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SHORT COMMUNICATION

Comparing ramp and pitfall traps for capturing wandering spiders

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Abstract. Pitfall traps are a common and inexpensive sampling method for epigeal spiders. They are most effective when the top edge of the trap is flush with the soil surface, which is not always possible if soil disturbance is prohibited, the soil layers are thin or the substrate is only exposed rock. Ramp traps are also inexpensive to construct and do not require soil disturbance, making them an appealing alternative to pitfall traps. We tested the efficacy of ramp traps for capturing wandering spiders at the Fort Pierre National Grassland in central South Dakota, USA. We set parallel transects of pitfall and ramp traps during three sampling periods from late May to early August 2010. Ramp traps captured twice as many individuals and, on average, 1.1 ± 0.34 SE more species than pitfall traps. Overall, ramp traps outperformed pitfall traps, and ramp traps are better for non-permanent sampling at point-specific locations.

Keywords: Linyphiidae, Lycosidae, sampling method, temporary trap

Although pitfall traps do not capture all spiders in the community, they are an effective sampling technique for determining the relative abundance and species richness of epigeal spiders (Greenslade 1964; Uetz & Unzicker 1977; Phillips & Cobb 2005). However, to trap effectively, the upper edge of the pitfall should be level with the soil surface, requiring excavation of a small hole into which the pitfall container is inserted. In areas of bare rock (e.g., scree slopes, caves), thin soil horizons over rock, or where soil disturbance is prohibited or requires substantial permitting (e.g., US National Parks), an alternative method of sampling the same epigeal community is desirable.

Bostanian et al. (1983) first described a ramp pitfall trap for capturing large beetles (>10 mm), but their trap structure was heavily biased toward their target taxa. Because the Bostanian et al. (1983) method was expensive and cumbersome to carry into the field, Bouchard et al. (2000) developed a more generalized ramp pitfall trap (hereafter, ramp trap) with greatly reduced cost, weight and size. Pearce et al. (2005) tested these traps and found them effective in reducing vertebrate by-catch. Here we report the results of a short-term study to test the efficacy of ramp traps against pitfall traps for capturing wandering spiders.

The field site was the War Creek Northeast allotment (field) in Stanley County of the Fort Pierre National Grassland (FPNG) in South Dakota, USA. The dominant vegetation is western wheatgrass [*Pascopyrum smithii* (Rydb.) Á. Löve], green needlegrass [*Nassella viridula* (Trin.) Barkworth], buffalo grass [*Buchloe dactyloides* (Nutt.) J.T. Columbus], silverleaf scurfpea [*Pediomelum argophyllum* (Pursh) J. Grimes] and prairie coneflower [*Ratibida columnifera* (Nutt.) Woot. & Standl.]. This field was not grazed at the time of sampling, but it is rotationally grazed (i.e., grazed at different times of the year) by cattle (maybe bison more than five years before this study) and occasionally left to rest without grazing, generally for a period of one to three years. The field is occasionally burned, though not during the decade prior to this study.

In late April 2010, we established five 6-m transects of pitfall traps in the FPNG field. The first transect was chosen near the middle of the field, then the four additional transects were positioned at the main compass points (north, south, east, and west) at least 300 m from the central transect. Each transect consisted of three pitfall traps at 3-m intervals. Each trap consisted of a 10 cm diameter, 20 cm tall PVC sleeve into which a 710 mL plastic cup was inserted and filled to approximately 4 cm depth with 100% propylene glycol. The PVC sleeve was capped on the bottom, and, when not in use, the sleeve was also capped on the top to prevent accidental trapping. To deter trap raiders (e.g., microtine rodents), to prevent captured invertebrates from climbing out of the trap, and to prevent precipitation from directly flooding the trap, an 8-cm powder funnel with its base enlarged to approximately 3 cm was inserted into the cup and a 15 cm × 15 cm board was placed over each trap, leaving approximately 3 cm clearance.

When sampling started, an identical transect of three ramp traps was set 8 m from and parallel to each transect of pitfall traps. Ramp trap design followed Bouchard et al. (2000), with modifications described hereinafter (see Fig. 1). We used 946 mL plastic 12 cm × 12 cm × 8 cm (L × W × H) containers with ramp entrances on

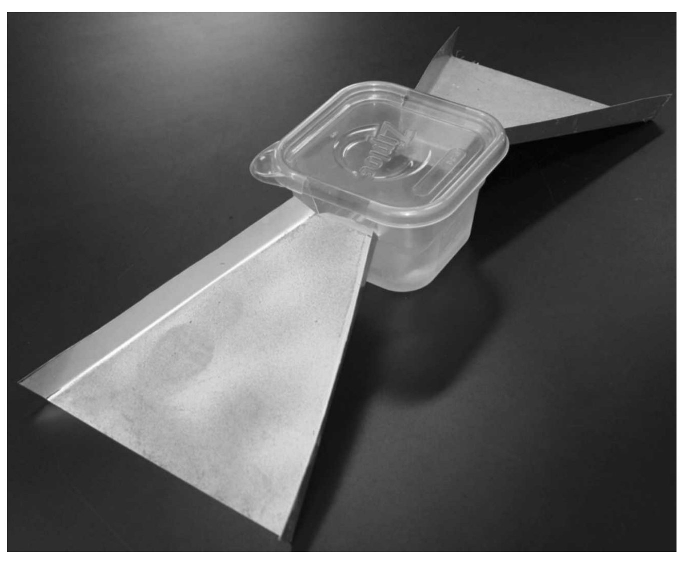

Figure 1.—A typical ramp trap used in this experiment.

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Table 1.—Total numbers of each family (in bold) and species captured in each trap type from Fort Pierre National Grassland, South Dakota, USA. Numbers represent only mature spiders.

Taxon	Pitfalls	Ramps
Agelenidae	**0**	**2**
Agelenopsis emertoni Chamberlin & Ivie 1935	0	2
Clubionidae	**1**	**4**
Clubiona mutata Gertsch 1941	1	4
Corinnidae	**13**	**15**
Castianeira descripta (Hentz 1847)	0	13
Phrurotimpus certus Gertsch 1941	10	2
Scotinella pugnata (Emerton 1890)	3	0
Dictynidae	**2**	**3**
Cicurina arcuata Keyserling 1887	2	0
Dictyna terrestris Emerton 1911	0	3
Gnaphosidae	**54**	**49**
Cesonia bilineata (Hentz 1847)	0	5
Drassodes auriculoides Barrows 1919	1	7
Drassyllus depressus (Emerton 1890)	2	0
Drassyllus nannellus Chamberlin & Gertsch 1940	4	1
Gnaphosa fontinalis Keyserling 1887	14	14
Gnaphosa parvula Banks 1896	1	1
Haplodrassus chamberlini Platnick & Shadab 1975	0	1
Sergiolus decoratus Kaston 1945	0	1
Zelotes hentzi Barrows 1945	31	18
Zelotes laccus (Barrows 1919)	1	1
Linyphiidae	**45**	**44**
Ceraticelus laticeps (Emerton 1894)	6	1
Ceratinops littoralis (Emerton 1913)	0	1
Coloncus siou Chamberlin 1949	0	1
Eridantes erigonoides (Emerton 1882)	10	3
Grammonota vitata Barrows 1919	0	1
Islandiana flaveola (Banks 1892)	12	16
Linyphiidae sp. 1	2	0
Linyphiidae sp. 2	5	0
Linyphiidae sp. 3	1	0
Linyphiidae sp. 4	6	0
Meioneta unimaculata (Banks 1892)	1	1
Mermessus index (Emerton 1914)	0	1
Mermessus sp. 1	2	16
Mermessus trilobatus (Emerton 1882)	0	2
Walkenaeria spiralis (Emerton 1882)	0	1
Lycosidae	**144**	**599**
Hogna frondicola (Emerton 1885)	2	6
Hogna helluo (Walckenaer 1837)	13	5
Pardosa distincta (Blackwall 1846)	42	185
Pardosa modica (Blackwall 1846)	0	2
Piratula minuta (Emerton 1885)	1	0
Schizocosa crassipalpata Roewer 1951	52	317
Schizocosa mccooki (Montgomery 1904)	34	84
Philodromidae	**6**	**90**
Ebo latithorax Keyserling 1884	1	0
Thanatus coloradensis Keyserling 1880	5	84
Thanatus striatus C. L. Koch 1845	0	4
Tibellus chamberlini Gertsch 1933	0	1
Tibellus duttoni (Hentz 1847)	0	1
Salticidae	**11**	**8**
Habronattus viridipes (Hentz 1846)	3	0
Neon nelli Peckham & Peckham 1888	1	0
Phidippus clarus Keyserling 1885	1	1
Phidippus pius Scheffer 1905	1	2
Salticidae sp. 1	0	1
Talavera minuta (Banks 1895)	5	4
Theridiidae	**41**	**41**
Asagena americana Emerton 1882	0	1
Crustulina stricta (O. Pickard-Cambridge 1861)	2	1
Euryopsis saukea Levi 1951	0	2
Theridion petraeum L. Koch 1872	1	1
Theridion pierre Levi & Patrick 2013	38	36
Thomisidae	**148**	**85**
Ozyptila conspurcata Thorell 1887	56	13
Xysticus acquiescens Emerton 1919	2	8
Xysticus bicuspis Keyserling 1887	79	52
Xysticus gulosus Keyserling 1880	4	0
Xysticus luctans (C. L. Koch 1845)	7	12

opposite sides (4 cm cut down from top, 5 cm across). The ramps were cut from sheets of aluminum flashing and the walking surface sprayed with textured spray paint that could be gripped by the spiders. Each ramp trap was filled to approximately 3 cm with 100% propylene glycol. A 38-cm nylon strap with a 20 cm galvanized nail through each end was used to secure the ramp trap in place (nails driven into the substrate), to prevent wind from blowing the trap over and to reduce disturbance by large vertebrates (e.g., browsing deer).

Using the ramp and pitfall traps concurrently, we conducted three sampling periods during 2010: 26 May to 9 June, 23 June to 7 July and 21 July to 5 August. The contents of the pitfall and ramp traps were transferred to Whirl-Pak bags with 100% propylene glycol as the preservative. Mature spiders were later sorted and identified to species (when possible), following Platnick (2013). The numbers of species caught in each trap type during each sampling period were compared using a one-way ANOVA (Minitab Statistical Software version 15.1: Minitab 2007), with number of species caught in each trap as the response variable, and trap type (i.e., pitfall or ramp trap) as the factor.

We captured 1405 mature spiders from 11 families and 60 species (Table 1). Pitfall traps captured 465 mature specimens from 10 families and 41 species, while ramp traps captured 940 specimens from 11 families and 48 species (Table 1). Twelve species were captured only in pitfall traps, and 19 species were captured only in ramp traps. During the first sampling period, pitfall traps captured an average of 5.87 ± 0.38 SE species, while ramp traps captured an average of 7.27 ± 0.44 species (n = 15 for both: Fig. 2). This difference was statistically significant ($F_{1,\ 28}$ = 5.82, P = 0.023: Fig. 2). During the following two sampling periods, pitfall traps captured an average of 6.00 ± 0.50 and 3.40 ± 0.41 species (Fig. 2), respectively, and ramp traps captured on average 7.27 ± 0.65 and 3.87 ± 0.37 species (Fig. 2), respectively. The difference was not significant for the second ($F_{1,\ 28}$ = 2.39, P = 0.133) or third ($F_{1,\ 28}$ = 0.77, P = 0.387) sampling periods. However, pooling all three sampling periods together (n = 45 for each trap type), ramp traps caught significantly more species ($F_{1,\ 88}$ = 4.79, P = 0.031), with an average of 5.09 ± 0.30 and 6.13 ± 0.37 species, respectively, caught in pitfall traps and ramp traps.

Compared to pitfall traps, ramp traps captured more than twice as many specimens and, on average, one more spider species per trap, making them an effective sampling alternative to pitfall traps. This result is consistent with other studies that have found ramp traps to be effective for capturing other epigeal arthropods (e.g., Goulet et al. 2004; Pearce et al. 2005). Although some species were exclusively caught in only one trap type or the other (Table 1), the common species were captured in both. During the third sampling period, the

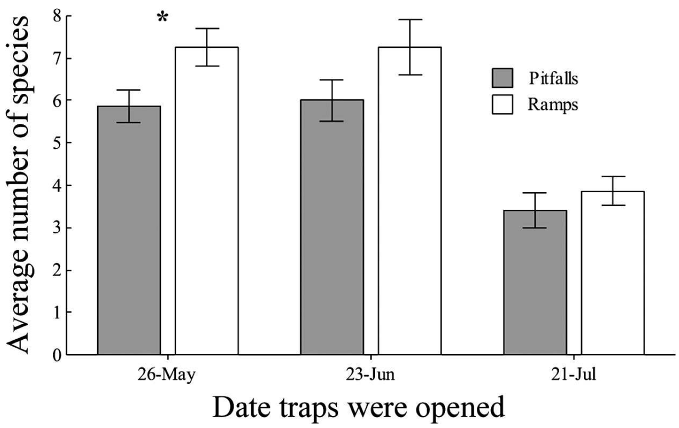

Figure 2.—Mean of species captured in pitfall and ramp traps during each sampling period. (*) indicates a significant difference at $\alpha < 0.05$. Error bars represent $\pm$ 1 SE.

convergence of the number of species captured with both sampling methods (Fig. 2) likely occurred because the breeding period for most wandering spiders was largely over, reducing the number of spiders searching for mates. Ramp traps had a higher propensity for singletons and doubletons (Table 1). Although singletons may confound statistical analyses based on abundance, they are valuable for studies seeking to inventory species present in a given area. Thus, the usefulness of ramp traps, like pitfall traps, depends upon the goals of the study.

A pitfall trap is open in all directions, while our ramp traps sampled from two opposite directions. Intuitively, this should reduce the efficacy of ramp traps, since the open space to enter the trap is greatly diminished. However, this clearly was not the case as ramp traps captured more than twice as many spiders. Moreover, ramp traps are fairly versatile and openings may be added to sample in all four directions of a square or rectangular container. Modifications could be made to the ramps to sample virtually in all directions by expanding the width of the base of the ramp, though Bouchard et al. (2000) warn that the ramp design should only be modified slightly for highest efficiency.

Ramp traps are placed on top of the substrate and they are obviously useful in areas where excavation of any kind is impossible, difficult, or prohibited. They are easily set up and emptied, and they require minimal maintenance, though one must be sure that the base of the ramp is as flush as possible with the substrate. However, if substrate excavation is possible and long-term, and repeated sampling in permanent point locations is desired, pitfall traps would be a better sampling method. Using our sampling design (i.e., permanent PVC sleeves left in the field) allows the same locations to be sampled multiple times, which may be desirable for long-term studies.

Ramp traps overcome many of the common problems associated with pitfall traps (Bouchard et al. 2000), such as flooding after heavy rains, dirt falling into the traps, vertebrate by-catch (Pearce et al. 2005) and soil disturbance around the trap. In our study, we did disturb the vegetation slightly to clear a place for the ramp trap, but this resulted in far less disturbance than excavating the substrate. Overall, ramp traps sampled more specimens and more species in the same period of time, making them a viable alternative to traditional pitfall traps.

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