

Synonymy of four *Pardosa* species (Araneae: Lycosidae) undiagnosable without geography

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Abstract. We examined a group of seven morphologically similar species of the genus *Pardosa* to determine the reliability of morphological identification characters independently of additional specimen data, such as habitat and geography. Of the seven, four shared diagnostic character states with other species. These four species have areas of both sympatric and allopatric distribution. Specimens collected from allopatric areas, thus expected to contain only one species, were identified using only the morphology of the specimens, keeping the locality data hidden, and the reliability of the identifications was assessed. Identifications of the allopatric specimens resulted in a 32% success rate, indicating that the sole use of morphological characters did not work well for identification in this group. Reliance on geographical data to direct an identification would likely result in identification errors in areas of sympatry. As a result we conclude *Pardosa tristis* (Thorell 1877), *P. prosaica* Chamberlin and Ivie 1947 and *P. dromaea* (Thorell 1877), are new synonyms of *Pardosa groenlandica* (Thorell 1872).

Keywords: Taxonomy, synonymy, label data

Taxonomic identification remains one of the most challenging aspects of the biological investigation of many species-rich taxa. Although molecular tools are seeing greater use, for many, morphology is the primary tool used to identify animal species, often in conjunction with other data such as habitat, geographical, or behavioral information (Packer et al. 2009). However, morphological differences are minor or difficult to discern for some taxa, requiring greater reliance on these other data types for correct identification. Reliance on such data is a questionable taxonomic practice, in which information not obtainable from the specimen itself is required for identification.

One such group of species can be found in the lycosid genus *Pardosa*. The seven species here defined as the *Pardosa groenlandica* species complex – *P. groenlandica* (Thorell 1872), *P. prosaica* Chamberlin & Ivie 1947, *P. tristis* (Thorell 1877), *P. dromaea* (Thorell 1877), *P. lowriei* Kronestedt 1975, *P. albomaculata* Emerton 1885 and *P. bucklei* Kronestedt 1975 – are all so morphologically similar that they were synonymized under *P. groenlandica* at one point or another in their taxonomic histories (Emerton 1894; Roewer 1955; Kronestedt 1975; Dondale & Redner 1990). Additionally, they all share similar geographical ranges, being found across the northern hemisphere from Iceland west to Russia above 32° latitude; each is sympatric with at least one other member of the species complex in a portion of its range. All seven are listed as valid species by Platnick (2013) based on the morphological taxonomic work of Kronestedt (1975), Dondale & Redner (1990), Dondale (1999) and Vogel (2004). The species group is part of the *modica* group of *Pardosa*, one of the most speciose genera of wolf spiders, and five of the members had been previously revised as a subgroup by Dondale (1999). Because of these attributes, these species make an excellent group to test the reliability of identifications made using only morphological diagnostic characters.

METHODS

Fresh specimens were predominantly collected from May through August 2009 across western North America (Fig. 1). In all, 175 adult spiders — 2 *P. albomaculata*, 5 *P. bucklei*, 8 *P. dromaea*, 67 *P. groenlandica*, 8 *P. lowriei*, 30 *P. prosaica*, and

55 *P. tristis* — were collected, preserved in 100% ethanol and stored at –20°C for future molecular work. Specimens have been deposited in the University of Alaska Museum (UAM) Insect Collection (<http://arctos.database.museum/saved/Pardosa-Slowik>) except for several specimens provided on loan by R.J. Adams (personal collection), Susan Wise-Eagle (personal collection), Gerry Blagoev (University of Ontario, Guelph), and Buzz Morrison [Denver Museum of Nature and Science (DMNS)]. To ensure correct identification of fresh specimens, a voucher set of specimens used in Dondale's sub-group revision (Dondale 1999) was provided by Charles Dondale via the Canadian National Collection (CNC), which consists of 15 *P. groenlandica*, 8 *P. dromaea*, 10 *P. bucklei*, 9 *P. tristis*, and 16 *P. prosaica*. Scanning electron micrographs of these CNC voucher specimens were taken using an ISI-SR50 microscope for aid in identification. Additionally, specimens from the DMNS arachnid collection and the University of Alaska Museum Insect Collection were examined. These included specimens identified by B.R. Vogel, C.D. Dondale, T. Kronestedt, D.J. Buckle, W.J. Gertsch, H.K. Wallace, and the first author. Specifically, attention was paid to the characters used in the original descriptions and in more recent taxonomic works by Kronestedt (1975), Dondale & Redner (1990), Dondale (1999) and Vogel (2004). Additionally, identification discussions were had with T. Kronestedt, C.D. Dondale and B.R. Vogel (J. Slowik pers. comm.).

To evaluate the consistency of the published characters for identification, species descriptions of each of the seven species (Kronestedt 1975; Dondale & Redner 1990; Dondale 1999; Vogel 2004) were examined for diagnostic characters that could be used to identify a species without additional habitat, geographical or behavioral data. To test the utility of shared morphological characters (Table 1), newly collected specimens were chosen that could be positively identified based on geography (from regions lacking sympatry with other species group members) and habitat alone. In all, 58 specimens were chosen randomly for a blind identification analysis in which attempts were made at identification using only the published characters in Dondale (1999) and Vogel (2004), keeping the location and habitat information hidden. The percentage of

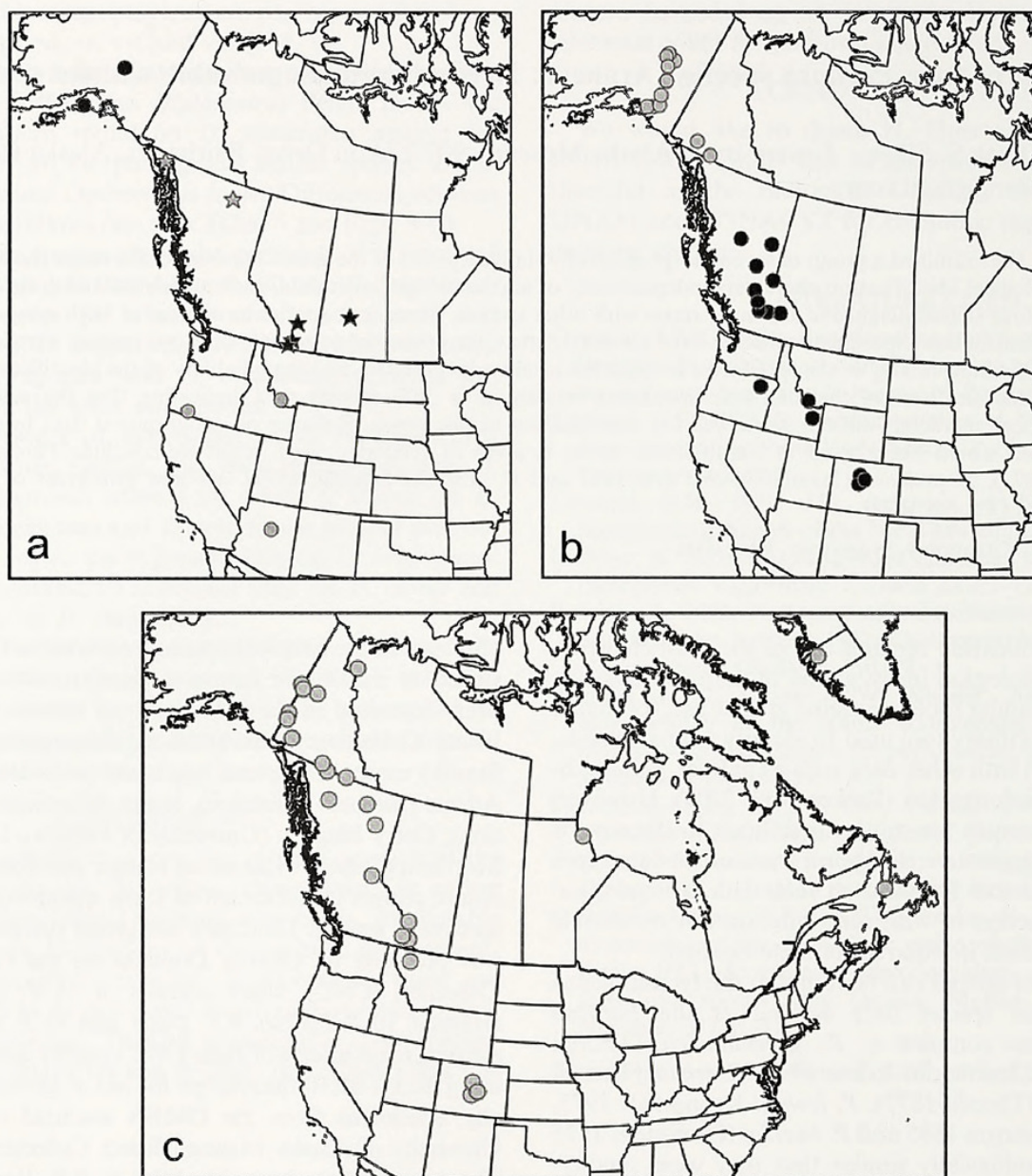


Figure 1.—Collection localities of *Pardosa groenlandica* species complex specimens used in this study. a—dark circles = *P. albomaculata*, light circles = *P. bucklei*, dark stars = *P. dromaea*, light stars = *P. lowriei*; b—dark circles = *P. tristis*, light circles = *P. prosaica*; c—light circles = *P. groenlandica*.

correct identifications was calculated and notes on the identifications were made.

To ensure that the diagnostic characters of these species were properly understood, we added our 58 blind identification specimens to 23 CNC voucher specimens (9 *P. dromaea*, 10 *P. bucklei*, and 4 *P. prosaica*) to replicate the morphometric analysis in Dondale (1999). Measurements on the 81 total specimens included carapace width, carapace length and the pl/q ratio of the epigyna, in which p is the length from the anterior end of the median septum (MS) to the atrial sclerite, and q is the total length of the MS (Dondale 1999). These new data were compared to Dondale's results using a student's t -test for the average of each character. The differences in the means of new data for these characters were compared using an ANOVA, as done in Dondale (1999). If our results matched those of Dondale (1999), this would confirm that we were correctly interpreting and using these diagnostic characters.

RESULTS

Using only the morphological characters provided in Kronestedt (1975), Dondale and Redner 1990, Dondale (1999) and Vogel (2004), three species of the *Pardosa groenlandica* species complex could be reliably identified. Both *P. albomaculata* and *P. lowriei* could be identified by the distinctive shape of their conductors and epigyna, particularly the shape of the atria, atrial sclerites, and medium septa (see Kronestedt 1975, Figs. 2–6). The other species all share the distinctive flat conductor tip identified by Dondale (1999) as a character of the *groenlandica* subgroup. *Pardosa bucklei* could be correctly identified using the distinctive thick embolus and the shape of the atrial sclerites, atrium, and MS relative to the atrium. Additionally, *P. bucklei* has a significantly smaller epigynum ($P < 0.0001$; $df = 4, 42$; $F = 10.37$), ranging from 0.60–0.73 mm in length compared to 0.82–1.08 mm for all

Table 1.—Comparison of published diagnostic character groups used for species identification. A “N” indicates that that character state is shared with the species with whom it shares its geographic range.

	Diagnostic embolus	Diagnostic RPTA	Diagnostic MS	Diagnostic atrium	Diagnostic atrial sclerites	Diagnostic size	Species habitat overlaps
<i>P. albomaculata</i>	Y	Y	N	Y	Y	N	<i>P. groenlandica</i>
<i>P. lowriei</i>	Y	Y	N	Y	Y	Y	<i>P. groenlandica</i> , <i>P. prosaica</i>
<i>P. bucklei</i>	Y	N	N	Y	Y	Y	<i>P. tristis</i> , <i>P. dromaea</i>
<i>P. groenlandica</i>	N	N	N	N	N	N	All but <i>P. bucklei</i>
<i>P. tristis</i>	N	N	N	N	N	N	<i>P. groenlandica</i> , <i>P. dromaea</i>
<i>P. prosaica</i>	N	N	N	N	N	N	<i>P. groenlandica</i> , <i>P. lowriei</i>
<i>P. dromaea</i>	N	N	N	N	N	Y	<i>P. groenlandica</i> , <i>P. tristis</i>

other species. This species showed little genitalic variation in specimens examined across its range. Additionally, *P. bucklei* is a smaller species and is generally found in a grassy or debris-filled habitat adjacent to water (Dondale 1999; J. Slowik pers. obs., B. Vogel pers. comm.), whereas other *groenlandica* species complex members prefer large scree or cobble areas (Dondale 1999; Vogel 2004, C. D. Dondale pers. comm.; B. R. Vogel pers. comm.; J. Slowik pers. obs.).

The other four members of the species complex (*P. groenlandica*, *P. tristis*, *P. prosaica* and *P. dromaea*) were found to lack distinctive morphological characters for reliable identification (Table 1). Results of the blind identifications involving these four species resulted in 43% (25 of 58 specimens) being incorrectly identified using the published morphological characters alone (Dondale 1999; Vogel 2004). Because multiple characters are used for identification, 24% (14 of 58 specimens) were found to possess characters from two or three possible species. These specimens could not be identified confidently to a single species. However, of the

potential species that these specimens could be, one of them had to be the correct species. Thus, if a determination had to be made, there was a 33–50% possibility that it would have been correct. The remaining 32% (19 of 58 specimens) were correctly identified based on the published characters for identification without the use of geographic or habitat information.

In particular, the shape of the retrolateral process of the terminal apophysis (RPTA, Fig. 2), which was mentioned as a useful character for species identification of the subgroup by Dondale (1999), was difficult to use and produced inconsistent results. Dissection of the palp is required to observe the RPTA, and damage to the RPTA may occur. Additionally, a lot of variation was seen in the RPTA shape within males from a single population (Mt. Evans, Colorado). A RPTA shape (Fig. 2, *P. tristis*) not mentioned in Dondale was found in several specimens of *P. tristis* from Kamloops and Prince George, British Columbia, and one specimen from Mt. Evans, Colorado. The RPTA shape does not appear to conform to

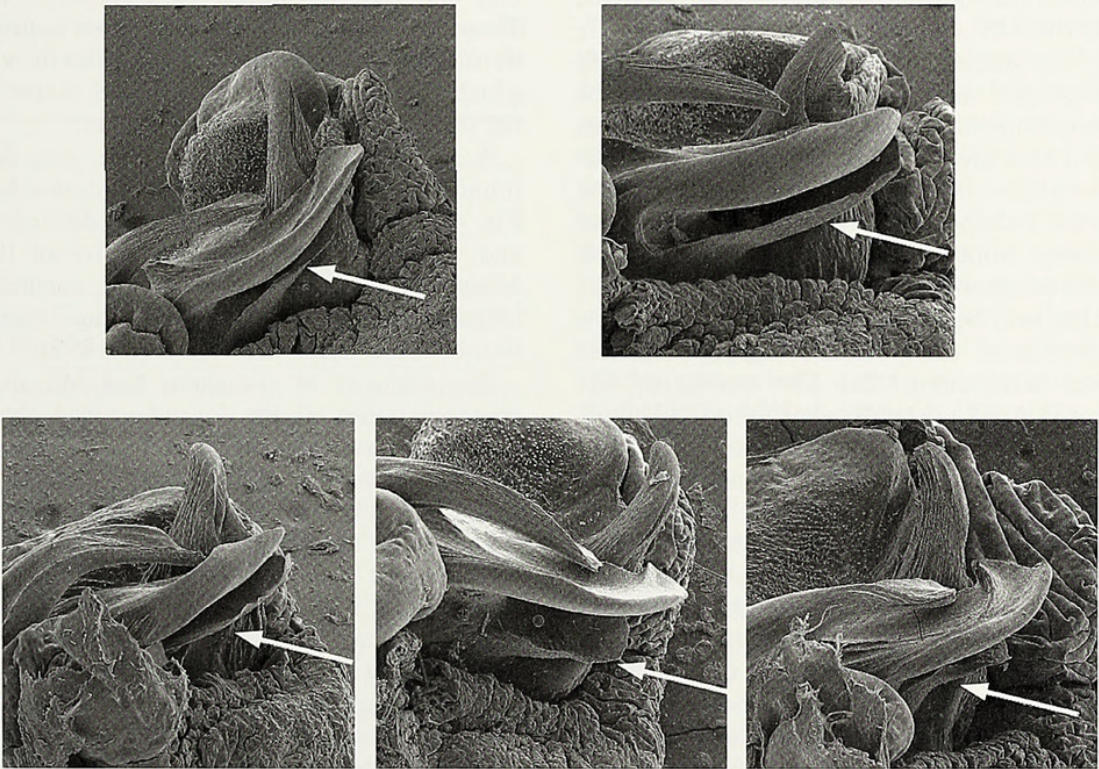


Figure 2.—Scanning electron micrographs of *Pardosa* palpal apical division. Clockwise from upper left; *P. groenlandica*, *P. tristis*, *P. dromaea*, *P. prosaica* and *P. bucklei*. Images 130 × except for *P. bucklei* 190 ×. Arrows point to retrolateral process of the terminal apophysis (RPTA).

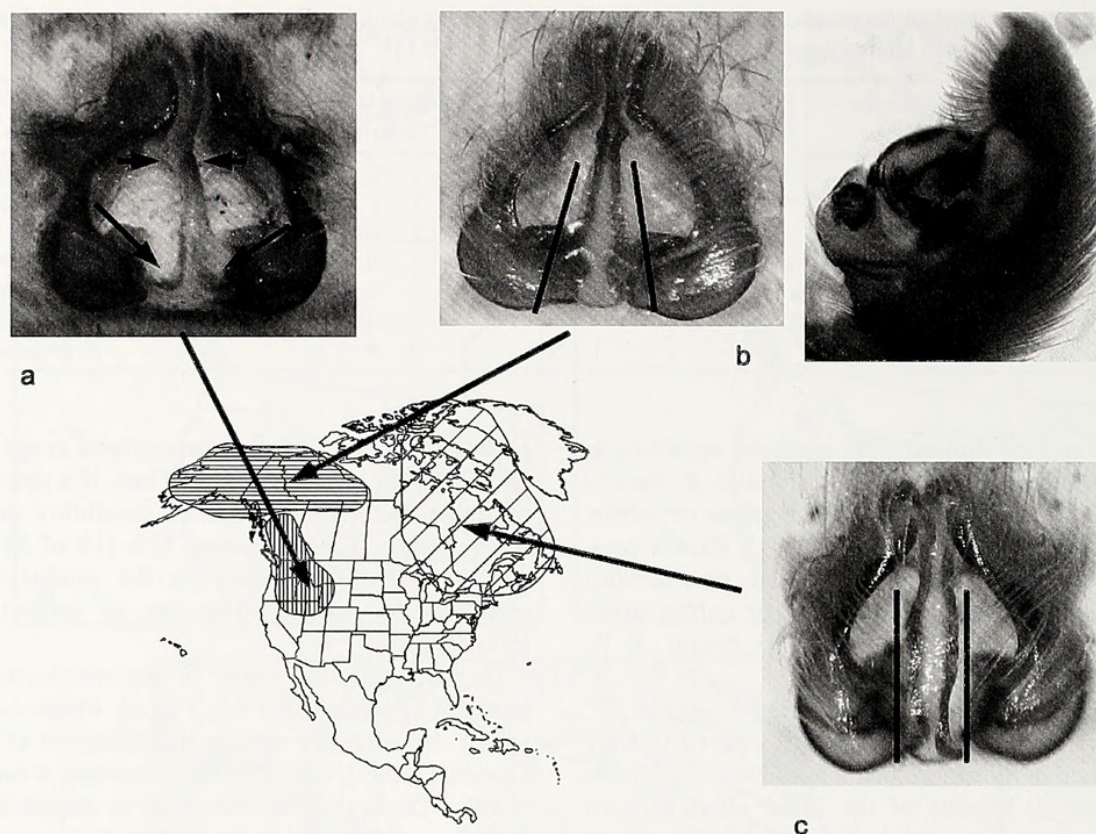


Figure 3.—Morphology and geographic distribution of three *Pardosa groenlandica* species. a—*Pardosa tristis*, inverted T shaped median septum (MS), arrows point to narrow anterior and posterior regions. b—*P. prosaica*, left image - urn shaped MS, lines emphasize widening of MS posteriorly; right image - palp, retrolateral view, arrow points to constriction on interior edge of the embolus. c—*P. groenlandica*, lines emphasize parallel shape of MS lateral edges.

clearly distinct shape categories, but rather appears variable within populations and species.

In the species descriptions for the four species (Dondale 1999; Vogel 2004) the MS shape and sizes of the atria are presented as useful for species identification. Dondale (1999) described three geographic variants based on the shape of the MS, which represented the 32% of our correct identifications in the blind trial. These are an inverted T shape, a bottle shape, and an urn shape with a constricted anterior neck (Fig. 3). The inverted T-shape MS variants are found west of the Rocky Mountains from New Mexico north to British Columbia in the Great Basin and described as *P. tristis* by Dondale (1999). They may be characterized by a long, narrow MS abruptly widening in the posterior region, with the posterior edge often being almost flat. The urn-shaped MS variants were found in Alaska extending east into the Yukon, and were described as *P. prosaica* by Dondale (1999). This variant may be characterized by a narrow anterior region widening into a curved arc along the lateral edge, with a curved posterior edge. The size of the posterior MS expansion was variable. Male specimens from Alaska and Yukon also had a constriction on the interior edge of the embolus (Fig. 3). However, females collected in eastern Yukon and northern British Columbia with urn-shaped median septa were collected with males that did not have the constricted embolus. It would appear that the distribution of urn-shaped median septa extends beyond that of the constricted embolus. The bottle-shaped MS variant was found in specimens from Newfoundland and Greenland and was described as *P. groenlandica* by

Dondale (1999). This form is characterized by a relatively wide anterior region, widening somewhat then extending posteriorly and creating almost parallel lateral edges of the MS. These geographic variants were often collected from populations in regions that were supposed to have only one species, which also had individuals with MS shapes not fitting one of the three previously described shapes.

A fourth shape, the "A" shape, was described as being found in both *P. tristis* and *P. prosaica* by Dondale (1999: Fig. 4). This shape did not have a distinct distribution trend and was one source of error in five of the identifications. Misinterpretation of the urn shape resulted in the incorrect identification of eleven specimens, due largely to the constriction of the anterior MS region (Table 2).

The majority of specimens had MS shapes that were a conglomeration of the four described shapes and did not present geographic patterns tied to MS morphology. Figure 4 shows an example, with a narrow anterior region widening similarly to a bottle-shaped MS, a gradual curving lateral edge similar to an urn-shaped MS and a flat posterior edge similar to an "A" or inverted T-shaped MS. This specimen could not be identified without recourse to its collection locality data. Other specimens had a narrow MS that failed to expand posteriorly at all (Somers Beach, Montana, $n = 2$). Specimens expressing median septa outside of the published descriptions were often collected syntopically, in regions that were supposed to have one species, with specimens that did present one of the four described shapes, demonstrating considerable within-population variation in this character.

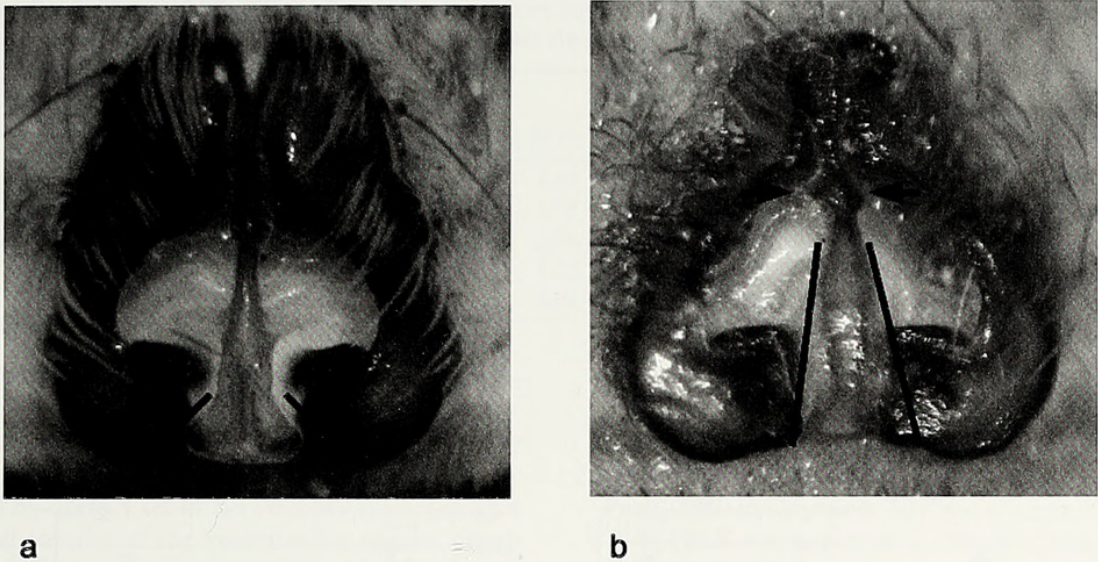


Figure 4.—Additional median septum (MS) shapes of *Pardosa groenlandica* species complex specimens. a—“A” shaped MS, lines emphasize abrupt posterior widening of MS. b—example of MS showing a conglomeration of characters, arrows point to wider anterior region similar to a bottle shaped MS, lines emphasize posterior swelling of MS similar to an urn shaped MS.

Comparison of the morphometric data with those of Dondale (1999) was only significantly different for one character, male *P. bucklei* carapace length (Fig. 5, $P = 0.0039$, $df=8$, $t = 4.01$). Our results showed *P. bucklei* to be significantly different from all other species included in the *groenlandica* subgroup for all measured characters (Table 3, $P < 0.05$). *Pardosa dromaea* was found to be significantly smaller for all characters except for female carapace length ($P < 0.05$). These data are in general agreement with Dondale’s results and led to the same general conclusions; that *P. bucklei*

and *P. dromaea* are smaller species and that *P. groenlandica*, *P. tristis*, and *P. prosaica* cannot be differentiated from each other using this morphometric approach.

DISCUSSION

This review of the *Pardosa groenlandica* species complex replicated and re-evaluated previous studies and results presented in previous taxonomic literature (Kronestedt 1975; Dondale & Redner 1990; Dondale 1999). Published species descriptions enabled reliable identifications of four species, *P. albomaculata*, *P. lowriei*, *P. bucklei* and *P. groenlandica*, with the latter as the senior synonym of *P. tristis*, *P. prosaica*, and *P. dromaea*. We conclude that the morphological variation present in the four species, *P. groenlandica*, *P. dromaea*, *P. tristis*, and *P. prosaica*, *sensu* Dondale (1999) is insufficient to warrant species designation as we were unable to reliably separate the four species. We found no clear morphological species boundaries in these species; rather, there are morphological geographic trends and large amounts of genitalic variation in presumably conspecific members collected syntopically (i.e., in the same place and time). The amount of variation recorded is consistent with other *Pardosa* studies in which high amounts of variation have been found in *Pardosa* species groups both among species and within populations (Holm 1939, 1967; Kronestedt 1975, 1986, 1988, 1993; Vogel 2004). We could not find any previously unused characters that might help to diagnose these four named species. These results do not rule out the presence of multiple species living in sympatry as mentioned by Dondale (1999), but they highlight the fact that if this is the case, we could find no consistent morphological way to separate them.

Dondale (1999) provided descriptions that could identify some individuals of a population. For example, some *P. prosaica* can be diagnosed by the urn-shaped MS and by the constriction on the embolus, some *P. tristis* by the inverted T-shaped MS, and some *P. groenlandica* by the bottle-shaped MS. Specimens identified as *P. dromaea* were significantly smaller and showed a significantly smaller epigynal *p/q* ratio;

Table 2.—Examples of females of the *Pardosa groenlandica* species complex incorrectly identified using median septa shape in the morphological review.

Species		Correct/incorrect	
<i>P. groenlandica</i>		3/8	
<i>P. dromaea</i>		4/7	
<i>P. tristis</i>		8/10	
<i>P. prosaica</i>		6/12	
Examples of error	Identified as	Correct species	Median septa shape
UAM100040085	<i>P. groenlandica</i>	<i>P. tristis</i>	parallel urn shape
UAM100050737	<i>P. groenlandica</i>	<i>P. prosaica</i>	narrow urn shape
UAM100040090	<i>P. groenlandica</i>	<i>P. prosaica</i>	narrow urn shape
UAM100040091	<i>P. groenlandica</i>	<i>P. prosaica</i>	narrow urn shape
UAM100039493	<i>P. groenlandica</i>	<i>P. prosaica</i>	narrow urn shape
UAM100045725	<i>P. dromaea</i>	<i>P. groenlandica</i>	wide urn shape
UAM100039724	<i>P. dromaea</i>	<i>P. tristis</i>	swelled “A” shape
UAM100039724	<i>P. dromaea</i>	<i>P. tristis</i>	swelled “A” shape
Chu 5	<i>P. tristis</i>	<i>P. groenlandica</i>	long “A” shape
UAM100040064	<i>P. tristis</i>	<i>P. groenlandica</i>	long “A” shape
UAM100045604	<i>P. prosaica</i>	<i>P. groenlandica</i>	wide urn shape
Chu 4	<i>P. prosaica</i>	<i>P. groenlandica</i>	wide urn shape
UAM100045726	<i>P. prosaica</i>	<i>P. groenlandica</i>	wide urn shape
UAM100045706	<i>P. prosaica</i>	<i>P. groenlandica</i>	wide urn shape
Chu 10	<i>P. prosaica</i>	<i>P. groenlandica</i>	wide urn shape
UAM100045758	<i>P. prosaica</i>	<i>P. tristis</i>	“A” shape

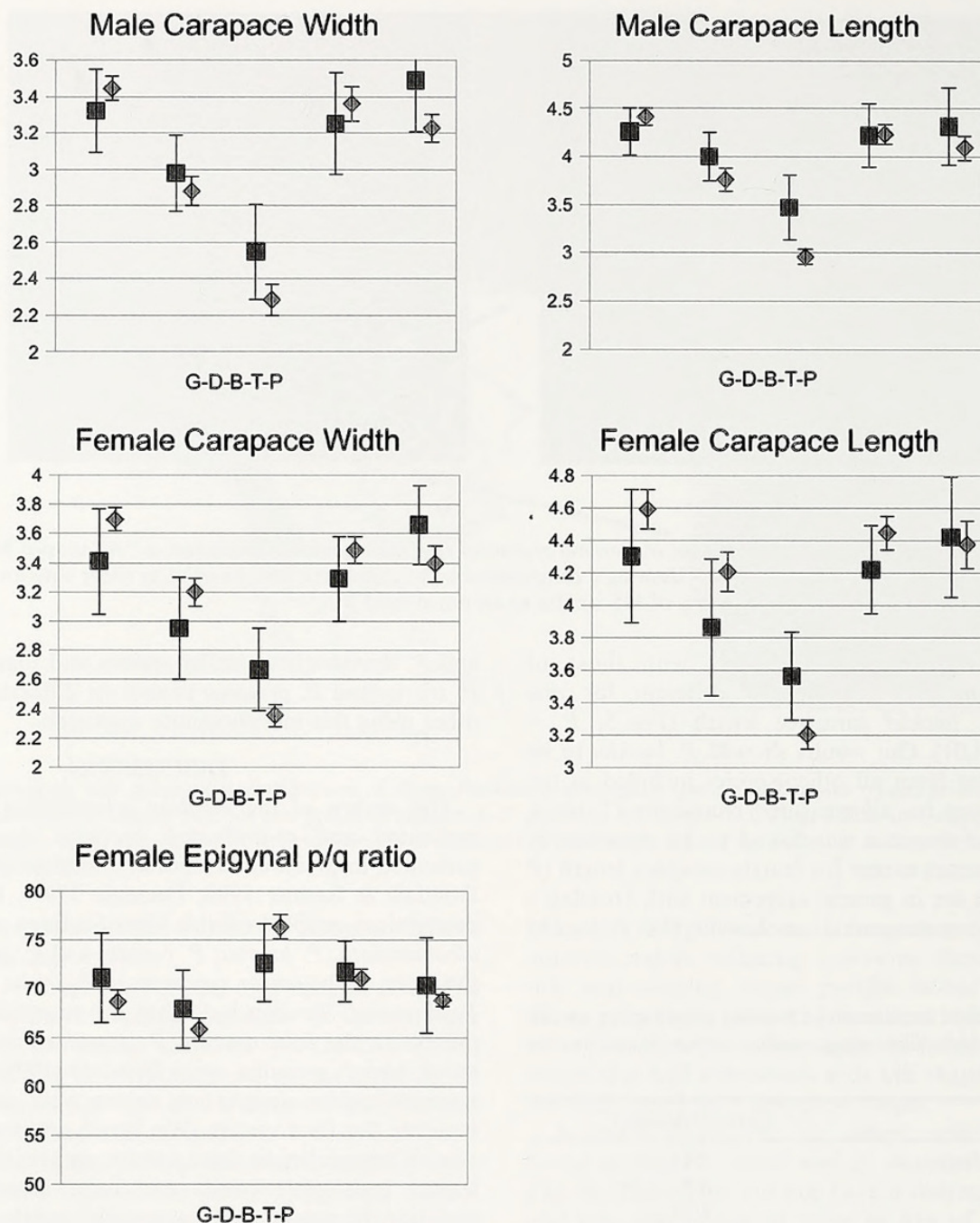


Figure 5.—Graphical comparison of morphometric characters used in Dondale (1999) with those collected in this study. Squares are Dondale's data; diamonds, results from this study. Error bars are one standard error. Y-axis is measured in mm, X-axis refers to order of species and corresponding column. G—*Pardosa groenlandica*; D—*P. dromaea*; B—*P. bucklei*; T—*P. tristis*; P—*P. prosaica*.

however, there are no male attributes for identification of these last three species. Additionally, the morphological differences that identify *P. dromaea* may be an artifact of the habitat, as the growth and development of juvenile *Pardosa* are affected by nutrition (Miyashita 1967; West-Eberhard 2005). The larger issue is that none of these identifiable forms exist in isolation from other variants showing a conglomeration of character states. It is as if the forms that had been described as species are just part of the variation. Thus identification of the variants requires the use of the proximity to specimens that are identified as one of the four identifiable forms. Use of this method for identification cannot be recommended because if species are sympatric there is no way of discerning species. Dondale (1999) and Vogel (2004) both present geographic regions for these

species in which no sympatry is thought to occur (i.e., there should be only one species of the group present). This is a tricky assumption, which assumes sampling adequate to determine true species distributions, not just sampling occurrences. There is no doubt that both Dondale and Vogel felt that this assumption had been met, or else they likely would not have made such a statement; however, as our blind identification results show, either these regions contain multiple species or these species contain variation outside that described for them.

This difficulty in defining species boundaries is not unexpected, as lycosid spiders, and particularly *Pardosa*, show a great deal of conservation in some genital structures across genera, while also showing large amounts of genital variation in other structures among populations and species (Wallace

Table 3.—Measurements (in mm) of the *Pardosa groenlandica* species complex. Means significantly different from other species are identified by the first letter of the species name. Asterisk signifies measurements significantly different from Dondale (1999).

Species	Carapace width						Carapace length						Epigynum		
	Male	SE	sig.	Female	SE	sig.	Male	SE	sig.	Female	SE	sig.	Epigynal ratio	SE	sig.
<i>P. groenlandica</i>	3.44	0.066326549		3.69	0.08		4.42	0.08		4.59	0.12		68.64	1.27	
<i>P. dromaea</i>	2.88	0.08	gtpb	3.20	0.10	gtpb	3.76	0.12	gtpb	4.21	0.12		65.82	1.19	gdtg
<i>P. bucklei</i>	2.29	0.087037407	gdtg	2.35	0.08	gdtg	2.96	0.07	gdtg*	3.20	0.09	gdtg	76.29	1.25	gdtg
<i>P. tristis</i>	3.36	0.094657277		3.49	0.09		4.23	0.11		4.45	0.10		71.00	1.03	
<i>P. prosaica</i>	3.23	0.073514927		3.39	0.12		4.09	0.12		4.37	0.15		68.80	0.61	

1942; Dondale & Redner 1990). Additionally, spiders are thought to be prime candidates for evolutionarily fast reproductive morphological changes (Eberhard & Huber 2010). However, by replicating Dondale's (1999) previously used methods and by using a set of his voucher specimens, we confirmed that our sample of the *groenlandica* species group fell within the species demarcations of prior authors.

The morphological trends found in these data raise questions that morphology alone has been unable to answer. For example, the inverted T-shaped MS is only found in populations west of the Rocky Mountains. Other MS shapes are also found within these same populations. Therefore, it could be hypothesized that these are two or more species in sympatry, or that the inverted T-shaped MS is a historic geographic race that is experiencing some introgression from a more variable shaped MS race representing MS shapes other than the inverted T-shape. If the latter hypothesis is assumed, it questions gene flow due to these spiders' ability to disperse long distances when young via ballooning (Greenstone et al. 1987; Crawford et al. 1995), as no specimens with inverted T-shaped median septa were found north or east of the Rockies. These questions may yield to future analyses of molecular data.

CONCLUSION

Our evaluation of morphological identification characters for members of the *Pardosa groenlandica* species complex found them to be reliable for three species, *P. albomaculata*, *P. lowriei*, *P. bucklei*. We found no reliable morphological characters to separate the four species, *P. groenlandica*, *P. tristis*, *P. prosaica*, and *P. dromaea*, sensu Dondale (1999). Because these four species are sympatric with one or more of each other, and the published identification characters resulted in a 32% success rate we conclude that *P. tristis*, *P. prosaica*, and *P. dromaea* are junior synonyms of *P. groenlandica*. Using a blind identification analysis allowed us to remove the reliance of data types not directly associated with the specimen in hand. This type of test may be useful for taxonomists working with morphologically similar species to test identification characters independent of bias from other data sources.

TAXONOMY

Family Lycosidae Sundevall 1883

Pardosa C.L. Koch 1847

Pardosa groenlandica Thorell 1872

Lycosa groenlandica Thorell 1872:157; Jackson 1933:147, Pl. 1, Fig. 4; Holm 1939:77, Fig. 3. Lectotype male and paralectotype female from Disko Island, West Greenland

(69°15'N, 3°32'W (Th. Fries). (Thorell Collection No. 244/1524a), 3 July 1871. Both deposited in the Swedish Museum of Natural History. Examined.

Lycosa iracunda Thorell 1877:514. Neotype male from Pikes Peak, 3660 m elevation, El Paso County, Colorado, 24 June 1940 (W.J. Gertsch and L. Hook), deposited in AMNH. Examined. Synonymized with *P. groenlandica* in Dondale 1999.

Lycosa indagatrix Thorell 1877:512. Holotype female from Denver (39°44'N, 104°59'W), Denver County, Colorado, 10 July 1875 (A.S. Packard, Jr.). Specimen lost or destroyed (Dondale 1999). Neotype male from South Platte River at 88th Street, Denver, Denver County, Colorado, 20 June 1985 (C.D. Dondale & J.H. Redner), deposited in CNC but unable to locate to examine. Synonymized with and designated type for *P. dromaea* in Dondale 1999.

Lycosa tristis Thorell 1877:510. Syntype female from "Idaho" (Idaho Springs, 39°44'N, 105°00'W), Clear Creek County, Colorado, 5 July 1875 (A.S. Packard, Jr.), and syntype female from Williams Canyon, "Manitou" (Manitou Springs, 38°51'N, 104°55'W), El Paso County, Colorado, 17 July 1875 (A.S. Packard, Jr.). Both lost or destroyed (Dondale 1999). Neotype female from Mt. Evans, 14,000 feet (4300 m) elevation (39°35'N, 105°38'W), Clear Creek County, Colorado, 25 July 1961 (B.H. Poole), deposited in CNC. Examined.

Lycosa dromaea Thorell 1878:395. New name for *L. indagatrix*, which was preoccupied.

Pardosa groenlandica Emerton 1894:423, Pl. 4, Fig. 1; Emerton 1902:79, Figs. 189, 190; Chamberlin 1908:200, Pl. 14, Fig. 6; Gertsch 1933:18; Comstock 1940:664, Fig. 731c; Braendegaard 1946:19, Figs. 6, 7; Levi 1951:225, Figs. 13, 14; Levi & Field 1954:456, Figs. 66, 68; Kronstedt 1975a:218, Figs. 3c, 4C-c; Dondale & Redner 1990:212, Figs. 300–304; Dondale 1999:439, Figs. 1, 14; Paquin & Dupérré 2003:163, Figs. 1807–1810; Vogel 2004:89, Figs. 71, 92.

Pardosa tristis Chamberlin & Ivie 1941:10; Roewer 1955:195; Dondale 1999:445, Figs. 2, 7, 8; Vogel 2004:91, f. 65, 91. New synonymy.

Pardosa nebraska Chamberlin & Ivie 1942:30, Pl. 7, Figs. 69, 70. Holotype male from 6 km west of Lexington (40°85'09"N, 99°85'59"W), Dawson County, Nebraska, 6 June 1933 (W. Ivie), deposited in AMNH. Examined. Synonymized with *P. dromaea* in Dondale and Redner 1990.

Pardosa prosaica Chamberlin & Ivie, 1947:21, Pl. 10, Figs. 89; Dondale 1999:446, Figs. 5, 10–13, 15. Holotype female from Quartz Creek, 15–16 miles (~ 24 km) N of Haycock

(65°13'N, 161°10'W), Seward Peninsula, Alaska, 11 August 1946 (R.D. Hamilton), deposited in AMNH. Not examined. New synonymy.

Pardosa dromaea Dondale & Redner 1990:209, Figs. 305–307; Dondale 1999:443, Figs. 4, 6; Vogel 2004:88, Figs. 72, 93. New synonymy.

Diagnosis.—*Pardosa groenlandica* is a member of the *modica* group (Kronstedt 1981); the species can be separated from all other members of the group by the males having a basally tapered embolus and a broad, flat, strongly curved conductor. Females have narrow, transverse atrial sclerites located along the posterior edge of the atrium, a median septum, which lacks elongated lateral protrusions from the anterior half of its length, and the median septum extends to the posterior edge.

ACKNOWLEDGMENTS

We would like to thank the University of Alaska Museum, Fairbanks, and the Denver Museum of Nature and Science for specimens. Thanks to Paula Cushing and Kevin Winker for assistance with this project. Thanks to Charles Dondale for both assistance and specimens and Bea Vogel for discussion on this group of spiders. We also thank Chris Grinter at the DMNS, Gunvi Lindberg at the Swedish Museum of Natural History, Louis Sorkin at the AMNH and Owen Lonsdale at the CNC for assistance with type specimens. Additional funds for collection travel came from a Society of Systematic Biologists Graduate Student Award to J. Slowik.

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Manuscript received 27 March 2013, revised 22 August 2013.



Slowik, Jozef and Sikes, Derek S. 2013. "Synonymy of four *Pardosa* species (Araneae: Lycosidae) undiagnosable without geography." *The Journal of arachnology* 41(3), 327–334. <https://doi.org/10.1636/k13-23.1>.

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