractides confusica* distribution.

**Etymology.** Specific epithet *confusica* was chosen in honor of the distance between the collection sites, and the fact that both of the specimens used to identify this group were mounted in Hoyer's solution, so there is no known record of the coloration found in this species (see remarks for additional notes).

**Distribution.** *M. confusica* is currently known from Alabama and New Brunswick, and

presumably along the coast from one collection site to the other (Fig. 29).

**Remarks.** In all analyses, *Monatractides confusica* groups with other members of the Eastern group with high support. Additionally, *M. confusica* groups with the two other species of monatractids also having elongated subcapitula; *M. montgomeryae* and *M. pertussiae*. Species hypotheses are supported by high COI divergence between species (at least 9.9% from its sister species), and by the morphological characters outlined in the diagnosis. It is notable that COI divergence between specimens in this species hypothesis is larger than expected (5%); this genetic divergence may be related to the wide geographic range between the sampled taxa, or may represent the presence of a cryptic species. This species is described using a single collected female and a single collected male; while the COI divergence between specimens could lead to the decision to split this grouping into two species, but it is the decision of these authors to not split this group at this time. Future sampling may recover additional specimens leading to splitting this species hypothesis into two separate species, but the morphological similarities between these two specimens are indicative of a single species group, given what is known about North American *Monatractides* at this time.

As noted in the Etymology section, both of the collected specimens were mounted in Hoyer's solution, which is the preferred mounting media for terrestrial mites. Hoyer's solution does have superior optical properties when compared to glycerin jelly (the preferred mounting medium for adult water mites) because of its high refraction index, and has the additional advantage of clearing soft tissues during slide preparation, allowing for better examination of sclerotized parts. However, as noted in Fisher et al. (2015), this medium leads to a rapid loss of pigmentation (the bright purples, oranges, and blues seen in monatractids), though structural color (often appearing orange) is retained.

***Monatractides cooki* (Habeeb, 1955)**

*Torrenticola cooki* Habeeb 1955:4.

**Material examined.** COTYPE (1♂): **USA, New Jersey:** from Sussex County, 23 May 1953, Cranberry Lake, by H. Habeeb. HH530047.

**Type deposition.** Cotype (1♂) deposited in the CNC.

**Diagnosis.** *Monatractides cooki* was collected from Cranberry Lake in New Jersey and a male was described. One male cotype was obtained for measurements. Presented herein is a tentative diagnosis, pending additional measurements. *M. cooki* is a large mite; one of the largest monatractids in North America, and definitely in the east. Based off dorsum measurements alone, this species can be differentiated from all other eastern species, except perhaps from *M. jordanensis*, which is also large (♂ dorsum length = 985 in *M. jordanensis*, 900 in *M. cooki*, >720 in all other eastern species; ♂ dorsum width = 832 in *M. jordanensis*, 720 in *M. cooki*, >700 in all other eastern species).

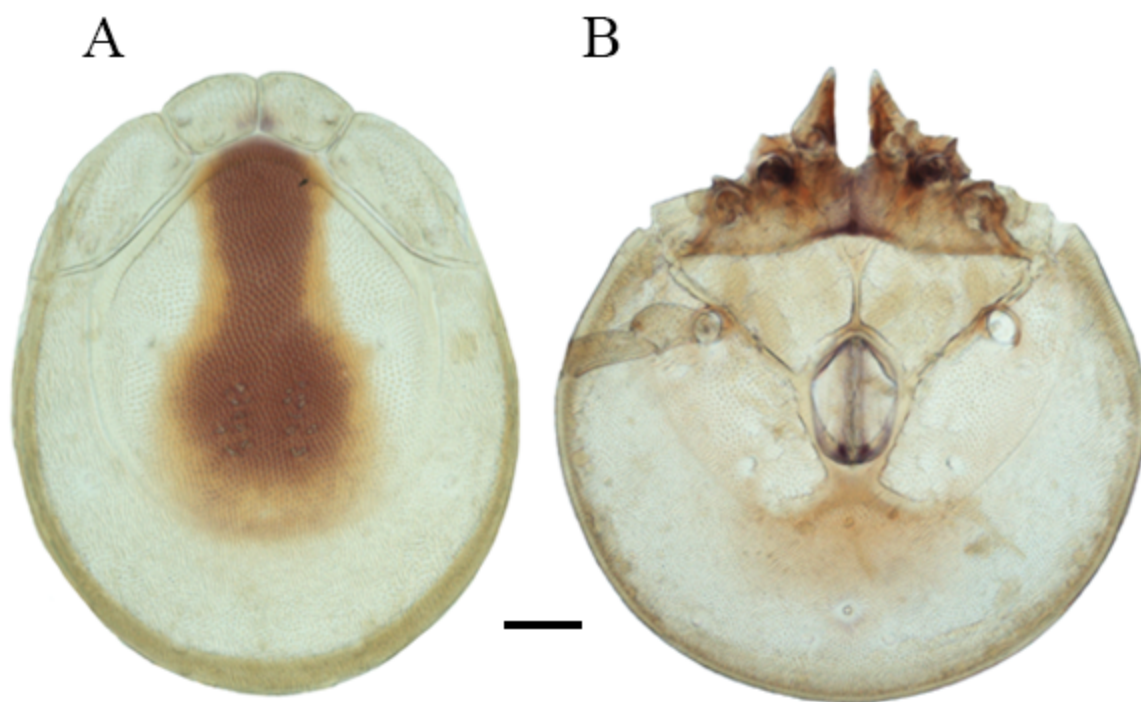
**Description. FEMALE** (n= 0) unknown.

**MALE (Fig. 30)** (n=1) with characters of the genus following specifications.

**Dorsum** (900 long; 720 wide) round and likely with some dorsal coloration. Anterio-medial platelets (120 long; 90 wide). Anterio-lateral platelets (223 long; 82.5 wide), free from dorsal plate. Dgl-4 closer to muscle scars than to the edge of dorsum (distance between Dgl-4 330). Dorsal plate proportions: dorsum length/width 1.24; dorsal width/distance between Dgl-4 0.95; anterio-medial platelet length/width 1.34; anterio-lateral platelet length/width 2.84; anterio-lateral/anterio-medial length 1.93.



**Venter** (835 long; 815 wide) colorless. Gnathosomal bay (125 long; 70 wide. Cxgl-4 subapical. **Medial suture** (125 long). **Genital plates** (180 long; 115 wide). Additional measurements: Cx-1 (245 long (total); 125 long (medial); Cx-3 (520 wide); anterior venter (225 long). Ventral proportions: gnathosomal bay length/width 2.09; anterior venter/genital field length 1.24; anterior venter length/genital field width 1.93.



**Figure 30.** *Monatractides cooki* male: **A** dorsal plates **B** venter (legs removed). Scale = 100  $\mu$ m.

**IMMATURES** unknown.

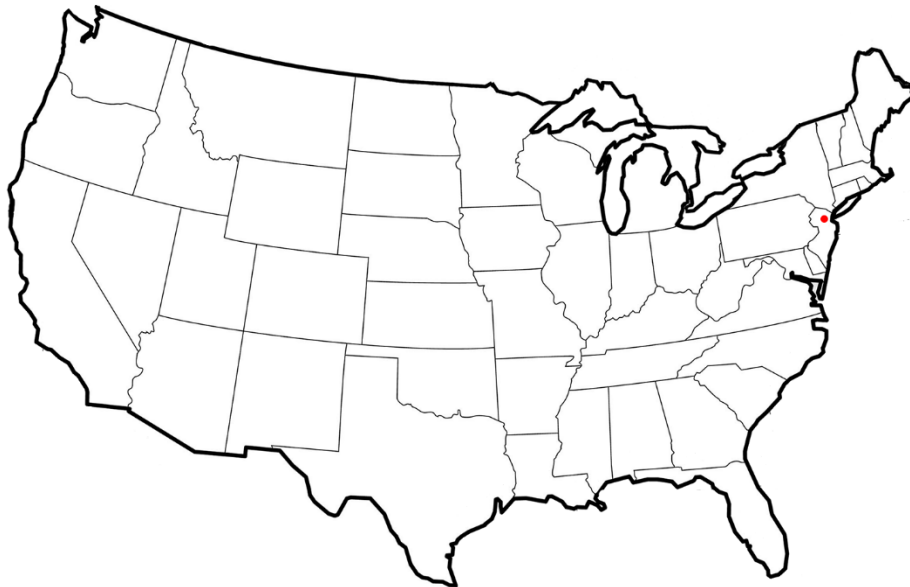
**Etymology.** Habeeb (1955) notes in the original description of *Torrenticola cooki* that



this species was named for David Cook.

**Distribution.** Known from Cranberry Lake, New Jersey (Fig. 31).

**Remarks.** *Monatractides cooki* is described from a single male cotype from the original collection. Unfortunately, no additional fresh specimens were recovered to allow for DNA extraction.



**Figure 31:** *Monatractides cooki* distribution.

***Monatractides curva* Nelson & Dowling sp. n.**

**Material examined.** HOLOTYPE (♀): **USA, Tennessee**, Sevier County, Great Smoky Mountains National Park; Greenbrier Picnic Area off Greenbrier Road, (35°42'42"N, 83°22'22"W), 10 September 2009, by IM Smith, IMS090106.

PARATYPES (57♀; 55♂): **USA, Tennessee:** (allotype) 1♂ from Sevier County, Great Smoky Mountains National Park; Greenbrier Picnic Area off Greenbrier Road, (35°42'42"N, 83°22'22"W), 10 September 2009, by IM Smith, IMS090106 • 1♀ and 1♂ from Sevier County, Great Smoky Mountains National Park; Greenbrier Picnic Area off Greenbrier Road, (35°42'42"N, 83°22'22"W), 10 September 2009, by IM Smith, IMS090106 • 1♂ from Sevier County, Great Smoky Mountains National Park; Sugarlands Nature Trail off Rt. 441/71, (35°40'40"N, 83°31'31"W), 10 September 2010, by IM Smith, IMS100125 • 1♂ from Sevier County, Great Smoky Mountains National Park; Sugarlands Nature Trail off Rt. 441/71, (35°40'40"N, 83°31'31"W), 14 September 2010, by IM Smith, IMS100136 • 1♀ from Blount County, Great Smoky Mountains National Park; Cades Cove; near parking lot for Abrams Falls Trail, (35°35'35"N, 83°51'51"W), 17 September 2010, by IM Smith, IMS100143 • 1♀ from Sevier County, Great Smoky Mountains National Park; Sugarlands Nature Trail off Rt. 441/71, (35°40'40"N, 83°31'31"W), 24 September 2010, by IM Smith, IMS100158 • **North Carolina, United States:** 1♀ and 1♂ from Swain County, Great Smoky Mountains National Park; Oconaluftee, beside Rt. 441, 1.9 km south of Collins Creek Picnic Area, (35°33'33"N, 83°19'19"W), 11 September 2009, by IM Smith, IMS090109 • 1♀ from Haywood County, Great Smoky Mountains National Park; Cataloochee; beside Mt. Sterling Rd. near bridge 1.7 km n. of road to Campground, (35°38'38"N, 83°4'4"W), 20 September 2010, by IM Smith, IMS100150 • **New Brunswick, Canada:** 1♂ from Victoria County, St. Quentin, Jardin Brook, beside Hwy 17,

7.2 km SW of Hwy 180, (47°29'29"N, 67°23'23"W), 4 September 2011, by IM Smith, IMS110058 • 1♀ and 1♂ from Victoria County, St. Leonard, Grand River, bsde Hwy 17, 33.7 km NW of Hwy 2, (47°10'10"N, 67°54'54"W), 4 September 2011, by IM Smith, IMS110060 • 1♂ from Charlotte County; Rollingham, Digdegaush Rv; beside HW 770, (45°18'18"N, 67°4'4"W), 3 October 2011, by IM Smith, IMS110118 • 1♂ from York County, Napadogan beside Rd J-19, 4.0 km S of Hwy 107, (46°24'24"N, 66°55'55"W), 6 October 2011, by IM Smith, IMS110126 • 1♀ from Kent County, Kouchibouguac National Park, (46°50'50"N, 64°59'59"W), 27 September 1977, by IM Smith, IMS770164A • 1♀ from York County, Nashwaak Experimental Watershed; beside Trunk Road (J-19) near Nashwaak Experimental Watershed Headquarters, (46°6'6"N, 66°36'36"W), 20 July 1980, by IM Smith, IMS800118B • 1♂ from York County, Nashwaak Experimental Watershed; above Road J-19, (46°6'6"N, 66°36'36"W), 21 July 1980, by IM Smith, IMS800119A • 1♀ and 1♂ from York County, Nashwaak Experimental Watershed; beside Road J-19, (46°6'6"N, 66°36'36"W), 21 July 1980, by IM Smith, IMS800120A • 1♀ and 1♂ from York County, Nashwaak Experimental Watershed; near Nashwaak River, (46°6'6"N, 66°36'36"W), 22 July 1980, by IM Smith, IMS800121A • 1♀ and 1♂ from York County, Nashwaak Experimental Watershed Area; beside road near Grand John Brook, (46°6'6"N, 66°36'36"W), 20 July 1981, by IM Smith, IMS810086 • 1♀ from York County, Nashwaak Experimental Watershed Area; beside Road J-19 near Narrows Mountain, (46°6'6"N, 66°36'36"W), 21 July 1981, by IM Smith, IMS810090B • 1♀ from York County, beside Hwy. 107 between Napadogan and Juniper, 27.3 km west of Road J-19, (46°40'40"N, 67°0'0"W), 22 July 1981, by IM Smith, IMS810092B • 1♀ and 1♂ from York County, beside Hwy. 107 between Napadogan and Juniper, 15.1 km west of Road J-19, (46°40'40"N, 67°0'0"W), 22 July 1981, by IM Smith, IMS810093 • 1♀ and 1♂ from York County, beside

Road J-19, 16 km north of Nashwaak Experimental Watershed Field Headquarters, (47°10'10"N, 67°0'0"W), 22 July 1981, by IM Smith, IMS810094A • 1♂ from York County, beside Road J-19, 16 km north of Nashwaak Experimental Watershed Field Headquarters, (47°10'10"N, 67°0'0"W), 22 July 1981, by IM Smith, IMS810094B • 2♀ from Charlotte County, beside Hwy. 770 at covered bridge at Rollingdam, (45°19'19"N, 67°5'5"W), 30 June 1989, by IM Smith, IMS890053 • 1♀ and 1♂ from York County, beside Hwy. 8, 1.7 km north of road to Durham Bridge, (46°7'7"N, 66°36'36"W), 2 July 1989, by IM Smith, IMS890058 • **Nova Scotia, Canada:** 1♀ and 2♂ from Inverness County, Cheticamp River, (0°0'0", 0°0'0"), 10 September 2011, by IM Smith, IMS110071 • 5♀ and 6♂ from Inverness County, Cape Breton Highlands NP, Cheticamp Entrance nr Salmon Pools Trailhead, near Cheticamp River, (46°38'38"N, 60°56'56"W), 10 September 2011, by IM Smith, IMS110072 • 2♀ and 1♂ from Inverness County, Cape Breton Highlands NP, Cheticamp Entrance near Salmon Pools Trailhead, stream near Cheticamp Rvr, (46°38'38"N, 60°56'56"W), 10 September 2011, by IM Smith, IMS110073 • 2♀ and 1♂ from Victoria County, Cape Breton Highlands N.P., Warren Lake Stream, Warren Lake Rec. Area beside trail on N side of stream, (46°42'42"N, 60°22'22"W), 12 September 2011, by IM Smith, IMS110078 • 1♀ and 1♂ from Inverness County, Cape Breton Highlands N.P., Grande Anse River, Grande Anse Picnic Area E of Pleasant Bay, (46°49'49"N, 60°49'49"W), 13 September 2011, by IM Smith, IMS110080 • 2♀ and 1♂ from Lunenburg County, New Germany, LaHave Rv., beside HW 10, (44°32'32"N, 64°43'43"W), 23 September 2011, by IM Smith, IMS110098 • 1♂ from Victoria County, Cape Breton Highlands National Park; Clyburn Brook Picnic Area beside Cabot Trail, (46°32'32"N, 60°28'28"W), 2 July 1981, by IM Smith, IMS810051A • 1♀ and 1♂ from Cape Breton Highlands National Park; Trout Brook Picnic Area beside Cabot Trail, (46°42'42"N, 60°58'58"W), 3 July 1981, by IM Smith, IMS810052 • 1♀

from Inverness County, Cape Breton Highlands National Park; Lone Shieling, (46°48'48"N, 60°37'37"W), 3 July 1981, by IM Smith, IMS810054A • 1♂ from Victoria County, Cape Breton Highlands National Park; Warren Lake Picnic Area; just above Warren Lake, (46°43'43"N, 60°27'27"W), 4 July 1981, by IM Smith, IMS810055 • 1♂ from Victoria County, Cape Breton Highlands National Park; beside Cabot Trail just south of Neils Harbour, (46°50'50"N, 60°24'24"W), 4 July 1981, by IM Smith, IMS810058 • 1♀ from Victoria County, Cape Breton Highlands National Park; beside road to Mary Ann Falls at Branch Pond Road, (46°46'46"N, 60°25'25"W), 5 July 1981, by IM Smith, IMS810059A • 1♀ and 1♂ from Victoria County, Cape Breton Highlands National Park; beside road to Mary Ann Falls at Branch Pond Road, (46°46'46"N, 60°25'25"W), 5 July 1981, by IM Smith, IMS810059B • 3♀ and 2♂ from Victoria County, Cape Breton Highlands National Park; Mary Ann Falls Picnic Area, (46°50'50"N, 60°25'25"W), 5 July 1981, by IM Smith, IMS810060 • 1♂ from Victoria County, Cape Breton Highlands National Park; Clyburn Brook Picnic Area; Clyburn Brook Trailhead, (46°42'42"N, 60°26'26"W), 6 July 1981, by IM Smith & JD Smith, IMS810062 • 1♀ from Inverness County, Cape Breton Highlands National Park; Grande Anse Picnic Area beside Cabot Trail, (46°49'49"N, 60°54'54"W), 7 July 1981, by IM Smith, IMS810065 • 1♂ from Victoria County, Cape Breton Highlands National Park; beside Cabot Trail 4.5 km. north of Neils Harbour, (46°53'53"N, 60°24'24"W), 7 July 1981, by IM Smith & AB Smith, IMS810066 • 1♂ from Victoria County, Cape Breton Highlands National Park; beside Cabot Trail just east of North Mountain, (46°49'49"N, 60°37'37"W), 8 July 1981, by IM Smith, IMS810067A • 1♀ and 2♂ from Victoria County, Cape Breton Highlands National Park; beside Cabot Trail just east of North Mountain, (46°49'49"N, 60°37'37"W), 8 July 1981, by IM Smith, IMS810067B • 1♀ and 1♂ from Victoria County, Cape Breton; Cape North Village; beside Cabot Trail just south of

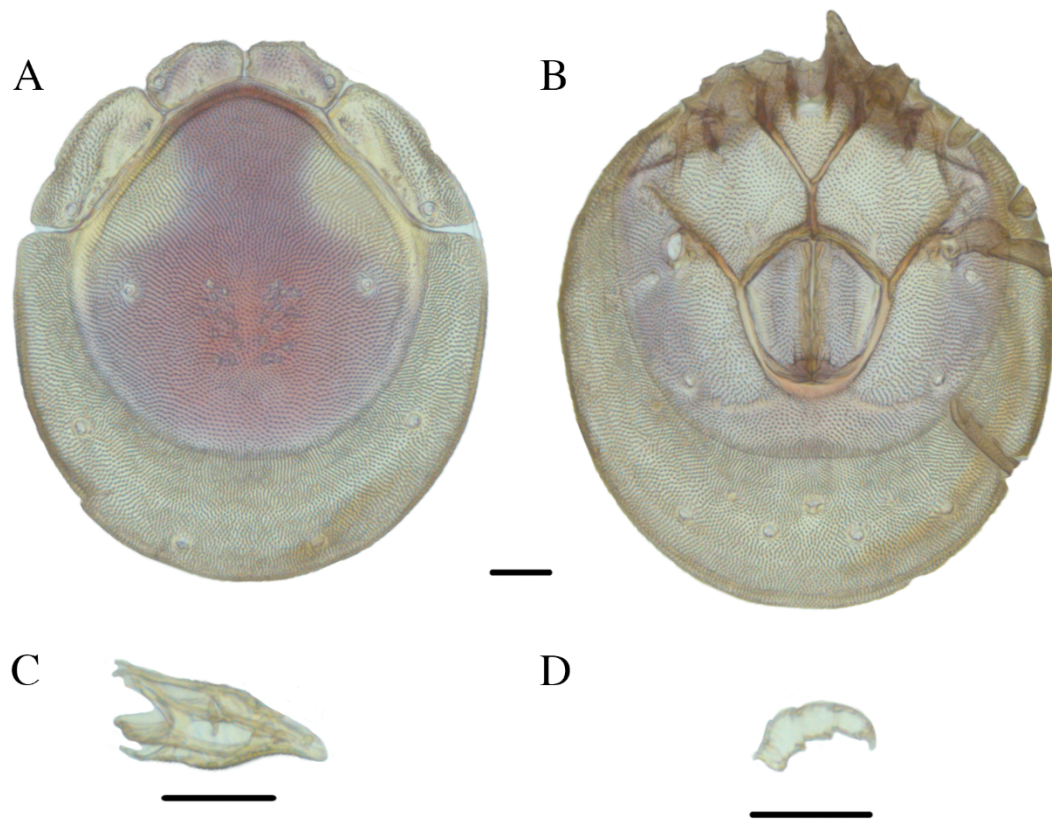
village, (47°51'51"N, 60°30'30"W), 8 July 1981, by IM Smith, IMS810068 • 1♀ and 1♂ from Victoria County, Cape Breton Highlands National Park; beside Cabot Trail, (46°51'51"N, 60°24'24"W), 9 July 1981, by IM Smith, IMS810070A • 1♀ from Victoria County, Tarbotvale; beside Cabot Trail, (46°21'21"N, 60°34'34"W), 10 July 1981, by IM Smith, IMS810071A • 1♀ from Victoria County, Ingonish; beside Cabot Trail, (46°42'42"N, 60°22'22"W), 11 July 1981, by IM Smith, IMS810074 • 1♀ from Inverness County, Cape Breton Highlands National Park; beside Cabot Trail west of Pleasant Bay, (46°53'53"N, 60°50'50"W), 13 July 1981, by IM Smith, IMS810077 • 1♀ from Inverness County, Margaree Valley; beside road to Big Intervale, (46°21'21"N, 60°58'58"W), 18 July 1981, by IM Smith, IMS810080 • 1♀ from Victoria County, beside road south of Baddeck Forks, (44°52'52"N, 61°5'5"W), 18 July 1981, by IM Smith, IMS810082 • 1♀ from Cumberland County, Wentworth; picnic area beside Hwy. 104, (45°39'39"N, 63°33'33"W), 19 July 1981, by IM Smith, IMS810085 • **Ontario, Canada:** 2♀ and 1♂ from Maple Leaf County, Papineau Cr; E of Davis Rd. bf HW 62, (45°15'15"N, 77°49'49"W), 18 August 2011, by IM Smith, IMS110053 • 1♂ from Parry Sound, beside Hwy. 11, 4.8 km south of Trout Creek, (45°59'59"N, 79°22'22"W), 22 July 1975, by IM Smith, IMS750101 • 1♀ and 1♂ from Lanark, Tatlock; beside Hwy. 511, 14.2 km north of Lanark Road 9, (45°10'10"N, 76°29'29"W), 25 May 1980, by IM Smith, IMS800014B • 1♀ and 1♂ from Muskoka County, Huntsville; beside road to Dyer Memorial, (45°20'20"N, 79°13'13"W), 26 August 1981, by IM Smith, IMS810032A • 1♀ and 1♂ from Nipissing County, Bastien Creek Picnic Area beside Hwy. 17 east of Mattawa, (46°19'19"N, 78°42'42"W), 30 August 1983, by IM Smith & CJ Hill, IMS830076A • 2♀ and 2♂ from Durham County, Kendal; Crown Land Day Use Area off Durham Road #9, (44°2'2"N, 78°32'32"W), 20 May 1989, by IM Smith, IMS890018 • 1♀ and 2♂ from Grey County, beside Wilders Lake Road 0.5 km. east of Varney,

(44°8'8"N, 80°48'48"W), 8 June 1989, by IM Smith, IMS890027 • **Quebec, Canada:** 1♂ from Gatineau County, Gatineau Park; off McCloskey Trail on hillside above boat launch area at Meech Lake, (45°32'32"N, 75°53'53"W), 27 July 2010, by IM Smith, IMS100106 • 1♀ and 1♂ from Gatineau County, Gatineau Park; beside Gatineau Parkway at Meech Lake Road, (45°34'34"N, 75°57'57"W), 15 September 1981, by IM Smith & C Cramer, IMS810034A • 1♂ from Gatineau County, Gatineau Park; beside Gatineau Parkway at Meech Lake Road, (45°34'34"N, 75°57'57"W), 24 August 1982, by IM Smith, CJ Hill & C Cramer, IMS820002A.

**Type deposition.** Holotype (♀), allotype (♂), and other paratypes (57♀; 54♂) deposited in the CNC.

**Diagnosis.** *Monatractides curva* is similar to other members of the Simulans group by having a relatively narrow subcapitulum, which can be used to differentiate this group from similar looking members of the Californica group. *M. curva*'s dorsal coloration is similar to *M. coastalis*, *M. gilbroskii*, and *M. simulans*, but can be most easily differentiated from them by possessing a downturned subcapitulum. In addition, *M. curva* can be differentiated using the genital field measurements (genital field width ♀ = 240-250 in *M. coastalis*, 200-215 in *M. curva*) and the measurement from the gnathosomal bay to the top of the genital field (gnathosomal bay-genital field length ♀ = 185-220 in *M. curva*, 240-260 in *M. gilbroskii*; ♂ = 190-240 in *M. curva*, 270-280 in *M. gilbroskii*). *M. curva* and *M. simulans* can be differentiated using anteriomedial plate measurements can also be used to differentiate these two species (anteriomedial plate width ♀ = 75-80 in *M. curva*, 95-120 in *M. simulans*; ♂ = 60-80 in *M. curva*, 80-105 in *M. simulans*).

**Description. FEMALE (Fig. 32)** (n= 58) (holotype measurements in parentheses when available) with characters of the genus with the following specifications.



**Figure 32.** *Monatractides curva* female: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum **D** pedipalp (setae not accurately depicted). Scale = 100  $\mu\text{m}$ .

**Dorsum** (720-830 (730) long; 590-730 (600) wide) round and with a light to dark purple pear shaped spot on the dorsum in area of primary sclerotization. Anterio-medial platelets (125-160 (125) long; 75-80 (80) wide). Anterio-lateral platelets (210-265 (220) long; 85-100 (90) wide), free from dorsal plate. Dgl-4 much closer to the edge of the dorsum than to the muscle scars (distance between Dgl-4 360-400 (380)). Dorsal plate proportions: dorsum length/width 1.09-1.25 (1.22); dorsal width/distance between Dgl-4 0.88-1.0(0.90); anterio-medial platelet length/width 1.56-2.0 (1.56); anterio-lateral platelet length/width 2.44-2.65 (2.44); anterio-lateral/anterio-medial length 1.56-1.77 (1.22).



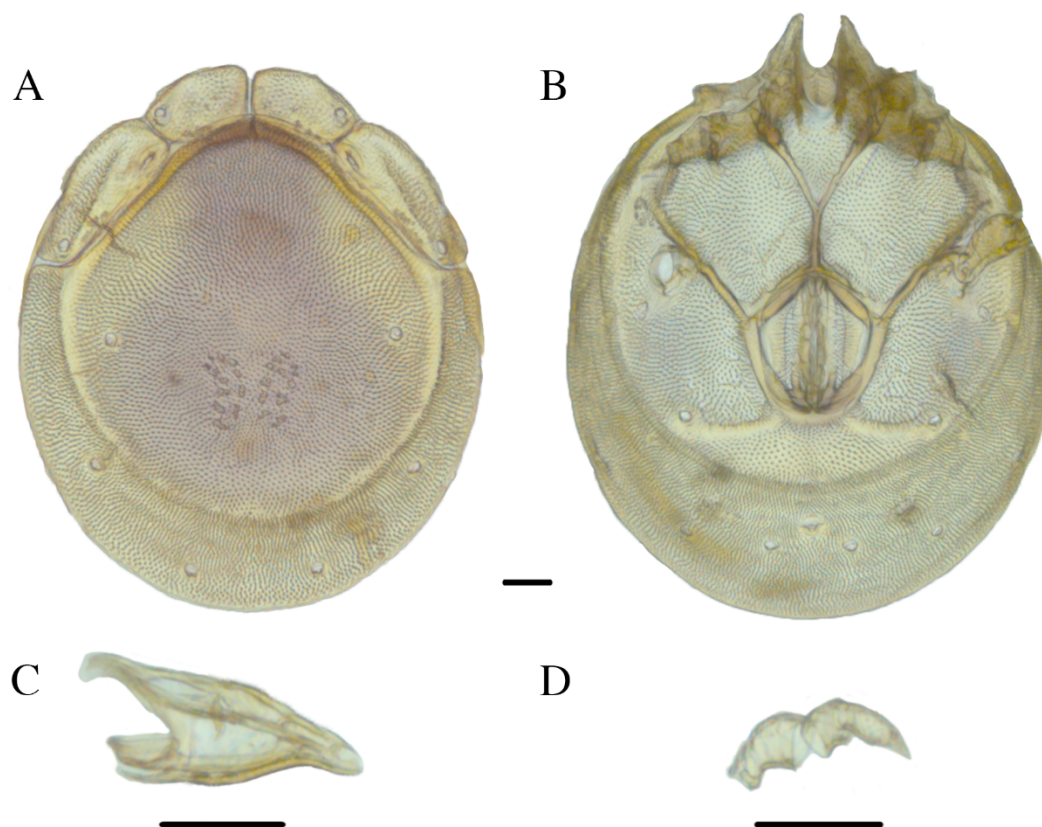
**Gnathosoma-Subcapitulum** (190-225 (215) long (ventral); 125-155 (152.5) long (dorsal); 40-45 (40) tall) colorless. Rostrum (85-90 (85) wide) very short and stocky. Chelicerae (190-210 (195) long with curved fangs (30-35 (30) long). Subcapitular proportions: ventral length/dorsal length (1.35-1.52 (1.41)). **Pedipalps** short and stocky (especially tibiae) with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (15-17.5 (15) long; 25-35 (55) wide); femur (40-45 (35) long; 32.5-35 (35) wide); genu (30-35 (30) long; 30-40 (35) wide); tibia (25-27.5 (35) long; 15-25 (25) wide); tarsus (15-25 (15) long; 12.5-15 (12.5) wide). Palpomere proportions: femur/genu 1.1-1.7 (1.17); tibia/femur 0.63-0.71 (0.71); tibia length/width 1.0-1.67 (1.67).

**Venter** (850-930 (850) long; 650-780 (650) wide) occasionally with purple coloration on areas of primary sclerotization. Gnathosomal bay (130-140 (140) long; 45-50 (50) wide. Cxgl-4 subapical. **Medial suture** (65-80 (70) long). **Genital plates** (220-250 (230) long; 200-215 (210) wide). Additional measurements: Cx-1 (250-360 (325) long (total); 120-130 (120) long (medial); Cx-3 (440-500 (470) wide); anterior venter (185-220 (190) long). Ventral proportions: gnathosomal bay length/width 2.60-2.89 (2.80); anterior venter/genital field length 0.77-0.96 (0.77); anterior venter length/genital field width 0.86-1.02 (0.90).

**MALE (Fig. 33)** (n =55) (allotypic measurements in parentheses when available) with characters of the genus following specifications.

**Dorsum** (630-750 (750) long; 500-640 (640) wide) round and with a light to dark purple pear shaped spot on the dorsum in area of primary sclerotization. Anterio-medial platelets (120-150 (150) long; 60-80 (80) wide). Anterio-lateral platelets (200-250 (240) long; 80-100 (95) wide), free from dorsal plate. Dgl-4 much closer to the edge of the dorsum than to the muscle scars (distance between Dgl-4 310-410 (410)). Dorsal plate proportions: dorsum length/width

1.17-1.30 (1.17); dorsal width/distance between Dgl-4 0.83-0.94 (0.94); antero-medial platelet length/width 1.63-2.0 (1.88); antero-lateral platelet length/width 2.40-2.88 (2.53); antero-lateral/antero-medial length 1.60-1.79 (1.60).



**Figure 33.** *Monatractides curva* male: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum **D** pedipalp (setae not accurately depicted). Scale = 100  $\mu$ m.

**Gnathosoma-Subcapitulum** (190-220 (215) long (ventral); 130-170 (155) long (dorsal); 50-100 (55) tall) colorless. Rostrum (69-95 (90) wide) short and stocky. Chelicerae (200-315 (205) long with curved fangs (25-35 (35) long). Subcapitular proportions: ventral length/dorsal length (1.24-1.46 (1.39)). **Pedipalps** short and stocky (especially tibiae) with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (15-20 (20) long; 20-35 (27.5) wide);

femur (40-45 (55) long; 35-45 (35) wide); genu (25-40 (40) long; 30-40 (32.5) wide); tibia (30-45 (40) long; 25-30 (25) wide); tarsus (15-20 (20) long; 10-20 (15) wide). Palpomere proportions: femur/genu 1.13-1.80 (1.13); tibia/femur 0.67-1.0 (0.89); tibia length/width 1.20-1.60 (1.60).

**Venter** (660-850 (850) long; 560-690 (690) wide) with purple coloration on areas of primary sclerotization. Gnathosomal bay (120-150 (130) long; 40-50 (50) wide. Cxgl-4 subapical. **Medial suture** (80-100 (80) long). **Genital plates** (170-200 (200) long; 130-170 (160) wide). Additional measurements: Cx-1 (230-375 (375) long (total); 100-150 (140) long (medial); Cx-3 (390-490 (490) wide); anterior venter (190-240 (235) long). Ventral proportions: gnathosomal bay length/width 1.56-3.50 (2.60); anterior venter/genital field length 1.05-1.24 (1.18); anterior venter length/genital field width 2.10-2.94 (2.94).

**IMMATURES** unknown.

**Etymology.** Specific epithet *curva* is from the Latin, referring to the downward curve found in the rostrum of *M. curva*.

**Distribution.** Known from eastern southern Canada and Tennessee and North Carolina around the Blue Ridge Mountains (Figure 34).

**Remarks.** In the combined analysis, *M. curva* is placed in the Oblongata group as a non-monophyletic clade. However, in the COI-only analysis *Monatractides curva* groups with other members of the Simulans group with high support, across the geographic range. The species hypothesis is supported by low COI divergence within the species (no more than 2.2%) and high divergence between species (at least 13% from its sister species), and by the morphological similarities outlined in the diagnosis.



**Figure 34.** *Monatractides curva* distribution.

***Monatractides emilyae* Nelson & Dowling, sp. n.**

**Material examined.** HOLOTYPE (♀): **CANADA, Ontario:** 1♀ from Hastings Co., Duff Corners; Vanderwater Conservation Area off Vanderwater Road east of Hwy. 37, (44°23'23"N, 77°19'19"W), 13 August 2009, by IM Smith, ML MacKenzie, IMS090089A.

PARATYPES (1♂): **CANADA, New Brunswick:** (allotype) 1♂ from Charlotte Co; Rollingham, Digdegaush Rv; beside HW 770, (45°18'18"N, 67°4'4"W), 3 October 2011, by IM Smith, IMS110118.

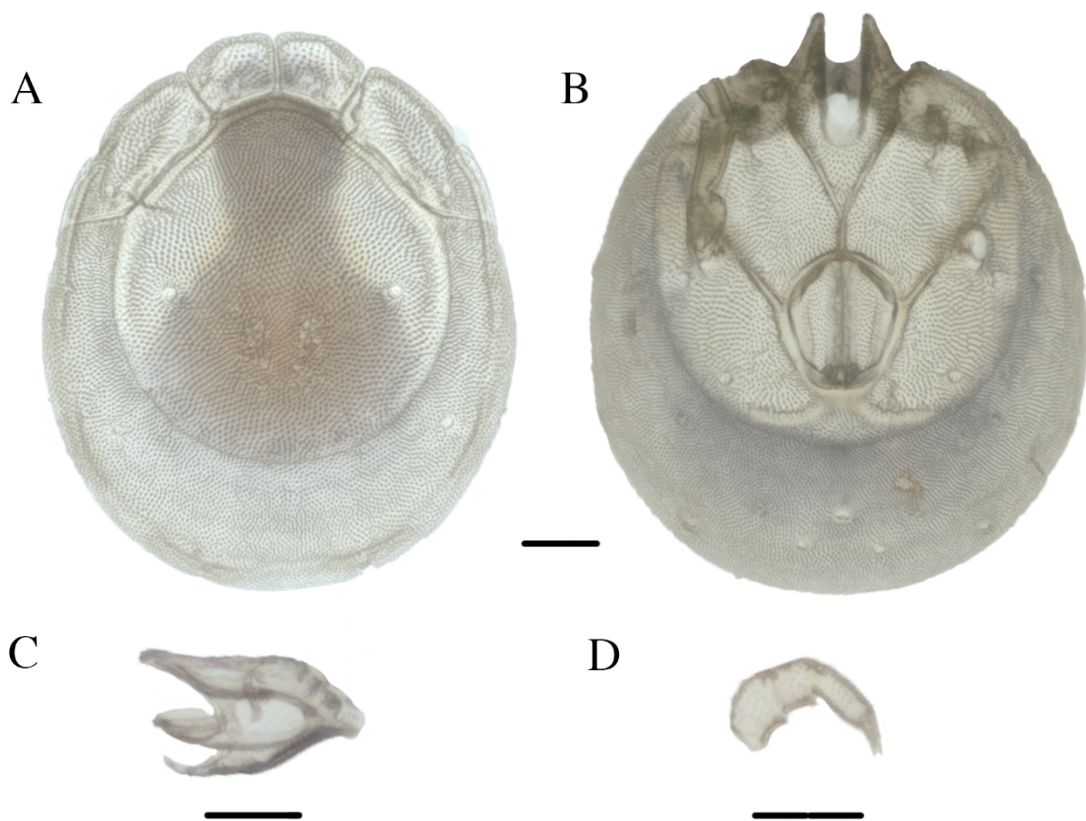
**Type deposition.** Holotype (♀) and allotype (♂) deposited in the CNC.

**Diagnosis.** *Monatractides emilyae* are similar to other members of the Easterly group by having notable dorsal coloration and patterning; in this case, an orange to dark orange pear-shaped spot on the dorsum. *M. emilyae* is most similar to *M. axfordii*, with similar coloration and size. However, they can be differentiated using the anteriomedial platelets (anteriomedial platelet length/width measurement ♀ = 1.3 in *M. emilyae*, 1.44-1.50 in *M. axfordii*; ♂ = 1.88 in *M. emilyae*, 2.3-2.5 in *M. axfordii*). The subcapitulum is wide, differentiating it from all species in the Easterly Elongatus group. *M. emilyae* can be easily differentiated from *M. williamsis*, *M. lynensis*, and *M. zirkleii* by the lack of both purple and orange dots on the dorsum.

**Description. FEMALE (Fig. 35)** (n=1) (holotype measurements in parentheses when available) with characters of the genus with the following specifications.

**Dorsum** (790 long; 660 wide) ovoid and with a brownish-orange pear-shaped coloration on the dorsal plate. Anterio-medial platelets (130 long; 100 wide). Anterio-lateral platelets (260 long; 110 wide), free from dorsal plate. Dgl-4 approximately equidistant to the edge of the dorsum to the muscle scars (distance between Dgl-4 330).

Dorsal plate proportions: dorsum length/width 1.30; dorsal width/distance between Dgl-4 0.93; antero-medial platelet length/width 2.36; antero-lateral platelet length/width 2.36; antero-lateral/anterio-medial length 2.0.



**Figure 35.** *Monatractides emilyae* sp. n. female: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum **D** pedipalp (setae not accurately depicted). Scale = 100  $\mu$ m.

**Gnathosoma-Subcapitulum** (195 long (ventral); 130 long (dorsal); 40 tall) colorless. Rostrum (110 wide) short and stocky. Chelicerae (210 long with curved fangs. Subcapitular proportions: ventral length/dorsal length (1.50). **Pedipalps** short and stocky (especially tibiae) with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (20 long; 30 wide); femur (50 long; 50 wide); genu (40 long; 35 wide); tibia (55 long; 30 wide); tarsus (30

long; 15 wide). Palpomere proportions: femur/genu 1.25; tibia/femur 1.10; tibia length/width 1.83.

**Venter** (850 long; 720 wide) with light bluish- purple coloration on venter, along the line of secondary sclerotization. Gnathosomal bay (160 long; 50 wide). Cxgl-4 subapical. **Medial suture** (60 long). **Genital plates** (200 long; 160 wide). Additional measurements: Cx-1 (300 long (total); 140 long (medial); Cx-3 (430 wide); anterior venter (200 long). Ventral proportions: gnathosomal bay length/width 3.20; anterior venter/genital field length 1.00; anterior venter length/genital field width 1.25.

**MALE (Fig. 36)** (n =1) with characters of the genus following specifications.

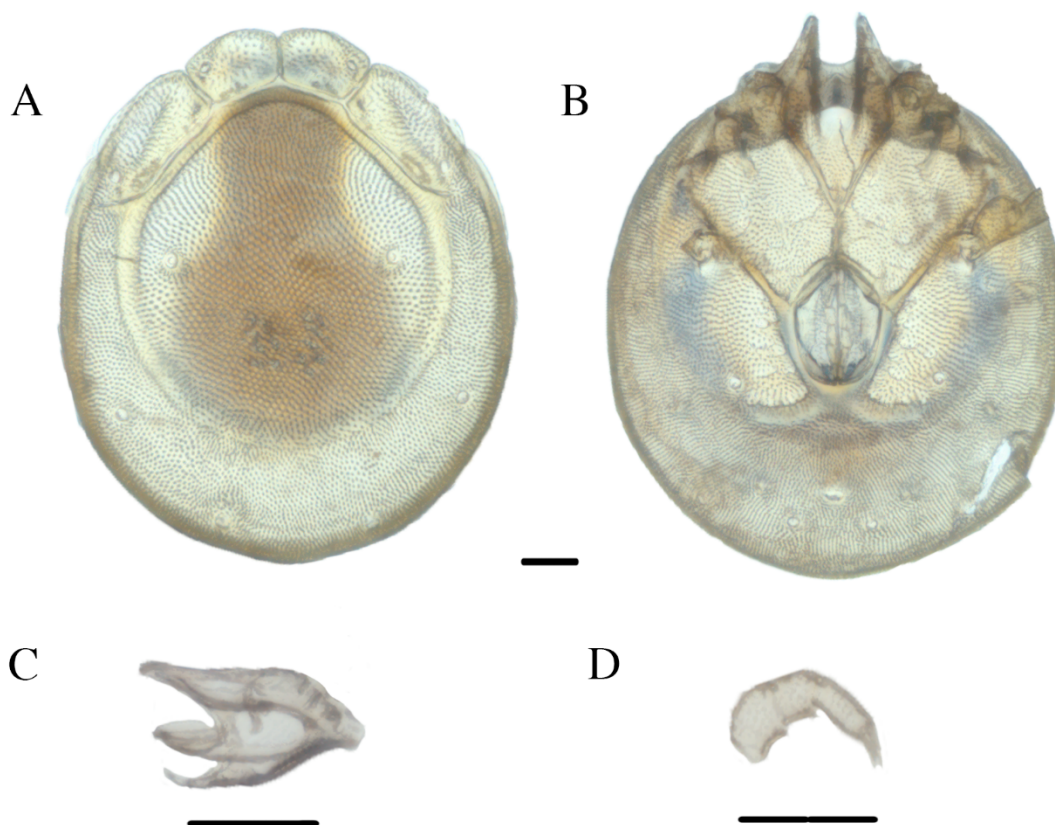
**Dorsum** (680 long; 570 wide) ovoid and with a brownish-orange pear-shaped coloration on the dorsal plate. Anterio-medial platelets (110 long; 80 wide). Anterio-lateral platelets (170 long; 90 wide), free from dorsal plate. Dgl-4 approximately equidistant to the edge of the dorsum to the muscle scars (distance between Dgl-4 300). Dorsal plate proportions: dorsum length/width 1.19; dorsal width/distance between Dgl-4 0.93; anterio-medial platelet length/width 1.38; anterio-lateral platelet length/width 1.89; anterio-lateral/anterio-medial length 1.55.

**Gnathosoma-Subcapitulum** (175 long (ventral); 115 long (dorsal)) colorless.

Rostrum very stocky. Chelicerae (175 long with curved fangs). Subcapitular proportions: ventral length/dorsal length (1.52). **Pedipalps** short and stocky (especially tibiae) with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (20 long; 30 wide); femur (55 long; 40 wide); genu (35 long; 35 wide); tibia (50 long; 25 wide); tarsus (30 long; 10 wide). Palpomere proportions: femur/genu 1.57; tibia/femur 0.91; tibia length/width 2.0.

**Venter** (780 long; 630 wide) with light bluish- purple coloration on venter, along the line

of secondary sclerotization. Gnathosomal bay (140 long; 50 wide. Cxgl-4 subapical. **Medial suture** (60 long). **Genital plates** (170 long; 120 wide). Additional measurements: Cx-1 (270 long (total); 140 long (medial); Cx-3 (390 wide); anterior venter (200 long). Ventral proportions: gnathosomal bay length/width 2.80; anterior venter/genital field length 1.18; anterior venter length/genital field width 1.67.



**Figure 36.** *Monatractides emilyae* sp. n. male: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum **D** pedipalp (setae not accurately depicted). Scale = 100  $\mu$ m.

**IMMATURES** unknown.

**Etymology.** Specific epithet *emilyae* is so chosen in honor of Emily Nelson; a fantastic inorganic chemist (and better sister and friend) who I tricked into taking Biology with me in



college. Thanks for sticking through it with me, Emily.

**Distribution.** Known in Eastern Canada from New Brunswick to Ontario. (Fig. 37).

**Remarks.** In all analyses, *Monatractides emilyae* groups with other members of the Easterly group with high support. This species hypothesis is supported by low COI divergence within the species (less than 1%), and high divergence between species (at least 5% from its sister species *M. williamsis* and over 14% from *M. zirkleii*), and by the morphological characteristics outlined in the diagnosis.



**Figure 37.** *Monatractides emilyae* distribution.

***Monatractides geographica* (Marshall, 1943)**

*Atractides geographicus* Marshall 1943: 314.

*Atractides californicus* Marshall 1943: 315.

**Material examined.** COTYPES (1♀ and 1 ♂): **USA, California:** from Santa Cruz County, Waddell Creek, 25-26 Aug 1932 by PR Needham. RM320007

OTHER MATERIAL (27♀, 16♂): **USA, California:** 1♂ (allotype) and 1♀ from Ventura County, beside Rt. 33 just above Wheeler Gorge Campground, (34°31'31"N, 119°16'16"W), 30 May 2010, by IM Smith, IMS100038 • 1♂ from Ventura County, beside Rt. 33 just above Wheeler Gorge Campground, (34°31'31"N, 119°16'16"W), 31 May 2010, by IM Smith, IMS100041 • 1♀ from Ventura County, beside Rt. 33 just above Wheeler Gorge Campground, (34°31'31"N, 119°16'16"W), 31 May 2010, by IM Smith, IMS100042 • 1♀ from El Dorado County, S Fork of American Rvr, off Rt 50, under sm bridge, (38°47'47"N, 120°9'9"W), 29 August 2013, by JR Fisher, JRF 13-0829-005 • 1♀ from Alpine County, Markleeville Cr, off Rt 89, downstream of bridge, (38°41'41"N, 119°46'46"W), 30 August 2013, by JR Fisher, JRF 13-0830-001 • 2♀ and 2♂ from Alpine County, W Fork of Carson Rvr, off Rt 89, downstream of bridge, (38°46'46"N, 119°55'55"W), 29 August 2013, by JR Fisher, JRF 13-0829-002 • 5♀ and 5♂ from Santa Cruz County, Waddell creek. Backwoods hike off Canyon Rd., (37°6'6"N, 122°16'16"W), 15 July 2015, by WA Nelson, JM Gilbert, WN 15-0715-002 • 1♀ from Trinity County, N Fork of Trinity Rvr, (40°46'46"N, 123°7'7"W), 18 August 2013, by JR Fisher, JRF

13-0818-005 • 1 ♀ from Del Norte County, Smith Rvr Nat Rec Area, Middle Fork of Smith Rvr, Grassy Flats campground, (41°51'51"N, 123°53'53"W), 15 August 2013, by JR Fisher, JRF 13-0815-002 • 1 ♀ from Monterey County, Big Sur Rvr, (36°14'14"N, 121°46'46"W), 4 September 2013, by JR Fisher, JRF 13-0904-004 • 1 ♀ from Siskiyou, S. Fork of Salmon Rvr, off Cecilville Rd, (41°10'10"N, 123°5'5"W), 17 August 2013, by JR Fisher, JRF 13-0817-003 • **Idaho, USA:** 1 ♀ from Blaine County, Confluence of Rook & Warm River, (43°38'38"N, 114°30'30"W), 28 July 2012, by RA Fisher, WA Nelson, JC O'Neill, ROW 12-0728-004 • 2 ♀ from Custer County, Stanley Cr. just before of confluence with Valley Cr., (44°15'15"N, 115°0'0"W), 30 July 2012, by JR Fisher, WA Nelson, JC O'Neill, ROW 12-0730-005 • **Montana, USA:** 1 ♀ and 1 ♂ from Ravalli County, E. Fk. Bitterroot Rv., (45°51'51"N, 114°1'1"W), 3 August 2012, by JR Fisher, WA Nelson, JC O'Neill, ROW 12-0803-005 • **Oregon, USA:** 1 ♀ from Tillamook County, Jordan Creek, (45°32'32"N, 123°34'34"W), 2 August 2013, by JC O'Neill, WA Nelson, JNOW 13-0802-004 • 2 ♀ from Tillamook County, Siuslaw National Forest, (45°6'6"N, 123°48'48"W), 6 August 2013, by JC O'Neill, WA Nelson, JNOW 13-0806-001 • 1 ♀ and 1 ♂ from Clackamas County, Mount Hood National Forest Hot Springs Fork, (44°58'58"N, 122°5'5"W), 7 August 2013, by JC O'Neill, WA Nelson, JNOW 13-0807-005 • 2 ♀ from Coos County, Golden and Silver Falls State Park, (43°28'28"N, 123°55'55"W), 10 August 2013, by JC O'Neill, WA Nelson, JNOW 13-0810-002 • 1 ♂ from Douglas County, Umpqua National Forest, Trib of Umqua River, (43°17'17"N, 122°37'37"W), 12 August 2013, by JC O'Neill, WA Nelson, JNOW

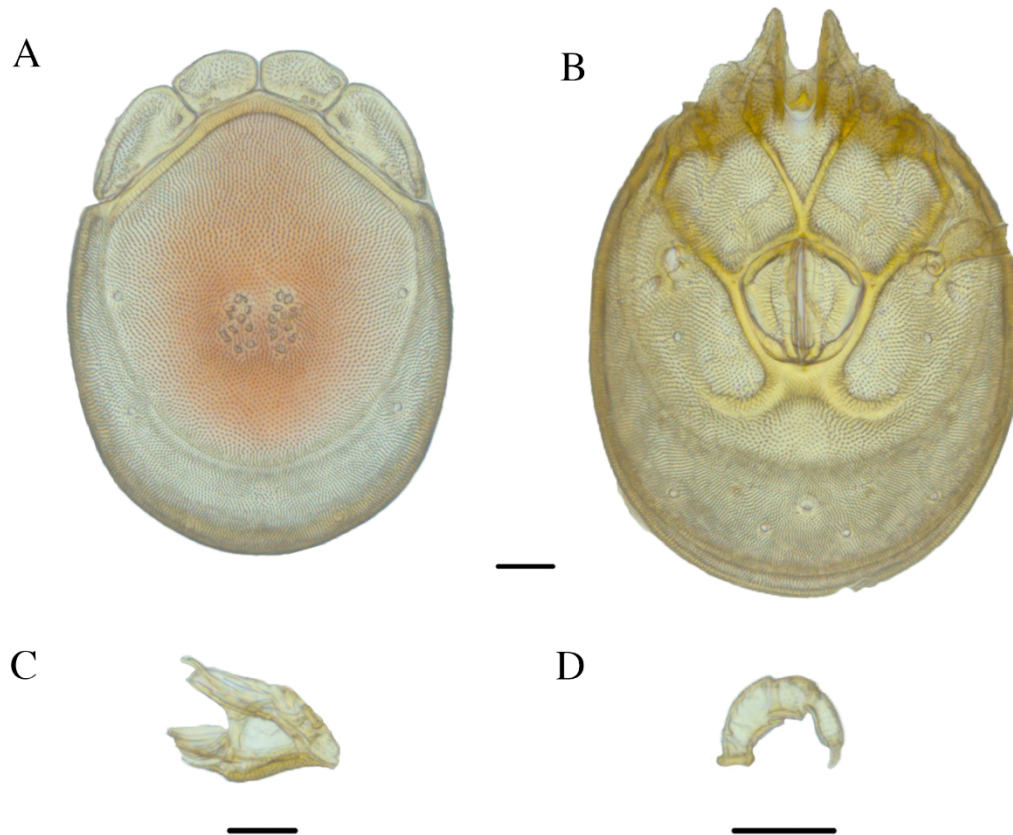
13-0812-006 • 1♀ and 1♂ from Curry County, Quosatana Cr, off Agnes Rd, upstream from bridge, (42°29'29"N, 124°14'14"W), 14 August 2013, by JR Fisher, JRF 13-0814-003 • 1♀ from Clatsop County, (45°47'47"N, 123°26'26"W), 2 August 2013, by JC O'Neill, WA Nelson, JNOW 13-0802-001 • **Utah, USA:** 1♂ from Wasatch County, Provo Rv.; just upstream of N. Fk. of Provo Rv.; (Smith's UT1), (40°35'35"N, 111°5'5"W), 23 July 2012, by JR Fisher, WA Nelson, JC O'Neill, ROW 12-0723-001 • **Washington, USA:** 1♂ from Grays Harbor County, Stewarts Creek, (47°15'15"N, 123°55'55"W), 25 July 2013, by JC O'Neill, WA Nelson, JNOW 13-0725-001 • 1♂ from Snohomish County, Mount Baker National Forest Boardman River, (48°4'4"N, 121°40'40"W), 28 July 2013, by JC O'Neill, WA Nelson, JNOW 13-0728-001.

**Type deposition.** Cotypes (♀ and ♂) and allotype (♂) deposited in the CNC. All other paratypes (27♀; 15♂) deposited in the ACUA.

**Diagnosis.** *Monatractides geographica* are similar to other members of the Californica clade (*M. siskiyouii* and *M. waddellica*) in having a large rostral height when compared to most other North American *Monatractides*. Like other members of this western clade, *M. geographica* has no distinctive dorsal or ventral patterning, but may have some light coloration on the dorsum, which can range from orange to purple. *M. geographica* can be differentiated from *M. siskiyouii* and *M. waddellica* by the length of the dorsum (dorsum length ♀ = 690-920 in *M. geographica*, 975-1240 in all other Californica clade ♀; ♂ = 560-730 in *M. geographica*, 830-1070 in all other Californica clade ♂). The only species in the Californica clade that may appear oblong, and has some overlapping ranges with *M. oblongata*, *M. geographica* can be differentiated from *M. oblongata* using the length/width of the anteriomedial platelet in ♀ (anteriomedial platelet

length/width measurement ♀ = 1.44-2.00 in *M. geographica* and 2.14-2.58 in *M. oblongata*).

**Redescription. FEMALE (Fig. 38)** (n=28) (holotype measurements in parentheses when available) with characters of the genus with the following specifications.



**Figure 39.** *Monatractides geographica* female: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum **D** pedipalp (setae not accurately depicted). Scale = 100  $\mu$ m.

**Dorsum** (690-920 (810) long; 490-710 (650) wide) round and often with purple or orange coloration, but without a distinct pattern. Anterio-medial platelets (110-165 (140) long; 60-100 (90) wide). Anterio-lateral platelets (180-250 (220) long; 70-110 (100) wide), free from dorsal plate. Dgl-4 much closer to the edge of the dorsum than to the muscle scars (distance

between Dgl-4 225-530 (510)). Dorsal plate proportions: dorsum length/width 1.25-1.53 (1.25); dorsal width/distance between Dgl-4 0.71-0.87 (0.87); antero-medial platelet length/width 1.44-2.0 (1.56); antero-lateral platelet length/width 2.1-2.71 (2.20); antero-lateral/anterio-medial length 1.36-1.73(1.57).

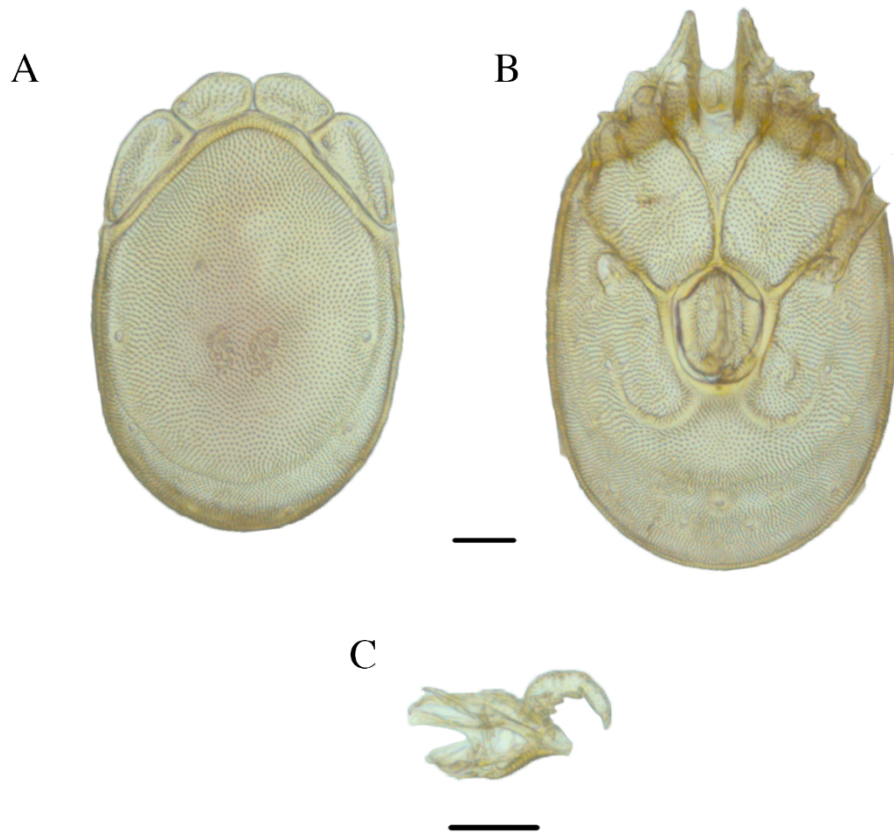
**Gnathosoma-Subcapitulum** (195-255 (225) long (ventral); 120-160 (140) long (dorsal); 25-55 (35) tall) colorless. Rostrum (120-160 (140) wide) very short and stocky. Chelicerae (180-270 (250) long with curved fangs (20.52.5(40) long). Subcapitular proportions: ventral length/dorsal length (1.45-1.70 (1.53). **Pedipalps** short and stocky (especially tibiae) with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (20-35 (25) long; 25-42.5 (35) wide); femur (50-85 (75) long; 40-57.5 (50) wide); genu (35-55 (45) long; 35-47.5 (45) wide); tibia (45-75 (50) long; 20-32.5 (25) wide); tarsus (25-37.5 (30) long). Palpomere proportions: femur/genu 0.91-1.86 (1.67); tibia/femur 0.67-1.10 (0.67); tibia length/width 1.8-2.75 (2.0).

**Venter** (800-1090 (980) long; 560-840 (720) wide). Gnathosomal bay (140-225 (170) long; 50-70 (60) wide. Cxgl-4 subapical. **Medial suture** (40-70 (50) long). **Genital plates** (190-230 (210) long; 180-230 (210) wide). Additional measurements: Cx-1 (270-375 (320) long (total); 110-160 (140) long (medial); Cx-3 (400-570 (500) wide); anterior venter (170-220 (200) long). Ventral proportions: gnathosomal bay length/width 2-3.8 (2.83); anterior venter/genital field length 0.81-1.0 (0.95); anterior venter length/genital field width 0.81-1.06 (0.95).

**MALE (Fig. 39)** (n =16) (allotypic measurements in parentheses when available) with characters of the genus following specifications.

**Dorsum** (560-730 (620) long; 350-550 (400) wide) round and with a purple or orange

coloration; without a distinct pattern. Anterio-medial platelets (90-130 (110) long; 50-85 (65) wide). Anterio-lateral platelets (150-320 (160) long; 60-100 (70) wide), free from dorsal plate. Dgl-4 much closer to the edge of the dorsum than to the muscle scars (distance between Dgl-4 290-450 (330)). Dorsal plate proportions: dorsum length/width 1.5-2.2 (1.69); dorsal width/distance between Dgl-4 0.97(0.97); anterio-medial platelet length/width 1.71-1.73 (1.71); anterio-lateral platelet length/width 1.88-4 (2.29); anterio-lateral/anterio-medial length 1.36-2.56 (1.45).



**Figure 38.** *Monatractides geographica* male: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum **D** pedipalp (setae not accurately depicted). Scale = 100  $\mu$ m.

**Gnathosoma-Subcapitulum** (160-210 (175) long (ventral); 95-135 (112.5) long (dorsal); 15-60 (22.5) tall) colorless. Rostrum (80-135 (107.5) wide) very short and stocky. Chelicerae (140-240 (147.5) long with curved fangs (30-40 (45) long). Subcapitular proportions: ventral length/dorsal length (1.33-1.73 (1.56)). **Pedipalps** short and stocky (especially tibiae) with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (20-25 (22.5) long; 20-35 (32.5) wide); femur (50-75 (55) long; 35-50 (40) wide); genu (30-50 (37.5) long; 30-40 (32.5) wide); tibia (40-60 (50) long; 20-30 (22.5) wide); tarsus (20-30 (22.5) long). Palpomere proportions: femur/genu 1.0-1.92 (1.47); tibia/femur 0.73-1.0 (0.91); tibia length/width 1.6-2.3 (2.22).

**Venter** (700-880 (740) long; 400-610 (520) wide). Gnathosomal bay (110-180 (125) long; 40-155 (155) wide. Cxgl-4 subapical. **Medial suture** (50-100 (85) long).

**Genital plates** (140-230 (155) long; 90-160 (115) wide). Additional measurements: Cx-1 (240-525 (250) long (total); 100-140 (135) long (medial); Cx-3 (310-450 (415) wide); anterior venter (170-215 (205) long). Ventral proportions: gnathosomal bay length/width 0.81-3.6 (0.81); anterior venter/genital field length 0.91-1.43 (1.32); anterior venter length/genital field width 1.31-2.22 (1.78).

#### **IMMATURES unknown.**

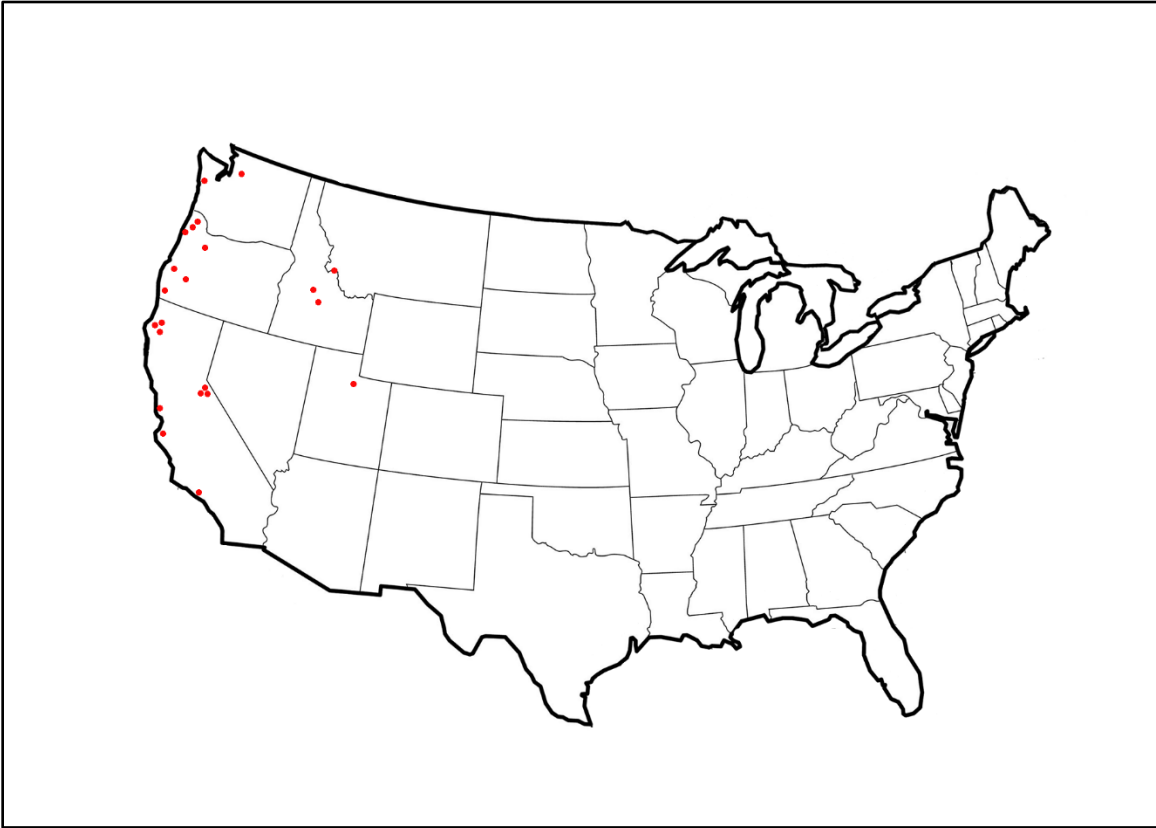
**Distribution.** *M. geographica* were previously known only from a few localities in California (Waddell creek and Merced River). We are able to extend the known range along the west coast from Washington through California and ranging east to Idaho and Utah (Fig. 40).

**Remarks.** *Monatractides geographica* groups with other members of the Californica complex, *M. waddellica* and *M. siskiyouii*, with high support in our COI analysis. This species



hypothesis is supported by high divergence between species (at least 11.1% difference from its sister species *M. waddellica* and *M. siskiyouii*), by the morphological characters outlined within the diagnosis, and the relatively low COI divergence within the species (5.6%). While 5.6% is a higher sequence variability than in most species hypotheses presented herein, it is notable that this variation is comparing one geographic extreme to the other; ‘within-range’ variation is notably less variable. E.g. COI variability seen in Idaho samples is 1.6%; variability across California is 0-3.9%. Given the topology of the COI tree and the morphological similarity, we suggest that this variability represents a continuum across a large geographic distribution, rather than isolated species.

When examining the types of *M. geographica* and *M. californica* (Marshall, 1943), it is apparent that *M. californica* is a junior synonym of *M. geographica*. We therefore synonymize *M. californica* with *M. geographica*. As First Revisers (ICZN Article 24.2), we select “*geographica*” as the senior synonym over “*californica*” due to the broader range implied with “*geographica*,” as the range has been expanded outside of the state of California.



**Figure 40.** *Monatradtices geographica* distribution.

***Monatractides gilbroskii* Nelson & Dowling, sp. n.**

**Material examined.** HOLOTYPE (♀): **USA, California**, Santa Cruz County, Waddell creek. Backwoods hike off Canyon Rd., (37°6'6"N, 122°16'16"W), 15 July 2015, by WA Nelson, JM Gilbert, WN 15-0715-002.

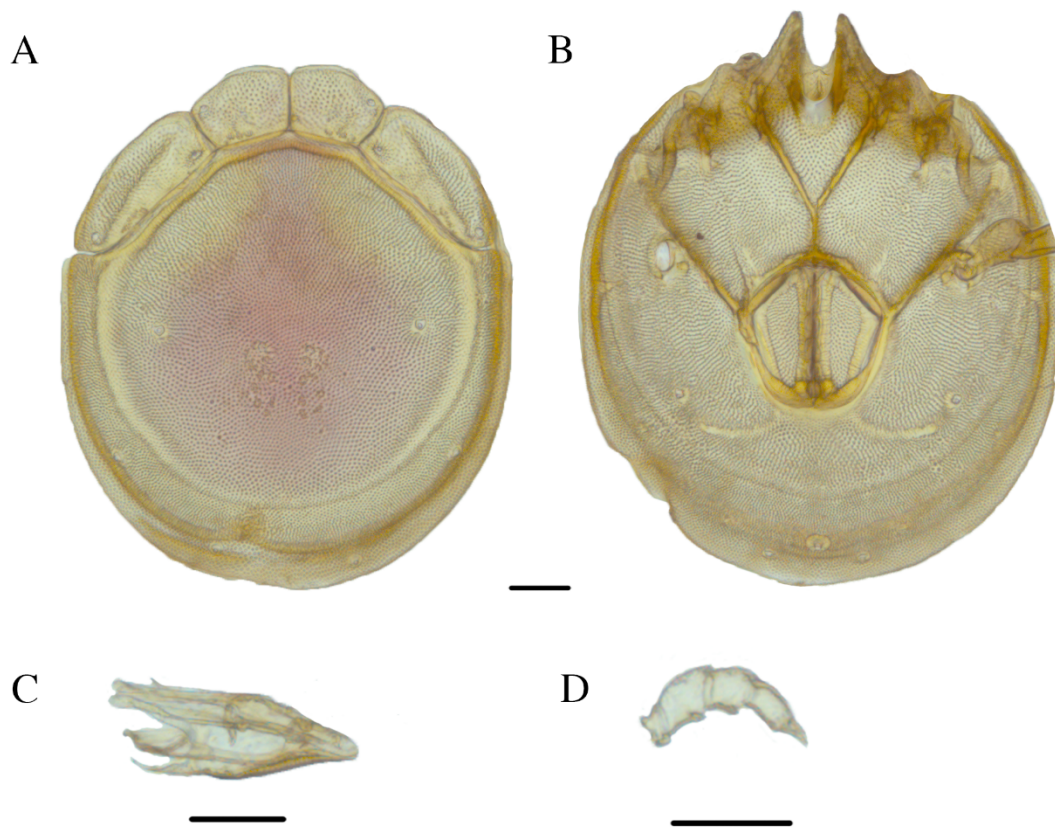
PARATYPES (3♀; 1♂): **USA, California**, (allotype) 1♂ from Santa Cruz County, Waddell creek. Backwoods hike off Canyon Rd., (37°6'6"N, 122°16'16"W), 15 July 2015, by WA Nelson, JM Gilbert, WN 15-0715-002 • 3♀ from Santa Cruz County, Waddell creek. Backwoods hike off Canyon Rd., (37°6'6"N, 122°16'16"W), 15 July 2015, by WA Nelson, JM Gilbert, WN 15-0715-002

**Type deposition.** Holotype (♀) and allotype (♂) deposited in the CNC. All other paratypes (3♂) deposited in the ACUA.

**Diagnosis.** *Monatractides gilbroskii* makes up the Gilbroski group along with *M. purrsiae*. The Gilbroski group is similar to other members of the Simulans group by having a long and narrow subcapitulum for a monatractid mite, which can be used to differentiate members of this group from similar looking members of the Californica group. Members of the Gilbroski group can be differentiated from *M. curva* by the lack of a downturned rostrum in the former. The Gilbroski group can be differentiated from *M. coastalis* by the lack of coloration on the venter in gilbroski mites, as well as the width of the dorsum (dorsum width ♀ = 760-820 in gilbroski mites 580-705 in *M. coastalis*). Gilbroski mites are very similar to *M. simulans* and can be differentiated using a combination of characters, including a gnathosomal bay to genital field measurement (gnathosomal bay-genital field/genital field length measurement ♀ = 1.0-1.19 in gilbroski mites, 0.78-0.92 in *M. simulans*, ♂ = 1.44-1.50 in gilbroski mites, 0.95-1.20 in *M.*

*simulans*). *M. gilbroskii* and *M. purrsiae* can be differentiated from each other using gnathosomal measurements (gnathosomal bay length/width measurement ♀ = 3.2-3.3 in *M. gilbroskii*, 2.16-2.9 in *M. purrsiae*; ♂ = 3.33 in *M. gilbroskii*, 2.77 in *M. purrsiae*).

**Description. FEMALE (Fig. 41)** (n= 4) (holotype measurements in parentheses when available) with characters of the genus with the following specifications.



**Figure 40.** *Monatractides gilbroskii* sp. n. female: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum **D** pedipalp (setae not accurately depicted). Scale = 100 µm.

**Dorsum** (900-990 (990) long; 750-820 (820) wide) ovoid and with the majority of the dorsal plate covered in a purple colored blotch. Anterio-medial platelets (150-152.5 (150) long;

130 (130) wide). Anterio-lateral platelets (290-320 (320) long; 140 (140) wide), free from dorsal plate. Dgl-4 closer to the edge of the dorsum than to the muscle scars (distance between Dgl-4 420-460 (460)). Dorsal plate proportions: dorsum length/width 1.20-1.21 (1.20); dorsal width/distance between Dgl-4 0.93-0.95 (0.95); anterio-medial platelet length/width 1.15-1.17 (1.15); anterio-lateral platelet length/width 2.07-2.29 (2.29); anterio-lateral/anterio-medial length 1.92-2.13 (2.13).

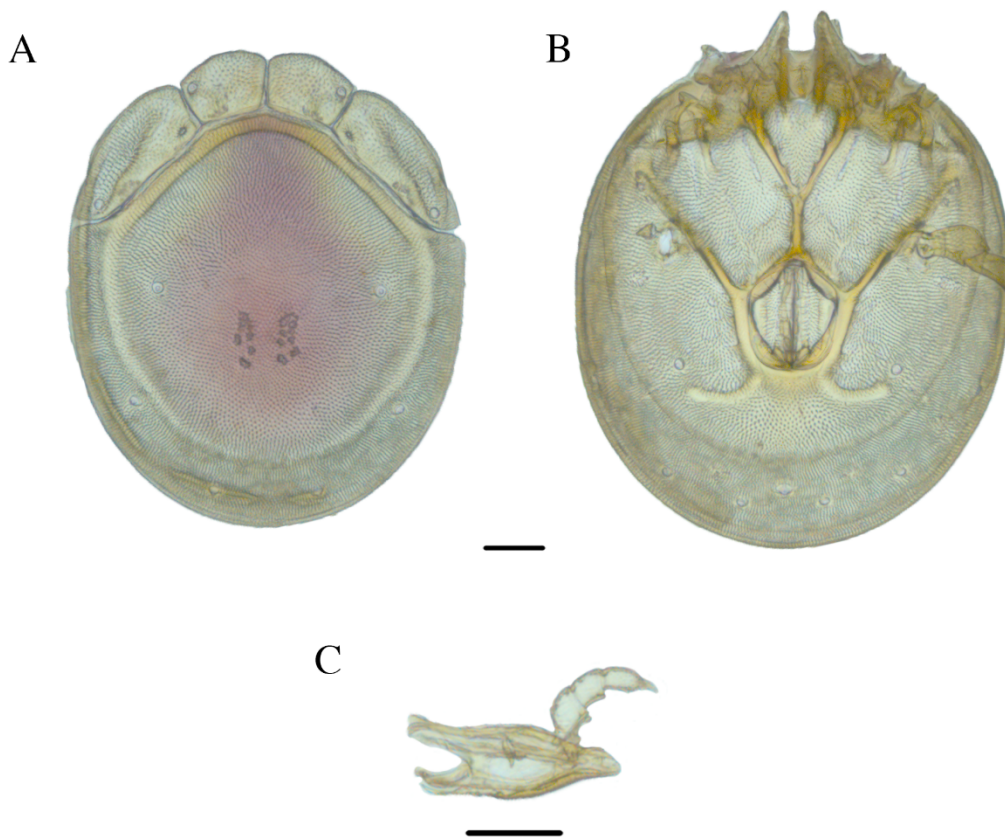
**Gnathosoma-Subcapitulum** (260-265 (260) long (ventral); 185-190 (190) long (dorsal); 50-55 (55) tall) colorless. Rostrum (95-100 (100) wide) long and narrow. Chelicerae (240-245 (245) long with curved fangs (35 (35) long). Subcapitular proportions: ventral length/dorsal length (1.39-1.41 (1.39)). **Pedipalps** short and stocky with small tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (25 long; 27.5 wide); femur (47.5 long; 37.5-40 (40) wide); tibia (55 (55) long; 27.5-30 (30) wide); tarsus (27.5 (27.5) long; 15-20 (15)). Palpomere proportions: tibia length/width 1.83-2.0 (1.83).

**Venter** (980-1140 (1140) long; 800-890 (890) wide) colorless. Gnathosomal bay (160-165 (165) long; 50 (50) wide. Cxgl-4 subapical. **Medial suture** (90 (90) long). **Genital plates** (240-250 (240) long; 220-230 (230) wide). Additional measurements: Cx-1 (410-440 (440) long (total); 160-190 (190) long (medial); Cx-3 (570 (570) wide); anterior venter (260-280 (260) long). Ventral proportions: gnathosomal bay length/width 3.2-3.3 (3.3); anterior venter/genital field length 1.04-1.17 (1.17); anterior venter length/genital field width 1.18-1.22 (1.22).

**MALE (Fig. 42)** (n=1) with characters of the genus following specifications.

**Dorsum** (800 long; 670) wide ovoid and with the majority of the dorsal plate covered in a purple blotch. Anterio-medial platelets (150 long; 110 wide). Anterio-lateral platelets (280

long; 120 wide), free from dorsal plate. Dgl-4 closer to the edge of the dorsum than to the muscle scars (distance between Dgl-4 400). Dorsal plate proportions: dorsum length/width 1.19; dorsal width/distance between Dgl-4 0.094; antero-medial platelet length/width 1.36; antero-lateral platelet length/width 2.33; antero-lateral/antero-medial length 1.87.



**Figure 41.** *Monatractides gilbroskii* sp. n. male: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum and pedipalp (setae not accurately depicted). Scale = 100  $\mu$ m.

**Gnathosoma-Subcapitulum** (220 long (ventral); 165 long (dorsal); 30 tall) colorless. Rostrum (85 wide) very long and narrow. Chelicerae (205 long) with curved fangs (30 long). Subcapitular proportions: ventral length/dorsal length (1.33. **Pedipalps** short and stocky

(especially tibiae) with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (20 long; 32.5 wide); femur (47.5 long; 42.5 wide); genu (42.5 long; 35 wide); tibia (45 long; 27.5 wide); tarsus (25 long; 15 wide). Palpomere proportions: femur/genu 1.12; tibia/femur 0.95; tibia length/width 1.64.

**Venter** (910 long; 730 wide) colorless. Gnathosomal bay (150 long; 45 wide. Cxgl-4 subapical. **Medial suture** (105 long). **Genital plates** (180 long; 155 wide). Additional measurements: Cx-1 (420 long (total); 160 long (medial); Cx-3 530 wide); anterior venter (270 long). Ventral proportions: gnathosomal bay length/width 3.33; anterior venter/genital field length 1.50; anterior venter length/genital field width 1.74.

**IMMATURES** unknown.

**Etymology.** Specific epithet *gilbroskii* is in honor of Wil and John Gilbert, the former who kindly let WAN crash at his place during the collection trip and the latter of whom tirelessly toted collection gear on a hike over bogs, through forest, and over a fence to collect this species.

**Distribution.** *M. gilbroskii* is known only from Waddell creek a single sampling location in California (Fig. 43).

**Remarks.** In both analyses, *M. gilbroskii* is placed in the Simulans group as a monophyletic clade. This species hypothesis is supported by low COI divergence within the species (less than 0.5%), high COI divergence between species (over 9%), and the morphological differences outlined in the diagnosis.



**Figure 43.** *Monatractides gilbroskii* sp. n. distribution.



***Monatractides jordanensis* (Marshall, 1930)**

*Atractides jordanensis* Marshall 1929: 317 • Marshall 1932: 248

*Torrenticola jordanensis* Crowell 1961: 330 • Prasad 1982: 185

**Material examined.** COTYPE (1♂): **USA, Wisconsin:** from Adams County, Goose Pond, 1927, by R Marshall, RM270002.

**Type deposition.** Cotype (1♂) deposited in the CNC.

**Diagnosis.** *Monatractides jordanensis* was recovered from Jordan Lake and Goose Pond. One male cotype was obtained for measurements. Presented herein is a tentative diagnosis, pending additional measurements. *M. jordanensis* is a large mite; one of the largest monatractids in North America, and definitely in the east. Based off dorsum measurements alone, this species can be differentiated from all other eastern species, except perhaps from *M. cooki*, which is also large (♂ dorsum length = 985 in *M. jordanensis*, 900 in *M. cooki*, >720 in all other eastern species; ♂ dorsum width = 832 in *M. jordanensis*, 720 in *M. cooki*, >700 in all other eastern species).

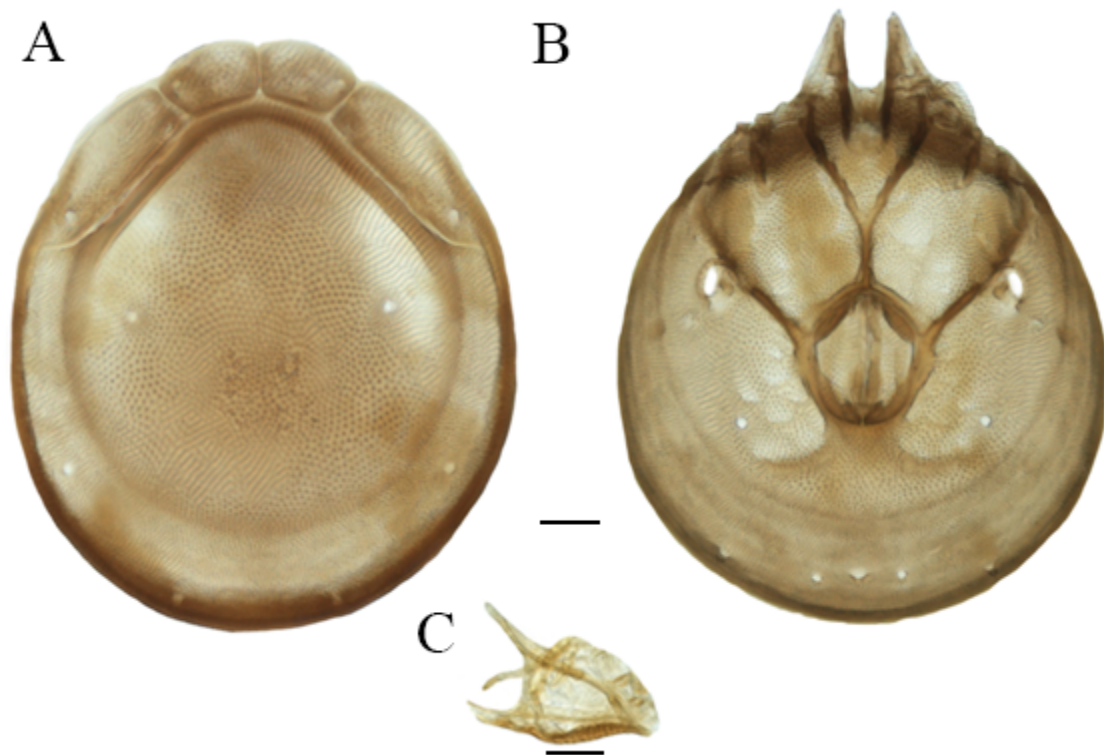
**Description. FEMALE** (n= 0) unknown.

**MALE (Fig. 44)** (n =1) with characters of the genus following specifications.

**Dorsum** (985 long; 835 wide) round and likely with some dorsal coloration. Anterio-medial platelets (160 long; 105 wide). Anterio-lateral platelets (220 long; 85 wide), free from dorsal plate. Dgl-4 equidistant to muscle scars and the edge of dorsum (distance between Dgl-4 425). Dorsal plate proportions: dorsum length/width 1.18; dorsal width/distance between Dgl-4 0.93; anterio-medial platelet length/width 1.47; anterio-lateral platelet length/width 2.60; anterio-

lateral/anterio-medial length 1.38.

**Gnathosoma-Subcapitulum** (285 long (ventral); 190 long (dorsal)); colorless. Rostrum (175 wide) short and stocky. Subcapitular proportions: ventral length/dorsal length (1.51).



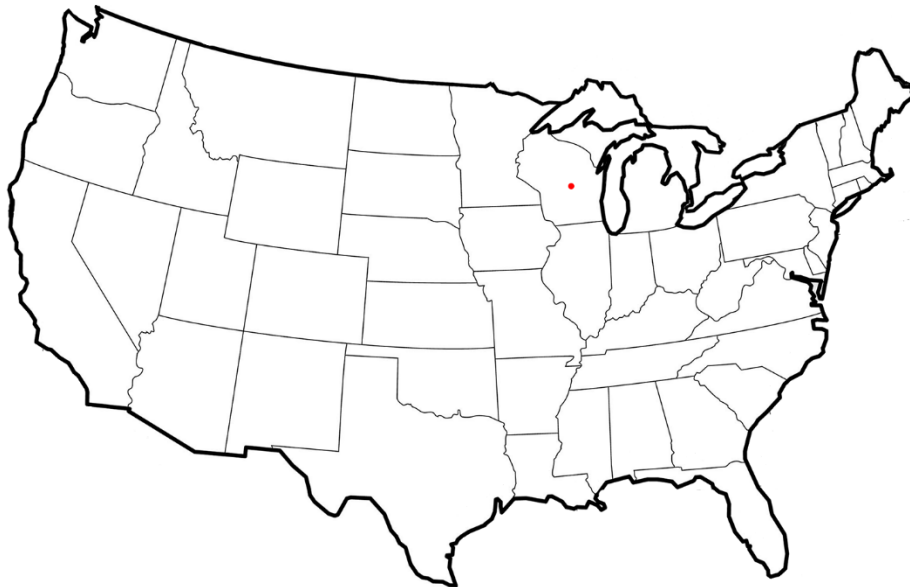
**Figure 44.** *Monatractides jordanensis* male: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum. Scale = 100  $\mu$ m.

**Venter** (1020 long; 815 wide) colorless. Gnathosomal bay (180 long; 75 wide. Cxgl-4 subapical. **Medial suture** (150 long). **Genital plates** (225 long; 170 wide). Additional measurements: Cx-1 (340 long (total); 155 long (medial); Cx-3 (560 wide); anterior venter (260 long). Ventral proportions: gnathosomal bay length/width 2.35; anterior venter/genital field length 1.18; anterior venter length/genital field width 1.58.

**IMMATURES** unknown.

**Etymology.** Marshall (1930) notes in the original description of *Atractides jordanensis* that this species was recovered from Jordan Lake. Presumably it is from this location that the species name is derived.

**Distribution.** Known from Jordan Lake and nearby Goose pond in Adams County, Wisconsin (Fig. 45).



**Figure 45:** *Monatractides jordanensis* distribution.

**Remarks.** *Monatractides jordanensis* is described from a single male cotype from the original collection. Unfortunately, no additional fresh specimens were recovered to allow for DNA extracion.

***Monatractides lynensis* Nelson & Dowling, sp. n.**

**Material examined.** HOLOTYPE (♀): **USA, Missouri, United States:** 1 ♀ from Crawford County, Huzzah Cr; Red Bluff cmpgrnd off Rd V, E of Davisville, (37°48'48"N, 91°9'9"W), 23 July 2011, by IM Smith, IMS110029.

PARATYPES (2 ♀; 1 ♂): **USA, Missouri,** (allotype) 1 ♂ from Crawford County, Huzzah Cr; Red Bluff cmpgrnd off Rd V, E of Davisville, (37°48'48"N, 91°9'9"W), 23 July 2011, by IM Smith, IMS110029 • 1 ♀ from Crawford County, Huzzah Cr; Red Bluff cmpgrnd off Rd V, E of Davisville, (37°48'48"N, 91°9'9"W), 23 July 2011, by IM Smith, IMS110029 • **USA, Alabama:** 1 ♀ from Lauderdale County, off Natchez Trace Parkway 7.0 km south of Tennessee State Line, (34°56'56"N, 87°49'49"W), 27 September 2010, by IM Smith, IMS100162.

**Type deposition.** Holotype (♀), allotype (♂), and other paratypes (2 ♀) deposited in the CNC.

**Diagnosis.** *Monatractides lynensis* are similar to other members of the Easterly group by their notable dorsal coloration; in this case, a purple spot with an orange streak stacked under it. The subcapitulum is wide, differentiating it from all species in the Easterly Elongatus group. *M. lynensis* is most similar to *M. williamsis*, *M. wolfendensis*, and *M. zirkleii* in dorsal coloration. *M. lynensis* can be quickly differentiated from *M. zirkleii* using the ventral coloration often present *M. zirkleii* and absent in *M. lynensis*. *M. williamsis* is a similarly sized and dorsally marked species, but can be differentiated using the anterior venter (anterior venter measurement ♀ = 170-180 in *M. williamsis*, 220-240 in *M. lynensis*; ♂ = 185 in *M. williamsis*; 215 in *M. lynensis*). *M. lynensis* can be separated from *M. wolfendensis* using the gnathosomal bay measurements in the males (gnathosomal bay length/width measurement ♂ = 1.79 in *M. lynensis*; 2.93 in *M.*

*wolfendensis*); no known characters are in use to differentiate females of these two species at this time.

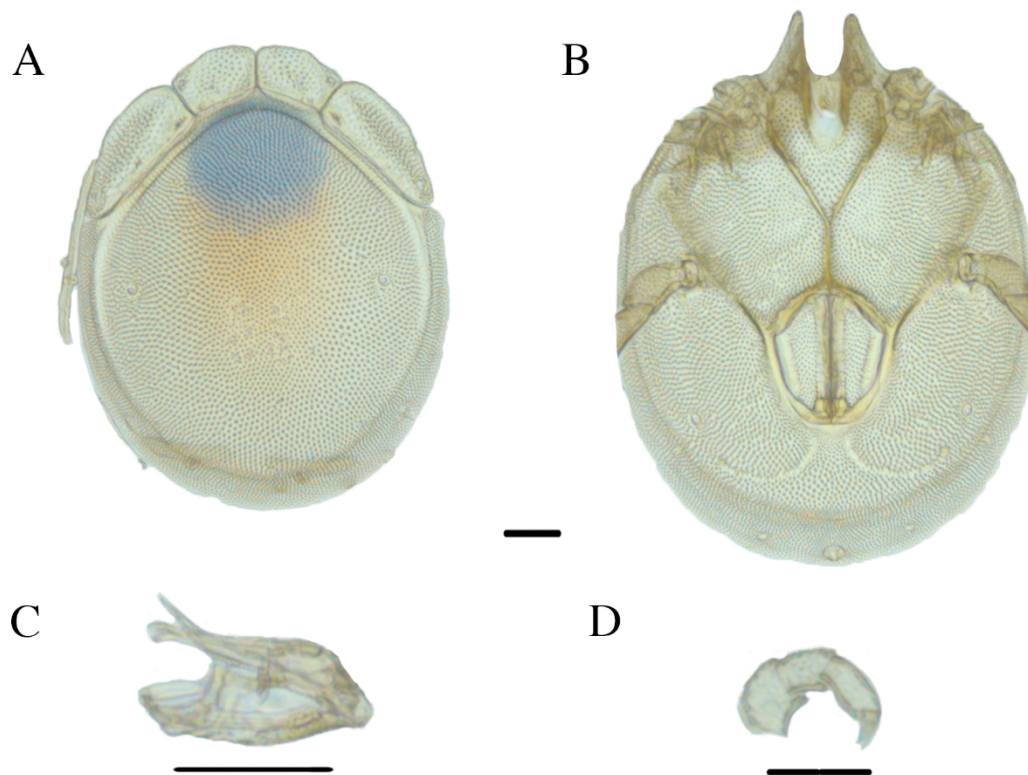
**Description. FEMALE (Fig. 46)** (n=3) (holotype measurements in parentheses when available) with characters of the genus with the following specifications.

**Dorsum** (710 (710) long; 540-560 (560) wide) ovoid with coloration restricted to a single dark spot anteriorly, with an orange streak posterior the dark spot and extending posteriorly. Anterio-medial platelets (130 (130) long; 70-80 (80) wide). Anterio-lateral platelets (210-230 (210) long; 80-90 (90) wide), free from dorsal plate. Dgl-4 closer to the edge of the dorsum than to the muscle scars (distance between Dgl-4 370 (370)). Dorsal plate proportions: dorsum length/width 1.27-1.31 (1.27); dorsal width/distance between Dgl-4 0.83-0.86 (0.86); anterio-medial platelet length/width 1.63-1.86 (1.63); anterio-lateral platelet length/width 2.33-2.88 (2.22); anterio-lateral/anterio-medial length 1.62-1.77 (1.62).

**Gnathosoma-Subcapitulum** (180 (180) long (ventral); 125-145 (145) long (dorsal); 30 (30) tall) colorless. Rostrum (90 (90) wide) very short and stocky. Chelicerae (185-200 (200) long with curved fangs (20-25 (25) long). Subcapitular proportions: ventral length/dorsal length (1.24-1.44 (1.24)). **Pedipalps** short and stocky (especially tibiae) with small tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (20-25 (20) long; 25-30 (25) wide); femur (50 (50) long; 40 (40) wide); genu (40 (40) long; 30-35 (35) wide); tibia (45-55 (45) long; 25 (25) wide); tarsus (25-30 (30) long; 15 (15) wide). Palpomere proportions: femur/genu 1.25 (1.25); tibia/femur 0.9-1.1 (0.90); tibia length/width 1.8-2.20 (1.80).

**Venter** (800-810 (810) long; 680-700 (700) wide) colorless. Gnathosomal bay (130 (130) long; 50-60 (60) wide. Cxgl-4 subapical. **Medial suture** (90-100 (100) long). **Genital plates**

(160-170 (160) long; 160 (160) wide). Additional measurements: Cx-1 (270 (270) long (total); 130-140 (140) long (medial); Cx-3 (500 (500) wide); anterior venter (220-240 (240) long). Ventral proportions: gnathosomal bay length/width 2.17-2.6 (2.17); anterior venter/genital field length 1.29-1.50 (1.50); anterior venter length/genital field width 1.38-1.50 (1.50).

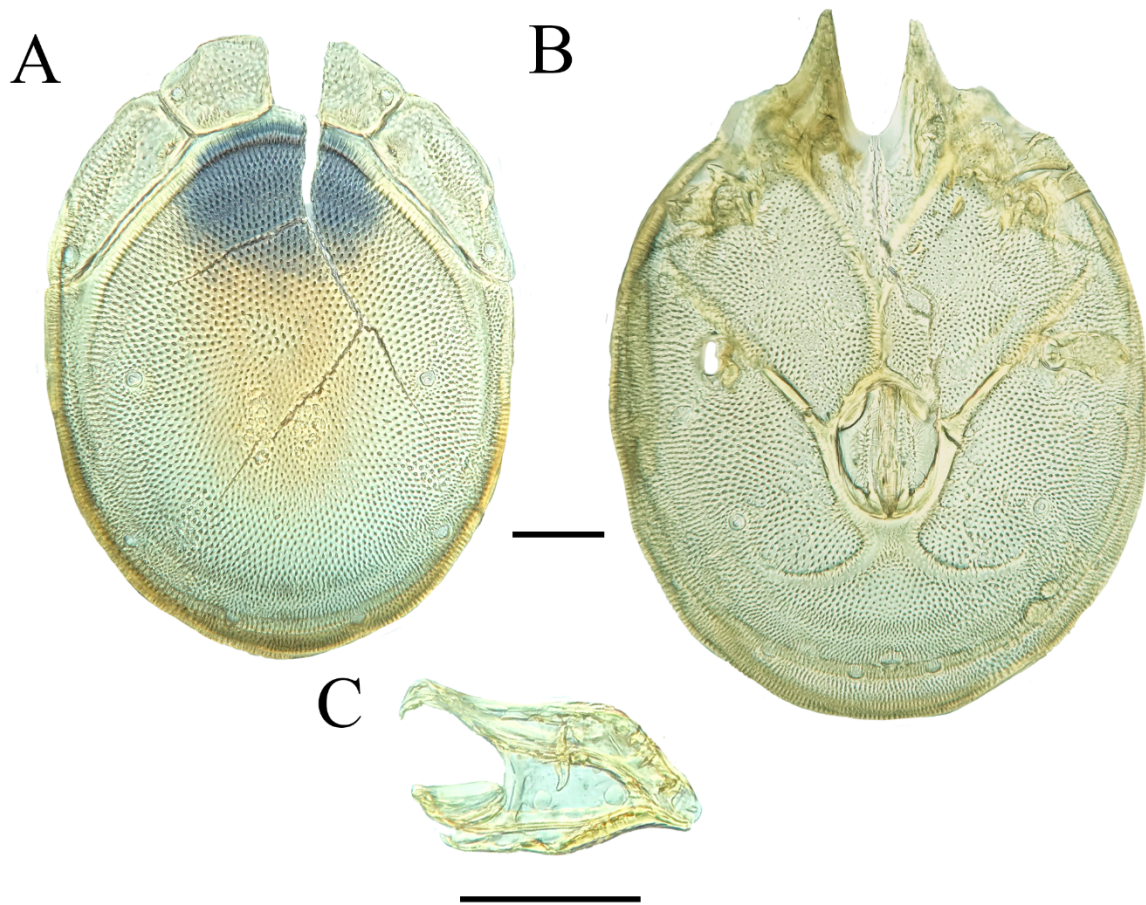


**Figure 46.** *Monatractides lynensis* sp. n. female: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum **D** pedipalp (setae not accurately depicted). Scale = 100  $\mu$ m.

**MALE (Fig. 47)** (n=1) (allotypic measurements in parentheses when available) with characters of the genus following specifications.

**Dorsum** (660 long; 500 wide) ovoid with coloration restricted to a single dark spot anteriorly, with an orange streak posterior the dark spot and extending posteriorly. Anterio-

medial platelets (120 long; 80 wide). Anterio-lateral platelets (215 long; 80 wide), free from dorsal plate. Dgl-4 closer to the edge of the dorsum than to the muscle scars (distance between Dgl-4 330) Dorsal plate proportions: dorsum length/width 1.32; dorsal width/distance between Dgl-4 0.85; anterio-medial platelet length/width 1.50; anterio-lateral platelet length/width 2.69; anterio-lateral/anterio-medial length 1.79.



**Figure 47.** *Monatractides lynensis* sp. n. male: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum. Scale = 100  $\mu$ m.

**Gnathosoma-Subcapitulum** (167.5 long (ventral); 115 long (dorsal); 25 tall) colorless. Rostrum (50 wide) very short and stocky. Chelicerae (147.5 long with curved fangs (27.5 long). Subcapitular proportions: ventral length/dorsal length (1.46). **Pedipalps** short and stocky



(especially tibiae) with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (22.5 long; 25 wide); femur (55 long; 40 wide); genu (37.5 long; 27.5 wide); tibia (50 long; 25 wide); tarsus (27.5 long; 12.5 wide). Palpomere proportions: femur/genu 1.47; tibia/femur 0.91; tibia length/width 2.00.

**Venter** (750 long; 600 wide) colorless. Gnathosomal bay (125 long; 70 wide). Cxgl-4 subapical. **Medial suture** (95 long). **Genital plates** (150 long; 115 wide). Additional measurements: Cx-1 (260 long (total); 145 long (medial); Cx-3 450 wide); anterior venter (215 long). Ventral proportions: gnathosomal bay length/width 1.79; anterior venter/genital field length 1.43; anterior venter length/genital field width 1.87.

**IMMATURES** unknown.

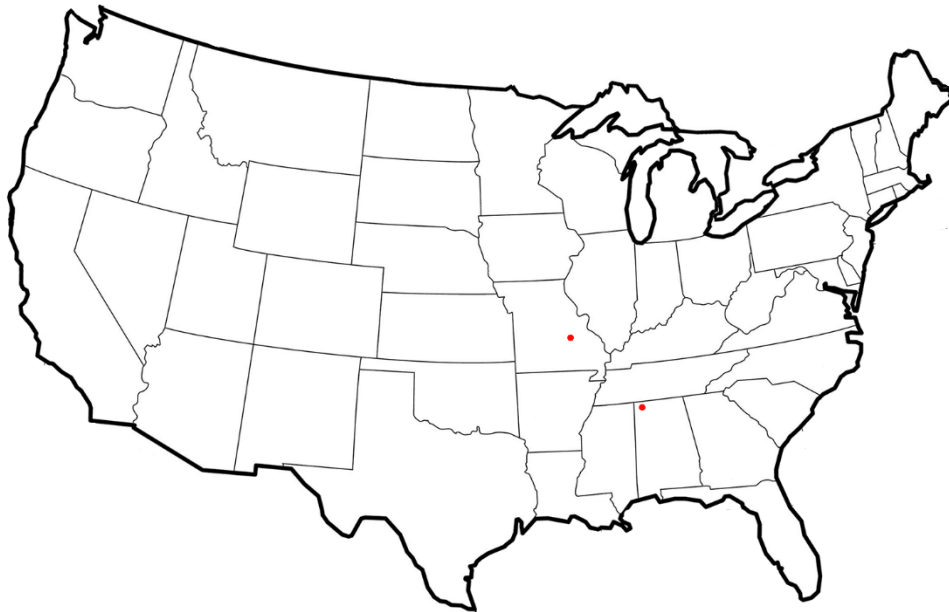
**Etymology.** Specific epithet *lynensis* is in honor of my (WAN's) father, Lyn Nelson, who has a deep love of the heat and his five offspring; nearly all of whom have pursued niche sciences he claims not to understand.

**Distribution.** *Monatractides lynensis* is known from middle of the southern part of North America – Missouri and Northern Alabama (Fig. 48).

**Remarks.** In all analyses, *Monatractides lynensis* groups, along with *M. wolfendensis*, with other members of the Easterly group with high support. This species hypothesis is supported by low COI divergence within species (3.5%), high COI divergence between species (at least 16.5% from its sister species) and by the morphological characteristics outlined in the diagnosis. The COI divergence within the species is 3.5%, which is higher sequence variability than in most species hypotheses presented herein, it is notable that this variation is comparing specimens from the Ouachita Mountains; an area well-known for endemic species, which may



possess higher genetic diversity. It is also notable that the COI divergence between specimens found in MO is 1.4%, which is higher than one might expect from samples taken from such close geographic proximity. While it is unknown if this COI divergence is related to endemism or the presence of a cryptic species group, given the topology of the COI tree and the morphological similarity, we suggest that this variability represents a continuum across a complex geographic range, rather than more than one isolated species.



**Figure 48.** *Monatractides lynensis* distribution.

***Monatractides montgomeryae* Nelson & Dowling, sp. n.**

**Material examined.** HOLOTYPE (♂): **USA, Arkansas:** 1: 1♂ from Montgomery County, Gaston, S Fork Ouachita Rvr; access off CR17 at FR903, (34°31'31"N, 93°45'45"W), 29 July 2011, by IM Smith, IMS110040.

**Type deposition.** Holotype (♂) deposited in the CNC.

**Diagnosis.** *Monatractides montgomeryae* are similar to other members of the Easterly group by the smaller size, although is unlike other members in that the one recovered specimen does not have any dorsal coloration, like many other eastern species. One of three species found in the *Elongatus* group, *M. montgomeryae* has an elongated subcapitulum compared to all other known monatractids; this represents an easy morphological character to narrow identification to *M. montgomeryae* or its sister species, *M. pertussiae* and *M. confusica*. *M. confusica* can be differentiated from the other *Elongatus* species using dorsal length (dorsum length ♂ = 570 in *M. montgomeryae*, 610-690 in other *Elongatus* species) and anteriomedial platelet measurements (anteriomedial platelet length/width ♂ = 2.33 in *M. montgomeryae*, 1.22-1.43 in other *Elongatus* species).

**Description. FEMALE** (n = 0) **unknown.**

**MALE (Fig. 49)** (n = 1) with characters of the genus following specifications.

**Dorsum** (570 long; 425 wide) ovoid, colorless. Anterio-medial platelets (105 long; 45 wide). Anterio-lateral platelets (175 long; 80 wide), free from dorsal plate. Dgl-4 closer or equidistant to the edge of the dorsum than to the muscle scars (distance between Dgl-4 300). Dorsal plate proportions: dorsum length/width 1.34; dorsal width/distance between Dgl-4 0.83; anterio-medial platelet length/width 2.33; anterio-lateral platelet length/width 2.19; anterio-

lateral/anterio-medial length 1.67.

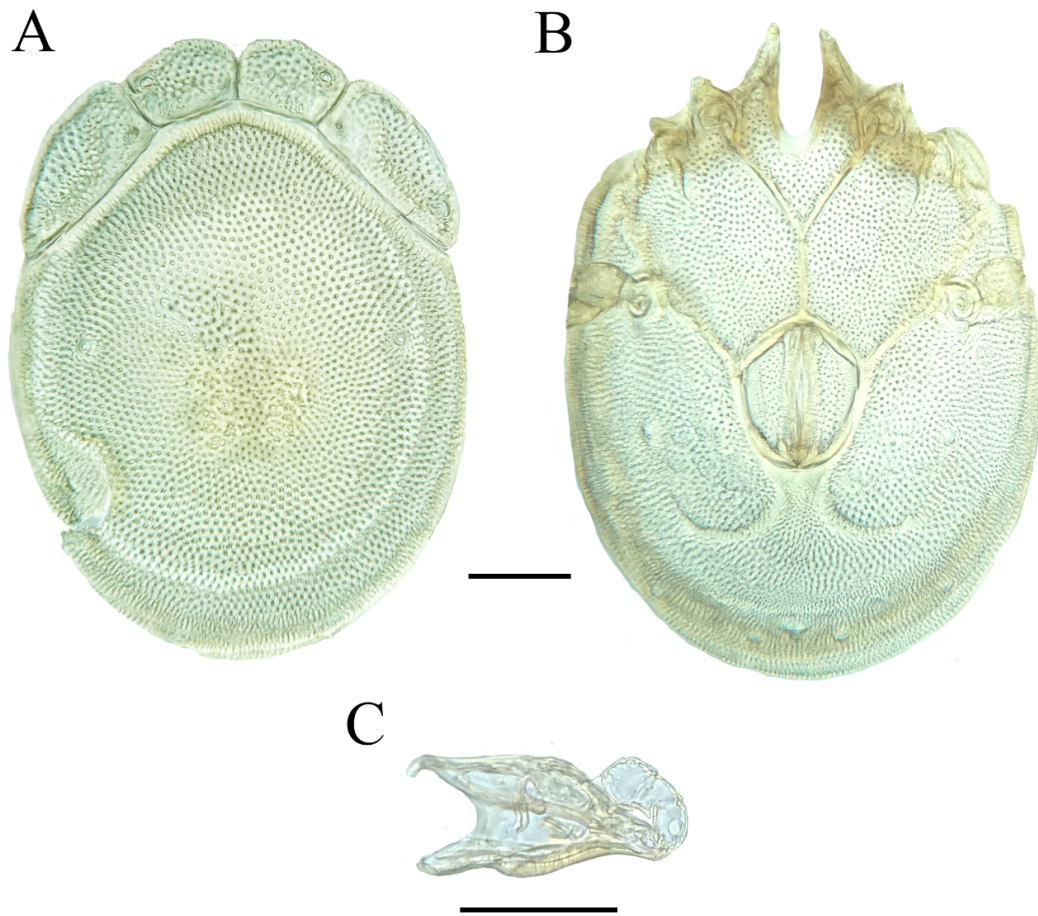
**Gnathosoma-Subcapitulum** (152.5 long (ventral); 117.5 long (dorsal); 25 tall) colorless. Rostrum (75 wide) relatively long and narrow. Chelicerae (145) long with curved fangs (22.5 long). Subcapitular proportions: ventral length/dorsal length (1.30). **Pedipalps** stocky with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter 15 long; 27.5 wide); femur (35 long; 32.5 wide); genu (25 long; 27.5 wide); tibia (32.5 long; 22.5 wide); tarsus (17.5 long; 12.5 wide). Palpomere proportions: femur/genu 1.40; tibia/femur 0.93; tibia length/width 1.44.

**Venter** (650) long; 470 wide) colorless. Gnathosomal bay (110 long; 40 wide). Cxgl-4 subapical. **Medial suture** (100 long). **Genital plates** (145 long; 120 wide). Additional measurements: Cx-1 (205 long (total); 100 long (medial); Cx-3 (350 wide); anterior venter (195 long). Ventral proportions: gnathosomal bay length/width 2.75; anterior venter/genital field length 1.34; anterior venter length/genital field width 1.63.

**IMMATURES unknown.**

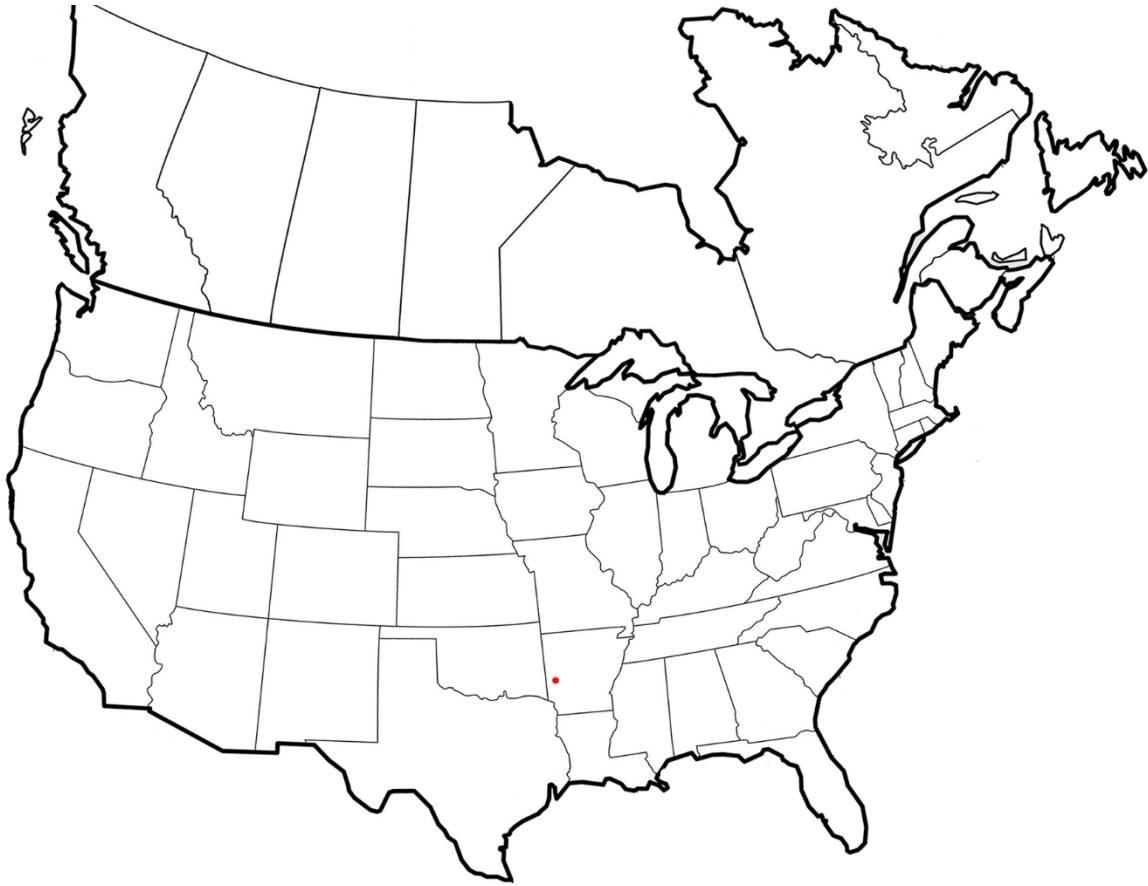
**Etymology.** Specific epithet (*montgomeryae*) was chosen for the county where the holotype was collected.

**Distribution.** *M. montgomeryae* is currently only known from Montgomery County, Arkansas (Fig. 50).



**Figure 49.** *Monatractides montgomeryae* sp. n. male: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum and pedipalp (setae not accurately depicted). Scale = 100  $\mu$ m.

**Remarks.** In all analyses, *Monatractides montgomeryae* groups with other members of the Easterly group with high support. Additionally, *M. montgomeryae* groups with the two other species of monatractids also having elongated subcapitula; *M. pertussiae* and *M. confusica*. This species hypothesis is supported by high COI divergence between species (at least 9.9% from its sister species), and by the morphological characters outlined in the diagnosis.



**Figure 50.** *Monatractides montgomeryae* distribution

***Monatractides oblongata* (Marshall, 1943)**

*Atractides oblongatus* Marshall 1943: 316

*Torrenticola oblongata* Crowell 1961: 330

**Material examined.** HOLOTYPE (♀): **USA, California**, Santa Cruz County, Waddell Creek, 25-26 Aug 1932 by PR Needham.

TOPOTYPE (1♀): **USA, California**, Santa Cruz County, Waddell Creek, 25-26 Aug 1932 by PR Needham.

OTHER MATERIAL: (21♀, 20♂): **USA, California:** (allotype) 1♂ from Santa Cruz County, Waddell creek. Backwoods hike off Canyon Rd., (37°6'6"N, 122°16'16"W), 15 July 2015, by WA Nelson, JM Gilbert, WN 15-0715-002 • 1♂ from Ventura County, beside Rt. 33 just above Wheeler Gorge Campground, (34°31'31"N, 119°16'16"W), 30 May 2010, by IM Smith, IMS100038 • 2♀ from Ventura County, beside Rt. 33 just above Wheeler Gorge Campground, (34°31'31"N, 119°16'16"W), 31 May 2010, by IM Smith, IMS100041 • 1♀ and 1♂ from Ventura County, beside Rt. 33 just above Wheeler Gorge Campground, (34°31'31"N, 119°16'16"W), 31 May 2010, by IM Smith, IMS100042 • 1♀ and 1♂ from Ventura County, Ojai; beside Rt. 33 just above Wheeler Gorge Campground, (34°31'31"N, 119°16'16"W), 25 July 1987, by IM Smith, IMS870109A • 1♀ from Ventura County, Ojai; beside Rt. 33 just above Wheeler Gorge Campground, (34°31'31"N, 119°16'16"W), 25 July 1987, by IM Smith, IMS870109B • 1♀ from Ventura County, Ojai; beside Rt. 33 just below Wheeler Gorge Campground, (34°31'31"N, 119°16'16"W), 27 July 1987, by IM Smith, IMS870112 • 2♀ and 2♂ from Monterey County, beside Rt. 1 south of Gorda, (35°49'49"N, 121°22'22"W), 28 July 1987, by IM Smith, IMS870114A • 2♂ from Monterey County, beside Rt. 1 south of Gorda, south side

of Salmon Creek, (35°49'49"N, 121°22'22"W), 28 July 1987, by IM Smith, IMS870115 • 1♀ and 1♂ from Monterey County, beside Rt. 1 south of Gorda, north side of Salmon Creek, (35°49'49"N, 121°22'22"W), 29 July 1987, by IM Smith, IMS870117 • 1♀ from El Dorado County, Upper Truckee Rvr, off Rt 89, downstream of bridge, (38°50'50"N, 120°1'1"W), 29 August 2013, by JR Fisher, JRF 13-0829-004 • 1♀ and 1♂ from Monterey County, Nacimiento Campground beside Nacimiento-Ferguson Road east of Lucia, (36°0'0"N, 121°24'24"W), 30 July 1987, by IM Smith, IMS870120A • 1♀ from Tuolumne, beside Rt. 49, 2.8 km south of Rt. 120, (37°47'47"N, 120°16'16"W), 2 August 1987, by IM Smith, IMS870125 • 1♂ from Mendocino County, beside Rt. 128 at Paul M. Dimmick Recreation Area, (39°10'10"N, 123°38'38"W), 4 August 1987, by IM Smith, IMS870127A • 1♀ from Monterey County, Hare Canyon Cr, near campground, (36°0'0"N, 121°31'31"W), 6 September 2013, by JR Fisher, JRF 13-0906-001 • 1♀ from Monterey County, Salmon Cr, off Rt. 1, upstream of bridge, (35°48'48"N, 121°21'21"W), 6 September 2013, by JR Fisher, JRF 13-0906-003 • 1♀ and 1♂ from Ventura County, N Fork of Matilija Cr, off Rt 33, (34°30'30"N, 119°16'16"W), 7 September 2013, by JR Fisher, JRF 13-0907-001 • 1♀ and 2♂ from Santa Cruz County, Waddell creek. Backwoods hike off Canyon Rd., (37°6'6"N, 122°16'16"W), 15 July 2015, by WA Nelson, JM Gilbert, WN 15-0715-002 •

**Arizona, United States:** 1♀ from Cochise County, Chiricahua Mountains; Cave Creek Recreation Area; Stewart Campground beside Forest Road 42 west of Portal, (31°53'53"N, 109°10'10"W), 16 July 1987, by IM Smith, IMS870094 •

**Oregon, United States:** 1♀ and 4♂ from Curry County, Port Orford; Humbug Mountain State Park Picnic Area off Rt. 101, (42°41'41"N, 124°25'25"W), 1 July 1983, by IM Smith, IMS830012 • 1♀ and 1♂ from Curry County, Port Orford; Humbug Mountain State Park Picnic Area off Rt. 101, (42°41'41"N, 124°25'25"W), 3 July 1983, by IM Smith, IMS830020A • 1♀ from Curry County, Port Orford;

Humbog Mountain State Park Picnic Area off Rt. 101, (42°41'41"N, 124°26'26"W), 3 July 1983, by IM Smith, IMS830020B • 1 ♀ and 1 ♂ from Curry County, Sixes; Edson Creek Campground beside Sixes River Road, (42°48'48"N, 124°24'24"W), 4 July 1983, by IM Smith, IMS830021A

**Type deposition.** Holotype (♀), allotype (♂) and topotype deposited in the CNC. All other paratypes (21 ♀; 20 ♂) deposited in the ACUA.

**Diagnosis.** *Monatractides oblongata* are similar to other members of this western group (*M. banjoii* and *M. brewsteri*) in being colorless and ovoid. *M. oblongata* can be easily differentiated from *M. banjoii* by the dorsum width (dorsum width ♀ = 700-1060; ♂ = 665-960 in *M. banjoii*, ♀ = 460-520; ♂ = 420-500 in *M. oblongata*). *M. oblongata* can be differentiated from *M. brewsteri* by the width of the genital field (genital field width ♀ = 70-80; ♂ = 65-75 in *M. oblongata*, ♀ = 45-60; ♂ = 40-50 in *M. brewsteri*).

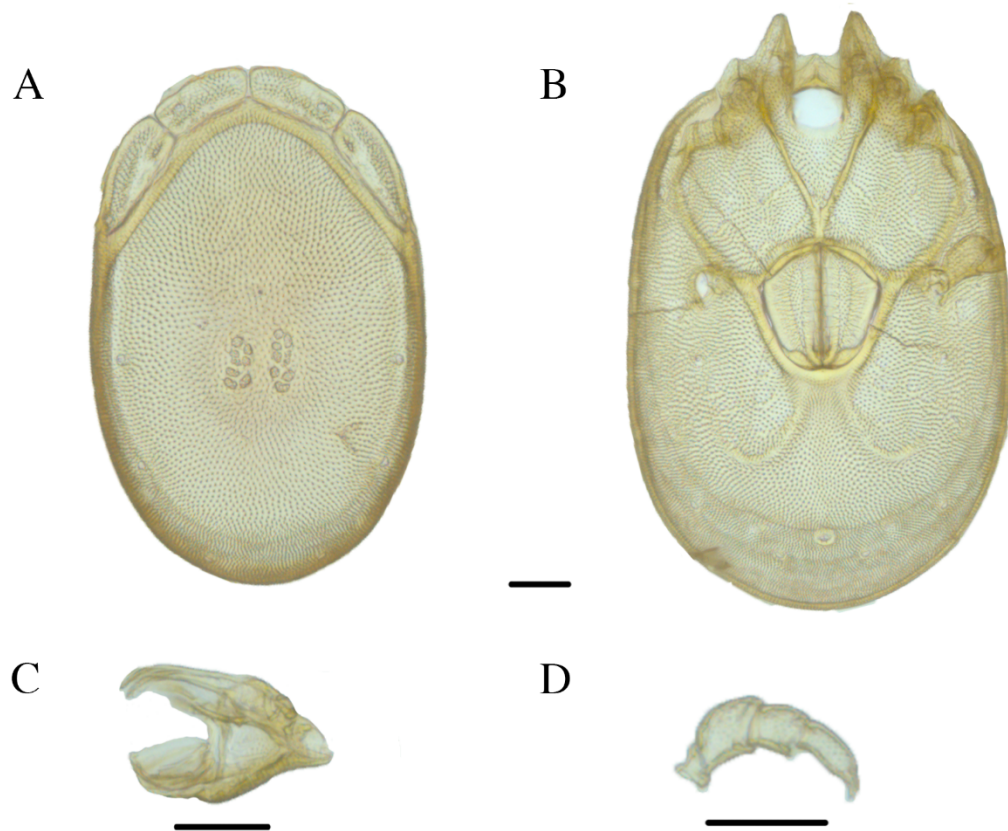
**Redescription. FEMALE (Fig. 51)** (n=21) (holotype measurements in parentheses when available) with characters of the genus with the following specifications.

**Dorsum** (710-840 (790) long; 460-530 (520) wide) ovoid and elongate with or without some light orange or pinkish coloration on dorsum in no distinct pattern. Anterio-medial platelets (130-155 (150) long; 60-70 (70) wide). Anterio-lateral platelets (160-190 (180) long; 60-70 (70) wide), free from dorsal plate. Dgl-4 much closer to the edge of the dorsum than to the muscle scars (distance between Dgl-4 380-450 (440)). Dorsal plate proportions: dorsum length/width 1.44-1.65 (1.52); dorsal width/distance between Dgl-4 0.64-0.74 (0.70); anterio-medial platelet length/width 2.14-2.58 (2.14); anterio-lateral platelet length/width 2.43-3.0 (2.57); anterio-lateral/anterio-medial length 1.14-1.33 (1.20).

**Gnathosoma-Subcapitulum** (200-240 (240) long (ventral); 120-145 (135) long (dorsal);



25-50 (50) tall) colorless. Rostrum (135-160 (160) wide) short and stocky. Chelicerae (190-220 (210) long with curved fangs (45-60 (60) long). Subcapitular proportions: ventral length/dorsal length (1.45=1.78 (1.78). **Pedipalps** short and stocky (especially tibiae) with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (25-30 (30) long; 25-35 (35) wide); femur (55-70 (65) long; 37.5-50 (50) wide); genu (40-45 (40) long; 25-45 (55) wide); tibia (50-65 (55) long; 25-30 (20) wide); tarsus (20-30 (20) long; 15-20 (20) wide). Palpomere proportions: femur/genu 1.22-1.63 (1.63); tibia/femur 0.83-1.0 (0.85); tibia length/width 1.67-2.27 (1.83).



**Figure 51.** *Monatractides oblongata* female: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum **D** pedipalp (setae not accurately depicted). Scale = 100 μm.

**Venter** (810-950 (930) long; 520-625 (590) wide) colorless. Gnathosomal bay (160-180 (180) long; 70-80 (80) wide. Cxgl-4 subapical. **Medial suture** (40-50 (50) long). **Genital plates** (180-200 (190) long; 160-185 (180) wide). Additional measurements: Cx-1 (300-365 (360) long (total); 110-140 (130) long (medial); Cx-3 (410-450 (440) wide); anterior venter (160-185 (180) long). Ventral proportions: gnathosomal bay length/width 2.25-2.57 (2.25); anterior venter/genital field length 1.84-0.95 (0.95); anterior venter length/genital field width 0.92- 1.06 (1.00).

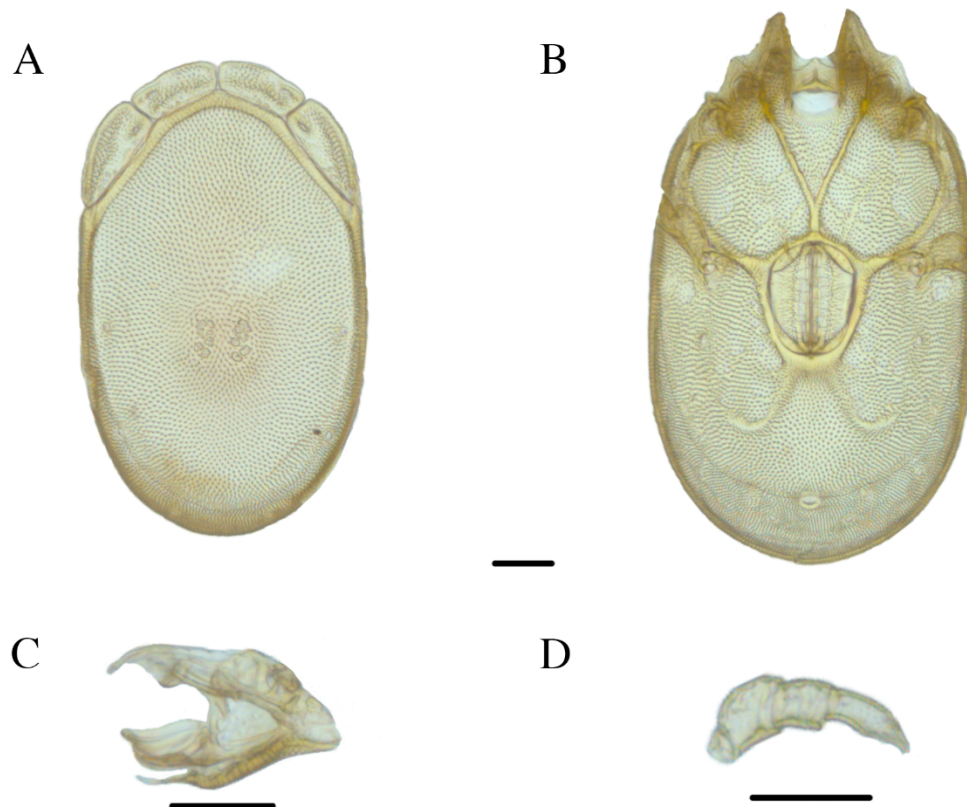
**MALE (Fig. 52)** (n =20) (allotypic measurements in parentheses when available) with characters of the genus following specifications.

**Dorsum** (680-780 (730) long; 420-500 (420 wide) ovoid and elongate with or without some light orange or pinkish coloration on dorsum in no distinct pattern. Anterio-medial platelets (120-145 (140) long; 50-70 (60) wide). Anterio-lateral platelets (160-190 (170) long; 60-80 (70) wide), free from dorsal plate. Dgl-4 much closer to the edge of the dorsum than to the muscle scars (distance between Dgl-4 330-420 (330)). Dorsal plate proportions: dorsum length/width 1.46-1.84 (1.74); dorsal width/distance between Dgl-4 0.62-0.74 (0.62); anterio-medial platelet length/width 1.86-2.60 (2.33); anterio-lateral platelet length/width 2.25-3.0 (2.43); anterio-lateral/anterio-medial length 1.17-1.50 (1.21).

**Gnathosoma-Subcapitulum** (190-225 (225) long (ventral); 125-140 (125) long (dorsal); 35-50 (35) tall) colorless. Rostrum (135-150 (140) wide) short and stocky. Chelicerae (180-205 (200) long with curved fangs (45-55 (55) long). Subcapitular proportions: ventral length/dorsal length (1.44-1.80 (1.80)). **Pedipalps** short and stocky (especially tibiae) with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (25-30 (25) long; 25-35 (30) wide); femur (55-65 (65) long; 40-50 (45) wide); genu (35-50 (45) long; 35-40 (40) wide); tibia (45-60

(55) long; 25-30 (25) wide); tarsus (20-30 (30) long; 10-15 (15) wide). Palpomere proportions: femur/genu 1.20-1.71 (1.44); tibia/femur 0.82-1.0 (0.85); tibia length/width 1.80-2.40 (2.20).

**Venter** (760-880 (860) long; 500-560 (500) wide) colorless. Gnathosomal bay (150-170 (160) long; 60-75 (70) wide. Cxgl-4 subapical. **Medial suture** (50-70 (50) long). **Genital plates** (160-185 (180) long; 120-145 (140) wide). Additional measurements: Cx-1 (340-410 (410) long (total); 110-150 (150) long (medial); Cx-3 (370-420 (400) wide); anterior venter (180-215 (200) long). Ventral proportions: gnathosomal bay length/width 2.0-2.58 (2.29); anterior venter/genital field length 1.03-1.19 (1.11); anterior venter length/genital field width 1.43-1.58 (1.43).



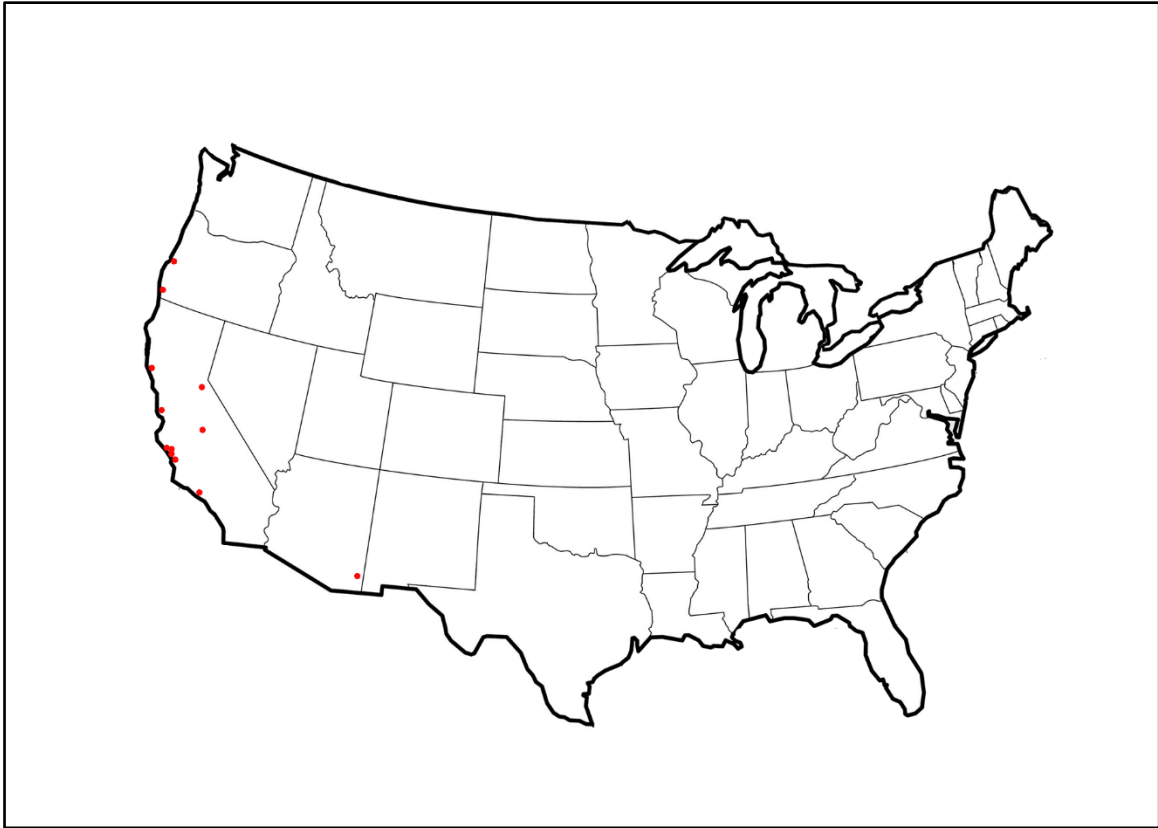
**Figure 52** *Monatractides oblongata* male: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum **D** pedipalp (setae not accurately depicted). Scale = 100  $\mu$ m.

**IMMATURES** unknown.

**Etymology.** Marshall (1943) opened the description with the following “the pronounced oblong form of the body suggests the specific name” which obviously lead to the specific epithet (*oblongatus*, which changed to *oblongata*) for this species.

**Distribution.** Originally described from two specimens in Santa Cruz County, California, we are able to extend the known range in California, as well as up into Oregon and extend down along the southwest into Arizona (Fig. 53).

**Remarks.** *Monatractides oblongata* group with the other member of the oblongata complex, *M. brewsteri*, with high support in our 28S analysis. Additionally, this group has morphologic and geographic similarities with *M. banjoii*, which has been included in this complex, sans sequencing data. Specimens within this complex are 0-2.7% different in COI sequence from each other and greater than 18% different from *M. brewsteri*. The species hypothesis is supported by phylogenetic affinity and by the morphological characters outlined in this redescription.



**Figure 53.** *Monatractides oblongata* distribution.

***Monatractides pertussiae* Nelson & Dowling, sp. n.**

**Material examined.** HOLOTYPE (♀): **CANADA, Ontario:** 1 ♀ from Hastings Co., Maynooth, Papineau Creek, beside Hwy 127, 1.4 km N of Madawaska Rd, (45°16'16"N, 77°59'59"W), 17 August 2011, by IM Smith, IMS110051

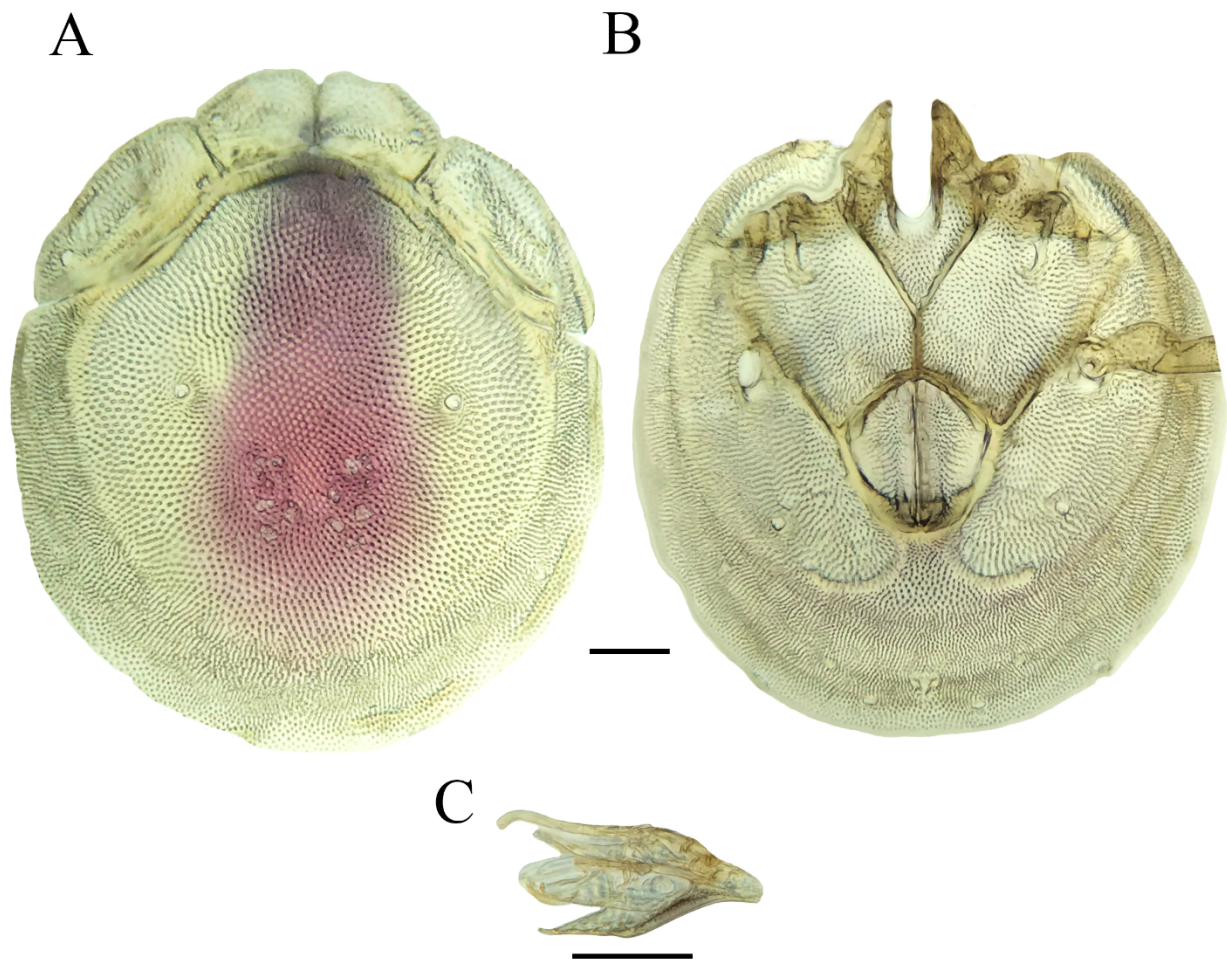
PARATYPES (3 ♀, 4 ♂): **CANADA, Ontario:** (allotype) 1 ♂ from Hastings Co., Maynooth, Papineau Creek, beside Hwy 127, 1.4 km N of Madawaska Rd, (45°16'16"N, 77°59'59"W), 17 August 2011, by IM Smith, IMS110051 • 1 ♀ and 2 ♂ from Hastings Co., Maynooth, Papineau Creek, beside Hwy 127, 1.4 km N of Madawaska Rd, (45°16'16"N, 77°59'59"W), 17 August 2011, by IM Smith, IMS110051 • 1 ♀ and 1 ♂ from Hastings, Price Conservation Area beside Hwy. 7 near Actinolite, (44°33'33"N, 77°20'20"W), 20 September 1983, by IM Smith, IMS830087 • 1 ♀ from Lanark, beside Lanark Road #15 between Ferguson Falls and Hwy. 511, (45°3'3"N, 76°23'23"W), 6 October 1983, by IM Smith & CJ Hill, IMS830093A.

**Type deposition.** Holotype (♀), allotype (♂), and other paratypes (3 ♀; 3 ♂) deposited in the CNC.

**Diagnosis.** *Monatractides pertussiae* are similar to many other members of this Easterly group by having notable dorsal coloration and patterning; in this case, a purple or pink “streak” down the otherwise colorless dorsum. Like other members of the Easterly Elongatus group, *M. pertussiae* has an elongated subcapitulum compared to all other known monatractids, which differentiates from all but its sister species, *M. montgomreyae* and *M. confusica*. *M. pertussiae* can be differentiated from *M. confusica* using the anteriomedial platelet length/width

measurement (anteriomedial platelet length/width ♀= 1.36-1.44 in *M. pertussiae*, 1.62 in *M. confusica*; ♂= 1.22-1.37 in *M. pertussiae*, 1.43 in *M. confusica*, and 2.33 in *M. montgomeryae*).

**Description. FEMALE (Fig. 54) (n=4)** (holotype measurements in parentheses when available) with characters of the genus with the following specifications.



**Figure 54.** *Monatractides pertussiae* sp. n. female: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum. Scale = 100  $\mu$ m.

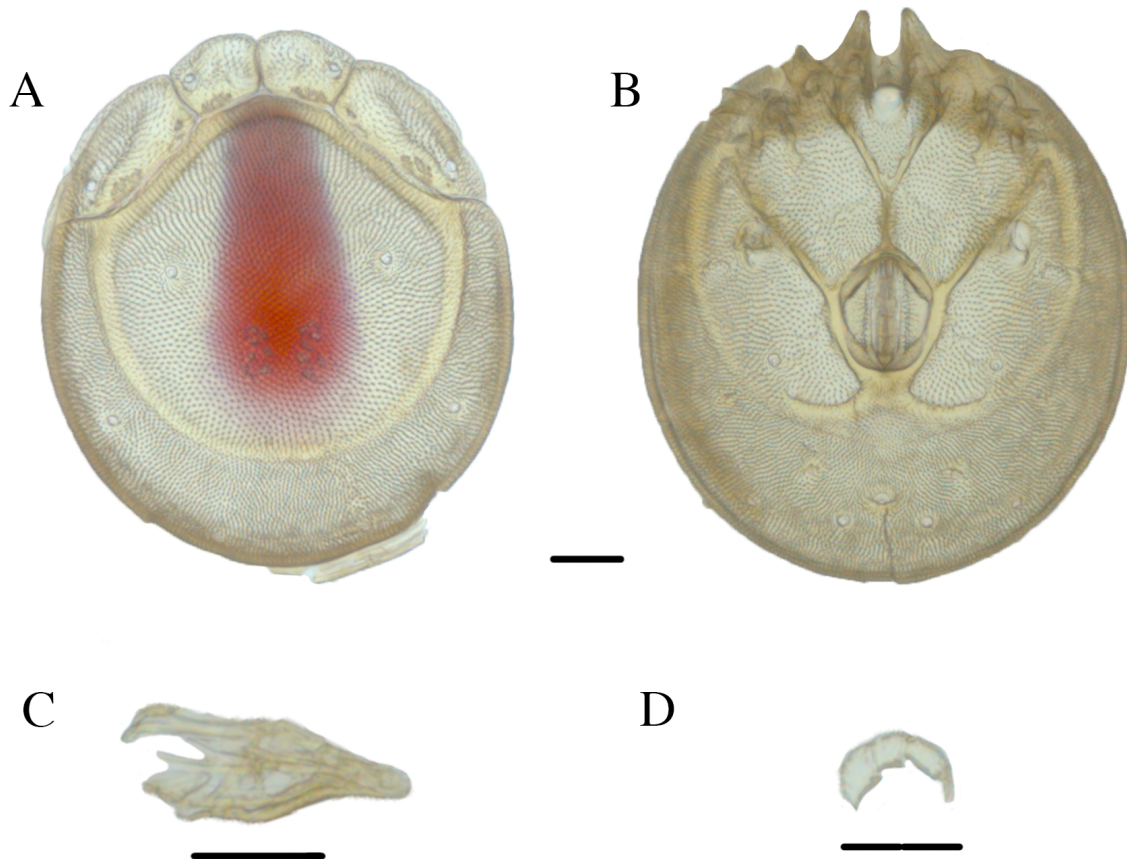
**Dorsum** – (735-830 (735) long; 640-690 (650) wide) round, with a pinkish to purple streak of color that starts at the base of the antero-medial-platelets and may or may not color their base. Antero-medial platelets (120-135 (135) long; 80-95 (95) wide). Antero-lateral platelets (240-250 (250) long; 95-110 (110) wide), free from dorsal plate. Dgl-4 closer or equidistant to the muscle scars than the edge of the dorsum (distance between Dgl-4 290-325 (290)). Dorsal plate proportions: dorsum length/width 1.13-1.2 (1.13); dorsal width/distance between Dgl-4 0.93-1.0 (1.0); antero-medial platelet length/width 1.37-1.44 (1.42); antero-lateral platelet length/width 2.27-2.53 (2.27); antero-lateral/antero-medial length 1.85-2.0 (1.85).

**Gnathosoma-Subcapitulum** (185-200 (185) long (ventral); 125-140 (130) long (dorsal); 40 (40) tall) colorless. Rostrum (85-95 (95) wide) long and often with a streak of color on the ventral side. Chelicerae (185-200 (185) long with curved fangs (25-30 (25) long). **Pedipalps** short and stocky with short tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (15-17.5 (15) long; 30 (30) wide); femur (27.5-47.5 (42.5) long; 35-40 (35) wide); genu (27.5-32.5 (32.5) long; 30-35 (32.5) wide); tibia (37.5-42.5 long; 25 wide); tarsus (22.5 long; 12.5-15 wide). Palpomere proportions: femur/genu 1.0-1.58 (1.31); tibia/femur 0.89-1.36; tibia length/width 1.5-1.7.

**Venter** (755-870 (755) long; 715-760 (715) wide) colorless. Gnathosomal bay (140-150 (140) long; 40-45 (40) wide. Cxgl-4 subapical. **Medial suture** (65-75 (70) long). **Genital plates** (180-190 (180) long; 160-170 (170) wide). Additional measurements: Cx-1 (325-330 (330) long (total); 110-120 (110) long (medial); Cx-3 (415-480 (480) wide); anterior venter (180-190 (190) long). Ventral proportions: gnathosomal bay length/width 3.33-3.5 (3.5); anterior venter/genital field length 1.0-1.06 (1.06); anterior venter length/genital field width 1.09-1.19 (1.12).



**MALE (Fig. 55)** (n =4) (allotypic measurements in parentheses when available) with characters of the genus following specifications.



**Figure 55.** *Monatractides pertussiae* sp. n. male: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum **D** pedipalp (setae not accurately depicted). Scale = 100 μm.

**Dorsum** – (630-690 (680) long; 570-620 (580) wide) round, with a pinkish to purple streak of color that starts at the base of the antero-medial-platelets and may or may not color their base. Antero-medial platelets (110-120 (110) long; 80-90 (90) wide). Antero-lateral platelets (210-240 (230) long; 90-100 (100) wide), free from dorsal plate. Dgl-4 closer or equidistant to the muscle scars than the edge of the dorsum (distance between Dgl-4 280-290

(280)). Dorsal plate proportions: dorsum length/width 1.11-1.17 (1.17); dorsal width/distance between Dgl-4 0.97-1.02 (0.97); antero-medial platelet length/width 1.22-1.38 (1.22); antero-lateral platelet length/width 2.30-2.40 (2.30); antero-lateral/antero-medial length 1.91-2.09 (2.09).

**Gnathosoma-Subcapitulum** (175-185 (175) long (ventral); 120-125 (125) long (dorsal); 35-40 (40) tall) colorless. Rostrum (75-80 (75) wide) relatively long and narrow, often with a streak of color on the venter. Chelicerae (160-195 (195) long with curved fangs (25-30 (25) long). Subcapitular proportions: ventral length/dorsal length (1.40-1.50 (1.40)). **Pedipalps** stocky with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (20-27.5 (20) long; 25-30 (25) wide); femur (30-40 (40) long; 35-37.5 (35) wide); genu (27.5-32.5 (30) long; 25-30 (25) wide); tibia (35-37.5 (35) long; 25-27.5 (25) wide); tarsus (17.5-25 (20) long; 10-15 (15) wide). Palpomere proportions: femur/genu 1.0-1.36 (1.33); tibia/femur 0.88-1.25 (0.88); tibia length/width 1.40-1.50 (1.40).

**Venter** (710-740 (740) long; 635-680 (680) wide) colorless. Gnathosomal bay (120-130 (120) long; 40 (40) wide. Cxgl-4 subapical. **Medial suture** (80-90 (90) long). **Genital plates** (150 (150) long; 112-130 (130) wide). Additional measurements: Cx-1 (240-325 (240) long (total); 110-120 (110) long (medial); Cx-3 (370-450 (370) wide); anterior venter (190-200 (200) long). Ventral proportions: gnathosomal bay length/width 3.0-3.25 (3.0); anterior venter/genital field length 1.27-1.33 (1.33); anterior venter length/genital field width 1.46-1.67 (1.54).

#### **IMMATURES unknown.**

**Etymology.** Specific epithet (*pertussiae*) is in honor of my (WAN's) dog, Pertussis, who is also a bit chunky, but also streaking fast; the coloration on this mite reminded this author of

Pertussis in her youth.

**Distribution.** *M. pertussiae* is currently known from the east, specifically from eastern Ontario (Fig. 56).



**Figure 56.** *Monatractides pertussiae* distribution

**Remarks.** In all analyses, *Monatractides pertussiae* groups with other members of the Easterly group with high support. Additionally, *M. pertussiae* groups with the two other species of monatractids also having elongated subcapitula; *M. montgomeryae* and *M. confusica*. Species hypotheses is supported by high COI divergence between species (at least 9.9% from its sister species), and by the morphological characters outlined in the diagnosis.

***Monatractides purrsiae* Nelson & Dowling, sp. n.**

**Material examined.** HOLOTYPE (♀): **USA, California**, Santa Cruz County, Waddell creek. Backwoods hike off Canyon Rd., (37°6'6"N, 122°16'16"W), 15 July 2015, by WA Nelson, JM Gilbert, WN 15-0715-002.

PARATYPES (4♀, 1♂): **USA, California**, (allotype) 1♂ from Nevada, Sagehen Cr, off Rt 89, (39°26'26"N, 120°12'12"W), 26 August 2013, by JR Fisher, JRF 13-0826-006 • 2♀ from El Dorado, Upper Truckee Rvr, off Rt 89, downstream of bridge, (38°50'50"N, 120°1'1"W), 29 August 2013, by JR Fisher, JRF 13-0829-004 • 1♀ from Nevada, Sagehen Cr, off Rt 89, (39°26'26"N, 120°12'12"W), 26 August 2013, by JR Fisher, JRF 13-0826-006 • **Washington, United States**: 1♀ from Lewis, Snoqualmie National Forest, (46°42'42"N, 122°14'14"W), 23 July 2013, by JC O'Neill, WA Nelson, JNOW 13-0723-002

**Type deposition.** Holotype (♀) and allotype (♂) deposited in the CNC. All other paratypes (3♀) deposited in the ACUA.

**Diagnosis.** *Monatractides purrsiae* makes up the Gilbroski group along with *M. purrsiae*. The Gilbroski group is similar to other members of the Simulans group by having a long and narrow subcapitulum for a monatractid mite, which can be used to differentiate members of this group from similar looking members of the Californica group. Members of the Gilbroski group can be differentiated from *M. curva* by the lack of a downturned rostrum in the former. The Gilbroski group can be differentiated from *M. coastalis* by the lack of coloration on the venter in gilbroski mites, as well as the width of the dorsum (dorsum width ♀ = 760-820 in gilbroski mites 580-705 in *M. coastalis*). Gilbroski mites are very similar to *M. simulans* and can be differentiated using a combination of characters, including a gnathosomal bay to genital field

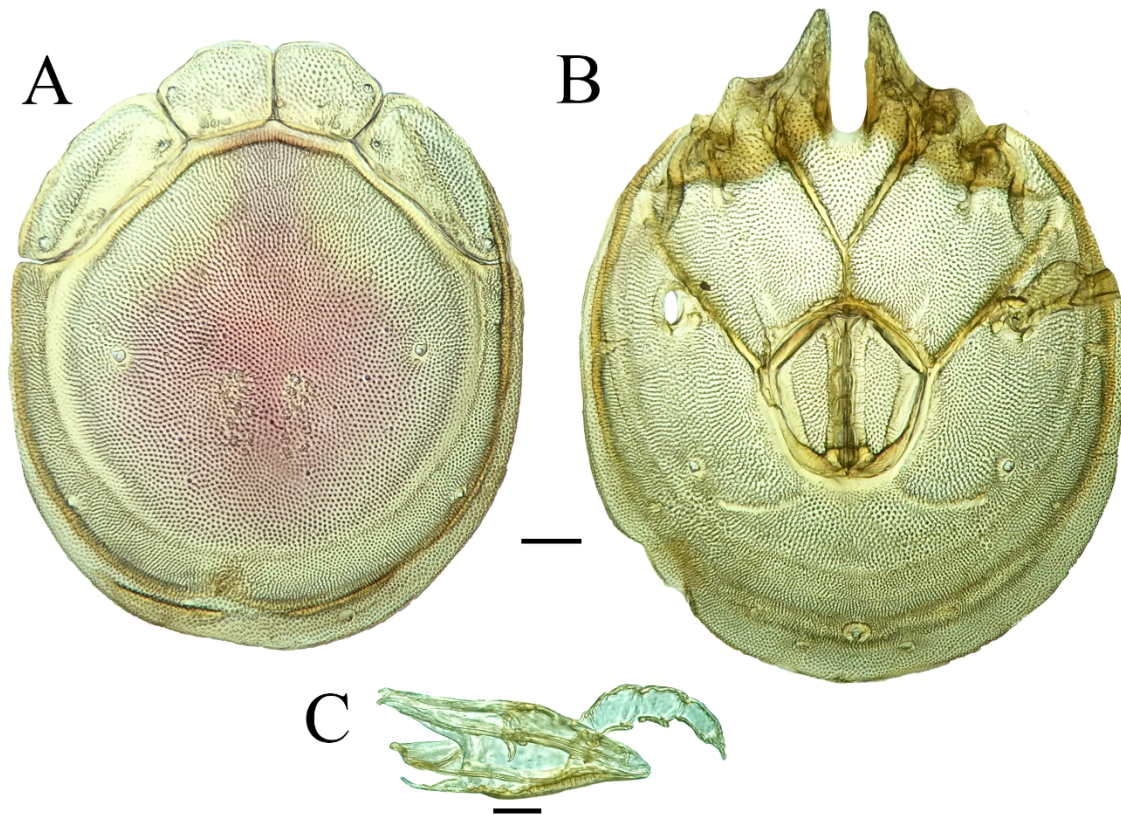
measurement (gnathosomal bay-genital field/genital field length measurement ♀ = 1.0-1.19 in gilbroski mites, 0.78-0.92 in *M. simulans*, ♂ = 1.44-1.50 in gilbroski mites, 0.95-1.20 in *M. simulans*). *M. gilbroskii* and *M. purrsiae* can be differentiated from each other using gnathosomal measurements (gnathosomal bay length/width measurement ♀ = 3.2-3.3 in *M. gilbroskii*, 2.16-2.9 in *M. purrsiae*; ♂ = 3.33 in *M. gilbroskii*, 2.77 in *M. purrsiae*).

**Description. FEMALE (Fig. 57)** (n= 5) (holotype measurements in parentheses when available) with characters of the genus with the following specifications.

**Dorsum** (880-980 (880) long; 760-820 (760) wide) ovoid and with the majority of the dorsal plate covered in a purple colored blotch. Anterio-medial platelets (130-170 (130) long; 110-130 (130) wide). Anterio-lateral platelets (285-300 (290) long; 120-130 (130) wide), free from dorsal plate. Dgl-4 closer to the edge of the dorsum than to the muscle scars (distance between Dgl-4 390-460 (460)). Dorsal plate proportions: dorsum length/width 1.16-1.23(1.16); dorsal width/distance between Dgl-4 0.90-0.99 (0.99); anterio-medial platelet length/width 1.0-1.36 (1.0); anterio-lateral platelet length/width 2.23-2.40 (2.23); anterio-lateral/anterio-medial length 1.76-2.23 (2.23).

**Gnathosoma-Subcapitulum** (250-260 (260) long (ventral); 175-185 (185) long (dorsal); 50-55 (55) tall) colorless. Rostrum (90-100 (100) wide) long and narrow. Chelicerae (235 long with curved fangs (30-35 (35) long). Subcapitular proportions: ventral length/dorsal length (1.35-1.43 (1.40)). **Pedipalps** short and stocky with small tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (17.5-20 (20) long; 35-37.5 (35) wide); femur 55 long; 45-50 (45) wide); genu (45-50 (45) long; 40 wide; tibia (45-55 (45) long; 25-30 (27.5) wide); tarsus (25-30 (25) long; 12.5-17.5 (17.5)). Palpomere proportions: femur/genu 1.22; tibia/femur 0.82-1.0 (0.82); tibia length/width 1.64-2.0 (1.64).

**Venter** (970-1120 (970) long; 810-950 (800) wide) colorless. Gnathosomal bay (130-170 (160) long; 50-65 (65) wide. Cxgl-4 subapical. **Medial suture** (70-100 (80) long). **Genital plates** (20-260 (260) long; 215-240 (240) wide). Additional measurements: Cx-1 (380-430 (420) long (total); 170-180 (180) long (medial); Cx-3 (570-640 (570) wide); anterior venter (250-260 (260) long). Ventral proportions: gnathosomal bay length/width 2.17-2.9 (2.5); anterior venter/genital field length 1.0-1.19 (1.0); anterior venter length/genital field width 1.08-1.18 (1.08).

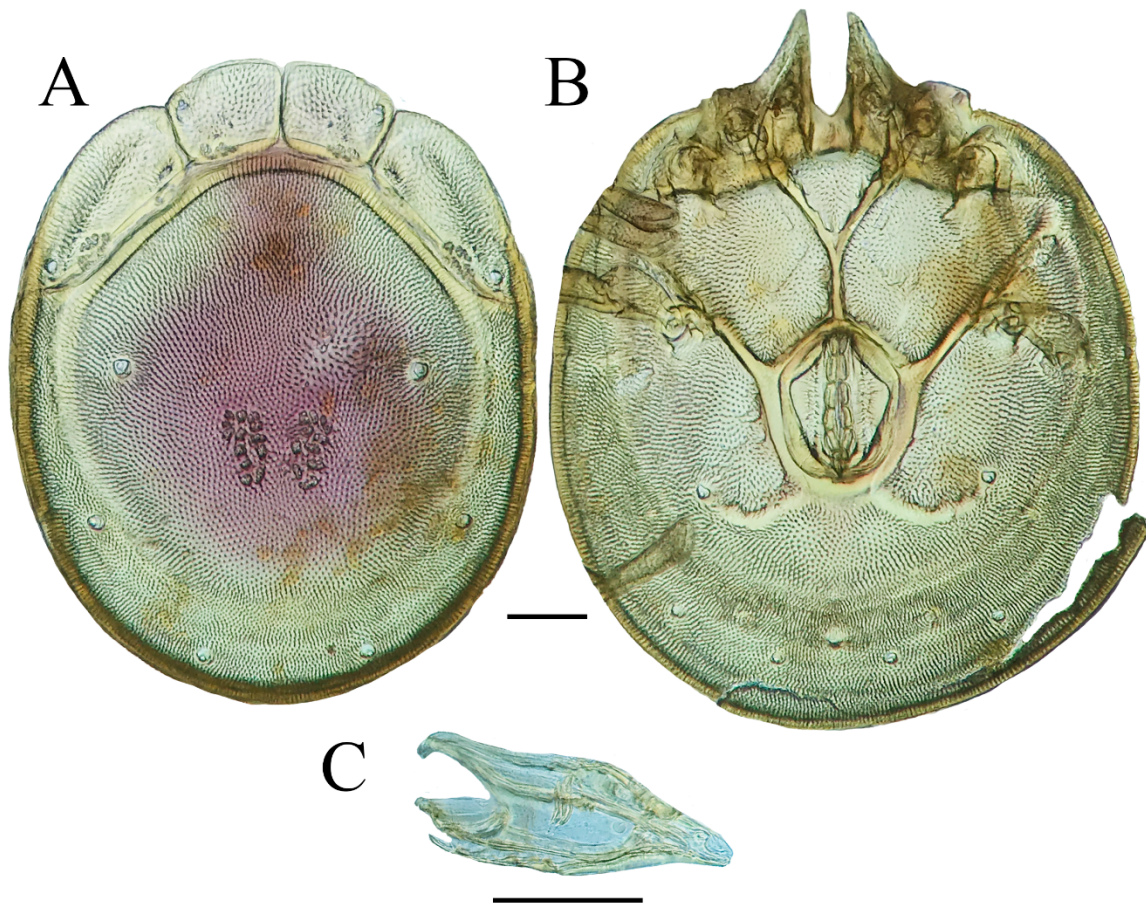


**Figure 57.** *Monatractides purrsiae* sp. n. female: **A** dorsal plates **B** venter (legs removed) **C** subcapitulu and pedipalp (setae not accurately depicted). Scale = 100  $\mu$ m.

**MALE (Fig. 58)** (n=1) with characters of the genus following specifications.



**Dorsum** (890 long; 650 wide) ovoid and with the majority of the dorsal plate covered in a purple blotch. Anterio-medial platelets (235 long; 120 wide). Anterio-lateral platelets (270 long; 110 wide), free from dorsal plate. Dgl-4 closer to the edge of the dorsum than to the muscle scars (distance between Dgl-4 380). Dorsal plate proportions: dorsum length/width 1.4; dorsal width/distance between Dgl-4 0.093; anterio-medial platelet length/width 1.96; anterio-lateral platelet length/width 2.45; anterio-lateral/anterio-medial length 1.15.



**Figure 58.** *Monatractides purrsiae* sp. n. male: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum and pedipalp (setae not accurately depicted). Scale = 100  $\mu$ m.

**Gnathosoma-Subcapitulum** (205 long (ventral); 155 long (dorsal); 30 tall) colorless. Rostrum (85 wide) very long and narrow. Chelicerae (210 long) with curved fangs (30 long). Subcapitular proportions: ventral length/dorsal length (1.32). **Pedipalps** short and stocky (especially tibiae) with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (20 long; 30 wide); femur (50 long; 45 wide); genu (35 long; 45 wide); tibia (45 long; 25 wide); tarsus (25 long; 15 wide). Palpomere proportions: femur/genu 1.25; tibia/femur 0.9; tibia length/width 1.8.

**Venter** (890 long; 700 wide) colorless. Gnathosomal bay (125 long; 45 wide. Cxgl-4 subapical. **Medial suture** (105 long). **Genital plates** (180 long; 150 wide). Additional measurements: Cx-1 (390 long (total); 160 long (medial); Cx-3 510 wide); anterior venter (260 long). Ventral proportions: gnathosomal bay length/width 2.77; anterior venter/genital field length 1.44; anterior venter length/genital field width 1.73.

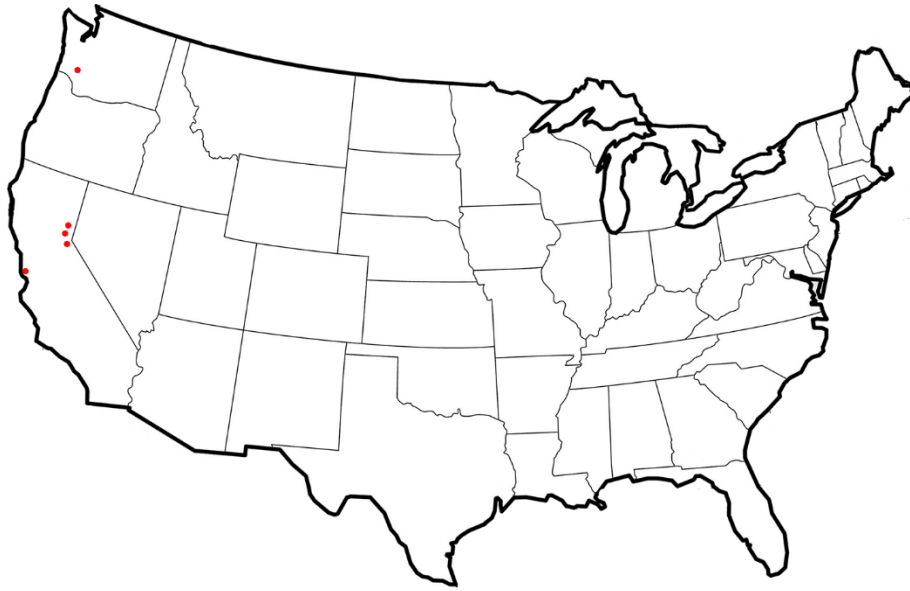
**IMMATURES** unknown.

**Etymology.** Specific epithet *purrsiae* was chosen in honor of Wil Gilbert's cat, Purrsus; an avid bug killer and resident of Santa Cruz, CA.

**Distribution.** *M. purrsiae* is known from central California and southern Washington (Fig. 59).

**Remarks.** In both analyses, *M. purrsiae* is placed in the Simulans group as a non-monophyletic clade. However, this species hypothesis is supported by low COI within-species divergence (2.1%), a lack of morphological differences between specimens, and high COI divergence among other species in the Simulans group (more than 7% between sister species *M. gilbroskii* and at least 16.7% from other species in the group).





**Figure 59.** *Monatractides purrsiae* sp. n. distribution.

***Monatractides rosiae* Nelson & Dowling, sp. n.**

**Material examined.** HOLOTYPE (♀): **USA, Texas:** 1 ♀ from Bandera County, beside Ranch Road 187, 0.5 km south of entrance to Lost Maples State Natural Area, (29°48'48"N, 99°34'34"W), 10 October 2010, by IM Smith, IMS100185.

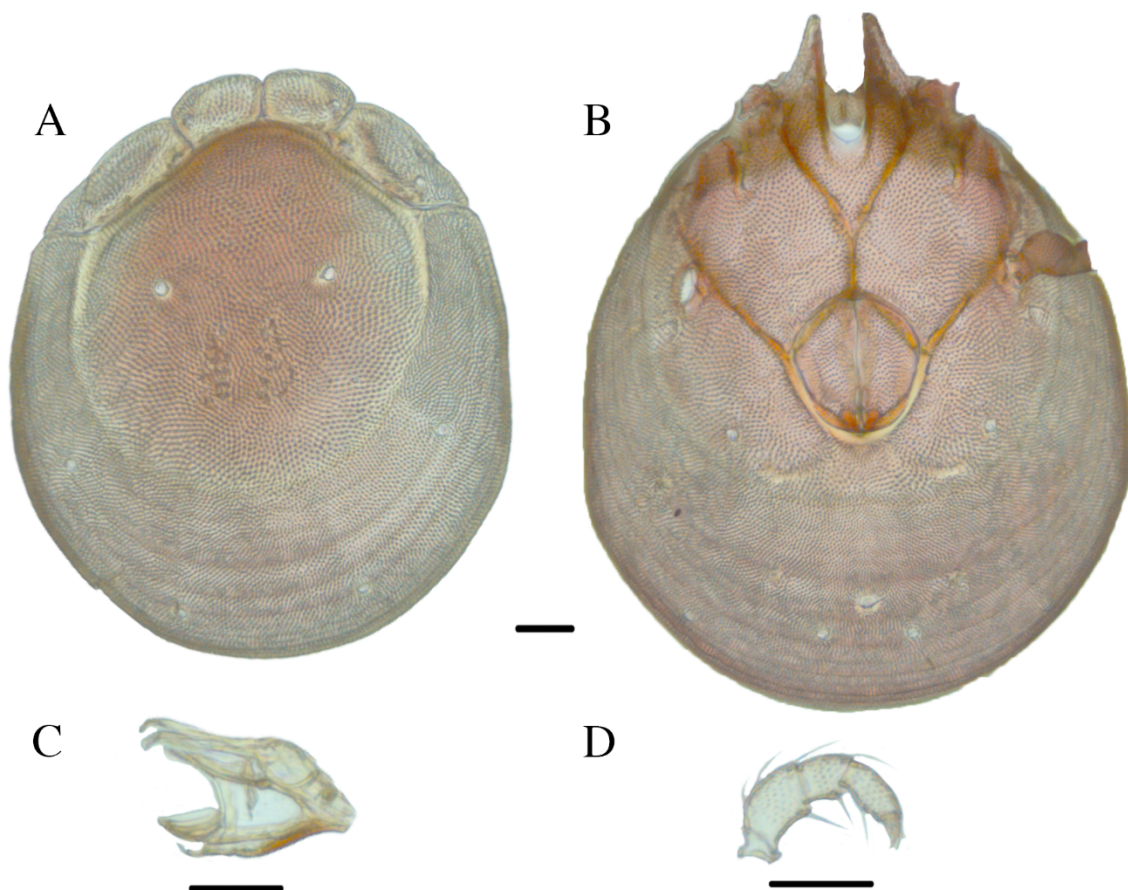
PARATYPES (10♀; 7♂): **USA, Texas:** (allotype) 1 ♂ from Val Verde County, Devils River State Natural Area; beside parking area near Blue Hole Spring, (29°53'53"N, 100°59'59"W), 4 October 2010, by IM Smith, IMS100170 • 4 ♀ and 3 ♂ from Kinney County, Brackettville; beside Rt. 90, 12.1 km west of Rt. 131, (29°20'20"N, 100°32'32"W), 26 May 2011, by IM Smith, IMS110018 • 3 ♀ from Kinney County, Brackettville; beside Rt. 90, 12.1 km west of Rt. 131, (29°20'20"N, 100°32'32"W), 9 October 2010, by IM Smith, IMS100183 • 2 ♀ and 2 ♂ from Kinney County, Brackettville; beside Rt. 90, 12.1 km west of Rt. 131, (29°20'20"N, 100°32'32"W), 3 October 2010, by IM Smith, IMS100169 • 1 ♂ from Bandera County, beside Ranch Road 187, 0.5 km south of entrance to Lost Maples State Natural Area, (29°48'48"N, 99°34'34"W), 10 October 2010, by IM Smith, IMS100185 • 1 ♀ from Bandera County, Lost Maples State Natural Area north of Vanderpool; picnic area, (29°49'49"N, 99°34'34"W), 27 May 2011, by IM Smith, IMS110025.

**Type deposition.** Holotype (♀), allotype (♂), and other paratypes (10♀; 6♂) deposited in the CNC.

**Diagnosis.** *Monatractides rosiae* is one of the largest species in North America; only exceeded in dorsum length by some individuals of *M. wilsonii*. Many *M. rosiae* can be identified easily by their very circular dorsum and striking pink coloration on both the dorsum and venter. This pigmentation varies from very bright to muted (see female in figure XX and male in figure

XX). *M. rosiae* can be differentiated from other members in the Easterly group by the dorsum width (dorsum width measurement ♀ = 720-840 in *M. rosiae* , 510-700 in all other Eastern clade ♀; ♂ =600-640 in *M. rosiae*, 420-625 in all other Eastern clade ♂) and genital field measurements (genital field width ♀ = 190-210 in *M. rosiae* , 140-190 in all other Eastern clade ♀; ♂ =140-150 in *M. rosiae*, 105-130 in all other Easterly group ♂).

**Description. FEMALE (Fig. 60) (n=11)** (holotype measurements in parentheses when available) with characters of the genus with the following specifications.



**Figure 60.** *Monatractides rosiae* sp. n. female: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum **D** pedipalp (setae not accurately depicted). Scale = 100  $\mu$ m.

**Dorsum** (800-920 (920) long; 720-840 (840) wide) round and with a dark to light rosey color on dorsal plate. Anterio-medial platelets (130-150 (150) long; 70-90 (90) wide). Anterio-lateral platelets (210-280 (210) long; 85-100 (100) wide), free from dorsal plate. Dgl-4 much closer to muscle scars than to the edge of the dorsum (distance between Dgl-4 260-300 (290)). Dorsal plate proportions: dorsum length/width 1.10-1.16 (1.10); dorsal width/distance between Dgl-4 0.94-1.03 (0.99); anterio-medial platelet length/width 1.56-1.86 (1.67); anterio-lateral platelet length/width 2.33-2.80 (2.80); anterio-lateral/anterio-medial length 1.5-1.92 (1.87).

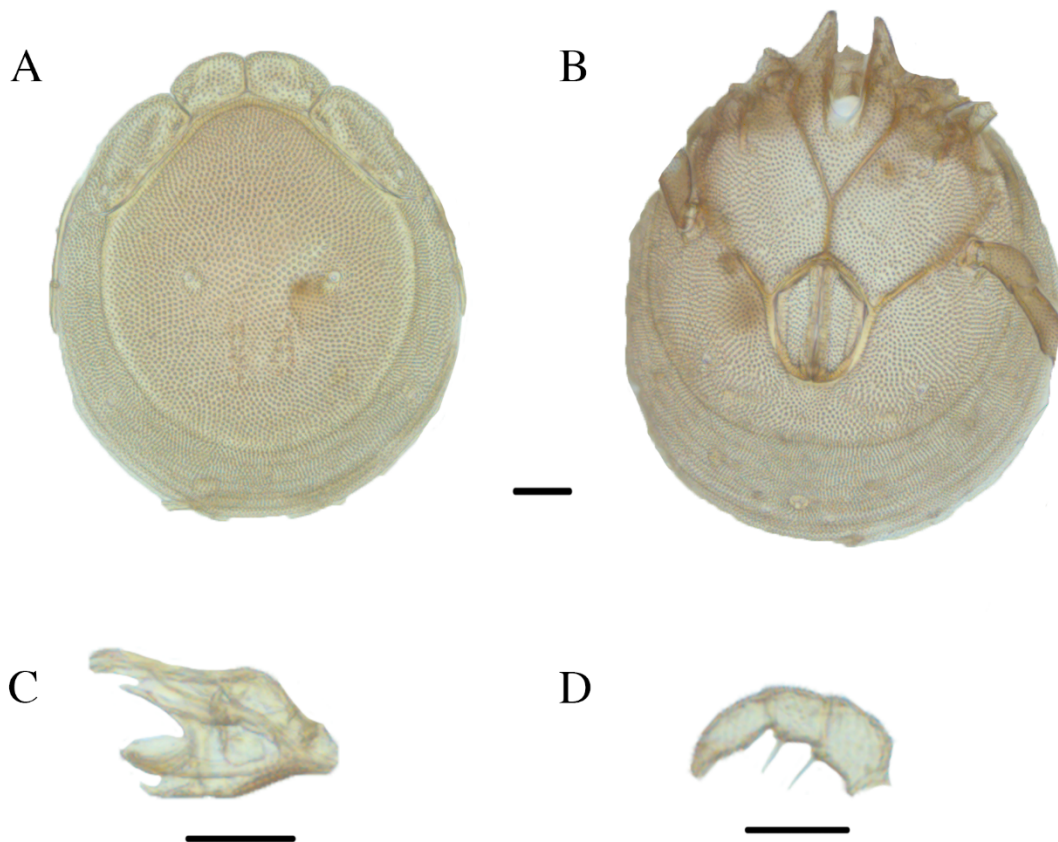
**Gnathosoma-Subcapitulum** (175-185 (185) long (ventral); 125-140 (135) long (dorsal); 25-35 (35) tall) colorless. Rostrum (110-140 (140) wide) short and stocky. Chelicerae (200-210 (210) long with curved fangs (35-45 (45) long). Subcapitular proportions: ventral length/dorsal length (1.25-1.40 (1.37)). **Pedipalps** short and stocky (especially tibiae) with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (25-30 (25) long; 30-47.5 (40) wide); femur (65-75 (75) long; 50-60 (50) wide); genu (45-50 (50) long; 40-45 (45) wide); tibia (60-75 (75) long; 30-35 (35) wide); tarsus (30-35 (35) long; 15-20 (15) wide). Palpomere proportions: femur/genu 1.44-1.67 (1.50); tibia/femur 0.80-1.0 (1.0); tibia length/width 1.17-2.17 (2.14).

**Venter** (940-1090 (1090) long; 790-900 (900) wide) with pink coloration on venter. Gnathosomal bay (180-200 (200) long; 60 (60) wide. Cxgl-4 subapical. **Medial suture** (80-105 (95) long). **Genital plates** (190-210 (210) long; 190-210 (210) wide). Additional measurements: Cx-1 (385-440 (440) long (total); 110-150 (140) long (medial); Cx-3 (480-540 (530) wide); anterior venter (210-240 (240) long). Ventral proportions: gnathosomal bay length/width 3.0-3.33 (3.33); anterior venter/genital field length 1.05-1.20 (1.14); anterior venter length/genital field width 1.05-1.26 (1.14).

**MALE (Fig. 61)** (n =7) (allotypic measurements in parentheses when available) with

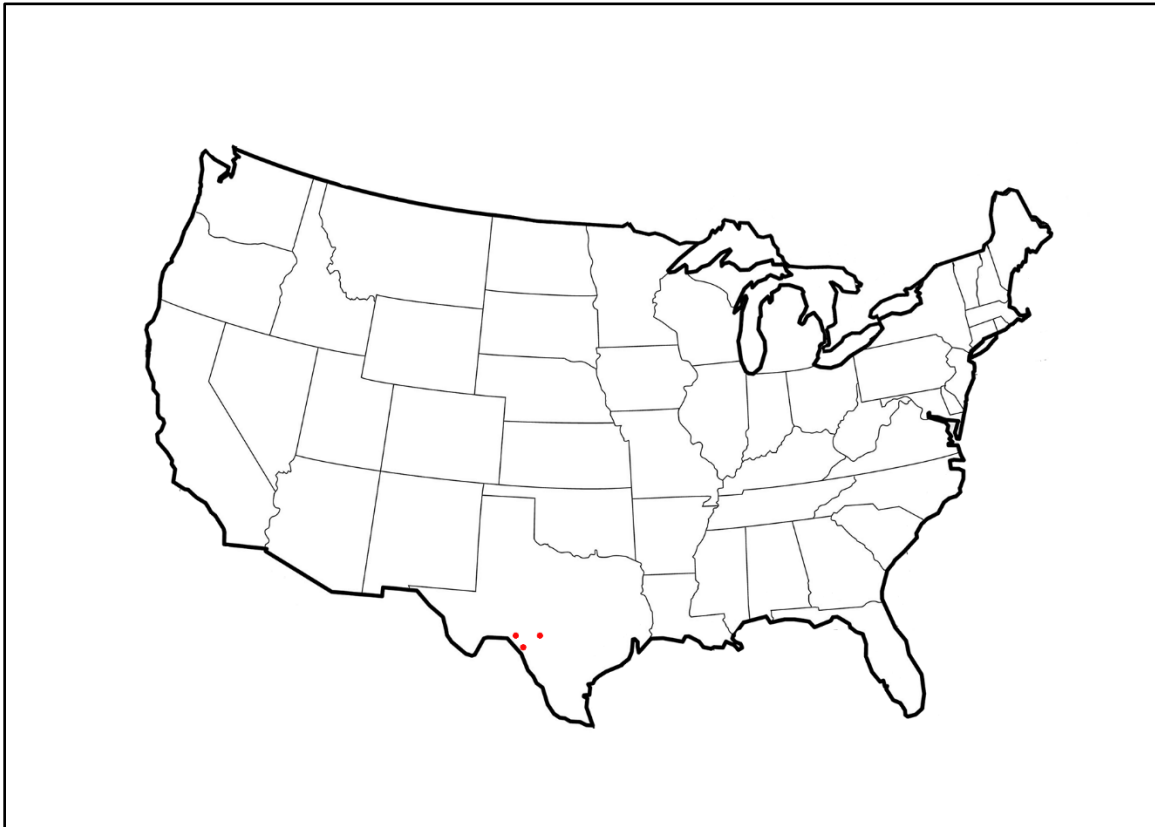
characters of the genus following specifications.

**Dorsum** (690-720 (700) long; 600-680 (600) wide) round and with a dark to light rosey color on dorsal plate. Anterio-medial platelets (110-130 (130) long; 70-80 (70) wide). Anterio-lateral platelets (200-250 (215) long; 80-90 (85) wide), free from dorsal plate. Dgl-4 closer to muscle scars than to the edge of the dorsum (distance between Dgl-4 230-265 (235)). Dorsal plate proportions: dorsum length/width 1.03-1.17 (1.17); dorsal width/distance between Dgl-4 1.95-1.06 (0.97); anterio-medial platelet length/width 1.57-1.86 (1.86); anterio-lateral platelet length/width 2.35-2.81 (2.53); anterio-lateral/anterio-medial length 1.65-1.92 (1.65).



**Figure 61.** *Monatractides rosiae* sp. n. male: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum **D** pedipalp (setae not accurately depicted). Scale = 100  $\mu$ m.

**Gnathosoma-Subcapitulum** (150-175 (175) long (ventral); 115-125 (120) long (dorsal); 25-30 (25) tall) colorless. Rostrum (110-125 (110) wide) very short and stocky. Chelicerae (170-190 (185) long with curved fangs (30-50 long). Subcapitular proportions: ventral length/dorsal length (1.46). **Pedipalps** short and stocky (especially tibiae) with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (20-25 (20) long; 30-35 (35) wide); femur (55-65 (55) long; 45-50 (50) wide); genu (35-45 (45) long; 35-40 (35) wide); tibia (50-60 (55) long; 30 (30) wide); tarsus (25-35 (25) long; 15-20 (15) wide). Palpomere proportions: femur/genu 1.22-1.57 (1.22); tibia/femur 0.83-1.0 (1.0); tibia length/width 1.67-2.0 (1.83).



**Figure 62.** *Monatractides rosiae* sp. n. distribution.

**Venter** (720-850 (780) long; 650-700 (650) wide) with light to dark rose color on venter. Gnathosomal bay (160-180 (160)) long; 50-60 (55) wide. Cxgl-4 subapical. **Medial suture** (80-110 (90) long). **Genital plates** (165-185 (180) long; 140-150 (140) wide).

Additional measurements: Cx-1 (370-400 (370) long (total); 110-140 (120) long (medial); Cx-3 (440-470 (440) wide); anterior venter (210-240 (220) long). Ventral proportions: gnathosomal bay length/width 2.75-3.40 (2.91); anterior venter/genital field length 1.17-1.27 (1.22); anterior venter length/genital field width 1.40-1.57 (1.57).

**IMMATURES** unknown.

**Etymology.** Specific epithet (*rosiae*) is taken from the family name of roses (Rosaceae), chosen because of this species pigmentation.

**Distribution.** Known from south eastern Texas (Fig. 62).

**Remarks.** In all analyses, *Monatractides rosiae* groups with other members of the Easterly group with high support. This species hypothesis is supported by low COI divergence within the species (less than 2%), high divergence between species (at least 12% from sister species in the Easterly group), and by morphological characteristics outlined in the diagnosis.

***Monatractides sevieri* Nelson & Dowling, sp. n.**

**Material examined.** HOLOTYPE (♀): **USA, Tennessee**, Sevier County: Great Smoky Mountains National Park; beside Greenbrier Road 0.5 km south of Rt. 321, (35°44'44"N, 83°24'24"W), 12 September 2010, by IM Smith, IMS100132.

PARATYPES (3♀; 7♂): **USA, Tennessee**: (allotype) 1♂ from Sevier County, Great Smoky Mountains National Park; beside Greenbrier Road 2.2 km south of Rt. 321, (35°43'43"N, 83°24'24"W), 2 September 2009, by IM Smith, IMS090093 • 1♀ and 1♂ from Monroe County, beside Forest Route 210, 1.8 km east of bridge at Bald River Falls, (35°19'19"N, 84°10'10"W), 5 July 1990, by IM Smith, IMS900079 • 1♀ from Sevier County, Great Smoky Mountains National Park; beside Greenbrier Road 2.2 km south of Rt. 321, (35°43'43"N, 83°24'24"W), 10 September 2010, by IM Smith, IMS100127 • 1♀ from Sevier County, Great Smoky Mountains National Park; beside Greenbrier Road 2.2 km south of Rt. 321, (35°43'43"N, 83°24'24"W), 12 September 2010, by IM Smith, IMS100131 • 2♂ from Sevier County, Great Smoky Mountains National Park; Greenbrier Picnic Area off Greenbrier Road, (35°42'42"N, 83°23'23"W), 10 September 2009, by IM Smith, IMS090107 • 2♂ from Monroe County, beside Forest Route #35, 2.3 km northeast of road from Rt. 165 to Miller Chapel Baptist Church, (35°21'21"N, 84°09'9"W), 12 September 2009, by IM Smith, IMS090112 • **North Carolina, United States**: 1♂ from Yancey County, Lost Cove Picnic Area beside Forest Route 472, 2.8 km south of Rt. 80, (35°45'45"N, 82°12'12"W), 28 June 1990, by IM Smith, IMS900065

**Type deposition.** Holotype (♀) and allotype (♂) deposited in the CNC. All other



paratypes (3♀; 6♂) deposited in the ACUA.

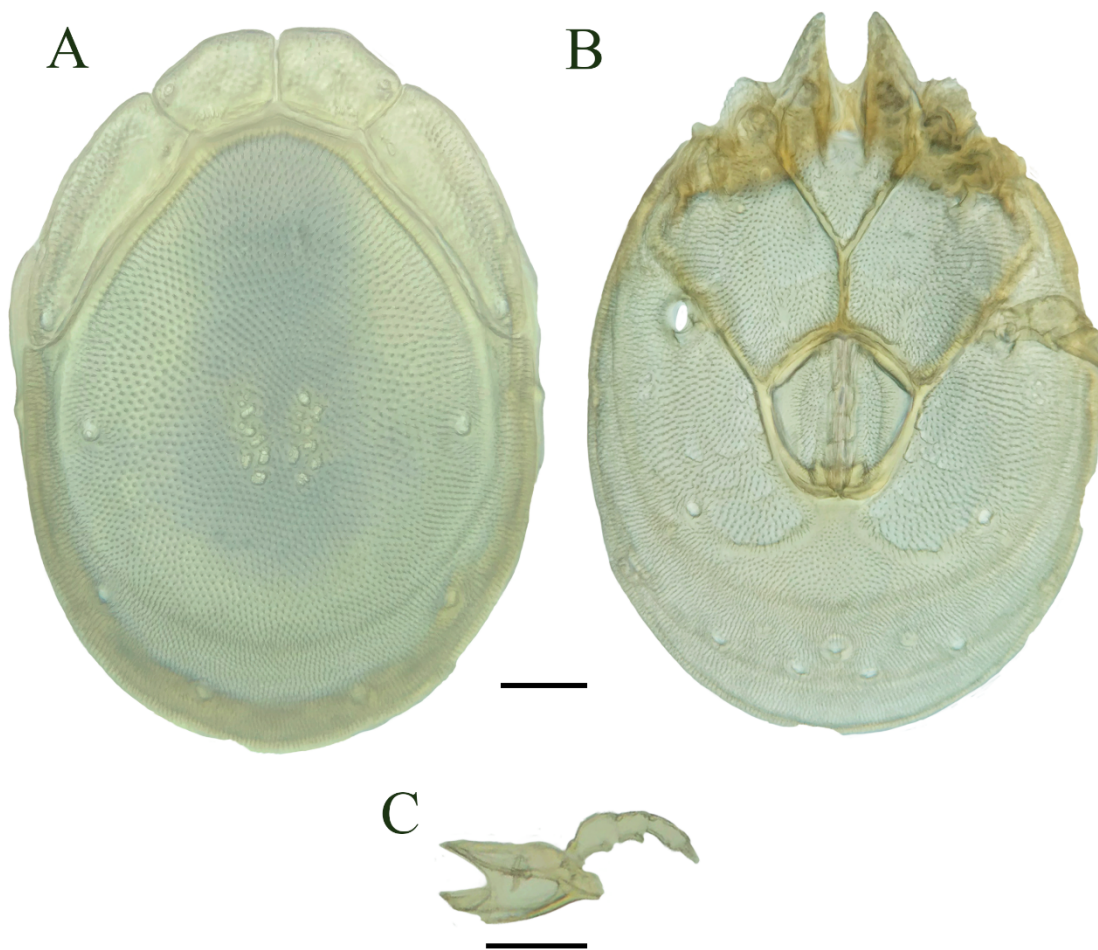
**Diagnosis.** *Monatractides seiveri* are similar to other members of the Easterly group by having some notable dorsal coloration and patterning, though *M. seiveri*'s purple blotch on the dorsum is less notable than other species in this group. *M. seiveri* is most similar morphologically to *M. axfordii*; they can be differentiated using the anteriolateral platelets (anteriolateral platelet length/width measurement ♀ = 2.87-3.0 in *M. seiveri*, 2.2-2.87 in *M. axfordii*; ♂ = 2.75-3.28 in *M. seiveri*, 2.3-2.5 in *M. axfordii*). The subcapitulum is wide, differentiating it from all species in the Easterly Elongatus group. *M. seiveri* can be easily differentiated from *M. williamsis*, *M. lynensis*, and *M. zirkleii* by the lack of both purple and orange dots on the dorsum.

**Description. FEMALE (Fig. 63)** (n= 4) (holotype measurements in parentheses when available) with characters of the genus with the following specifications.

**Dorsum** (650-680 (650) long; 490 (490) wide) oval, with a light purple blotch extending from antero-medial platelets back over the dorsum. Antero-medial platelets (580-620 (580) long; 120 (120) wide). Antero-lateral platelets (230-240 (230) long; 80 (80) wide), free from dorsal plate. Dgl-4 much closer to the edge of the dorsum than to the muscle scars (distance between Dgl-4 370-390 (390)). Dorsal plate proportions: dorsum length/width 1.22-1.39 (1.33); dorsal width/distance between Dgl-4 0.79-0.84 (0.84); antero-medial platelet length/width 1.50 (1.50); antero-lateral platelet length/width 2.88-3.0 (2.88); antero-lateral/anterio-medial length 1.92-2.0 (1.92).

**Gnathosoma-Subcapitulum** (155-175 (155) long (ventral); 120 (120) long (dorsal); 30-35 (35) tall) colorless. Rostrum (80-85 (85) wide) stocky. Chelicerae (170-180 (170) long with

curved fangs (20-25 (20) long). Subcapitular proportions: ventral length/dorsal length (1.29-1.46 (1.29)). **Pedipalps** short and stocky (especially tibiae) with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (15-20 (20) long; 25 (25) wide); femur (45 (45) long; 40-45 (45) wide); genu (20-35 (35) long; 25-30 (30) wide); tibia (40-45 (45) long; 25 (25) wide); tarsus (20-30 (30) long; 10-15 (10) wide). Palpomere proportions: femur/genu 1.29-1.50 (1.29); tibia/femur 0.89-1.0 (1.0); tibia length/width 1.60-1.80 (1.80).



**Figure 63.** *Monatractides sevieri* sp. n. female: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum and pedipalp (setae not accurately depicted). Scale = 100  $\mu$ m.

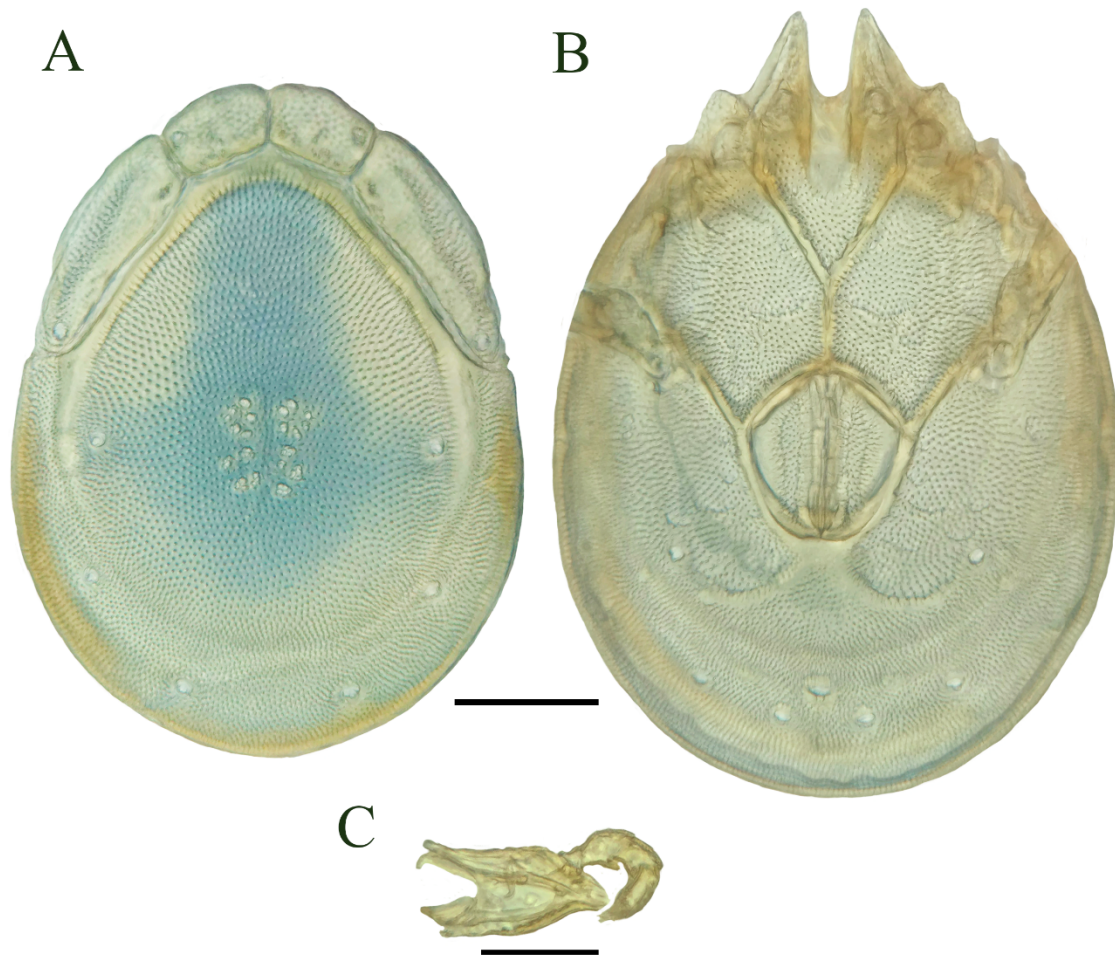
**Venter** (770-780 (770) long; 550 (550) wide) colorless. Gnathosomal bay (120-130 (130) long; 40 (40) wide. Cxgl-4 subapical. **Medial suture** (80-90 (80) long). **Genital plates** (170-190 (170) long; 160-170 (160) wide). Additional measurements: Cx-1 (250-350 (350) long (total); 130-140 (140) long (medial); Cx-3 (410 (410) wide); anterior venter 210-220 (220) long). Ventral proportions: gnathosomal bay length/width 3.0 (3.0); anterior venter/genital field length 1.11-1.29 (1.29); anterior venter length/genital field width 1.24-1.38 (1.38).

**MALE (Fig. 64)** (n =7) (allotypic measurements in parentheses when available) with characters of the genus following specifications.

**Dorsum** (540-620 (620) long; 400-470 (470) wide) oval, with a light purple blotch extending from antero-medial platelets back over the dorsum. Antero-medial platelets (100-110 (110) long; 60-70 (70) wide). Antero-lateral platelets (210-230 (230) long; 65-80 (80) wide), free from dorsal plate. Dgl-4 much closer to the edge of the dorsum than to the muscle scars (distance between Dgl-4 300-340 (340)). Dorsal plate proportions: dorsum length/width 1.32-1.26 (1.32); dorsal width/distance between Dgl-4 0.82-0.84 (0.84); antero-medial platelet length/width 1.43-1.67 (1.57); antero-lateral platelet length/width 2.75-3.29 (2.88); antero-lateral/antero-medial length 2.09-2.30 (2.09).

**Gnathosoma-Subcapitulum** (140-160 (160) long (ventral); 100-110 (110) long (dorsal); 25-30 (25) tall) colorless. Rostrum (70-75 (75) wide) stocky. Chelicerae (125-155 (140) long with curved fangs (20-30 (55) long). Subcapitular proportions: ventral length/dorsal length (1.33-1.50 (1.45)). **Pedipalps** short and stocky (especially tibiae) with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (15.2- (20) long; 22.5-25 (22.5) wide); femur (30-45 (42.5) long; 30-35 (35) wide); genu (30-35 (35) long; 25-27.5 (27.5) wide); tibia (37.5-40 (37.5) long; 20-25 (25) wide); tarsus (17.5-25 (25) long; 10 (10)). Palpomere proportions: femur/genu

0.86-1.50 (1.21); tibia/femur 0.88-1.33 (0.88); tibia length/width 1.50-2.0 (1.50).



**Figure 64.** *Monatractides sevieri* sp. n. male: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum and pedipalp (setae not accurately depicted). Scale = 100  $\mu$ m.

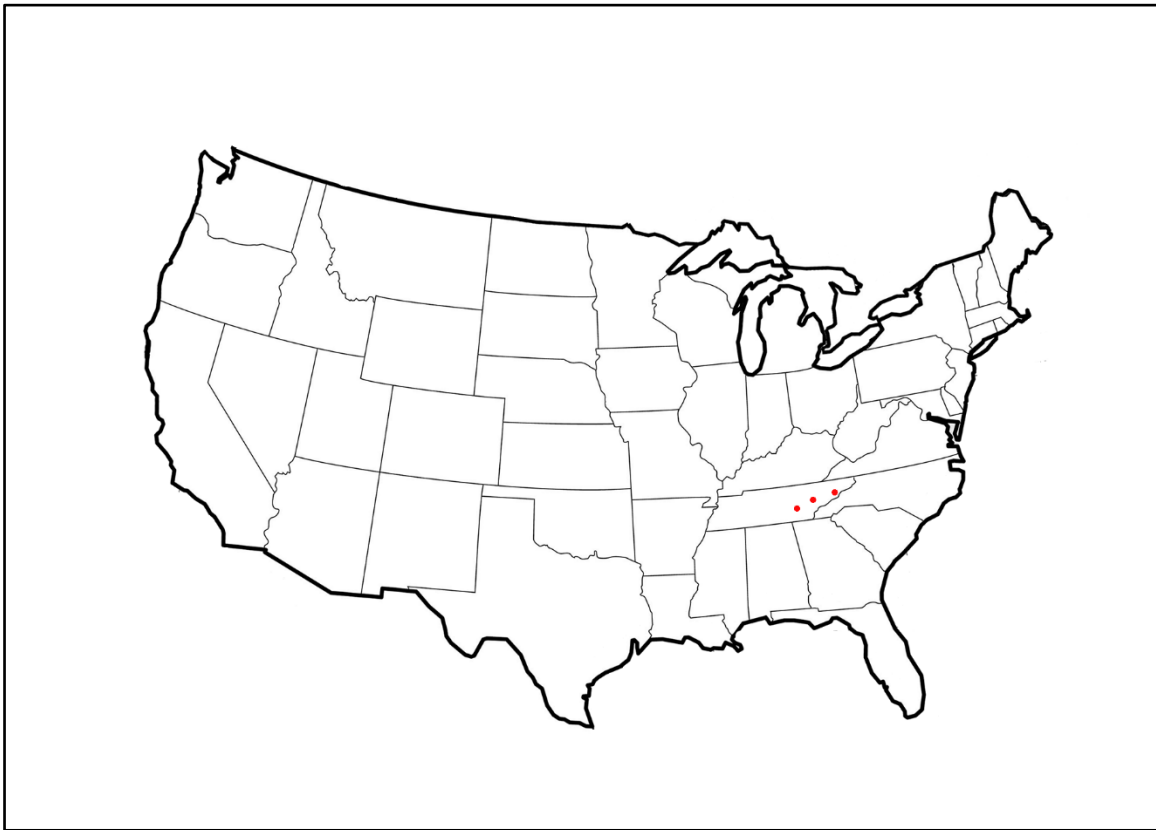
**Venter** (640-725 (725) long; 440-530 (530) wide) colorless. Gnathosomal bay (100-115 (115) long; 35-40 (40) wide. Cxgl-4 subapical. **Medial suture** (80-95 (80) long). **Genital plates** (130-170 (170) long; 100-150 (150) wide). Additional measurements: Cx-1 (220-320 (320) long (total); 110-120 (120) long (medial); Cx-3 (340-380 (380) wide); anterior venter (200-220 (210) long). Ventral proportions: gnathosomal bay length/width 2.75-3.0 (2.88); anterior venter/genital field length 1.24-1.57 (1.24); anterior venter length/genital field width 1.40-2.20 (1.40).

**IMMATURES** unknown.

**Etymology.** Specific epithet (*sevieri*) refers to Sevier County, the location where the holotype was collected.

**Distribution.** Known from eastern Tennessee (Fig. 65).

**Remarks.** In COI analyses, *Monatractides sevieri* groups with other members of the Easterly group with high support. This species hypothesis is supported by low COI divergence within the species (less than 0.5%), and high divergence between species (at least 16% from sister species in the Easterly group), and by morphological characteristics outlined in the diagnosis.



**Figure 65.** *Monatractides sevieri* sp. n. distribution.

***Monatractides simulans* (Marshall, 1933)***Atractides simulans* Marshall 1933: 40*Torrenticola simulans* Crowell 1961: 331*Monatractides simulans* Conroy & Bilyj 2009

**Material examined.** COTYPES (3♀): **USA, Wyoming:** from Medicine Bow National Forest, 1928, by JW Scott, RM280072.

OTHER MATERIAL (28♀; 26♂): **USA, Idaho:** (allotype) 1♂ from Butte County, Pass Creek, (43°57'57"N, 113°26'26"W), 26 July 2012, by JR Fisher, WA Nelson, JC O'Neill, ROW 12-0726-001 • 1♂ from Lemhi, N. Br. Salmon River; off FR91, downstream of bridge, (45°29'29"N, 113°59'59"W), 2 August 2012, by JR Fisher, WA Nelson, JC O'Neill, ROW 12-0802-004 • 2♀ from Butte County, Pass Creek, (43°57'57"N, 113°26'26"W), 26 July 2012, by JR Fisher, WA Nelson, JC O'Neill, ROW 12-0726-001 • 2♀ and 1♂ from Custer County, Basin Creek Campground beside Rt. 75 between Sunbeam and Stanley, (44°16'16"N, 114°49'49"W), 2 July 1985, by IM Smith, IMS850066 • 1♀ and 1♂ from Lemhi, beside Rt. 93, 15 km north of North Fork, (45°26'26"N, 114°0'0"W), 1 July 1985, by IM Smith, IMS850062 • 1♀ from Custer County, Jordan Cr. off Loon Cr. Rd., (44°22'22"N, 114°43'43"W), 30 July 2012, by JR Fisher, WA Nelson, JC O'Neill, ROW 12-0730-004 • 1♀ from Lemhi County, Silver Cr., along Silver Cr. Rd., (44°55'55"N, 114°22'22"W), 31 July 2012, by JR Fisher, WA Nelson, JC O'Neill, ROW 12-0731-003 • 2♀ from Blaine County, beside Rt. 75 between Obsidian and Galena Summit, (43°53'53"N, 114°51'51"W), 3 July 1985, by IM Smith, IMS850067 • **California, United States:** 1♀ from Placer County, Ward Cr, off Ward Cr Blvd, (39°8'8"N, 120°10'10"W), 27 August 2013, by JR Fisher, JRF 13-0827-001 • **Montana, United States:** 2♀ and 1♂ from

Ravalli County, Medicine Springs; Spring Gulch Campground beside Rt. 93, (45°51'51"N, 114°1'1"W), 1 July 1985, by IM Smith, IMS850060 • 1♂ from Powell County, Monture Creek at fishing access off Hwy 200 west of Ovando, (47°2'2"N, 112°13'13"W), 9 August 2012, by AJ Radwell, JA Hinsey, AJR 12-0809-415A • 1♂ from Mineral County, South Fork of Fish Creek beside Fish Creek Road between Hwy 12 and I-90, (46°49'49"N, 114°39'39"W), 7 August 2012, by AJ Radwell, JA Hinsey, AJR 12-0807-413 • 4♂ from Missoula County, Lee Cr at Lee Cr Campground; upstream of bridge, (46°42'42"N, 114°32'32"W), 7 August 2012, by JR Fisher, WA Nelson, JC O'Neill, ROW 12-0807-001 • 1♀ and 4♂ from Missoula County, Granite Creek north of Lolo Hot Springs on Fish Creek Road off Hwy 12, upstream of bridge, (46°43'43"N, 114°32'32"W), 7 August 2012, by AJ Radwell, JA Hinsey, AJR 12-0807-412 • 1♀ from Beaverhead County, Joseph Cr.; off 43, (45°40'40"N, 113°54'54"W), 3 August 2012, by JR Fisher, WA Nelson, JC O'Neill, ROW 12-0803-001 • 2♀ from Ravalli County, Piquette Cr; upstream of Piquette Cr Rd, (45°51'51"N, 114°11'11"W), 6 August 2012, by JR Fisher, WA Nelson, JC O'Neill, ROW 12-0806-002 • 1♀ from Ravalli County, Lost Horse Rv. downstream of confluence of N Lost Horse, (46°7'7"N, 114°18'18"W), 3 August 2012, by JR Fisher, WA Nelson, JC O'Neill, ROW 12-0803-006 • **Nevada, United States:** 1♀ and 2♂ from Humboldt County, Paradise Valley; Hinkey Summit, (41°40'40"N, 117°32'32"W), 16 June 1976, by IM Smith, IMS760123 • **Utah, United States:** 1♂ from Wasatch County, Main Cr; next to Main Canyon Rd., (40°19'19"N, 111°21'21"W), 22 July 2012, by JR Fisher, WA Nelson, JC O'Neill, ROW 12-0722-005 • **Washington, United States:** 1♀ from Okanogan County, Okanogan National Forest N. Fork Salmon Creek, (48°37'37"N, 119°48'48"W), 29 July 2013, by JC O'Neill, WA Nelson, JNOW 13-0729-008 • 1♀ from Ferry County, Colville National Forest; Boulder Creek or Trib of Boulder Creek, (48°49'49"N, 118°16'16"W), 30 July 2013, by JC

O'Neill, WA Nelson, JNOW 13-0730-004 • **Wyoming, United States:** 2♀ and 2♂ from Johnson County, beside Rt. 16, 14.9 km west of road to South Fork Campground, (44°10'10"N, 106°55'55"W), 18 August 1987, by IM Smith & JD Smith, IMS870158A • 1♀ and 1♂ from Albany County, N Fork of Crazy Woman Creek ~9 miles west of Southfork campground beside Hwy 16, Big Horn National Forest, (44°10'10"N, 106°54'54"W), 14 August 2012, by AJ Radwell, JA Hinsey, AJR 12-0814-418B • 2♀ and 2♂ from Albany County, South Clear Cr, across from Southfork cpgrnd on Hwy 16 west of Buffalo, WY, Big Horn National Forest, (44°16'16"N, 106°57'57"W), 14 August 2012, by AJ Radwell, JA Hinsey, AJR 12-0814-419 • 3♀ and 3♂ from Albany County, N Fork of Crazy Woman Creek ~9 miles west of Southfork campground beside Hwy 16, Big Horn National Forest, (44°10'10"N, 106°54'54"W), 14 August 2012, by AJ Radwell, JA Hinsey, AJR 12-0814-418A

**Type deposition.** Cotypes (3♀) and allotype (♂) deposited in the CNC. All other paratypes (28♀; 25♂) deposited in the ACUA.

**Diagnosis.** *Monatractides simulans* is the namesake member of the Simulans group and, along with *M. gilbroskii*, is one of the largest members of that group. Similar to other members of the group, *M. simulans* has a narrow subacapitulum compared to other monatractids, which separates this species from other similar looking western species of the Californica group. *M. simulans* can be separated from *M. vanni* by geographic range and by the combination of dorsal and subcapitular measurements (dorsum width/Dgl-4 ♀ = 0.84-0.85 in *M. vanni*, 0.86-0.94 in *M. simulans*; subcapitular ventral length/dorsal length ♂ = 1.21-1.33 in *M. vanni*, 1.34-1.52 in *M. simulans*). *M. simulans* can be quickly differentiated from *M. coastalis* by the lack of coloration on the venter in *M. simulans*. *M. simulans* and *M. curva* can be differentiated using the distinctive downturned rostrum in the latter, and from *M. gilbroski* using a combination of



characters, including a gnathosomal bay to genital field measurement (gnathosomal bay-genital field/genital field length measurement ♀ = 1.0-1.19 in *M. gilbroskii*, 0.78-0.92 in *M. simulans*, ♂ = 1.44-1.50 in *M. gilbroski*, 0.95-1.20 in *M. simulans*). A full combination of characters to differentiate these similar species is outlined in the key.

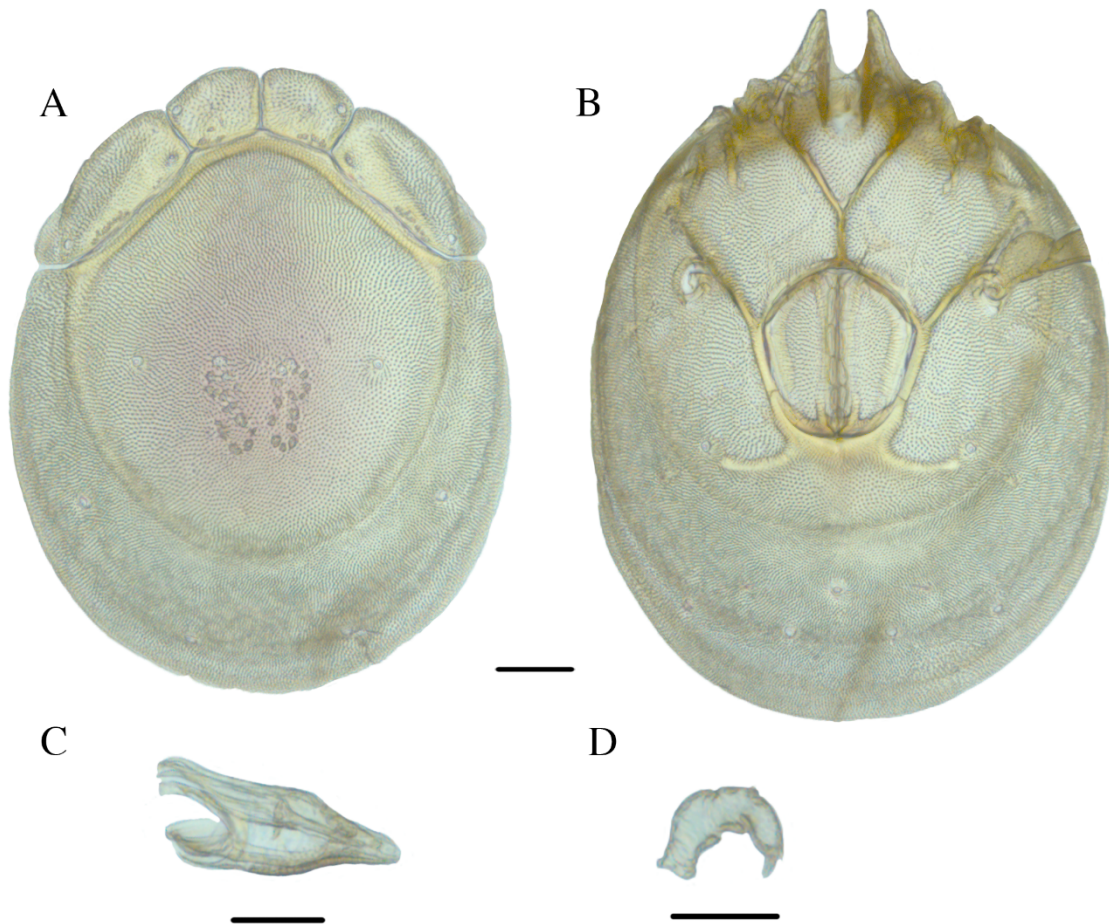
**Description. FEMALE (Fig. 66)** (n= 28) following characters of the genus with the following specifications.

**Dorsum** (830-1035 long; 685-890 wide) round and often with a light purple blotch on dorsum, without a distinct pattern. Anterio-medial platelets (150-170 long; 95-120 wide). Anterio-lateral platelets (260-320 long; 110-135 wide), free from dorsal plate. Dgl-4 closer to muscle scars than the edge of dorsum (distance between Dgl-4 360-475). Dorsal plate proportions: dorsum length/width 1.16-1.26; dorsal width/distance between Dgl-4 0.87-0.94; anterio-medial platelet length/width 1.33-1.70; anterio-lateral platelet length/width 2.25-2.64; anterio-lateral/anterio-medial length 1.53-2.0.

**Gnathosoma-Subcapitulum** (240-270 long (ventral); 170-235 long (dorsal); 40-60 tall) colorless. Rostrum (95-105 wide) long and narrow. Chelicerae (220-255 long with curved fangs (30-40 long). Subcapitular proportions: ventral length/dorsal length (1.11-1.51). **Pedipalps** short and stocky (especially tibiae) with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (20-27.5 long; 35-42.5 wide); femur (50-60 long; 42.5-50 wide); genu (40-50 long; 35-40 wide); tibia (45-55 long; 25-32.5 wide); tarsus (22.5-30 long; 15 wide). Palpomere proportions: femur/genu 1.0-1.33; tibia/femur 0.82-1.1; tibia length/width 1.5-2.0.

**Venter** (900-1190 long; 770-950 wide) colorless. Gnathosomal bay (150-180 long; 50-70 wide. Cxgl-4 subapical. **Medial suture** (60-100 long). **Genital plates** (215-300 long; 190-270

wide); individuals may have light purple coloration on genital plates. Additional measurements: Cx-1 (360-440 long (total); 140-170 long (medial); Cx-3 (550-630 wide); anterior venter (210-260 long). Ventral proportions: gnathosomal bay length/width 2.5-3.2; anterior venter/genital field length 0.79-1.12; anterior venter length/genital field width 0.88-1.26.



**Figure 66.** *Monatractides simulans* female: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum **D** pedipalp (setae not accurately depicted). Scale = 100 μm.

**MALE (Fig. 67)** (n =26) (allotypic measurements in parentheses when available) with characters of the genus following specifications.

**Dorsum** (740-900 (810) long; 500-720 (660) wide) round and often with a light purple

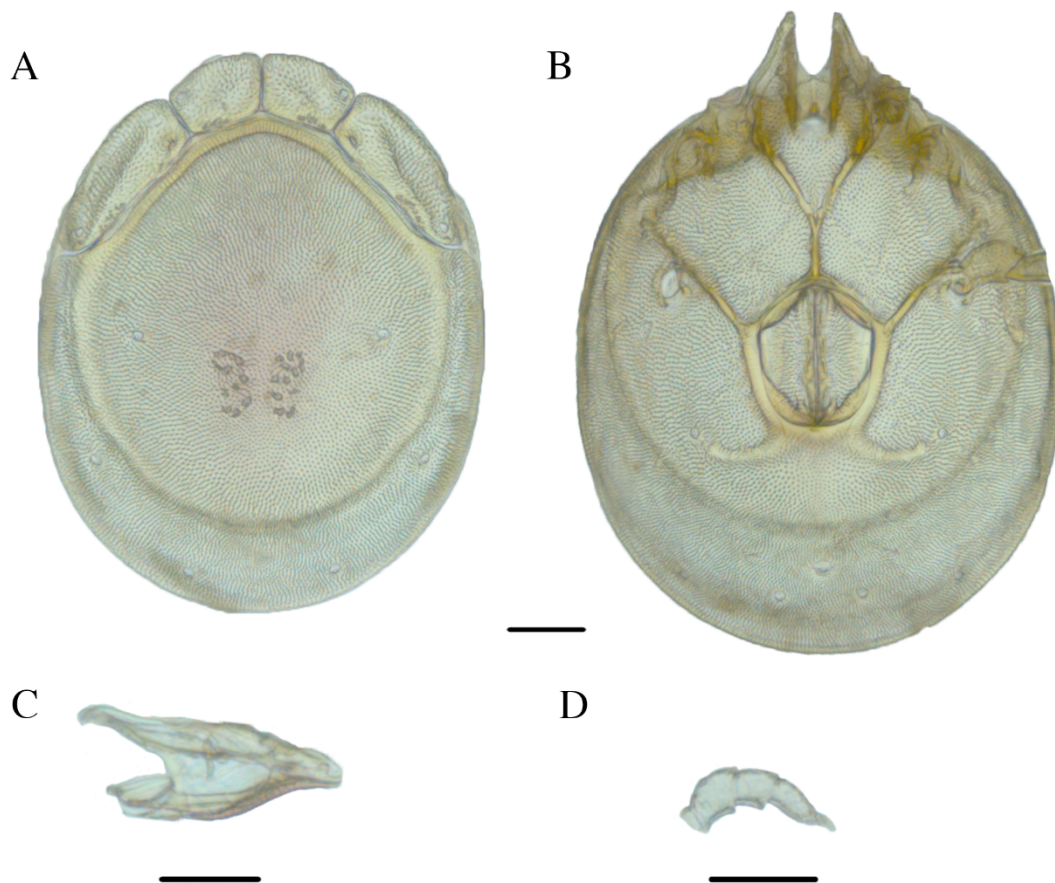
blotch on dorsum, without a distinct pattern. Anterio-medial platelets (135-165 (150) long; 80-105 (100) wide). Anterio-lateral platelets (220-300 (270) long; 90-130 (90) wide), free from dorsal plate. Dgl-4 closer to muscle scars than the edge of dorsum (distance between Dgl-4 320-440 (390)). Dorsal plate proportions: dorsum length/width 1.17-1.48 (1.23); dorsal width/distance between Dgl-4 0.74-0.94 (0.88); anterio-medial platelet length/width 1.40-1.75 (1.50); anterio-lateral platelet length/width 2.20-3.0 (3.0); anterio-lateral/anterio-medial length 1.57-1.82 (1.80).

**Gnathosoma-Subcapitulum** (200-247.5 (230) long (ventral); 145-185 (165) long (dorsal); 40-50 (50) tall) colorless. Rostrum (85-95 (95) wide) short and stocky. Chelicerae (200-240 (225) long with curved fangs (27.5-35 (35) long). Subcapitular proportions: ventral length/dorsal length (1.34-1.52 (1.39)). **Pedipalps** short and stocky (especially tibiae) with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (20-22.5 (20) long; 30-35 (30) wide); femur (45-60 (50) long; 40-45 (40) wide); genu (35-45 (40) long; 30-40 (35) wide); tibia (35-47.5 (45) long; 25-30 (25) wide); tarsus (25-30 (25) long; 12.5-15 (15) wide). Palpomere proportions: femur/genu 1.11-1.36 (1.25); tibia/femur 0.78-0.95 (0.90); tibia length/width 1.33-1.80 (1.80).

**Venter** (820-1020 (920) long; 660-770 (740) wide) colorless. Gnathosomal bay (130-170 (150) long; 50-60 (60) wide. Cxgl-4 subapical. **Medial suture** (80-110 (105) long). **Genital plates** (190-225 (210) long; 150-180 (170) wide); individuals may have light purple coloration on genital plates. Additional measurements: Cx-1 (360-440 (390) long (total); 130-150 (150) long (medial); Cx-3 (460-550 (520) wide); anterior venter (200-265 (250) long). Ventral proportions: gnathosomal bay length/width 2.50-3.20 (2.50); anterior venter/genital field length 0.95-1.20 (1.19); anterior venter length/genital field width 1.18-1.47 (1.27).

**IMMATURES** unknown.

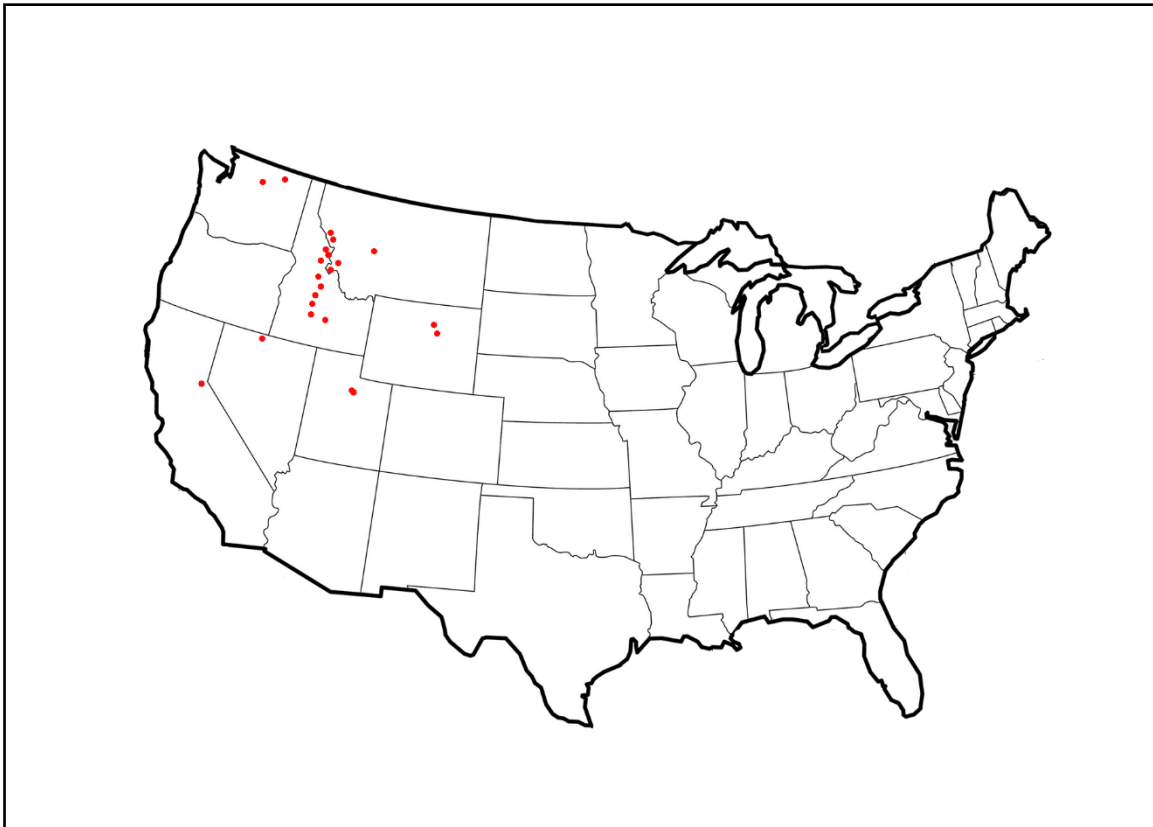
**Etymology.** Marshall (1933) notes in the original description of *Atractides simulans* that this species is similar to a previously described mite *A. jordanensis* (now *M. jordanensis*), and it is from this that presumably the original epithet is derived; from the Latin *simulans*, meaning “imitating” or “copying.”



**Figure 67.** *Monatractides simulans* male: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum **D** pedipalp (setae not accurately depicted). Scale = 100  $\mu$ m.

**Distribution.** Western United States from Oregon through Colorado and south into Northern California and Utah (Fig. 68).

**Remarks.** *Monatractides simulans* groups with other members of the Simulans group in all analyses. This species hypothesis is supported by high COI divergence between species (at least 12% difference), by the morphological characters outlined in the diagnosis, and the relatively low COI divergence within the species (2.8%).



**Figure 68:** *Monatractides simulans* distribution.

***Monatractides siskiyouii* Nelson & Dowling, sp. n.**

**Material examined.** HOLOTYPE (♀): **USA, California**, Siskiyou County: S. Fork of Salmon Rvr, off Cecilville Rd, (41°10'10"N, 123°5'5"W), 17 August 2013, by JR Fisher, JRF 13-0817-003.

PARATYPES (1♀): **USA, California**: (1♀) Siskiyou County, Shadow Cr, off Cecilville Rd, (41°12'12"N, 123°4'4"W), 17 August 2013, by JR Fisher, JRF 13-0817-002.

**Type deposition.** Holotype (1♀) and paratype (1♀) deposited in the CNC.

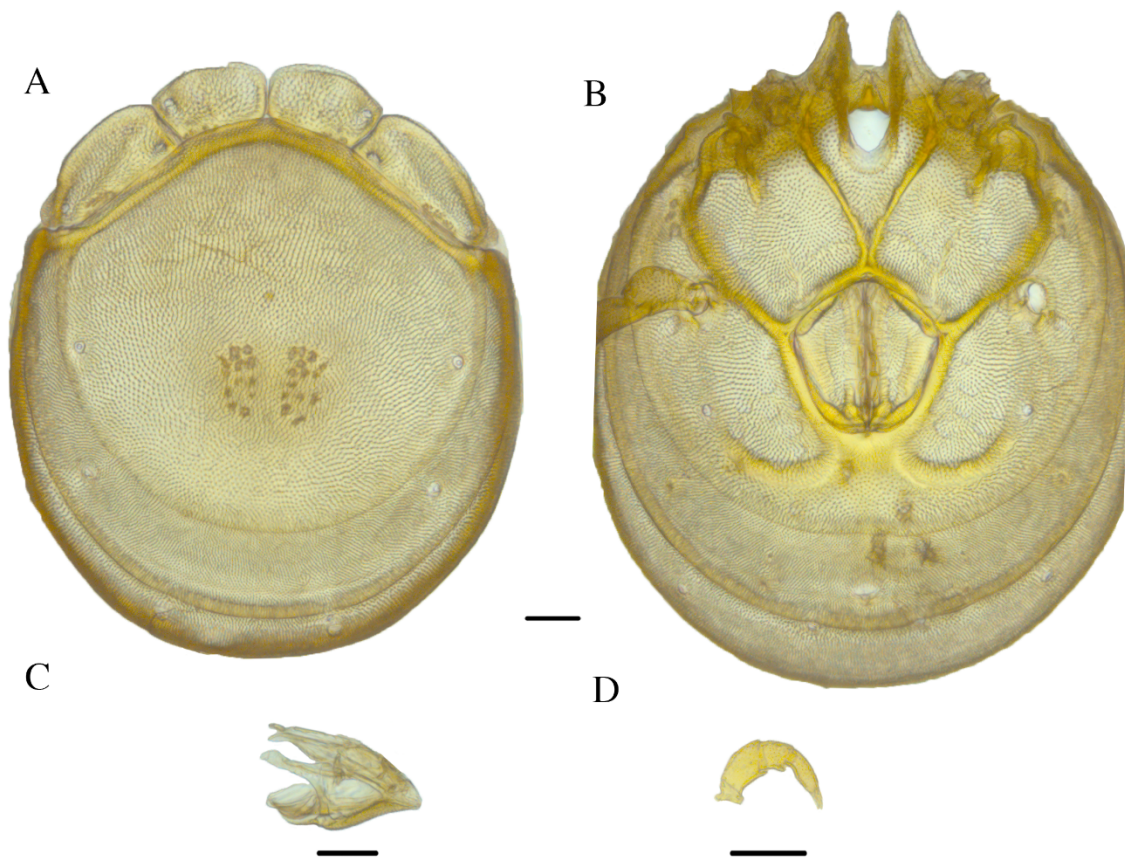
**Diagnosis.** *Monatractides siskiyouii* are similar to other members of the Californica group (*M. waddellica* and *M. geographica*) in having a large rostral height when compared to most other North American *Monatractides*. Like other members of this western clade, *M. siskiyouii* has no distinctive dorsal or ventral patterning, but may have some light purple coloration on the dorsum. Mites in the Siskiyouii group can be differentiated from *M. geographica* by the dorsum length/width measurements (dorsum length/width measurement ♀ = 1.14-1.16 in the Siskiyouii group, 1.24-1.53 in *M. geographica*). *M. waddellica* and mites in the Siskiyouii group share many morphological similarities, but can be separated by the gnathosomal bay to genital measurement (gnathosomal bay – genital field length ♀ = 270-300 in *M. waddellica*, 210-240 in the Siskiyouii group ♀). Known only from female specimens, *M. siskiyouii* can be separated from its sister species *M. vonnegutii* by the distance between Dgl-4 and the dorsal width, after separating it from *M. waddellica* (Dgl-4 distance ♀ = 620 in *M. siskiyouii*, 675-695 in *M. vonnegutii*; dorsum width ♀ = 855-870 in *M. siskiyouii*, 950-975 in *M. vonnegutii*).

**Description. FEMALE (Fig. 69)** (n=2) with characters of the genus with the following



specifications.

**Dorsum** (950-975 long; 850-855 wide) round and colorless or with orange cuticular coloration, without a distinct pattern. Anterio-medial platelets (180 long; 110 wide). Anterio-lateral platelets (270-280 long; 120 wide), free from dorsal plate. Dgl-4 closer to the edge of the dorsum than to the muscle scars (distance between Dgl-4 620). Dorsal plate proportions: dorsum length/width 1.14; dorsal width/distance between Dgl-4 0.95; anterio-medial platelet length/width 1.64; anterio-lateral platelet length/width 2.25- 2.30; anterio-lateral/anterio-medial length 1.50.



**Figure 69.** *Monatractides siskiyouii* female sp. n.: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum **D** pedipalp (setae not accurately depicted). Scale = 100 μm.

**Gnathosoma-Subcapitulum** (220-225 long (ventral); 165-170 long (dorsal); 30 tall) colorless. Rostrum (152.5-165 wide) very short and stocky. Chelicerae (225 long with curved fangs (55 long). Subcapitular proportions: ventral length/dorsal length (1.27-1.29). **Pedipalps** short and stocky (especially tibiae) with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (30-35 long; 40 wide); femur (75 long; 60 wide); genu (60 long; 50 wide); tibia (85 long; 30-35 wide); tarsus (35 long; 15 wide).

**Venter** (1155-1165 long; 940 wide). Gnathosomal bay (215 long; 70-75 wide. Cxgl-4 subapical. **Medial suture** (40 long). **Genital plates** (270 long; 255 wide). Additional measurements: Cx-1 (430 long (total); 170 long (medial); Cx-3 (620 wide); anterior venter (210 long). Ventral proportions: gnathosomal bay length/width 3.07; anterior venter/genital field length 0.82; anterior venter length/genital field width 0.78.

**MALE** unknown.

**IMMATURES** unknown.

**Etymology.** Specific epithet *siskiyouii* refers to Siskiyou County, California, where the holotype was collected.

**Distribution.** *Monatractides siskiyouii* is currently described from two female specimens from two locations in the Klamath National Forest., California (Fig. 70).

**Remarks.** In all analyses, *Monatractides siskiyouii* groups with the other members of the Californica group, *M. geographica* and *M. waddellica*, with high support. *M. siskiyouii* groups with its sister species, *M. vonnegutii* with high support in all analyses. This species hypothesis is supported by low COI divergence within the species (1.2%), high COI divergence between species (at least 8.3% from its sister species *M. vonnegutii*, and 11.1% from other members of



the Californica group), and by the morphological characters outlined in the diagnosis.



**Figure 70.** *Monatractides siskiyouii* sp. n. distribution.

***Monatractides vanni* Nelson & Dowling, sp. n.**

**Material examined.** HOLOTYPE (♀): **USA, Arizona**, Cochise County, Chiricahua Mountains east of Sunizona; beside Mormon Canyon Trail above Sycamore Campground, (31°51'51"N, 109°19'19"W), 29 March 2010, by IM Smith, IMS100008.

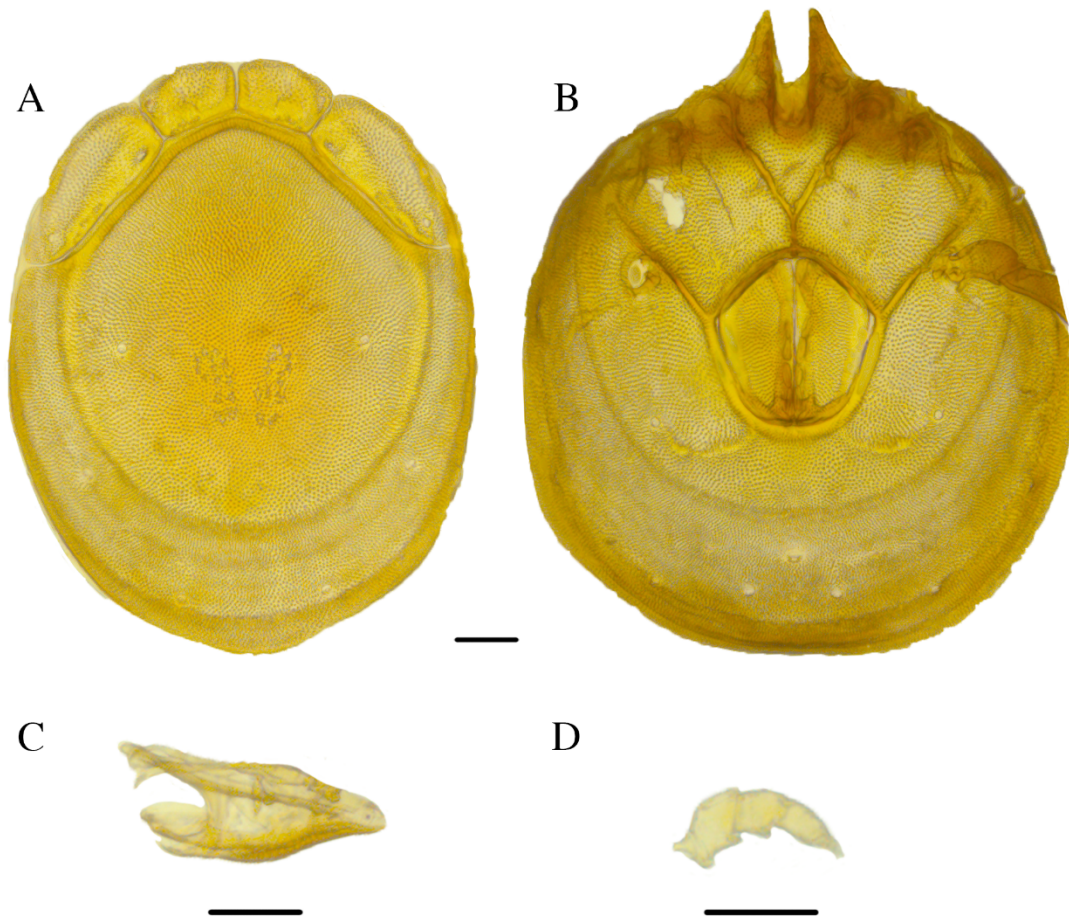
PARATYPES (2♀; 3♂): **USA, New Mexico**, (allotype) 1♂ from Catron County, Glenwood; Whitewater Picnic Area 8 km east of Rt. 180, (33°22'22"N, 108°50'50"W), 12 July 1987, by IM Smith, IMS870084 • 2♀ and 2♂ from San Miguel, Pecos; beside Rt. 63 at Dalton Campground, (35°39'39"N, 105°41'41"W), 6 July 1987, by IM Smith, IMS870071

**Type deposition.** Holotype (♀), allotype (♂), and other paratypes (2♀; 2♂) deposited in the CNC.

**Diagnosis.** *Monatractides vanni* is similar to other members of the Simulans group by having a long and narrow subcapitulum, which can be used to differentiate members of this group from similar looking members of the Californica group. *M. vanni* appears to lack the purple dorsal coloration found in *M. gilbroski*, *M. curva*, *M. coastalis*, and *M. simulans*. *M. vanni* is currently known from Arizona and New Mexico, which does not overlap with the known ranges of any other members of the Simulans group. Most similar to *M. simulans*, *M. vanni* can be differentiated using a combination of dorsal and subcapitular measurements (dorsum width/Dgl-4 ♀ = 0.84-0.85 in *M. vanni*, 0.86-0.94 in *M. simulans*; subcapitular ventral length/dorsal length ♂ = 1.21-1.33 in *M. vanni*, 1.34-1.52 in *M. simulans*). A full combination of characters to differentiate these similar species is outlined in the key.

**Description. FEMALE (Fig. 71)** (n= 3) (holotype measurements in parentheses when

available) with characters of the genus with the following specifications.



**Figure 71.** *Monatractides vanni* sp. n. female: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum **D** pedipalp (setae not accurately depicted). Scale = 100  $\mu$ m.

**Dorsum** (950-995 (995) long; 735-780 (780) wide) round and occasionally with some orange coloration on dorsum without a distinct pattern. Anterio-medial platelets (160-210 (160) long; 100-110 (110) wide). Anterio-lateral platelets (280-310 (310) long; 120-130 (130) wide), free from dorsal plate. Dgl-4 closer to muscle scars than edge of the dorsum (distance between Dgl-4 360-420 (420)). Dorsal plate proportions: dorsum length/width 1.28-1.29 (1.28); dorsal width/distance between Dgl-4 0.84-0.85 (0.85); anterio-medial platelet length/width 1.45-2.10

(1.45); antero-lateral platelet length/width 2.33-2.38 (2.38); antero-lateral/antero-medial length 1.33-1.94 (1.94).

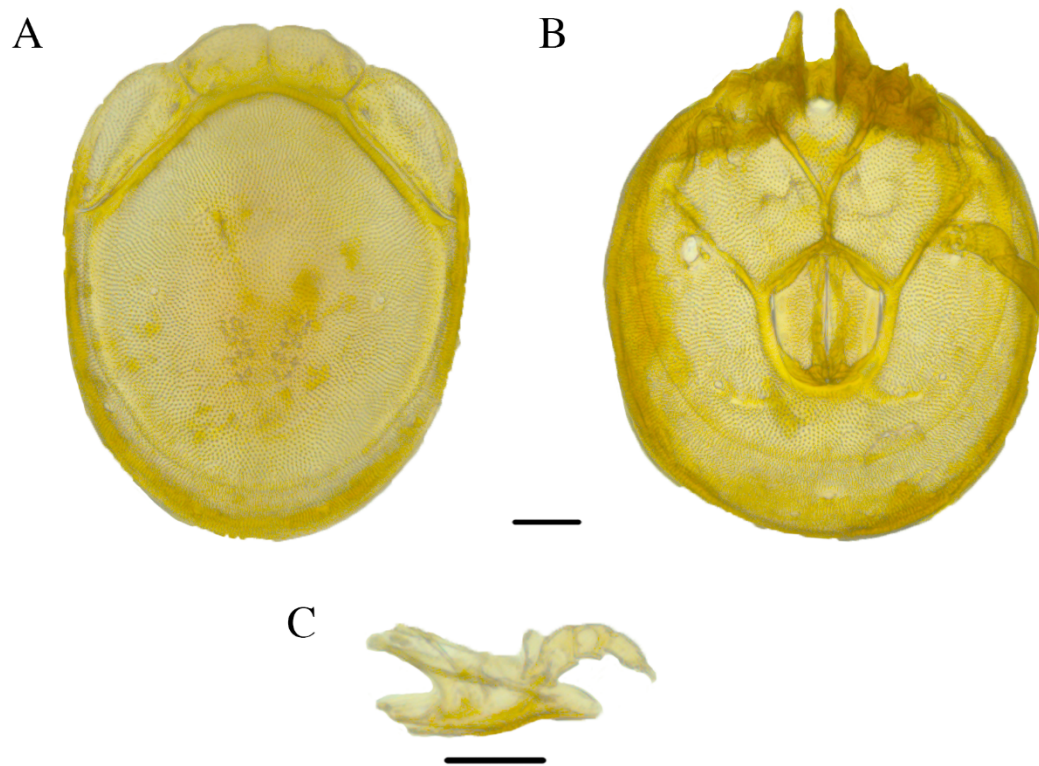
**Gnathosoma-Subcapitulum** (230-240 (240) long (ventral); 180-185 (185) long (dorsal); 30-35 (35) tall) colorless. Rostrum (95-105 (105) wide) longer and narrow. Chelicerae (242.5-245 (242.5) long with curved fangs (30-35 (30) long). Subcapitular proportions: ventral length/dorsal length (1.28-1.30 (1.30). **Pedipalps** short and stocky (especially tibiae) with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (20-25 (25) long; 35 (55) wide); femur (50-55 (55) long; 45-55 (50) wide); genu (40-45 (45) long; 35-40 (40) wide); tibia (45 (45) long; 27.5-30 (27.5) wide); tarsus (30 (30) long; 15 (15) wide). Palpomere proportions: femur/genu 1.22-1.25 (1.22); tibia/femur 0.82-0.90 (0.82); tibia length/width 1.50-1.64 (1.64).

**Venter** (1030-1060 (10300) long; 870-935 (935) wide) without coloration. Gnathosomal bay (120-160 (120) long; 50-60 (60) wide. Cxgl-4 subapical. **Medial suture** (70-75 (70) long). **Genital plates** (280 (280) long; 240-250 (250) wide). Additional measurements: Cx-1 (400 (400) long (total); 160-170 (170) long (medial); Cx-3 (560-610 (610) wide); anterior venter (240 (240) long). Ventral proportions: gnathosomal bay length/width 2.0-3.2 (2.0); anterior venter/genital field length 0.86 (0.86); anterior venter length/genital field width 0.96-1.0 (0.96).

**MALE (Fig. 72)** (n =3) (allotypic measurements in parentheses when available) with characters of the genus following specifications.

**Dorsum** (770-810 (810) long; 600-630 (63) wide) round and occasionally with some orange coloration on dorsum without a distinct pattern. Antero-medial platelets (140-155 (140) long; 90-110 (110) wide). Antero-lateral platelets (250-270 (270) long; 100-120 (120) wide),

free from dorsal plate. Dgl-4 much closer to the edge of the dorsum than to the muscle scars (distance between Dgl-4 320-370 (370)). Dorsal plate proportions: dorsum length/width 1.27-1.29 (1.29); dorsal width/distance between Dgl-4 0.87-0.89 (0.89); antero-medial platelet length/width 1.27-1.67 (1.27); antero-lateral platelet length/width 2.08-2.50 (2.25); antero-lateral/anterio-medial length 1.67-1.93 (1.93).



**Figure 72.** *Monatractides vanni* sp. n. male: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum and pedipalp (setae not accurately depicted). Scale = 100  $\mu$ m.

**Gnathosoma-Subcapitulum** (200-210 long (ventral); 157.5-165 long (dorsal); 30-50 tall) colorless. Rostrum (75-95 wide) very short and stocky. Chelicerae (205-220 long with curved fangs (27.5-30 long). Subcapitular proportions: ventral length/dorsal length (1.21-1.33).

**Pedipalps** short and stocky (especially tibiae) with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (20-25 long; 30-35 wide); femur (45-50 long; 42.5-47.5 wide); genu (40 long; 35-40 wide); tibia (45 long; 25 wide); tarsus (25 long; 15 wide). Palpomere proportions: femur/genu 1.13-1.25; tibia/femur 0.90-1.0; tibia length/width 1.80.

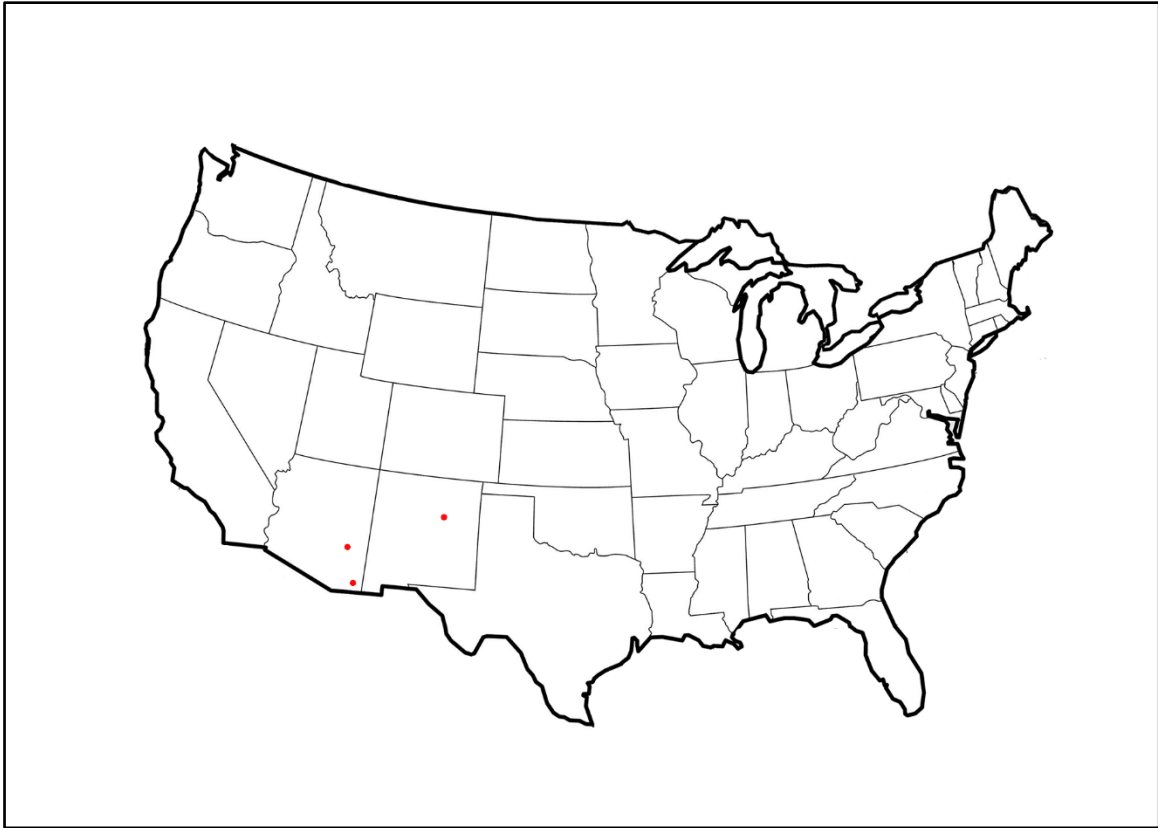
**Venter** (820-920 (920) long; 700-770 (700) wide), colorless. Gnathosomal bay (140-160 (160) long; 50-60 (60) wide. Cxgl-4 subapical. **Medial suture** (85-105 (105) long). **Genital plates** (210-230 (220) long; 170-190 (180) wide). Additional measurements: Cx-1 (380-420 (420) long (total); 150 (150) long (medial); Cx-3 (480-530 (500) wide); anterior venter (240-260 (260) long). Ventral proportions: gnathosomal bay length/width 2.67-2.90 (2.67); anterior venter/genital field length 1.09-1.21 (1.18); anterior venter length/genital field width 1.32-1.50 (1.44).

**IMMATURES** unknown.

**Etymology.** Specific epithet *vanni* is in honor of a good friend, Chris Vann, who is strong for a bodybuilder, so it only seems fitting that a strong-but-pretty hydrachnid should be named for him.

**Distribution.** Currently known from southern Arizona and New Mexico (Fig. 73).

**Remarks.** *Monatractides vanni* groups with other members of the Simulans group with high support in the COI-only analysis. This species hypothesis is supported by high divergence between species (at least 10%) and by the morphological characters outline within the diagnosis.



**Figure 73.** *Monatractides vanii*.sp. n. distribution.

***Monatractides vonnegutii* Nelson & Dowling, sp. n.**

**Material examined.** HOLOTYPE (♀): **USA, California**, Los Angeles County, N Fork of San Gabriel Rvr, off Rt 39, (34°16'16"N, 117°50'50"W), 8 September 2013, by JR Fisher, JRF 13-0908-001.

PARATYPES (1♀, 2♂): **USA, California**: (allotype) • 1♂ Santa Cruz County, Whitehouse Creek, off highway 1, (37°10'10"N, 122°19'19"W), 15 July 2015, by WA Nelson, JM Gilbert, WN 15-0715-001 • 1♂ from Butte County in Bear Cr, off Rt 70, (39°50'50"N, 121°23'23"W), 24 August 2013, by JR Fisher, JRF 13-0824-001 • 1♀ El Dorado County, S Fork of American Rvr, off Rt 50, under sm bridge, (38°47'47"N, 120°9'9"W), 29 August 2013, by JR Fisher, JRF 13-0829-005.

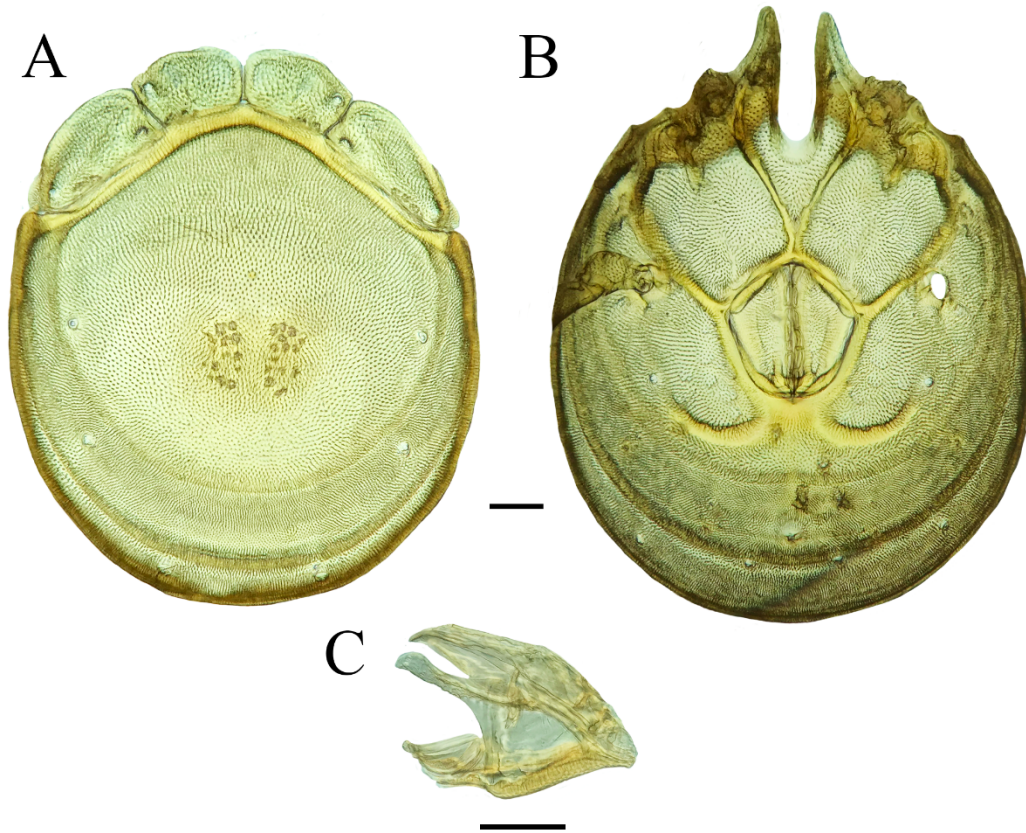
**Type deposition.** Holotype (♀) and allotype (♂) deposited in the CNC. All other paratypes (1♀; 1♂) deposited in the ACUA.

**Diagnosis.** *Monatractides vonnegutii* are similar to other members of the Californica group (*M. waddellica* and *M. geographica*) in having a large rostral height when compared to most other North American *Monatractides*. Like other members of this western clade, *M. vonnegutii* has no distinctive dorsal or ventral patterning, but may have some light purple coloration on the dorsum. Mites in the Siskiyouii group can be differentiated from *M. geographica* by the dorsum length/width measurements (dorsum length/width measurement ♀ = 1.14-1.16 in the Siskiyouii group, 1.24-1.53 in *M. geographica*). *M. waddellica* and mites in the Siskiyouii group share many morphological similarities, but can be separated by the gnathosomal bay to genital measurement (gnathosomal bay – genital field length ♀ = 270-300 in *M. waddellica*, 210-240 in the Siskiyouii group ♀). *M. vonnegutii* can be separated from its sister



species *M. siskiyouii* by the distance between Dgl-4 and the dorsal width, after separating it from *M. waddellica* (Dgl-4 distance ♀ = 620 in *M. siskiyouii*, 675-695 in *M. vonnegutii*; dorsum width ♀ = 855-870 in *M. siskiyouii*, 950-975 in *M. vonnegutii*). As *M. siskiyouii* is only described using female specimens, differentiation for males remains unknown.

**Description. FEMALE (Fig. 74) (n=2)** with characters of the genus with the following specifications.



**Figure 74.** *Monatractides vonnegutii* female sp. n.: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum. Scale = 100  $\mu$ m.

**Dorsum** (975-1070 long; 855-920 wide) round and colorless or with purple cuticular coloration, without a distinct pattern. Anterio-medial platelets (180-210 long; 110-130 wide). Anterio-lateral platelets (270-280 long; 120-140 wide), free from dorsal plate. Dgl-4 closer to the edge of the dorsum than to the muscle scars (distance between Dgl-4 620-695). Dorsal plate proportions: dorsum length/width 1.14-1.16; dorsal width/distance between Dgl-4 0.95; anterio-medial platelet length/width 1.62-1.64; anterio-lateral platelet length/width 2.0-2.25; anterio-lateral/anterio-medial length 1.33-1.50.

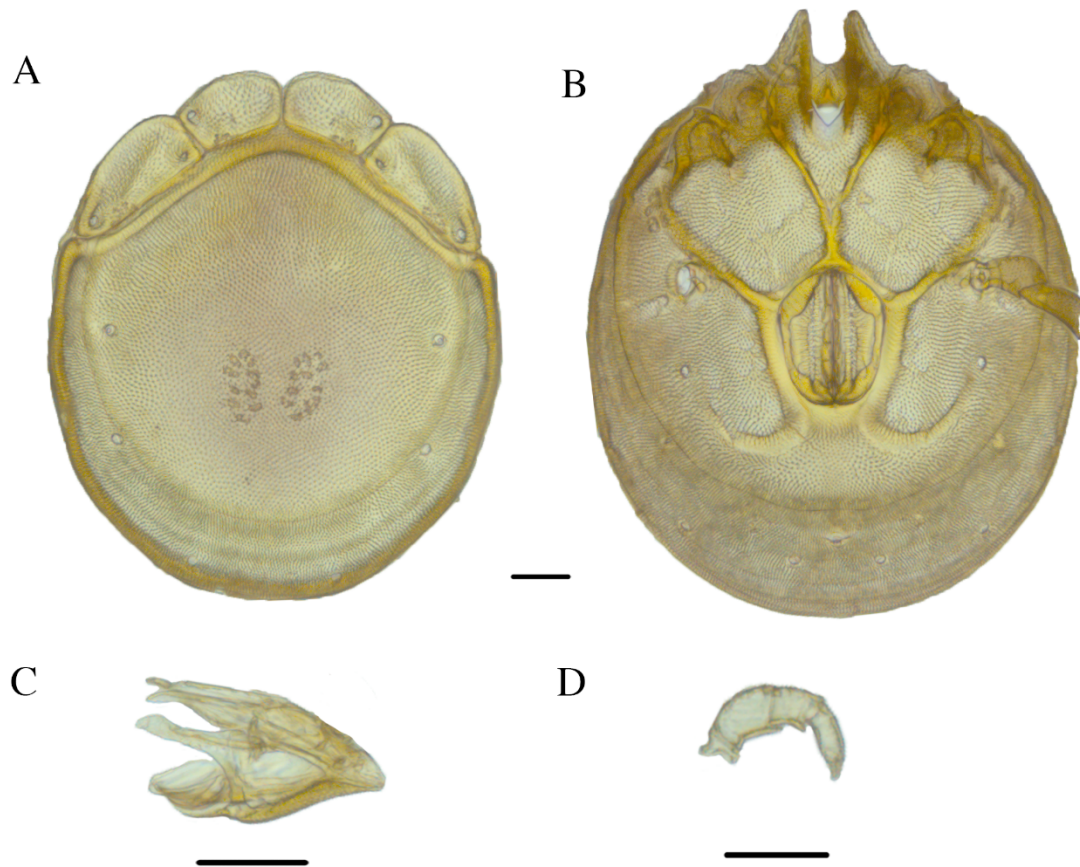
**Gnathosoma-Subcapitulum** (220-255 long (ventral); 170-185 long (dorsal); 30 tall) colorless. Rostrum (185 wide) very short and stocky. Chelicerae (225-250 long with curved fangs (55 long). Subcapitular proportions: ventral length/dorsal length 1.38. **Pedipalps** short and stocky (especially tibiae) with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (30 long; 40 wide); femur (70 wide); genu (60 long; 50 wide); tibia (85 long; 35 wide); tarsus (35 long; 20 wide). Palpomere proportions: tibia length/width 2.43.

**Venter** (1165-1230 long; 940-1010 wide). Gnathosomal bay (215-250 long; 70 wide. Cxgl-4 subapical. **Medial suture** (40-45 long). **Genital plates** (270-280 long; 255-265 wide). Additional measurements: Cx-1 (430-480 long (total); 170-180 long (medial); Cx-3 (620-690 wide); anterior venter (210-230 long). Ventral proportions: gnathosomal bay length/width 3.07-3.57; anterior venter/genital field length 0.78-0.82; anterior venter length/genital field width 0.82-0.87.

**MALE (Fig. 75)** (n =2) (allotypic measurements in parentheses when available) with characters of the genus following specifications.

**Dorsum** (830-960 (830) long; 750-840 (750) wide) round and occasionally with a light

purple coloration; without a distinct pattern. Anterio-medial platelets (170-180 (170) long; 110 (110) wide). Anterio-lateral platelets (250-280 (250) long; 120 (120) wide), free from dorsal plate. Dgl-4 much closer to the edge of the dorsum than to the muscle scars (distance between Dgl-4 570-615 (570). Dorsal plate proportions: dorsum length/width 1.11-1.14 (1.11); dorsal width/distance between Dgl-4 0.94-0.95 (0.95); anterio-medial platelet length/width 1.55-1.64 (1.55); anterio-lateral platelet length/width 2.08-2.33 (2.08); anterio-lateral/anterio-medial length 1.47-1.56 (1.56).



**Figure 75.** *Monatractides vonnegutii* male sp. n.: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum **D** pedipalp (setae not accurately depicted). Scale = 100 μm.

**Gnathosoma-Subcapitulum** (220-250 (245) long (ventral); 135-170 (135) long (dorsal); 25-30 (25) tall) colorless. Rostrum (120-170 (120) wide) very short and stocky. Chelicerae (210-250 (210) long with curved fangs (45-55 (45) long). Subcapitular proportions: ventral length/dorsal length (1.47-1.81 (1.81)). **Pedipalps** short and stocky (especially tibiae) with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (25-30 (25) long; 35-45 (35) wide); femur (70-90 (70) long; 50-60 (50) wide); genu (50-55 (50) long; 40-50 (40) wide); tibia (55-75 (55) long; 25-30 (25) wide); tarsus (25-35 (25) long; 15-20 (15) wide). Palpomere proportions: femur/genu 1.36-1.8 (1.40); tibia/femur 0.79-0.93 (0.79); tibia length/width 2.2-2.5 (2.20).

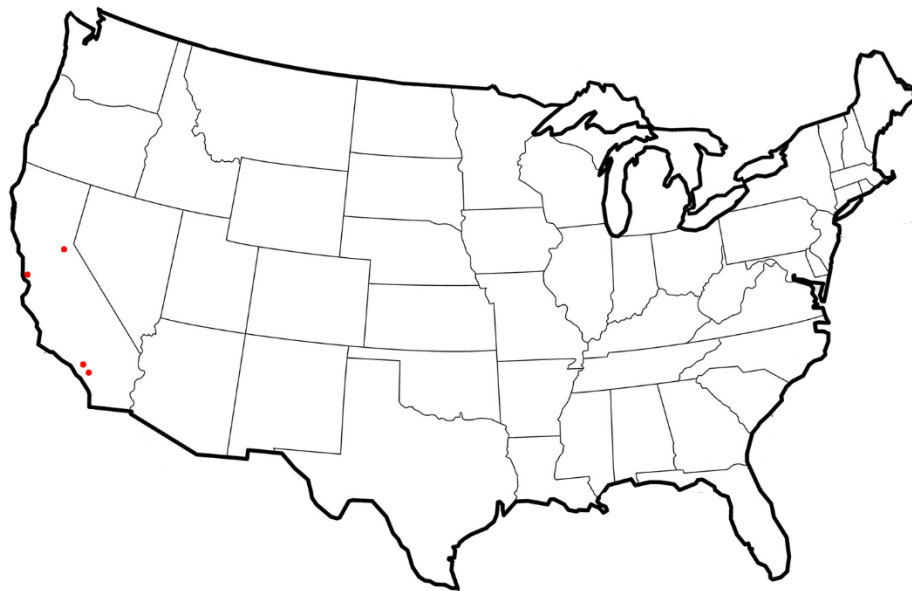
**Venter** (1010-1135 (1010) long; 820-960 (820) wide) colorless, or with faint purple coloration on areas of primary sclerotization. Gnathosomal bay (190-215 (190) long; 50-70 (50) wide. Cxgl-4 subapical. **Medial suture** (75-95 (75) long). **Genital plates** (230-240 (230) long; 180-200 (180) wide). Additional measurements: Cx-1 (435-490 (435) long (total); 160-180 (160) long (medial); Cx-3 (580-600 (580) wide); anterior venter (240-260 (240) long). Ventral proportions: gnathosomal bay length/width 3.07-3.8 (3.8); anterior venter/genital field length 1.04-1.17 (1.04); anterior venter length/genital field width 1.33-1.4 (1.33).

**IMMATURES** unknown.

**Etymology.** Specific epithet *vonnegutii* is in honor of author Kurt Vonnegut (1922-2007); his dystopian societies, irreverent wit, and discussions of counterculture are greatly appreciated reading.

**Distribution.** *Monatractides vonnegutii* is currently known from central and southern California (Fig. 76).

**Remarks.** In all analyses, *Monatractides vonnegutii* groups with its the other members of the Californica group, *M. geographica* and *M. waddellica*, with high support. *M. vonnegutii* groups with its sister species, *M. siskiyouii* with high support in all analyses. This species hypothesis is supported by low COI divergence within the species (1.2%), high COI divergence between species (at least 8.3% from its sister species *M. vonnegutii*, and 11.1% from other members of the Californica group), and by the morphological characters outlined in the diagnosis.



**Figure 76.** *Monatractides vonnegutii* sp. n. distribution.

***Monatractides waddellica* (Marshall, 1943)**

*Atractides waddellicus* Marshall 1943: 312.

**Material examined.** HOLOTYPE (♀): **USA, California**, Santa Cruz County, Waddell Creek, 25-26 Aug 1932 by PR Needham, RM320007.

TOPOTYPE (1♂) (allotype): **USA, California**, Santa Cruz County, Waddell Creek, 25-26 Aug 1932 by PR Needham, RM320007.

OTHER MATERIAL: (3♀; 3♂): **USA, California**: 3♀ and 1♂ from Trinity County, Wilson Cr, off Wildwood Rd, (40°25'25"N, 123°3'3"W), 20 August 2013, by JR Fisher, JRF 13-0820-003 • 1♂ from Del Norte County, Smith Rvr Nat Rec Area, Middle Fork of Smith Rvr, Grassy Flats campground, (41°51'51"N, 123°53'53"W), 15 August 2013, by JR Fisher, JRF 13-0815-002 • 1♂ from Siskiyou County, S. Fork of Salmon Rvr, off Caribou Rd, (41°8'8"N, 123°6'6"W), 17 August 2013, by JR Fisher, JRF 13-0817-004.

**Type deposition.** Holotype (♀) and topotype (♂) deposited in the CNC. All other paratypes (3♀; 3♂) deposited in the ACUA.

**Diagnosis.** *Monatractides waddellica* are similar to other members of the Californica group (*M. geographica* and *M. siskiyouii*) in having a large rostral height when compared to most other North American *Monatractides*. Like many western species of monatractids, *M. waddellica* has no distinct dorsal patterning, but may have some orange blotchy dorsal coloration. *M. waddellica* can be differentiated from other members of the Californica group by the length between the gnathosomal bay and the start of the genital field (gnathosomal bay - genital field length ♀ = 270-300 in *M. waddellica*, 170- 240 in all other Californica group ♀; ♂ = 290-310 in *M. waddellica*, 180-280 in all other California group ♂ ). In ♂ *M. waddellica*, this

measurement serves to differentiate this species from all other species in North America except for *M. elongatus*; however the two species can be differentiated by the longer genital field length found in *M. waddellica* ( $\sigma = 285$ -290 in *M. waddellica*; 190-225 in *M. elongatus*). Female *M. waddellica* can be differentiated from *M. geographica* by having larger dorsum length and width measurements (dorsum length  $\varphi = 1100$ -1240 in *M. waddellica*, 690-920 in *M. geographica*; dorsum width  $\varphi = 940$ -1040 in *M. waddellica*, 490-710 in *M. geographica*). *M. waddellica* and *M. siskiyouii* share many morphological similarities, but can be separated by the gnathosomal bay to genital measurement (gnathosomal bay – genital field length  $\varphi = 270$ -300 in *M. waddellica*, 210-240 in *M. siskiyouii*  $\varphi$ ;  $\sigma = 290$ -310 in *M. waddellica*, 240-280 in *M. siskiyouii*  $\sigma$ ).

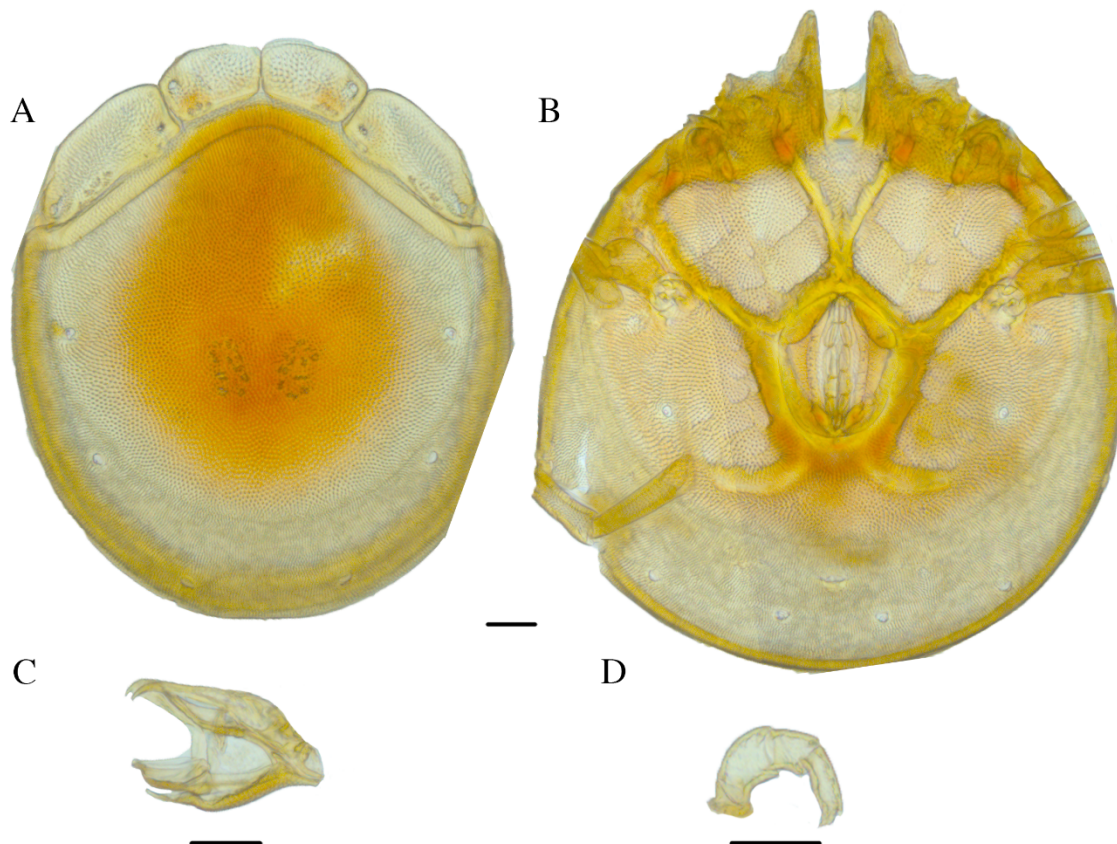
**Redescription. FEMALE (Fig. 77)** (n=4) (holotype measurements in parentheses when available) with characters of the genus with the following specifications.

**Dorsum** (1100-1240 (1100) long; 940-1040 (940) wide) round and often with a purple coloration without a distinct pattern. Anterio-medial platelets (200-220 (200) long; 120-130 (120) wide). Anterio-lateral platelets (350 (350) long; 140-150 (140) wide), free from dorsal plate. Dgl-4 much closer to the edge of the dorsum than to the muscle scars (distance between Dgl-4 750-770 (750)). Dorsal plate proportions: dorsum length/width 1.17-1.19 (1.17); dorsum width/distance between Dgl-4 0.9-0.94 (0.94); anterio-medial platelet length/width 1.54-1.83 (1.54); anterio-lateral platelet length/width 2.33-2.5 (2.33); anterio-lateral/anterio-medial length 0.9-0.94 (0.94).

**Gnathosoma-Subcapitulum** (275-280 (275) long (ventral); 195 (195) long (dorsal); 50 (50) tall) colorless. Rostrum (180-205 (180) wide) very short and stocky. Chelicerae (270-290 (270) long with curved fangs (55-60 (55) long). Subcapitular proportions: ventral length/dorsal



length (1.41-1.44 (1.41)). **Pedipalps** short and stocky (especially tibiae) with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (35-45 (35) long; 55 (55) wide); femur (100-105 (100) long; 60-70 (60) wide); genu (70-75 (75) long; 55-60 (55) wide); tibia (85-90 (85) long; 35-40 (35) wide); tarsus (40 (40) long). Palpomere proportions: femur/genu 1.33-1.5 (1.33); tibia/femur 0.85-0.86 (0.85); tibia length/width 2.25-2.43 (2.43).



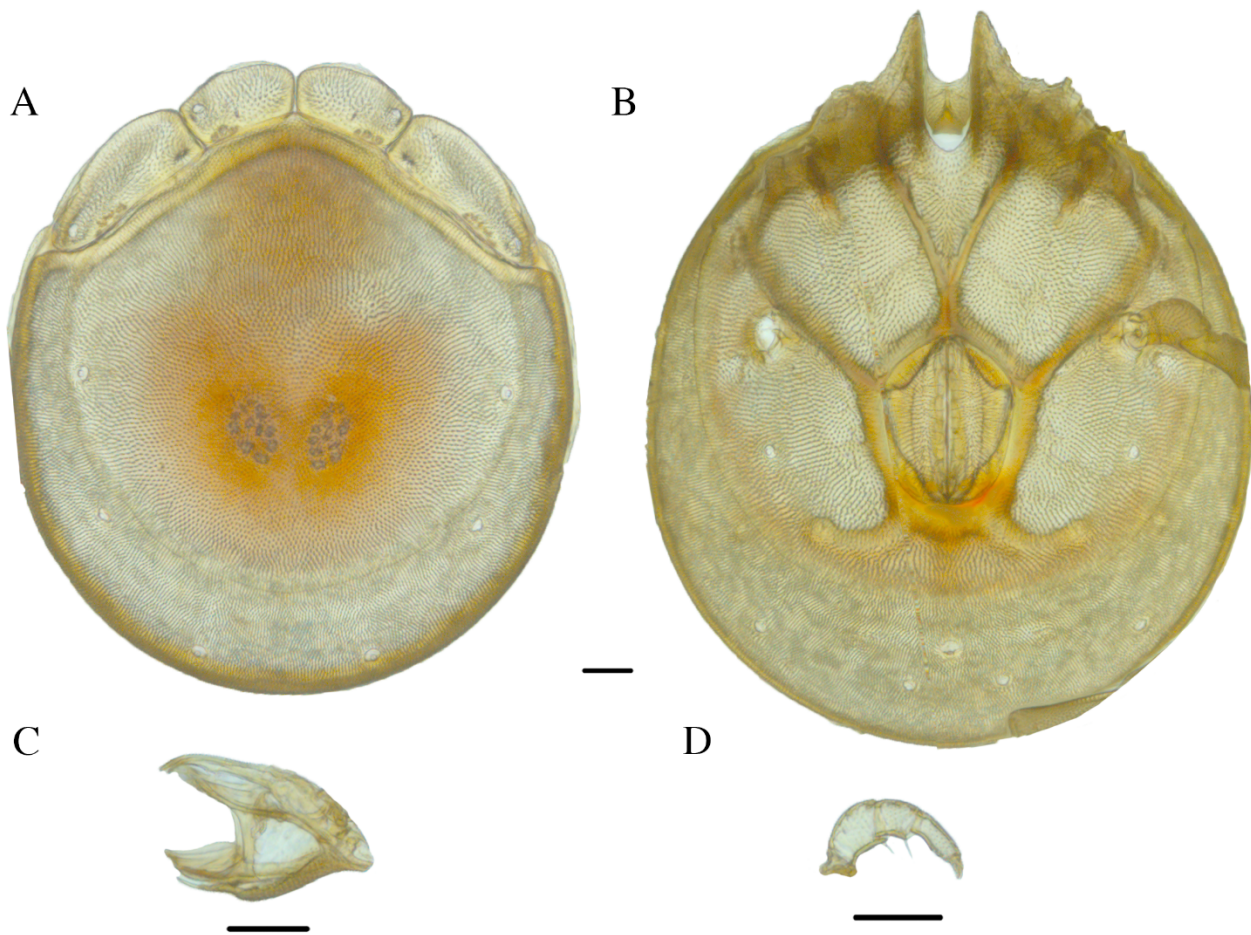
**Figure 77.** *Monatractides waddellica* female: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum **D** pedipalp (setae not accurately depicted). Scale = 100  $\mu$ m.

**Venter** (1250-1360 (1250) long; 1020-1220 (1020) wide) with orange coloration on areas of primary sclerotization. Gnathosomal bay (220-250 (220) long; 80-90 (80) wide. Cxgl-4 subapical. **Medial suture** (60-70 (70) long). **Genital plates** (280-310 (280) long; 230-300 (230) wide). Additional measurements: Cx-1 (520-540 (520) long (total); 210-230 (230) long



(medial); Cx-3 (760-790 (770) wide); anterior venter (270-300 (300) long). Ventral proportions: gnathosomal bay length/width 2.75-3.0 (2.75); anterior venter/genital field length 0.87-1.07 (1.07); anterior venter length/genital field width 0.9-1.3 (1.3).

**MALE (Fig. 78)** (n =4) (allotypic measurements in parentheses when available) with characters of the genus following specifications.



**Figure 78.** *Monatractides waddellica* male: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum **D** pedipalp (setae not accurately depicted). Scale = 100  $\mu$ m.

**Dorsum** (1030-1070 (1070) long; 920-960 (960) wide) round and often with a purple coloration; without a distinct pattern. Anterio-medial platelets (190-205 (205) long; 110-120

(120) wide). Anterio-lateral platelets (300-315 (300) long; 120-130 (130) wide), free from dorsal plate. Dgl-4 much closer to the edge of the dorsum than to the muscle scars (distance between Dgl-4 700-740 (740)). Dorsal plate proportions: dorsum length/width 1.11-1.12 (1.11); dorsal width/distance between Dgl-4 0.97(0.97); anterio-medial platelet length/width 1.71-1.73 (1.71); anterio-lateral platelet length/width 2.31-2.63 (2.31); anterio-lateral/anterio-medial length 1.46-1.66 (1.46).

**Gnathosoma-Subcapitulum** (265-280 (280) long (ventral); 195-200 (195) long (dorsal); 35-40 (35) tall) colorless. Rostrum (195 (195) wide) very short and stocky. Chelicerae (265-280 (265) long with curved fangs (55-60 (55) long). Subcapitular proportions: ventral length/dorsal length (1.36-1.40 (1.40)). **Pedipalps** short and stocky (especially tibiae) with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (40-45 (45) long; 50 (50) wide); femur (95-100 (95) long; 65-70 (65) wide); genu (60-65 (65) long; 55-57.5 (57.5) wide); tibia (82.5-85 (82.5) long; 30-35 (35) wide); tarsus (30-35 (35) long). Palpomere proportions: femur/genu 1.46-1.67 (1.46); tibia/femur 0.85-0.87 (0.87); tibia length/width 2.36-2.83 (2.36).

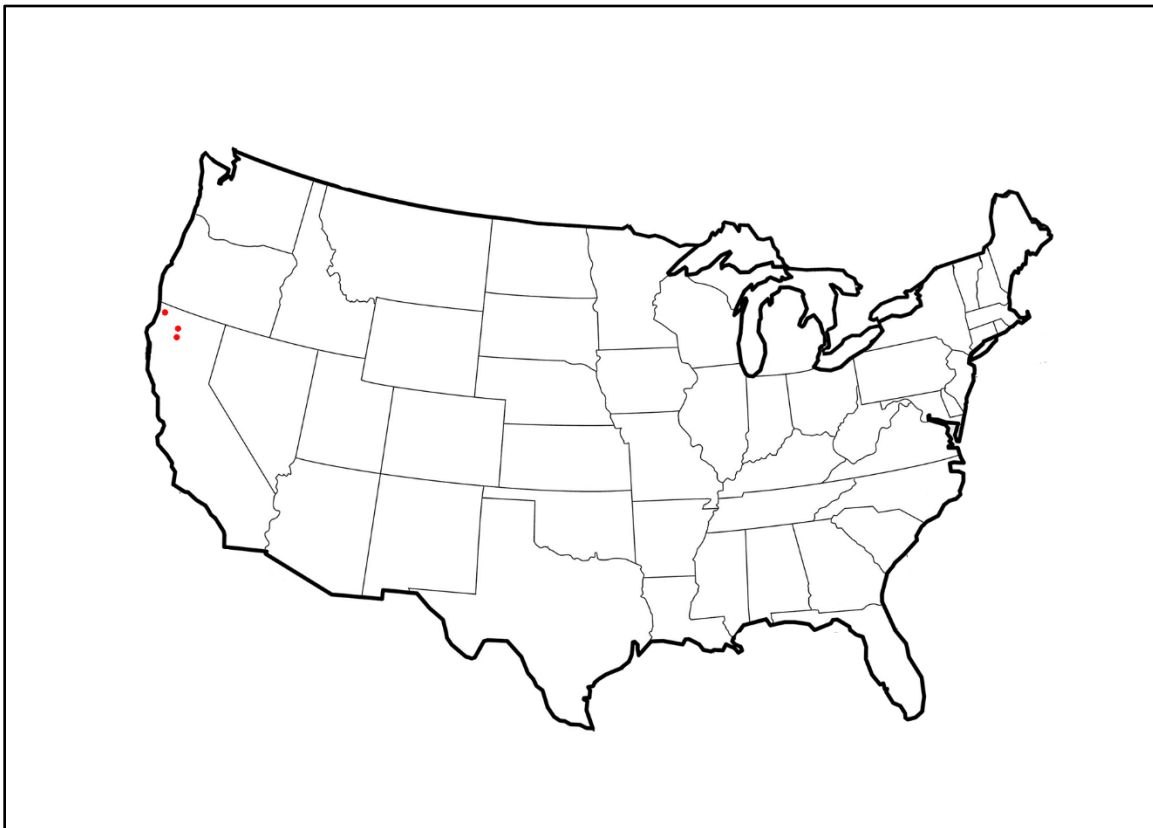
**Venter** (1220-1230 (1230) long; 1010-1030(1030) wide) with orange coloration on areas of primary sclerotization. Gnathosomal bay (230 (230) long; 80-90 (90) wide. Cxgl-4 subapical. **Medial suture** (90 (90) long). **Genital plates** (285-290 (290) long; 225-240 (240) wide). Additional measurements: Cx-1 (515-540 (540) long (total); 200-220 (220) long (medial); Cx-3 (720 (720) wide); anterior venter (290-310 (310) long). Ventral proportions: gnathosomal bay length/width 2.56-2.88(2.56); anterior venter/genital field length 1.02-1.07 (1.07); anterior venter length/genital field width 1.21-1.38 (1.38).

**IMMATURES** unknown.

**Etymology.** The reason for the specific epithet (*waddellica*) was not explicitly stated by Marshall, but one must assume it refers the creek in which the holotype was collected in Santa Cruz, CA.

**Distribution.** Northern California (Fig.79).

**Remarks.** *Monatractides waddellica* group with the other members of the Californica group, *M. geographica* and *M. siskiyouii*, with high support; specimens are less than 1% different in COI sequence from each other. In all analyses, *M. waddellica* groups with the other morphologically similar species: *M. siskiyouii*. *Monatractides waddellica* is greater than 11.5% different in COI from its sister species (*M. siskiyouii* and *M. geographica*). This clade of three species corresponds to a geographic group; the aptly named Californica group. This species hypothesis is supported by low COI divergence within the species (0-0.8%) and high divergence between species (over 10%), and by the morphological characters outlined in the diagnosis.



**Figure 79.** *Monatractides waddellica* distribution.

***Monatractides williamsis* Nelson & Dowling, sp. n.**

**Material examined.** HOLOTYPE (♀): **USA, Mississippi:** 1♀ from Attala County, beside Natchez Trace Parkway 2 km south of Rt. 12, (33°4'4"N, 89°31'31"W), 30 September 2010, by IM Smith, IMS100168.

PARATYPES (1♀; 1♂): **USA, Mississippi:** (allotype) 1♂ from Attala, beside Natchez Trace Parkway 2 km south of Rt. 12, (33°4'4"N, 89°31'31"W), 30 September 2010, by IM Smith, IMS100168 • 1♀ from Attala, beside Natchez Trace Parkway 2 km south of Rt. 12, (33°4'4"N, 89°31'31"W), 30 September 2010, by IM Smith, IMS100168.

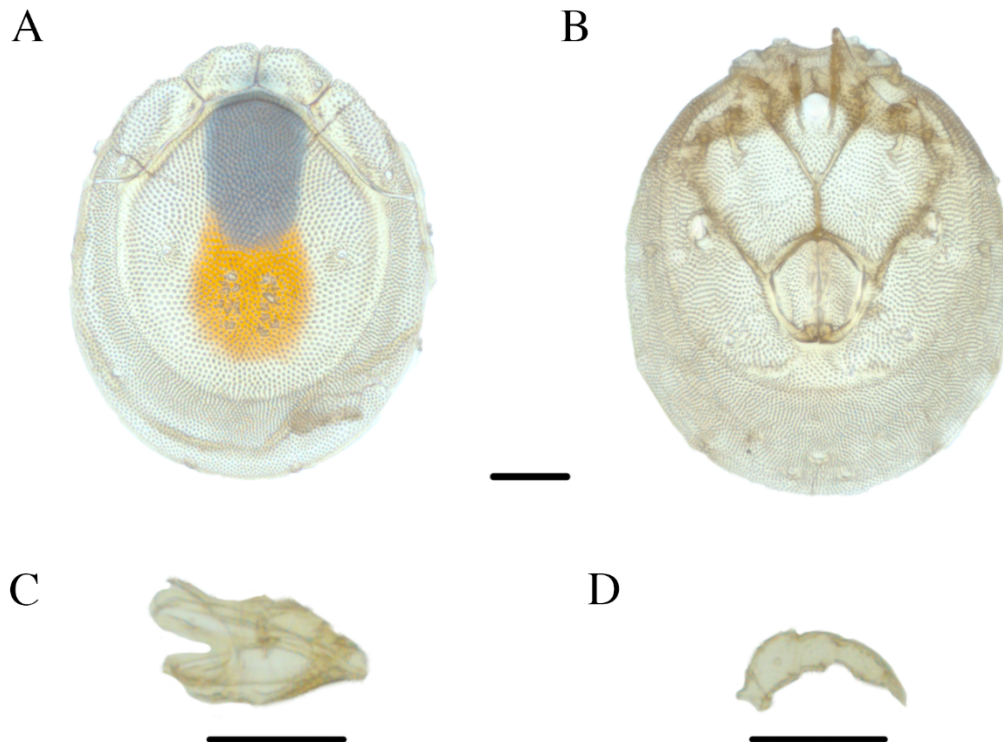
**Type deposition.** Holotype (♀), allotype (♂), and other paratypes (1♀) deposited in the CNC.

**Diagnosis.** *Monatractides williamsis* are similar to the majority of the members of the Easterly group by having notable dorsal coloration and patterning; in this case, a purple blotch with an orange blotch or streak stacked under it. The subcapitulum is wide, differentiating it from all species in the Easterly Elongatus group. *M. williamsis* is most similar to *M. zirkleii* in dorsal coloration; these two species can be quickly differentiated using the ventral coloration often present in *M. zirkleii* and absent in *M. williamsis*. *M. williamsis* is also notably smaller than *M. zirkleii* (dorsum width ♀ = 700 in *M. zirkleii*, 520-530 in *M. williamsis*; ♂ = 490-550 in *M. zirkleii*, 450 in *M. williamsis*). *M. lynensis* is a similarly sized and dorsally marked species, but can be differentiated using the distance between the genital field and the gnathosomal bay (gnathosomal bay to genital field length ♀ = 170-180 in *M. williamsis*, 210-240 in *M. lynensis*; ♂ = 185 in *M. williamsis*; 210-225 in *M. lynensis*).

**Description. FEMALE (Fig. 80) (n=2)** (holotype measurements in parentheses when

available) with characters of the genus with the following specifications.

**Dorsum** (630-650 (630) long; 520-530 (520) wide) ovoid with coloration restricted to a single dark spot anteriorly, with an orange spot posterior the dark spot. Dark anterior coloration may extend to antero-medial platelets. Antero-medial platelets (110 (110) long; 70 (70) wide). Antero-lateral platelets (200 (200) long; 80 (80) wide), free from dorsal plate. Dgl-4 much closer to the edge of the dorsum than to the muscle scars (distance between Dgl-4 270-280 (270)). Dorsal plate proportions: dorsum length/width 1.21-1.23 (1.21); dorsal width/distance between Dgl-4 0.91-0.93 (0.93); antero-medial platelet length/width 1.57 (1.57); antero-lateral platelet length/width 2.50 (2.50); antero-lateral/antero-medial length 1.82 (1.82).



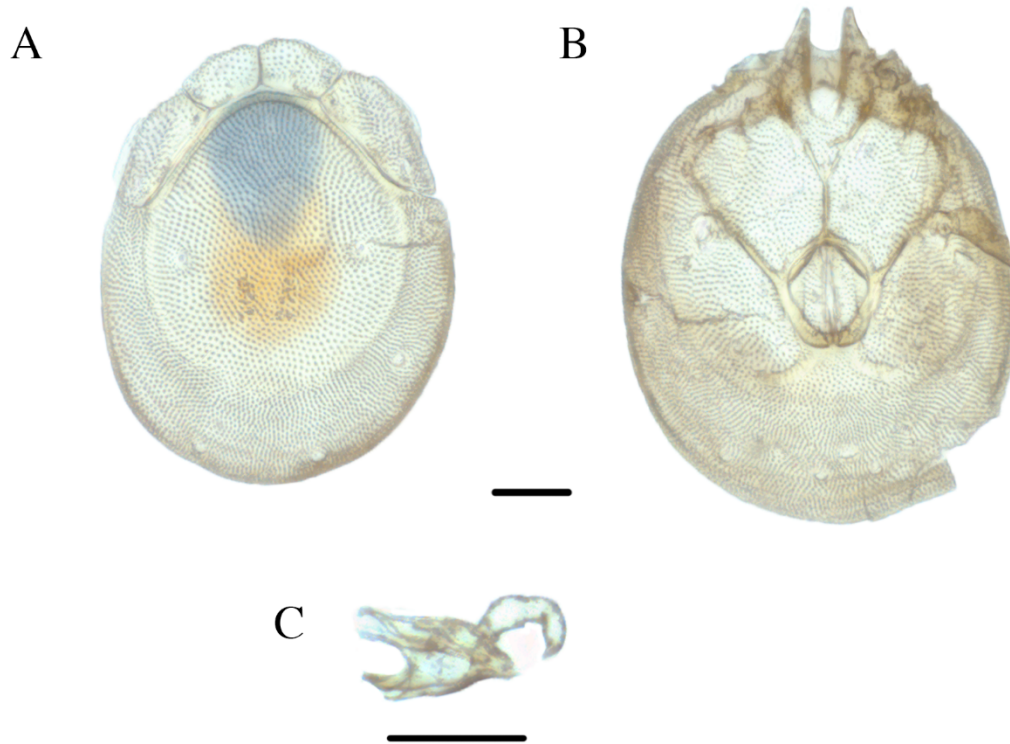
**Figure 80.** *Monatractides williamsis* sp. n. female: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum **D** pedipalp (setae not accurately depicted). Scale = 100  $\mu$ m.

**Gnathosoma-Subcapitulum** (165-170 (170) long (ventral); 110-120 (120) long (dorsal); 20-35 (35) tall) colorless. Rostrum (80-95 (80) wide) very short and stocky. Chelicerae (150-155 (150) long with curved fangs (25-30 (30) long). Subcapitular proportions: ventral length/dorsal length (1.42-1.50 (1.42)). **Pedipalps** short and stocky (especially tibiae) with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (20-25 (20) long; 25 (25) wide); femur (50-55 (55) long; 40-45 (40) wide); genu (40 (40) long; 30-35 (30) wide); tibia (45-50 (45) long; 25 (25) wide); tarsus (25 (25) long; 15 (15) wide). Palpomere proportions: femur/genu 1.25-1.38 (1.38); tibia/femur 0.82-1.0 (0.82); tibia length/width 1.8-2.0 (1.8).

**Venter** (690-710 (690) long; 560-570 (560) wide) colorless. Gnathosomal bay (140-145 (140) long; 40-50 (50) wide. Cxgl-4 subapical. **Medial suture** (60-80 (80) long). **Genital plates** (160 (160) long; 140-150 (140) wide). Additional measurements: Cx-1 (230-320 (230) long (total); 100 (100) long (medial); Cx-3 (360-390 (360) wide); anterior venter (170-180 (180) long). Ventral proportions: gnathosomal bay length/width 2.80-3.63 (2.80); anterior venter/genital field length 1.06-1.13 (1.13); anterior venter length/genital field width 1.13-1.29 (1.29).

**MALE (Fig. 81)** (n =1) with characters of the genus following specifications.

**Dorsum** (540 long; 450 wide) void with coloration restricted to a single dark spot anteriorly, with an orange spot posterior the dark spot. Dark anterior coloration may extend to antero-medial platelets. Antero-medial platelets (105 long; 60). Antero-lateral platelets (150 long; 70 wide), free from dorsal plate. Dgl-4 much closer to the edge of the dorsum than to the muscle scars (distance between Dgl-4 235). Dorsal plate proportions: dorsum length/width 1.20; dorsal width/distance between Dgl-4 0.94; antero-medial platelet length/width 1.75; antero-lateral platelet length/width 2.14; antero-lateral/anterio-medial length 1.43.



**Figure 81.** *Monatractides williamsis* sp. n. male: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum and pedipalp (setae not accurately depicted). Scale = 100  $\mu$ m.

**Gnathosoma-Subcapitulum** (135 long (ventral); 95 long (dorsal); 20 tall) colorless. Rostrum (75 wide) very short and stocky. Chelicerae (130) long with curved fangs (25 long). Subcapitular proportions: ventral length/dorsal length (1.42). **Pedipalps** short and stocky (especially tibiae) with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (17.5 long; 25 wide); femur (45 long; 35 wide); genu (30 long; 27.5 wide); tibia (20 long; 22.5 wide); tarsus (20 long; 12.5 wide). Palpomere proportions: femur/genu 1.50; tibia/femur 0.89; tibia length/width 1.78.

**Venter** (625 long; 540 wide) colorless. Gnathosomal bay (110 long; 35 wide). Cxgl-4



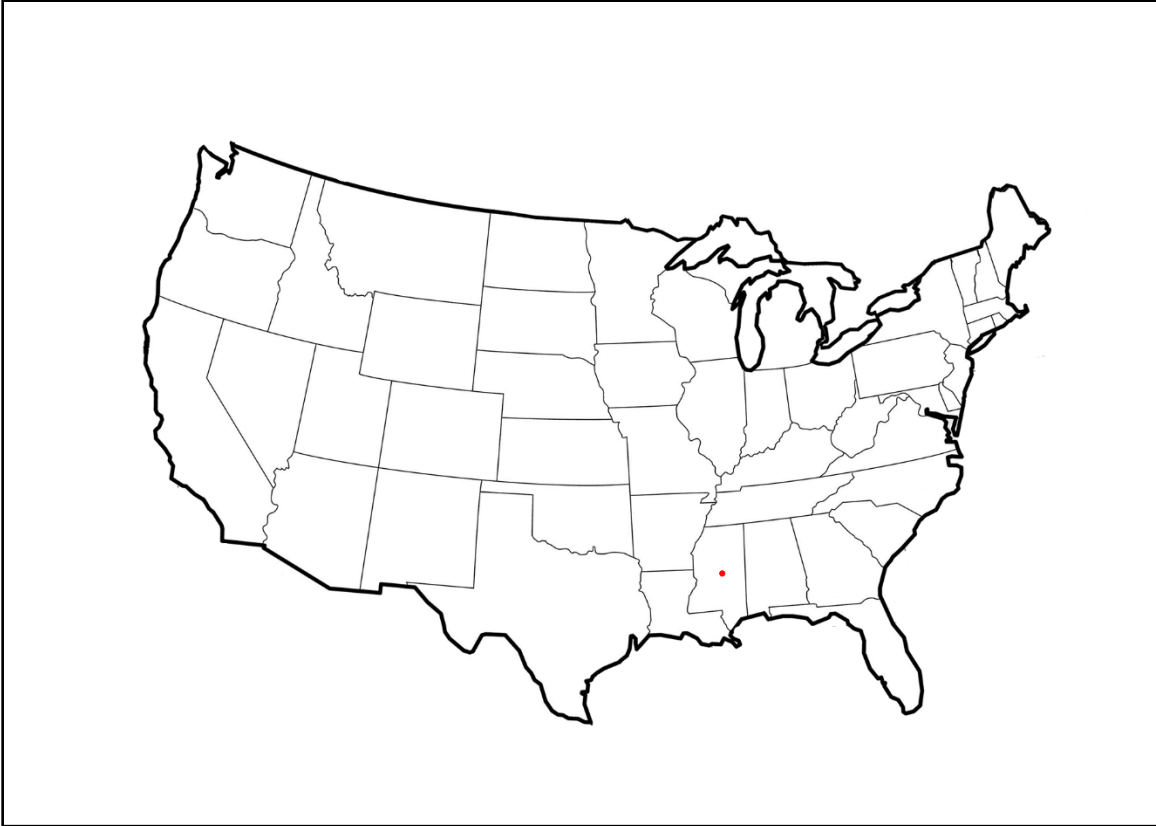
subapical. **Medial suture** (70 long). **Genital plates** (127.5 long; 105 wide). Additional measurements: Cx-1 (290 long (total); 107.5 long (medial); Cx-3 (335 wide); anterior venter (185 long). Ventral proportions: gnathosomal bay length/width 3.14; anterior venter/genital field length 1.45; anterior venter length/genital field width 1.76.

**IMMATURES** unknown.

**Etymology.** Specific epithet *williamsis* is in honor of Mississippi's great pride, Ray Williams – one of (if not THE) the strongest drug-tested powerlifter on the planet, who is thought to be very close to the physiologic limit for muscle size and geometry for human beings. Inspiring many to new athletes to a niche sport, Ray deserves an arachnid named in his honor.

**Distribution.** *Monatractides williamsis* is known from one location in Mississippi (Fig. 82).

**Remarks.** In all analyses, *Monatractides williamsis* groups with other members of the Easterly group with high support. This species hypothesis is supported by low COI divergence within the species (less than 1%), and high divergence between species (at least 5% from its sister species *M. emilyae* and over 14% from *M. zirkleii*), and by the morphological characteristics outlined in the diagnosis.



**Figure 82.** *Monatractides williamsis* sp. n. distribution.

***Monatractides wolfendensis* Nelson & Dowling, sp. n.**

**Material examined.** HOLOTYPE (♀): **USA, Arkansas:** 1 ♀ from Montgomery County, Caddo Gap, access track off Manfred Rd 0.3 km W of Rt. 8, Caddo River, (34°23'23"N, 93°37'37"W), 29 July 2011, by IM Smith, IMS110037.

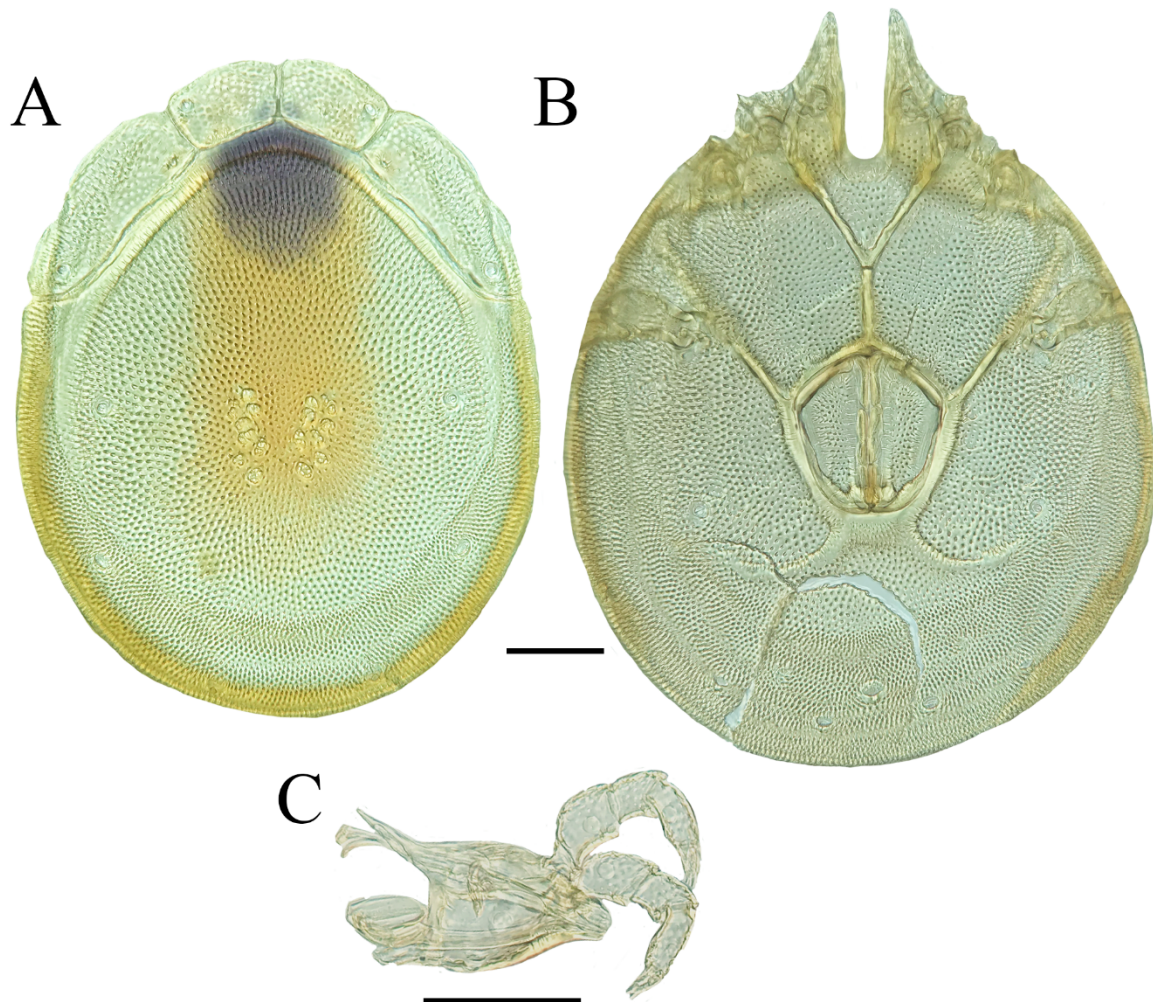
PARATYPES (2 ♀; 1 ♂): **USA, Arkansas,** (allotype) 1 ♂ from Montgomery County, Caddo Gap, access track off Manfred Rd 0.3 km W of Rt. 8, Caddo River, (34°23'23"N, 93°37'37"W), 29 July 2011, by IM Smith, IMS110037 • 1 ♀ from Montgomery County, Caddo Gap, access track off Manfred Rd 0.3 km W of Rt. 8, Caddo River, (34°23'23"N, 93°37'37"W), 29 July 2011, by IM Smith, IMS110037 • 1 ♀ from Polk County, E. Saline Cr; beside FR38, N of Shady Lake Rec Area, (34°22'22"N, 94°1'1"W), 30 July 2011, by IM Smith, IMS110041

**Type deposition.** Holotype (♀), allotype (♂), and other paratypes (2 ♀) deposited in the CNC.

**Diagnosis.** *Monatractides wolfendensis* are similar to other members of the Easterly group by their notable dorsal coloration; in this case, a purple spot with an orange streak stacked under it. The subcapitulum is wide, differentiating it from all species in the Easterly Elongatus group. *M. wolfendensis* is most similar to *M. williamsis*, *M. lynensis*, and *M. zirkleii* in dorsal coloration. *M. wolfendensis* can be quickly differentiated from *M. zirkleii* using the ventral coloration often present *M. zirkleii* and absent in *M. wolfendensis*. *M. williamsis* is a similarly sized and dorsally marked species, but can be differentiated using the anterior venter (anterior venter measurement ♀ = 170-180 in *M. williamsis*, 220-225 in *M. wolfendensis*; ♂ = 185 in *M. williamsis*; 225 in *M. wolfendensis*). *M. lynensis* can be separated from *M. wolfendensis* using the gnathosomal bay measurements in the males (gnathosomal bay length/width measurement ♂ =

1.79 in *M. lynensis*; 2.93 in *M. wolfendensis*); no known characters are in use to differentiate females of these two species at this time.

**Description. FEMALE (Fig. 83) (n=3)** (holotype measurements in parentheses when available) with characters of the genus with the following specifications.



**Figure 83.** *Monatractides wolfendensis* sp. n. female: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum and pedipalp (setae not accurately depicted). Scale = 100  $\mu$ m.

**Dorsum** (650-720 (650) long; 520-540 (520) wide) ovoid with coloration restricted to a single dark spot anteriorly, with an orange streak posterior the dark spot and extending

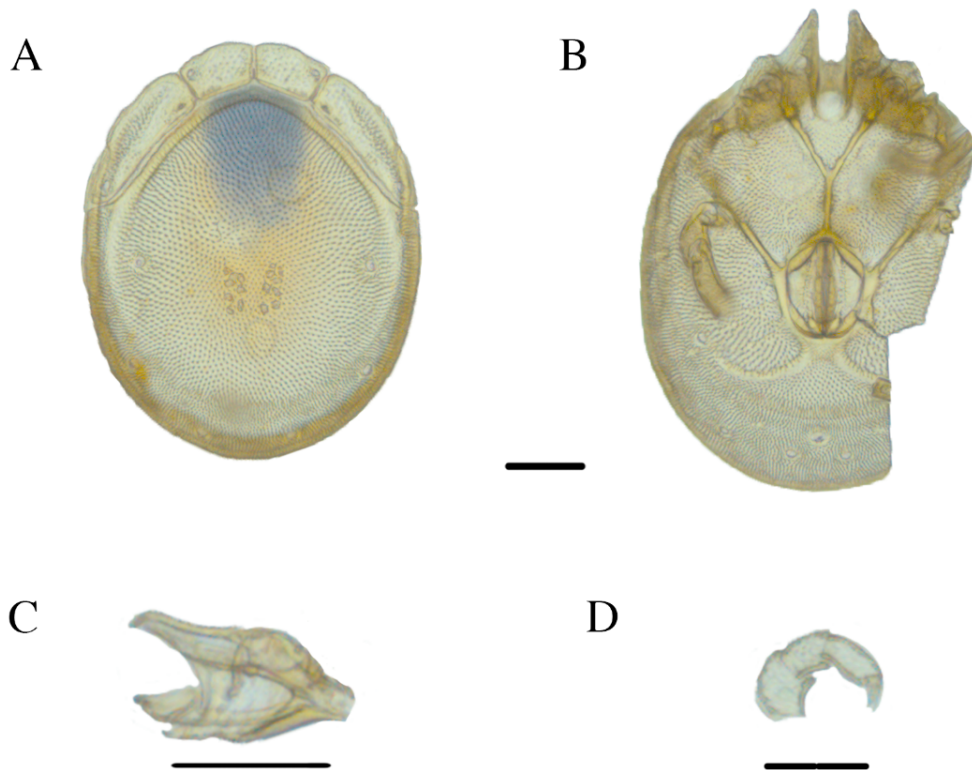
posteriorly. Anterio-medial platelets (110-120 (110) long; 70 (70) wide). Anterio-lateral platelets (210-220 (210) long; 70-80 (75) wide), free from dorsal plate. Dgl-4 closer to the edge of the dorsum than to the muscle scars (distance between Dgl-4 360-370 (360)). Dorsal plate proportions: dorsum length/width 1.25-1.33 (1.25); dorsal width/distance between Dgl-4 0.82-0.88 (0.88); anterio-medial platelet length/width 1.57-1.71 (1.57); anterio-lateral platelet length/width 2.63-3.14 (2.80); anterio-lateral/anterio-medial length 1.75-2.0 (1.91).

**Gnathosoma-Subcapitulum** (167.5-175 (167.5) long (ventral); 117.5-120 (117.5) long (dorsal); 12.5-30 (22.5) tall) colorless. Rostrum (75-77.5 (77.5) wide) very short and stocky. Chelicerae (150-195 (150) long with curved fangs (25 (25) long). Subcapitular proportions: ventral length/dorsal length (1.43-1.46 (1.43)). **Pedipalps** short and stocky (especially tibiae) with small tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (15-25 (20) long; 25 (25) wide); femur (47.5-50 (47.5) long; 35 (35) wide); genu (35-37.5 (37.5) long; 30 (30) wide); tibia (45-47.5 (47.5) long; 20-25 (20) wide); tarsus (27.5-30 (27.5) long; 12.5-15 (12.5) wide). Palpomere proportions: femur/genu 1.27-1.43 (1.27); tibia/femur 0.9-1.0 (1.0); tibia length/width 1.8-2.38 (2.38).

**Venter** (770-840 (770) long; 590-720 (590) wide) colorless. Gnathosomal bay (125-130 (125) long; 40-60 (40) wide. Cxgl-4 subapical. **Medial suture** (80-105 (105) long). **Genital plates** (162.5-180 (162.5) long; 150-160 (155) wide). Additional measurements: Cx-1 (240-260 (240) long (total); 115-130 (115) long (medial); Cx-3 (400-520 (400) wide); anterior venter (220-225 (225) long). Ventral proportions: gnathosomal bay length/width 2.17-3.13 (3.13); anterior venter/genital field length 1.22-1.38 (1.38); anterior venter length/genital field width 1.38-1.47 (1.45).

**MALE (Fig. 84)** (n =1) with characters of the genus following specifications.

**Dorsum** (580 long; 450 wide) ovoid with coloration restricted to a single dark spot anteriorly, with an orange streak posterior the dark spot and extending posteriorly. Anterio-medial platelets (105 long; 60 wide). Anterio-lateral platelets (190 long; 70 wide), free from dorsal plate. Dgl-4 closer to the edge of the dorsum than to the muscle scars (distance between Dgl-4 325) Dorsal plate proportions: dorsum length/width 1.29; dorsal width/distance between Dgl-4 0.87; anterio-medial platelet length/width 1.75; anterio-lateral platelet length/width 2.71; anterio-lateral/anterio-medial length 1.81.



**Figure 84.** *Monatractides wolfendensis* sp. n. male: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum **D** pedipalp (setae not accurately depicted). Scale = 100  $\mu$ m.

**Gnathosoma-Subcapitulum** (157.5 long (ventral); 107.5 long (dorsal); 17.5 tall)

colorless. Rostrum (80 wide) very short and stocky. Chelicerae (142.5 long with curved fangs (27.5 long). Subcapitular proportions: ventral length/dorsal length (1.47). **Pedipalps** short and stocky (especially tibiae) with tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (20 long; 25 wide); femur (45 long; 37.5 wide); genu (30 long; 30 wide); tibia (42.5 long; 22.5 wide); tarsus (25 long; 12.5 wide). Palpomere proportions: femur/genu 1.50; tibia/femur 0.94; tibia length/width 1.89.

**Venter** (660 long; 495 wide) colorless. Gnathosomal bay (110 long; 37.5 wide). Cxgl-4 subapical. **Medial suture** (90 long). **Genital plates** (37.5 long; 107.5 wide). Additional measurements: Cx-1 (235 long (total); 125 long (medial); Cx-3 375 wide); anterior venter (95 long). Ventral proportions: gnathosomal bay length/width 2.93; anterior venter/genital field length 1.64; anterior venter length/genital field width 2.09.

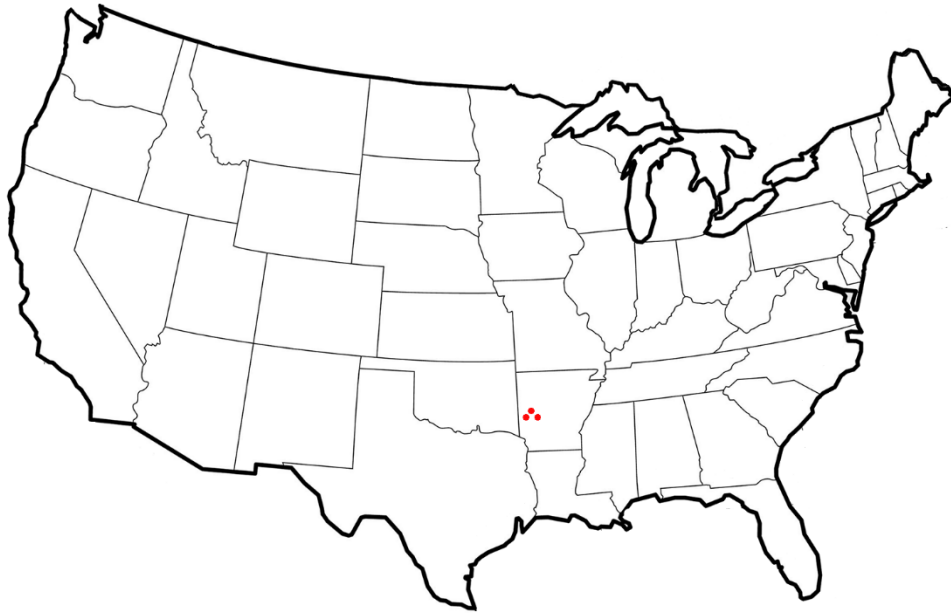
**IMMATURES** unknown.

**Etymology.** Specific epithet *wolfendensis* is chosen in honor of Ross Wolfenden.

**Distribution.** *Monatractides wolfendensis* is known from the Ouichita Mountains in Arkansas (Fig. 85).

**Remarks.** In all analyses, *Monatractides wolfendensis* groups with other members of the Easterly group with high support. This species hypothesis is supported by low divergence within the species (2.2%), high COI divergence between species (at least 16.5% from its sister species), and by the morphological characteristics outlined in the diagnosis. It is notable that the intraspecies COI variation is higher than might be expected within such a small geographic range; however, this variation is derived from comparing specimens across the Interior

Highlands (Ouachita mountains); an area well-known for endemic species, which may possess higher genetic diversity. While it is unknown if this COI divergence is related to endemism or the presence of a cryptic species group, given the topology of the COI tree and the morphological similarity, we suggest that this variability represents a continuum across a complex geographic range, rather than more than one isolated species.



**Figure 85.** *Monatractides wolfendensis* distribution.



***Monatractides zirkleii* Nelson & Dowling, sp. n.**

**Material examined.** HOLOTYPE (♀) **USA, Missouri:** 1 ♀ from Crawford County, Huzzah Cr; Red Bluff cmpgrnd off Rd V, E of Davisville, (37°48'48"N, 91°9'9"W), 23 July 2011, by IM Smith, IMS110029.

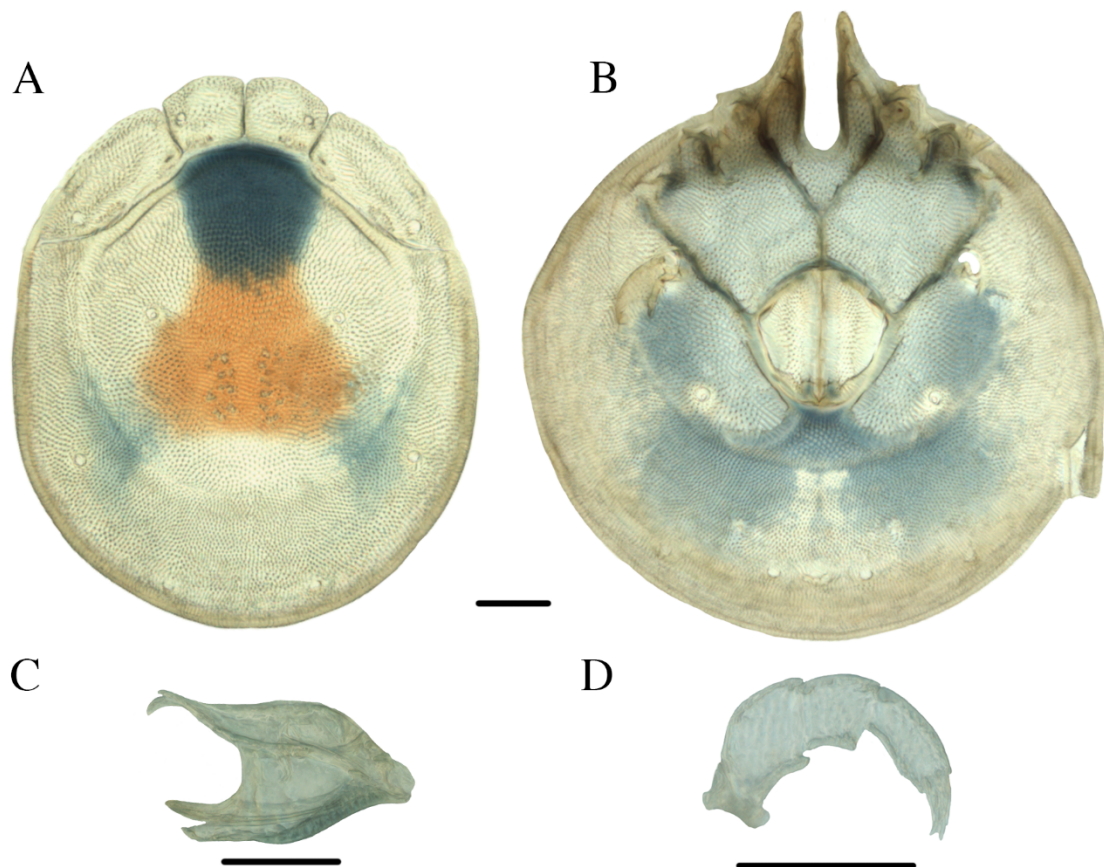
PARATYPES (3♂): **USA, Missouri:** (allotype) 1 ♂ from Crawford County, Huzzah Cr; Red Bluff cmpgrnd off Rd V, E of Davisville, (37°48'48"N, 91°9'9"W), 23 July 2011, by IM Smith, IMS110029 • 2 ♂ from Crawford County, Huzzah Cr; Red Bluff cmpgrnd off Rd V, E of Davisville, (37°48'48"N, 91°9'9"W), 23 July 2011, by IM Smith, IMS110029

**Type deposition.** Holotype (♀) and allotype (♂) deposited in the CNC. All other paratypes (2♂) deposited in the ACUA.

**Diagnosis.** *Monatractides zirkleii* are similar to many other members of the Easterly group by having notable dorsal coloration and patterning; in this case, a purple blotch with an orange blotch stacked under it. As shown in the female color plate for this species, there can be additional purple coloration on the dorsum, as well as some ventral coloration in either sex. This ventral coloration may be quickly used to differentiate it from *M. williamsis*, which also has a purple-orange blotch combo; however, *M. williamsis* is notably smaller than *zirkleii* (dorsum width ♀ = 700 in *M. zirkleii*, 520-530 in *M. williamsis*; ♂ = 490-550 in *M. zirkleii*, 450 in *M. williamsis*). The subcapitulum is wide, differentiating it from all species in the Easterly Elongatus group. *M. emilyae* and *M. axfordii* are both similarly sized species, but can be quickly differentiated from *M. zirkleii* by the single (or near single) orange to dark orange pear-shaped blotch on the dorsum; while *M. axfordii* may have some purple coloration, it is not a distinct dot, as is seen in *M. zirkleii*. Additional and more formalized separation of the species can be

obtained by measurement comparison; for this information, see the key.

**Description. FEMALE (Fig. 86)** (n=1) (holotype measurements) with characters of the genus with the following specifications.



**Figure 86.** *Monatractides zirkleii* sp. n. female: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum **D** pedipalp (setae not accurately depicted). Scale = 100  $\mu$ m.

**Dorsum** (820 long; 700 wide) ovoid and with bluish-purple coloration separated into anterior and often posterior portions, and bold orange medially. Anterio-medial platelets (120 long; 105 wide). Anterio-lateral platelets (250 long; 110 wide), free from dorsal plate. Dgl-4 closer to the muscle scars than to the edge of the dorsum (distance between Dgl-4 300). Dorsal plate proportions: dorsum length/width 1.17; dorsal width/distance between Dgl-4 0.96; antero-

medial platelet length/width 1.14; antero-lateral platelet length/width 2.27; antero-lateral/anterio-medial length 2.08.

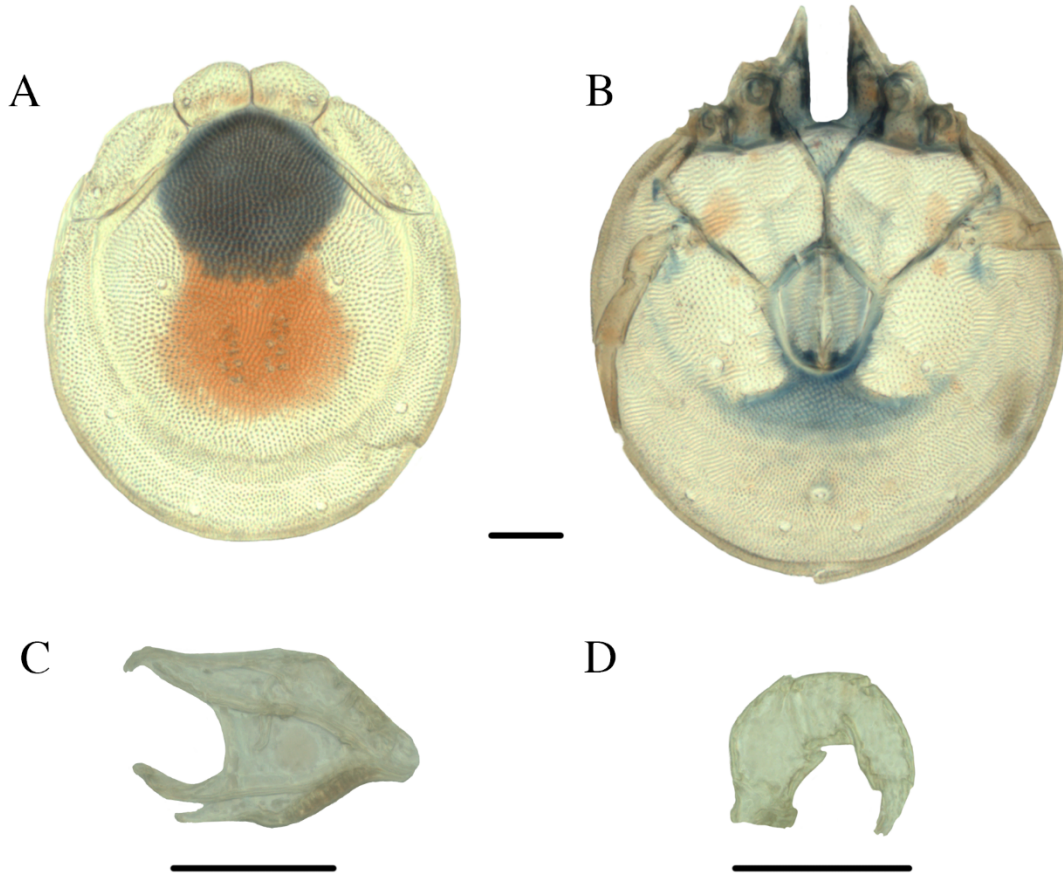
**Gnathosoma-Subcapitulum** 210 long (ventral); 135 long (dorsal); 30 tall) with bluish-purple coloration on the venter of the subcapitulum. Rostrum (110 wide) short and stocky. Chelicerae (180) long with curved fangs (35 long). Subcapitular proportions: ventral length/dorsal length (1.56). **Pedipalps** short and stocky with small tuberculate ventral extensions on femora and genua. Palpomeres: trochanter (22.5 long; 30 wide); femur (60 long; 50 wide); genu (40) long; 40 wide); tibia (55 long; 30 wide); tarsus (30 long; 20 wide). Palpomere proportions: femur/genu 1.50; tibia/femur 0.92; tibia length/width 1.83.

**Venter** (960 long; 830 wide) with varying levels of purple-bluish coloration. Gnathosomal bay 180 long; 55 wide. Cxgl-4 subapical. **Medial suture** (70 long). **Genital plates** (210 long; 190 wide). Additional measurements: Cx-1 380 long (total); 130 long (medial); Cx-3 (510 wide); anterior venter (200 long). Ventral proportions: gnathosomal bay length/width 3.27; anterior venter/genital field length 0.95; anterior venter length/genital field width 1.05.

**MALE (Fig. 87)** (n =3) (allotypic measurements in parentheses when available) with characters of the genus following specifications.

**Dorsum** (630-650 (630) long; 490-570 (550) wide) ovoid and with bluish-purple coloration separated into anterior and often posterior portions, and bold orange medially. Posterior bluish-purple coloration can be strong, faint, or absent. Antero-medial platelets (105-110 (105) long; 65-75 (75) wide). Antero-lateral platelets (195-205 (195) long; 75-85 (80) wide), free from dorsal plate. Dgl-4 closer to the muscle scars than to the edge of the dorsum (distance between Dgl-4 250-300 (250)). Dorsal plate proportions: dorsum length/width 1.14-

1.29 (1.15); dorsal width/distance between Dgl-4 0.88-0.97 (0.96); antero-medial platelet length/width 1.40-1.69 (1.40); antero-lateral platelet length/width 2.29-2.73 (2.44); antero-lateral/antero-medial length 1.77-1.86 (1.86).



**Figure 87.** *Monatractides zirkleii* sp. n. male: **A** dorsal plates **B** venter (legs removed) **C** subcapitulum **D** pedipalp (setae not accurately depicted). Scale = 100  $\mu$ m.

**Gnathosoma-Subcapitulum** (157.5-162.5 (162.5) long (ventral); 102.5-110 (110) long (dorsal); 17.5-22.5 (22.5) tall) colorless. Rostrum (77.5-90 (90) wide) very short and stocky. Chelicerae (140-150 (147.5) long with curved fangs (25-32.5 (25) long). Subcapitular proportions: ventral length/dorsal length (1.48-1.55 (1.48)). **Pedipalps** short and stocky (especially tibiae) with tuberculate ventral extensions on femora and genua. Palpomeres:

trochanter (17.5-22.5 (22.5) long; 22.5-30 (30) wide); femur (50-52.5 (52.5) long; 35-41.25 (41.25) wide); genu (37.5-47.5 (37.5) long; 27.5-32.5 (32.5) wide); tibia (37.5-50 (50) long; 22.5-25 (25) wide); tarsus (25 (25) long; 12.5-15 (15) wide).

Palpomere proportions: femur/genu 1.11-1.40 (1.40); tibia/femur 0.75-0.95 (0.95); tibia length/width 1.67-2.0 (2.0).

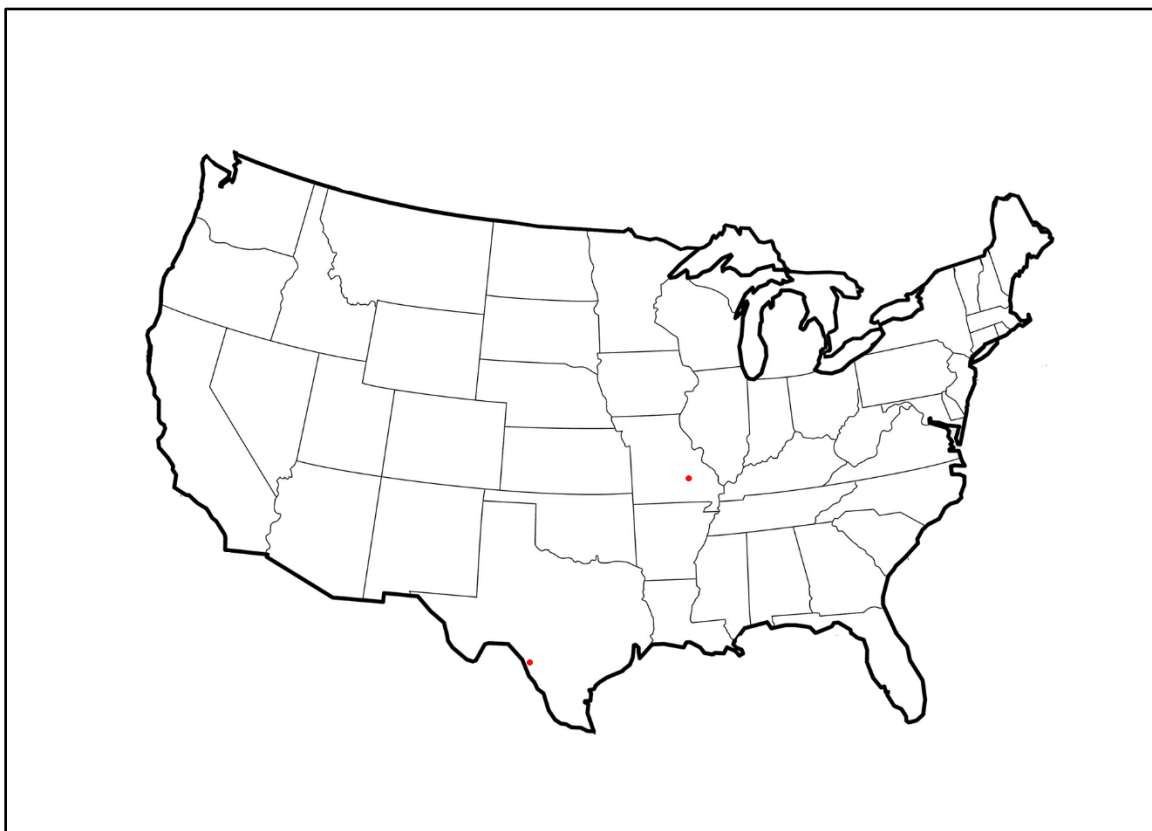
**Venter** (730-760 (740) long; 600-720 (620) wide) with varying levels of purple-bluish coloration. Occasionally with orange coloration on areas of primary sclerotization. Gnathosomal bay (120-145 (145) long; 45-50 (45) wide. Cxgl-4 subapical. **Medial suture** (85-90 (90) long). **Genital plates** (150 (150) long; 115-130 (130) wide). Additional measurements: Cx-1 (235-260 (260) long (total); 105-115 (115) long (medial); Cx-3 (410-470 (410) wide); anterior venter (200-210 (210) long). Ventral proportions: gnathosomal bay length/width 2.5-3.22 (3.22); anterior venter/genital field length 1.33-1.40 (1.40); anterior venter length/genital field width 1.60-1.74 (1.62).

**IMMATURES** unknown.

**Etymology.** Specific epithet *zirkleii* after Colton Zirkle; an ozark chinquapin champion, budding naturalist, and forever a Missouri man at heart.

**Distribution.** *Monatractides zirkleii* is known from two areas Missouri (Fig. 88).

**Remarks.** In all analyses, *Monatractides zirkleii* groups with other members of the Easterly group with high support. This species hypothesis is supported by low COI divergence within the species (1.3%) and high divergence between species (at least 14.3% from its sister species *M. emilyae* and *M. williamsis*), and by the morphological characteristics outlined in the diagnosis.



**Figure 88.** *Monatractides zirkleii* distribution.

### Key to the *Monatractides* of the United States and Canada

Only known from males: *M. cooki*\*, *M. jordanensis*\*, *M. montgomeryae*\*

Only identifiable using males: *M. lynensis*, *M. wolfendensis*

Only known from females: *M. coastalis*

\*Species known from a single specimen

- 1      Female: genital field pentagonal; medial suture usually short, occasionally long, but never as long as a conspecific male..... 2
  - Male: genital field rectangular; medial suture long ..... 30
- 2 (1)   Dorsal and ventral pigmentation diagnostic, with pink-rose coloration on dorsum and venter. Body large (Dorsum: 800-920 long; 730-840 wide); known only from Texas. .... *M. rosiae* **sp. n.** (Fig. 60)
  - Body measurements not as above; lacking pink-rose coloration on dorsum and venter..... 3
- 3 (2)   Capitulum ventral length/rostrum height > 1.9 .....4
  - Capitulum ventral length/rostrum height < 1.9 .....18
- 4 (3)   Sampling location from western North America.....5
  - Sampling location from eastern North America.....10
- 5 (4)   Rostrum with a distinctive downward curve; body large (dorsum: 730-830 long; 590-730 wide); dark to light purple dorsal and ventral coloration, lacking a distinct pattern. Known from Tennessee..... *M. curva* **sp.n.** (Fig 32)
  - Rostrum lacking distinctive downward curve; body size not as above; may or may not have purple dorsal and ventral coloration .....6
- 6 (5)   Gnathosomal bay-genital field/genital field length measurement large (1.0-1.19)..... 7
  - Gnathosomal bay-genital field/genital field length measurement medium (0.76-0.92))...8
- 7 (6)   Gnathosomal bay length/width measurement large (3.2-3.3). Known only from Waddell Creek in Santa Cruz, CA..... *M. gilbroskii* **sp. n.** (Fig. 41)
  - Gnathosomal bay length/width measurement smaller than above (2.16-2.90). Known from Washington and California..... *M. purrsiae* **sp. n.** (Fig. 57)

- 8 (6) Body colorless; dorsum length/width = 1.27-1.29; dorsum width/Dgl 4 = 0.84-0.85; known from Arizona and New Mexico ..... *M. vanni* **sp. n.** (Fig. 71)
- Body not as above; measurements not as above; gnathosomal bay – genital field/genital field length measurement = 0.76-0.92 .....9
- 9 (8) Anterio-lateral plate width = 90-100; ventral coloration present on body; known from the coast of Oregon and Washington; only females described.... *M. coastalis* **sp. n.** (Fig. 25)
- Anterio-lateral plate width = 110-135..... *M. simulans* (Fig. 66)
- 10 (4) Dorsum with distinctive coloration (purple spot at the top edge of dorsal plate, orange spot stacked under it (e.g. Fig. 80)). With or without additional purple coloration on dorsum and/or venter.....11
- Dorsum coloration not as above, though may possess dashes, splotches, etc. of color, or be colorless.....14
- 11 (10) Body larger (dorsum length = 820; width = 700). Females of *zirkelii* are known from one specimen collected from Huzzah Creek in Crawford Co., MO. .... *zirkelii* **sp. n.** (Fig. 86)
- Dorsal measurements not as above.....12
- 12 (11) Gnathosomal bay – genital field/genital field length = 1.06-1.13. Known from Mississippi .....*williamsis* **sp.n.** (in part) (Fig. 80)
- Gnathosomal bay – genital field/genital field length = 1.22-1.50 .....13
- 13 (12) Small, round in body, purple and orange coloration on dorsum. No known differentiation besides geography known to differentiate between *M. lynensis* and *M. wolfendensis* females. Specimen from the Missouri Ozarks or Alabama..... *M. lynensis* **sp. n.** Fig. 46)
- Small, round in body, purple and orange coloration on dorsum. No known differentiation besides geography known to differentiate between *M. lynensis* and *M. wolfendensis* females. Specimen from the Ouachita Mountains in Arkansas..... *M. wolfendensis* **sp. n.** (Fig. 83)



- 14 (10) Dorsum width = 720-840 AND anterio-medial platelet length/width = 1.55-1.86; dorsum often with purple pigmentation; collections from Tennessee and North Carolina..... *M. sevieri* **sp. n.** (in part) (Fig. 63)
- Body measurements not in the combination above..... 15
- 15 (14) Anterio-lateral platelet length/anterio-medial platelet length = 1.69-1.91, dorsal patterning consists of an orange to dark orange pear-shaped area on dorsum, extending on to anterio-medial platelets. Known from Ontario, Canada.... *M. axfordii* **sp. n.** (Fig. 12)
- Anterio-lateral platelet length/anterio-medial platelet length measurement not as above..... 16
- 16 (15) Gnathosomal bay- genital field/CxII+III mL. Dorsum brownish to purple. Known from Ontario and New Brunswick ..... *M. emilyae* **sp. n.** (Fig. 35)
- Gnathosomal bay- genital field/CxII+III mL = 2.14-3.0. Some members of the *Elongatus* group key out here ..... 17
- 17 (16) Dorsum with a bright purple or pink streak starting at the front of the dorsal plate and extending to muscle scars; anterio-medial platelet length/width = 1.36-1.44. Known from Ontario..... *M. pertussiae* **sp. n.** (Fig. 54)
- Anterio-medial platelet length/width = 1.62; dorsum colorless (in recovered species – but may have color)..... *M. confusica* **sp. n.** (Fig. 27)
- 18 (3) Specimen from the Interior Highlands; dorsal patterning with purple and orange ..... 19
- Specimen not as above ..... 20
- 19 (18)) Dorsal measurements = 820 long, 700 wide. Known from one campground in Crawford County, MO..... *M. zirkelii* **sp. n.** (Fig. 86) (in part)
- Dorsal measurements = 630-650 long; 520-530 wide. Specimens describing taxa have been collected from Mississippi..... *M. williamsis* **sp. n.** (Fig. 80)
- 20 (18) Specimens collected from eastern North America ..... 21
- Specimens collected from western North America ..... 22

- 21 (20) Gnathosomal bay-genital field/genital field length = 1.0-1.05  
 ..... *M. axfordii* **sp. n.** (Fig. 12)
- gnathosomal bay-genital field/genital field length = 1.10-1.29 collections from Tennessee and North Carolina ..... *M. sevieri* **sp. n.** (in part) (Fig. 63)
- 22 (20) Dorsum width <650 ..... 23
- Dorsum width >650 ..... 26
- 23 (22) Genital field width = 145-175 AND gnathosomal bay width = 45-60; Species from the Texas group ..... 24
- Measurements not the combination above ..... 25
- 24 (23) Anterio-medial platelet length/width = 1.17-1.88; gnathosomal bay – genital field measurement = 125-160 ..... *M. brewsteri* **sp. n.** (Fig. 22)
- Anterio-medial platelet length/width = 2.14-2.33; gnathosomal bay – genital field measurement = 165-185 ..... *M. banderae* **sp. n.** (Fig. 16)
- 25 (23) Anterio-medial platelet length/width = 2.14-2.58 ..... *M. oblongata* (Fig. 51)
- Anterio-medial platelet length/width = 1.44-2.0 ..... *M. geographica* (in part) (Fig. 38)
- 26 (22) Dorsum length/width measurement 1.14-1.16 AND distance between Dgl-4 = 620-695 ..... Siskiyouii Group .... 27
- Measurements in specimen not as above ..... 28
- 27 (26) Dgl-4 distance = 620 AND dorsum width = 855 ..... *M. siskiyouii* **sp. n.** (Fig. 69)
- Dgl-4 distance = 675-695; dorsum width = 950-975 ..... *M. vonnegutii* **sp. n.** (Fig. 74)
- 28 (26) Dorsal length/width = 1.24-1.52; anteriomedial platelet length = 110-165  
 ..... *M. geographica* (in part) (Fig. 38)
- Measurements not as above ..... 29

- 29 (28) Gnathosomal bay length/width = 3.07-4.22; antero-lateral platelet length = 350; distance between Dgl 4 = 750-770 ..... *M. waddellica* (Fig. 77)
- Gnathosomal bay length/width = 2.75-3.0; antero-lateral platelet length = 220-340; distance between Dgl 4 = 480-730. Known from Arizona and New Mexico ..... *M. banjoii* **sp. n.** (Fig. 19)

### Key to Males

- 30 (1) Dorsum length > 790 ..... 31
- Dorsum length < 790 ..... 39
- 31 (30) Sampling location from the East to the Great Lakes area ..... 32
- Sampling locale from the west, including Midwest (excluding the great lakes) and southwest ..... 33
- 32 (31) Dorsum L = 985; dorsum width = 832; antero-medial platelet length/width = 1.47. Known from Wisconsin. Measurements based of 1 specimen ..... *M. jordanensis* (Fig. 44)
- Dorsum L = 900; dorsum width = 720; antero-medial platelet length/width = 1.34. Known from Cranberry Lake, New Jersey. Measurements based of 1 specimen ..... *M. cooki* (Fig. 30)
- 33 (30) Capitulum ventral length / rostrum height measurement < 2.0 ..... 34
- Capitulum ventral length / rostrum height measurement > 2.0 ..... 35
- 34 (33) Genital field length = 190-260; dorsum length = 800-1100. Colorless. Known from New Mexico and Arizona ..... *M. banjoii* (in part) **sp. n.** (Fig. 20)
- Genital field length = 285-290; dorsum length = 1030-1070. Known from central and northern California ..... *M. waddellica* (Fig. 78)
- 35 (33) Dorsum width = 750-840; dorsum length/width = 1.11-1.14. Body round. Known from California ..... *M. vonnegutii* **sp. n.** (in part) (Fig. 75)
- Dorsum measurements not as above ..... 36

- 36 (35) Gnathosomal bay – genital field/ genital field length measurement = 1.44-1.5; genital field length < 180 ..... 37
- Gnathosomal bay – genital field/ genital field length measurement < 1.3 ..... 38
- 37 (36) Gnathosomal bay length/width measurement = 2.77; body ovoid (dorsal measurements = 890 long, 650 wide), Known from California and Washington ..... *M. purrsiae* **sp. n.** (Fig. 58)
- Gnathosomal bay length/width measurement = 3.33; body ovoid (dorsal measurements = 800 long, 670 wide). Known from Santa Cruz, CA..... *M. gilbroskii* **sp. n.** (Fig. 42)
- 38 (36) Dorsal plate width = 580-690; anterio-medial plate width = 60-90; idiosoma width = 560-690. Known from Oregon through Colorado and south into Northern California and Utah ..... *M. simulans* (Fig. 67)
- Dorsal plate width = 690-720; anterio-medial plate width = 90-110; idiosoma width = 700-770. Known from Arizona and New Mexico..... *M. vanni* **sp. n.** (Fig. 72)
- 39 (30) Capitulum ventral length / rostrum height measurement > 2.0..... 35
- Capitulum ventral length / rostrum height measurement < 2.0..... 51
- 36 (35) Dorsum with distinctive coloration of a purple spot starting at the top edge of the dorsal plate, with an orange spot stacked under the purple one. May or may not have additional purple coloration on dorsum and/or venter..... 37
- Dorsum coloration not as above, though may possess dashes, splotches, etc. of pigment, or be colorless ..... 39
- 37 (36) Dorsum length = 630-650; dorsum width = 490-550. Specimens collected from Huzzah Creek in Crawford County, MO..... *M. zirkleii* **sp. n.** (in part) (Fig. 87)
- Dorsal measurements not as above ..... 38
- 38 (37) Gnathosomal bay length/width measurement = 1.79. Known from Missouri and Northern Alabama..... *M. lynensis* **sp. n.** in part) (Fig. 47)
- Gnathosomal bay length/width measurement = 2.93. Known from the Arkansas Ozarks ..... *M. wolfendensis* **sp. n.** (in part) (Fig. 84)

- 39 (36) Dorsum width = 600-680; antero-medial platelet length = 110-130. Dorsum and venter pigmented with varying intensities of pink. Known only from Texas  
 ..... *M. rosiae* **sp. n.** (Fig. 61)  
 - Measurements not as above, body without pink coloration..... 40
- 40 (39) Sampling locale from the East to the Great Lakes area ..... 41  
 - Sampling locale from the west, including Midwest (excluding the great lakes) and southwest ..... 47
- 41 (40) Anterio-lateral platelet length/ antero-medial platelet length = 1.88; dorsal length/width = 1.19. Dorsum with purple coloration. Known from Ontario.....  
 ..... *M. emilyae* **sp. n.** (Fig. 33)  
 - Measurements not as above ..... 42
- 42 (41) Rostrum visibly elongate; subcapitulum appears longer than wide ..... 43  
 - Rostrum not elongate; subcapitulum appears as wide as long, or nearly so ..... 46
- 43 (42) Gnathosomal bay – genital field/genital length = 1.05-1.25; body with purple coloration on dorsum and venter. Known from Tennessee ..... *M. curva* **sp. n.** (Fig. 33)  
 - Gnathosomal bay – genital field/genital length measurement not as above. Known from Canada and southeastern USA ..... Elongatus group ..... 44
- 44 (43) Anterio-medial platelet length/width measurement = 2.33. Known from Ouichita River in Arkansas ..... *M. montgomeryae* **sp. n.** (Fig. 49)  
 - Measurements not as above ..... 45
- 45 (44) Anterio-medial platelet length/width measurement = 1.22-1.37; dorsum with bright pink or purple streak. Known from Ontario..... *M. pertussiae* **sp. n.** (Fig. 55)  
 - Anterio-medial platelet length/width measurement = 1.43; dorsum colorless or may have color. Known from Alabama and New Brunswick ..... *M. confusica* **sp. n.** (Fig. 28)

- 46 (42) Dorsal length/width = 1.32-1.36; anterio-lateral platelet length/anterio-medial platelet length = 2.1-2.3. Known from Tennessee and North Carolina  
..... *M. sevieri* **sp. n.** (in part) (Fig. 64)
- Anterio-lateral platelet length/width = 2.0-2.3; anterio-lateral platelet length/ anterio-medial platelet length = 1.77-1.82 ..... *M. axfordii* **sp. n.** (Fig. 14)
- 47 (40) Dorsal length= 800-890; dorsal width = 650-670 ..... 48
- Dorsal measurements not as above (length = 430-730) ..... 49
- 48 (47) Gnathosomal bay length/width measurement = 2.77; body ovoid (dorsal measurements = 890 long, 650 wide), Known from California and Washington  
..... *M. purrsiae* **sp. n.** (Fig. 58)
- Gnathosomal bay length/width measurement = 3.33; body ovoid (dorsal measurements = 800 long, 670 wide). Known from Santa Cruz, CA  
..... *M. gilbroskii* **sp. n.** (in part) (Fig. 42)
- 49 (47) Genital field to cauda measurement = 230-300. Known from west coast.....  
..... *M. geographica* (in part) (Fig. 39)
- Genital field to cauda measurement = 200-225..... 50
- 50 (49) Dorsum length/width measurements = 1.16. Colorless. Known from Texas.....  
..... *M. brewsteri* **sp. n.** (Fig. 23)
- Dorsum length/width measurements = 1.24-1.29. Colorless. Known from Texas .....  
..... *M. banderae* **sp. n.** (Fig. 17)
- 51(39) Dorsum with distinctive coloration of a purple spot starting at the top edge of the dorsal plate, with an orange spot stacked under the purple one. May or may not have additional purple coloration on dorsum and/or venter..... 52
- Dorsum coloration not as above, though may possess dashes, splotches, etc. of pigment, or be colorless .....55
- 52 (51) Dorsum length = 630-650; dorsum width = 490-550. Specimens collected from Huzzah Creek in Crawford County, MO.....*M. zirkleii* **sp. n.** (in part) (Fig. 87)
- Dorsal measurements not as above ..... 53

53 (52) Gnathosomal bay – genital field/genital field length < 1.8.....	
.....	<i>M. williamsis</i> <b>sp. n.</b> (Fig. 81)
- Gnathosomal bay – genital field/genital field length > 1.8.....	54
54(53) Gnathosomal bay length/width measurement = 1.79. Known from Missouri and Northern Alabama.....	<i>M. lynensis</i> <b>sp. n.</b> (in part) (Fig. 47)
- Gnathosomal bay length/width measurement = 2.93. Known from the Arkansas Ozarks .....	<i>M. wolfendensis</i> <b>sp. n.</b> (in part) (Fig. 84)
55 (51) Sampling locale from the East to the Great Lakes area .....	56
- Sampling locale from the west, including Midwest (excluding the great lakes) and southwest .....	55
56 (55) Dorsal length/width = 1.32-1.36; antero-lateral platelet length/anterio-medial platelet length = 2.1-2.3. Known from Tennessee and North Carolina .....	<i>M. sevieri</i> <b>sp. n.</b> (in part) (Fig. 64)
- Measurements not as above .....	57
57 (56) Antero-lateral platelet length/width = 2.0-2.3; antero-lateral platelet length/ antero-medial platelet length = 1.77-1.82 .....	<i>M. axfordii</i> <b>sp. n.</b> (Fig. 14)
- Antero-lateral platelet length/width = 1.88; antero-lateral platelet length/ antero-medial platelet length = 1.55 .....	<i>M. emilyae</i> <b>sp. n.</b> (Fig. 36)
58 (55) Dorsal length = 800-1110; capitulum ventral length/capitular base length = 5.4-6.5 From New Mexico and Arizona.....	<i>M. banjoii</i> <b>sp.n.</b> (in part) (Fig. 20)
- Dorsal length = 470-760 .....	59
59 (58) Antero-lateral platelet length/ antero-medial platelet length > 1.30 .....	60
- Antero-lateral platelet length/ antero-medial platelet length < 1.30 .....	61

- 60(59) Dorsum length/width measurements = 1.16. Colorless. Known from Texas.....  
 ..... *M. brewsteri* **sp. n.** (Fig. 23)
- Dorsum length/width measurements = 1.24-1.29. Colorless. Known from Texas .....  
 ..... *M. banderae* **sp. n.** (Fig. 17)
- 61 (59) Rostrum height = 80-130; gnaothosomal bay width = 40-60; gnathosomal bay  
 length/width = 1.83-3.6..... *M. geographica* (in part) (Fig. 40)
- Rostrum height = 135-150; gnaothosomal bay width = 60-75; gnathosomal bay  
 length/width = 2.0-2.58..... *M. oblongata* (Fig. 40)



## IV Conclusions

This dissertation aimed at addressing the following goals: 1) describe all available North American species of *Monatractides* using integrative methods; 2) re-describe previously recognized species, synonymizing when necessary; 3) create an identification key to all North American species.

Contained herein is the description of 21 new species to science, one synonymy, and re-description of the remaining 6 known species. This raises the total number of species in North America to 27. In addition to providing morphological evidence for all species, 24 of these species are supported by molecular evidence (COI). Additionally, a phylogenetic hypothesis (COI+28S) for North American *Monatractides* is presented utilizing 24 species. A dichotomous key to all of these species is provided that relies on body shape, major structures, and select morphometrics; where possible, distribution and coloration are provided for each species to aid in identification, but not relied upon for species identification, and offered as secondary support. This enables identification of specimens that have lost their color (e.g. through slide preparation).

Cotypes or topotypes of previously described species were examined and, in four cases, additional fresh specimens of the same species were obtained through additional sampling, and examples of these species were able to be included in the phylogenetic analysis. In the other cases, morphological examination took place using slide-mounted specimens, and measurements and micrographs were taken and included herein. Two of the currently described species were determined to be described using teneral (immature) specimens; because morphological descriptions rely so heavily on measurements and derived morphometrics, these two species were not re-described or included in the key to North American *Monatractides*.

Four species groups and 3 sub-groups are proposed herein, created using the COI analysis and key morphological features, many of which are recognizable under low magnification. The combined analysis (COI+28S) includes members of all 4 species groups and all 3 sub-groups. The 3 sub-groups comprise of sister species that initially were groups into a single morphotypes, but were later examined more closely and separated based off the topography of the COI analysis.

Future *Monatractides* collections should focus on areas known for endemism, especially the Interior Highlands, which contain species represented herein by single specimens, suggesting the presence of unsampled and rare species. In addition, areas remain uninvestigated in North America, including almost all lentic environments, and those contained in the Great Plains, which may contain low species richness, but it is likely these species were missed by this dissertation. Areas on the East Coast should be the focus of some additional sampling, as some species there are also described using single specimens.

To conclude, the above components addresses and fulfills the aforementioned goals of this dissertation, and the taxonomic status of North American *Monatractides* is such that the genus can be better utilized by other disciplines and the focus of non-taxonomic research. European studies have shown that water mites are excellent indicators of water quality (Smit & van der Hammen 1992, Smith et al., 2010), with the same research showing water mites to have the potential to be better bioindicators than insect taxa typically used for such analyses. In a recent paper questioning why water mites remain ignored and underutilized in bioindicator research, Goldschmidt (2016) suggested it is likely related to the perceived problem of taxonomic difficulty surrounding water mites. In North America, this perceived difficulty has been a reality, with most species undescribed, thus rendering additional ecological data and

research nearly meaningless. *Monatractides* represents a single genus, but with this dissertation, the monographs describing the family Torrenticolidae, one of the most specious and abundant of aquatic invertebrates in many North American lotic environments, is complete. It is likely that torrenticolid mites are sensitive to many factors relating to lotic health, including temperature, riparian vegetation, organic and inorganic pollution, and habitat modification. With the completion of this dissertation, the whole of the Torrenticolidae is open to examination for future bioindicator research.

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