Volume 2020 Number 4
Winter 2020/2021

Bulletin of the
Oregon Entomological Society

Carabid beetles (Coleoptera: Carabidae) of Puget Sound Lowland *Sphagnum* bogs and some other small lentic wetlands

James C. Bergdahl[1]

Keywords: insects, ground beetles, Pacific Northwest, British Columbia, Washington, Oregon, *Agonum belleri*, *Eanus hatchi*, field surveys, trap records.

> "*It benefits no one if your natural history records remain in your field notebook, computer database, or insect cabinet… Publish your data and put it into the permanent record.*"
>
> Eugene J. Scarpulla (editor), The Maryland Entomologist 6(3): 1, 2015.

Introduction

Carabid beetles (Coleoptera, Carabidae) are primarily ground-dwelling predators of soft-bodied soil invertebrates. There are about 720 carabid species and recognized subspecies known from the Pacific Northwest (British Columbia, Washington, Idaho and Oregon) today. About 100 of these are regional endemics. About 46% of the fauna are winged wetland species with high dispersal power; about 20% are flightless, most of them large mesophilic forest species. A very small percentage of the wetland carabid species are flightless; many of them are regional endemics. One of them—the iridescent, flightless hygrophile *Agonum belleri* (Hatch, 1933), aka Beller's Ground Beetle—is thought to be narrowly restricted to *Sphagnum* bogs in coastal areas of Oregon, Washington, and British Columbia (Photo 1). Since it occurs on Haida Gwaii and at Prince Rupert, it probably also occurs in at

Photo 1. *Agonum belleri* Hatch, 1933, whose adults are suspected of always being flightless. Josh Dunlap (Oregon Department of Agriculture) photo.

1 – Conservation Biology Center, 919 S. Adams St., Spokane, WA 99204, USA. email <jcbergdahl@gmail.com>.
urn:lsid:zoobank.org:author:7727AE64-B4B9-45EF-9BEA-67611A9C203B; ORCID id: <https://orcid.org/0000-0003-1263-9760>.

Edited by **Ron Lyons** <pondhawk@integra.net>. Hosted by **Jim Johnson** <gomphusjim@google.com>.

least the southern sector of the southeast Alaska panhandle.

Sphagnum bogs are one the most ancient lowland communities along the West Coast—many of them are now extremely isolated, relictual habitat remnants of late-Pleistocene/early-Holocene muskeg that is thought to have once covered vast expanses of the coastal region at low elevations soon after the close of the Last Glacial Maximum. Many of these peculiar wetlands that exist today formed in depressions created when huge blocks of ice were left behind in moraine piles as Pleistocene glaciers retreated from Puget Sound. When these ice chunks melted they created kettle bogs, which are typically small but deep-water wetlands, with no stream running into them. *Sphagnum* bogs have also developed in oxbows with poorly draining clay bottoms created by meandering rivers, and marginal wetlands created by old shorelines of ocean beaches and lakes. Many of the large *Sphagnum* bogs in our coastal areas were converted to commercial cranberry farms many years ago (Weathers 1983). In King County today *Sphagnum* bogs represent only 3% of all freshwater wetland types. A disproportionate number of rare plant and animal species in the region are *Sphagnum*-bog specialists, including disjunct boreal-arctic species at the southern extreme of their North American range, and local endemics. Two of the most unique bog plants in the Puget Sound area are the insectivorous *Drosera* species (sundews; *D. rotundifolia* L. and *D. anglica* Hudson; Photo 5). *Sphagnum* bogs are comparatively harsh environments ('wet deserts') with odd chemical (highly acidic, low oxygen, and mineral/nutrient deficient soils) and physical ecology (hydrodynamic input dominated by direct rainfall into relatively small watersheds/basins). Compared to ground conditions in the forests that surround them, bog surfaces typically get much colder at night and much hotter during the day. Their ecological integrity is easily compromised by human modification of their uplands, especially changes in their unique hydrology. *Sphagnum* bogs are challenging habitats to do research on because they are rare and the floating moss mats are often difficult to access.

During the summers of 1996 through 1999 I intensively sampled *Sphagnum* bogs from southwest Oregon to northern Vancouver Island for carabid beetles. The primary reason for these bog surveys was documentation of populations of *Agonum belleri*. This beetle was known from only eleven bogs in British Columbia, Washington, and Oregon when I started. I also surveyed for *Eanus hatchi* Lane, 1938 (Coleoptera, Elateridae), aka Hatch's Click Beetle (Photo 2), another *Sphagnum* beetle with beautiful iridescent coloration, which was known from only four bogs in the Seattle area despite its ability to fly. From 1984–1996 both of these beetles were formally classified by the US Fish & Wildlife Service (USFWS) as "category-2 candidates" for listing as threatened or endangered (<https://ecos.fws.gov/ecp0/profile/speciesProfile?sId=5643>). Today they have no formal status with the USFWS since the agency drastically cut back on the length of the list of candidates, eliminating all category-2 species. However both are today considered sensitive or potentially at-risk species by Washington and Oregon state wildlife agencies, and the US Forest Service.

My surveys utilized both pitfall traps and hand-collecting, but primarily the later so as to greatly expand the number of bogs investigated and to cover a much larger survey area (since running traplines is much more time consuming and requires repeat visits to a study site). Fortunately I found *A. belleri* fairly easy to find on *Sphagnum* bogs during their active season April–September. This was however not the case for *E. hatchi*, which has consistently remained very rare in collections. Over these four field seasons I surveyed nearly 100 *Sphagnum* wetlands, and documented more than two dozen previously unknown *A. belleri* populations, including the first records from Vancouver Island and the huge Burns Bog in the heart of the Vancouver (BC) metro area. I relocated *A. belleri* populations at most of the 11 bogs it had previously been recorded at between Vancouver (BC) and the Mt. Hood (OR) area, including its significantly-degraded type locality at Chase Lake in suburbia near Edmonds (WA). Based on surveys done in 1978, this bog was declared extinct by Paul Johnson (1979), leading the USFWS (1978) to declare *A. belleri* extinct there too. This status determination for the Chase Lake population subsequently cascaded through the literature (e.g. Pyle et al. 1981; WA-DFW 1995). *Eanus hatchi*'s type locality is also Chase Lake; if its population there is now extinct it may have been

Photo 2. *Eanus hatchi* Lane, 1938. Flight wings are slightly visible between elytral suture at rear end. Henri Goulet (Agriculture Canada, Ottawa) photo.

Photo 3: Sunday Creek Bog, in the heavily logged North Fork Snoqualmie River watershed, King County, Washington, 08 July 1996. A logging road runs through the edge of this bog. J.C. Bergdahl photo.

Photo 4. *Ledum* brambles on floating Sphagnum mats, Mud Lake, Tokul Creek, near the town of Snoqualmie, King County, Washington, 12 July 1996. J.C. Bergdahl photo.

in part caused by "over-harvesting" by many years of collecting trips to the site by entomology classes from the University of Washington 1930–50s. The vast majority of *E. hatchi* specimens known to mankind now resides at the Oregon State University Arthropod Collection and are from Chase Lake.

I found *E. hatchi* on only two of the many bogs I sampled; neither population had been recorded before. It still remains unknown in Canada. *A belleri* is now known from most Washington counties bordering Puget Sound, whereas *E. hatchi* is still known only from King and Snohomish counties. I ran traplines on hundreds of wetlands on 60 San Juan and Gulf Islands 1985–1993, but never encountered either beetle there. Although my surveys indicate both species appear to be limited in distribution to low elevations in the Puget Sound area, I collected *A. belleri* in August 1997 on a bog at elevation 1090 m (3575 ft) near the Mt. Cain Ski Area on northern Vancouver Island, the highest record I know of for the beetle. The few known locales for *A. belleri* in Oregon are at ca. 3000 feet in the southern approaches to Mt. Hood.

The primary objective of this paper is to report the results of some of my pitfall trap surveys for carabid beetles on of a variety of peat wetlands in the Seattle area during the 1996 summer field season. The results of these surveys were presented at the 1997 U.S. Environmental Protection Agency 8th Northwest Biological Assessment Workgroup Conference (McCall, Idaho), but the proceedings were never formally published (Bergdahl 1997). Since Washington and Oregon state wildlife agencies, US Forest Service, and the Xerces Society for Invertebrate Conservation have recently surveyed some of the same bogs for *Sphagnum* beetles, it seems appropriate to publish my results at this time.

Survey Results and Discussion

To better understand the habitat affinity and other aspects of the

Photo 5: *Drosera rotundifolia* L. on bog moss mats on the Oregon Coast. Rick Westcott photo.

Photo 6: Flowering *Kalmia occidentalis* Small, *Ledum* bushes, and thick *Sphagnum* moss mats on a raised bog on the Olympic Peninsula. The great Burns Bog in the metro Vancouver (BC) area is many hundreds of hectares of this type of heath vegetation. Washington State Department of Natural Resources photo.

Table 1: Summary of 1996 (June–October) carabid beetle sampling-effort and catch composition from nine *Sphagnum* bogs and five non–*Sphagnum* wetlands in the central Puget Sound lowlands, King and Snohomish counties, Washington State, USA. (Bergdahl 1997)

	Sphagnum Bogs										Non-*Sphagnum* Wetlands						
	King's Lake (*Snoqualmie*)	Snoqualmie (*Snoqualmie*)	Chase Lake (*Edmonds*)	Eagle Ridge (*North Bend*)	Sunday Creek (*Snoqualmie*)	Little Mountain (*North Bend*)	Tub Lake (*SeaTac*)	Queen's (*Redmond*)	Mud Lake (*Snoqualmie*)	Sub-Total	Dead Cedar Marsh (*Snoqualmie*)	Swamp 'Road 30310' (*Snoqualmie*)	Otter Lake (*Hobart*)	Round Lake Varzea (*Issaquah*)	Tradition Lake (*Issaquah*)	Sub-Total	Grand 'Total'
Trap effort:																	
Number of successful pitfall traps	43	45	12	32	24	24	21	31	19	**251**	11	12	12	12	12	**59**	**310**
Number of days	133	133	92	93	115	93	42	53	109	**139**	200	200	159	140	140	**839**	**978**
Number of pitfall trap-days	5,782	5,996	1,104	2,976	2,687	2,232	882	1,643	2,071	**25,373**	1,100	1,200	995	840	840	**4,975**	**30,348**
Trap catches:																	
Number of trapped specimens	71	804	37	326	253	111	75	10	15	**1,702**	338	549	273	180	5,523	**6,863**	**8,565**
Number of trapped species	14	13	7	12	6	10	8	7	3	**38**	19	23	18	11	19	**43**	
Catch/effort (# trapped carabids/# trap-days)	0.012	0.134	0.034	0.110	0.094	0.050	0.085	0.006	0.007	**0.067**	0.307	0.458	0.274	0.214	6.575	**1.379**	**0.282**
Hand-collections:																	
Number of hand-collected specimens	30	2	60	0	23	1	10	7	4	**137**	105	69	17	0	10	**201**	**338**
Number of hand-collected species	4	2	12	0	9	1	3	3	3	**23**	14	11	6	0	4	**18**	
Sample summary:																	
Total number of specimens	**101**	**806**	**97**	**326**	**276**	**112**	**85**	**17**	**19**	**1,839**	**443**	**618**	**290**	**180**	**5,533**	**7,064**	**8,903**
Total number of species	**16**	**14**	**13**	**12**	**11**	**10**	**10**	**8**	**5**	**46**	**22**	**25**	**19**	**11**	**19**	**50**	

ecology of *Agonum belleri*, from June to October 1996 I pitfall trapped and hand collected all carabid species on 9 *Sphagnum* bogs (e.g. Photos 3 & 4) and 5 non-*Sphagnum* bog wetlands in the vicinity of known *A. belleri* populations in King and Snohomish counties. The *Sphagnum* bogs were typically a mosaic of wet floating *Sphagnum* mats, fen, and drier *Ledum*-heath habitat (Photos 3, 4, 6). The other study sites were small peaty ponds and swamps in nearby forested areas. The samples produced 30,348 trap-days; 8,903 specimens; and 69 carabid species (Tables 1 & 2). Eighteen (18) species were only found on *Sphagnum* bogs, 23 species only on non-*Sphagnum* wetlands, and 28 species on both. Of the 46 species recorded on *Sphagnum* bogs, only four species were found on more than half of the bogs sampled, and 25 species were collected on only 1 of the 9 bogs. The only hygrophilic carabid species that is probably a resident on all of the wetlands is *Bembidion fortestriatum* (Motschulsky, 1845) (total incidence=11). Two of the 69 species represent new (first) records for Washington State, and one is apparently an undescribed species closely related to *Bembidion (Plataphus) viator* Casey, 1918 (Dr. George Ball, *pers. comm.*, 12 Feb 1997). The species remains undescribed (in the "*B. occultator* group", David Maddison, *pers. comm.*, 09 Feb 2020).The carabid community on *Sphagnum* bogs showed an exceptionally low abundance (activity-density)—the average number of carabids trapped per trap-day was only 0.07, whereas on non-*Sphagnum* wetlands the catch was 1.38 individuals per trap-day, a ratio of ~1:20 (Table 1). Wet *Sphagnum* and dry *Ledum* heaths were equally depauperate. *Sphagnum* fens typically support a wider array of species.

The preponderance of carabid species with low incidence on *Sphagnum* bogs in the these samples may be a product of one or more of the following factors: 1) small sample size or sample error, 2) many flightless and winged stragglers from other habitats, 3) source vs. sink population dynamics, 4) true meta-population dynamics, or 5) deterioration and extirpation of relict populations. Ecological knowledge of the species trapped on bogs indicates many of them are winged stragglers looking for open disturbed sites such as those common on river floodplains, forest clearcuts, farm fields and alpine zones, or flightless species from adjacent woodlands (Table 2). *Agonum belleri* was found on all of the *Sphagnum* bogs but none of the non-*Sphagnum* wetlands, indicating it is a very narrow habitat specialist. Some of the *A. belleri* records in the table are the first reported populations for some of these bogs. The only other carabid species in the samples that appears to be a *Sphagnum* specialist is *Agonum mutatum* (Gem. & Har., 1868); however this beetle was only found on 4 of the bogs despite it being a winged species with a large geographic range in North America (Lindroth 1966: 601; Bousquet 2012: 1234).

Agonum belleri is most easily found on warm sunny days running around on the surface of floating *Sphagnum* mats, where they may aggregate. *A. belleri* appears to be a klepto-parasite of the insectivorous *Drosera* species it invariably co-occurs with since it

can be found eating small insects trapped on sundew leaves, during the day and at night. It is unlikely *A. belleri* is establishing new populations in the Puget Sound region. Therefore the beetle should continue to be ranked as a potentially at-risk species of special concern in Washington, Oregon, and British Columbia. Since availability of suitable habitat is key to survival and conservation of stenotopic *Sphagnum* insects, all remaining *Sphagnum* bogs should receive: 1) special protection by state/provincial and local authorities because of their unique contribution to the region's biodiversity, and 2) restoration efforts to repair damages to them since negative impacts are widespread in developed areas. Collection of *A. belleri* without a good reason should be discouraged, and specimens should be collected only in a way that they can be used for gene analysis. Transplantation should be evaluated as a future management option to restore lost populations if need be. Whereas *Agonum belleri* (Beller's Ground Beetle) is now understood to be more abundant than previously thought, *Eanus hatchi* (Hatch's Click Beetle) remains one of the

Table 2: Distribution of 69 carabid beetle species (Coleoptera: Carabidae) across nine *Sphagnum* bogs and five non–*Sphagnum* wetlands in the central Puget Sound region, Washington State, USA. (Bergdahl 1997)

		Sphagnum Bogs										*non-Sphagnum Wetlands*						
No	*Species* [* = introduced sp. + = upland forest sp. ✓ = new WA sp. record]	Kings Lake	Snoqualmie	Chase Lake	Eagle Ridge	Sunday Creek	Little Mountain	Tub Lake	Queens	Mud Lake	Incidence	Dead Cedar Marsh	Swamp 'Rd 30310'	Otter Lake	Round Lake Varzea	Tradition Lake	Incidence	Total Incidence
Species collected only on *Sphagnum* bogs:																		
1	*Agonum belleri*	●	●	●	●	●	●	●	●	●	9	○	○	○	○	○	0	9
2	*Agonum cupreum*	○	○	○	○	○	○	●	○	○	1	○	○	○	○	○	0	1
3	*Agonum cupripenne*	●	○	○	○	○	○	○	○	○	1	○	○	○	○	○	0	1
4	*Agonum mutatum*	○	●	○	●	●	○	○	○	●	4	○	○	○	○	○	0	4
5	*Anisodactylus consobrinus*	○	○	●	○	○	○	○	○	○	1	○	○	○	○	○	0	1
6	*Bembidion improvidens*	●	○	○	○	○	○	○	○	○	1	○	○	○	○	○	0	1
7	*Bembidion quadrimaculatum*	●	●	○	○	○	○	○	○	○	2	○	○	○	○	○	0	2
8	*Bembidion tetracolum*	○	○	●	○	○	○	○	○	○	1	○	○	○	○	○	0	1
9	*Bradycellus congener*	●	○	○	○	○	○	○	○	○	1	○	○	○	○	○	0	1
10	*Chlaenius interruptus*	○	●	○	○	○	○	○	○	○	1	○	○	○	○	○	0	1
11	*Harpalus affinus* *	○	○	○	○	○	○	○	●	○	1	○	○	○	○	○	0	1
12	*Harpalus somulentus*	●	●	○	○	○	○	○	○	○	2	○	○	○	○	○	0	2
13	*Leistus ferruginosus*	○	○	○	○	○	○	●	○	○	1	○	○	○	○	○	0	1
14	*Pterostichus crenicollis*	○	●	○	○	○	○	○	○	○	1	○	○	○	○	○	0	1
15	*Pterostichus patruelis* ✓	○	○	●	○	○	○	○	○	○	1	○	○	○	○	○	0	1
16	*Scaphinotus angulatus* +	○	○	○	●	○	○	○	○	○	1	○	○	○	○	○	0	1
17	*Stenolophus fuliginosus*	○	●	○	○	○	○	○	○	○	1	○	○	○	○	○	0	1
18	*Zacotus mathewsii* +	●	○	○	○	○	○	○	○	○	1	○	○	○	○	○	0	1
Species collected only on non-*Sphagnum* wetlands:																		
19	*Agonum harrisi*	○	○	○	○	○	○	○	○	○	0	●	○	●	○	●	3	3
20	*Agonum melanarium*	○	○	○	○	○	○	○	○	○	0	○	○	○	○	●	1	1
21	*Anisodactylus similus*	○	○	○	○	○	○	○	○	○	0	○	○	●	○	○	1	1
22	*Badister ferruginosus*	○	○	○	○	○	○	○	○	○	0	○	●	○	●	○	2	2
23	*Badister grandiceps*	○	○	○	○	○	○	○	○	○	0	○	●	○	●	○	2	2
24	*Bembidion castum*	○	○	○	○	○	○	○	○	○	0	○	○	●	○	○	1	1
25	*Bembidion nigripes*	○	○	○	○	○	○	○	○	○	0	●	●	○	○	○	2	2
26	*Bembidion platynoides*	○	○	○	○	○	○	○	○	○	0	○	○	●	○	○	1	1
27	*Bembidion siticum*	○	○	○	○	○	○	○	○	○	0	○	○	○	○	●	1	1
28	*Bradycellus lecontei*	○	○	○	○	○	○	○	○	○	0	●	○	○	○	○	1	1
29	*Clivina sp.*	○	○	○	○	○	○	○	○	○	0	○	○	○	○	●	1	1
30	*Cychrus tuberculatus* +	○	○	○	○	○	○	○	○	○	0	●	○	○	○	○	1	1
31	*Elaphrus americanus*	○	○	○	○	○	○	○	○	○	0	●	○	○	○	○	1	1
32	*Harpalus cordifer* +	○	○	○	○	○	○	○	○	○	0	○	●	●	○	○	2	2
33	*Harpalus herbivagus*	○	○	○	○	○	○	○	○	○	0	○	●	○	○	○	1	1
34	*Omus dejeani* +	○	○	○	○	○	○	○	○	○	0	○	●	○	○	○	1	1
35	*Paratachys edax*	○	○	○	○	○	○	○	○	○	0	○	○	○	○	●	1	1
36	*Pterostichus adstrictus*	○	○	○	○	○	○	○	○	○	0	○	○	○	●	●	2	2
37	*Pterostichus algidus* +	○	○	○	○	○	○	○	○	○	0	○	○	○	○	●	1	1
38	*Pterostichus amethystinus* +	○	○	○	○	○	○	○	○	○	0	○	●	○	●	○	2	2
39	*Pterostichus herculaneus* +	○	○	○	○	○	○	○	○	○	0	○	○	○	●	○	1	1
40	*Stenolophus flavipes*	○	○	○	○	○	○	○	○	○	0	●	○	○	○	○	1	1
41	*Stenolophus incultus*	○	○	○	○	○	○	○	○	○	0	○	●	○	○	○	1	1

. . . table continued on next page

Table 2 continued: Distribution of 69 carabid beetle species (Coleoptera: Carabidae) across nine *Sphagnum* bogs and five non–*Sphagnum* wetlands in the central Puget Sound region, Washington State, USA. (Bergdahl 1997)

		Sphagnum Bogs										non-*Sphagnum* Wetlands						
No	*Species* [* = introduced sp. + = upland forest sp. ✓ = new WA sp. record]	Kings Lake	Snoqualmie	Chase Lake	Eagle Ridge	Sunday Creek	Little Mountain	Tub Lake	Queens	Mud Lake	Incidence	Dead Cedar Marsh	Swamp 'Rd 30310'	Otter Lake	Round Lake Varzea	Tradition Lake	Incidence	Total Incidence
Species collected on both *Sphagnum* bogs and other wetland types:																		
42	*Acupalpus carus*	○	○	○	○	○	○	●	○	○	1	●	○	●	○	○	2	3
43	*Agonum brevicolle*	○	○	●	●	●	●	○	○	○	4	●	●	○	○	●	3	7
44	*Agonum ferruginosum*	○	○	○	●	○	○	○	○	○	1	●	●	●	●	●	5	6
45	*Agonum gratiosum*	○	●	○	○	●	○	○	●	○	3	●	○	○	○	○	1	4
46	*Agonum suturale*	●	○	○	○	○	●	○	○	○	2	○	○	●	○	○	1	3
47	*Anchomenus quadratus*	○	○	○	○	○	●	○	○	●	2	●	●	●	○	○	3	5
48	*Bembidion acutifrons*	○	○	○	●	○	○	○	○	○	1	○	●	○	●	●	3	4
49	*Bembidion connivens*	○	○	○	○	○	○	●	○	○	1	●	●	○	○	●	3	4
50	*Bembidion fortestriatum*	●	●	○	●	●	●	●	●	○	7	●	●	●	○	●	4	11
51	*Bembidion incrematum*	●	○	●	○	●	○	○	○	○	3	●	●	●	○	●	4	7
52	*Bembidion iridescens*	○	○	●	○	○	○	○	○	○	1	●	●	○	○	●	3	4
53	*Bembidion versicolor*	●	○	○	○	●	○	○	○	○	2	●	○	○	○	○	1	3
54	*Bembidion new sp. near viator*	○	○	○	○	○	○	●	○	○	1	●	●	●	○	○	3	4
55	*Blethisa oregona*	○	○	○	○	●	○	●	●	○	3	●	●	●	○	●	4	7
56	*Bradycellus californicus*	●	●	○	○	○	○	●	○	○	3	●	○	○	○	○	1	4
57	*Bradycellus conformis*	○	○	●	○	○	○	○	●	○	2	●	●	●	○	○	3	5
58	*Calathus fuscipes*	○	○	○	●	○	○	○	○	○	1	○	○	○	○	●	1	2
59	*Elaphrus clairvillei*	○	○	○	●	○	●	○	○	○	2	●	○	○	○	○	1	3
60	*Loricera decempunctata*	○	●	●	○	○	●	○	●	○	4	●	●	●	●	●	5	9
61	*Microlestes nigrinus*	○	○	○	○	○	○	○	○	●	1	○	●	○	○	○	1	2
62	*Pterostichus lama* +	○	○	○	○	●	○	○	○	○	1	○	●	○	○	○	1	2
63	*Pterostichus luctuosus*	○	●	●	●	●	●	○	○	●	6	●	●	○	○	●	3	9
64	*Pterostichus melanarius* *	●	○	○	○	○	○	○	○	○	1	○	●	○	●	●	3	4
65	*Pterostichus pumilus* +	●	○	●	●	○	○	○	○	○	3	○	○	●	○	○	1	4
66	*Scaphinotus angusticollis* +	○	○	○	○	○	○	○	●	○	1	○	○	○	●	○	1	2
67	*Scaphinotus marginatus*	●	●	○	○	○	○	○	○	○	2	○	○	●	●	○	2	4
68	*Stenolophus anceps*	○	○	●	○	●	●	○	○	○	3	●	○	●	○	○	2	5
69	*Trechus chalybeus*	●	●	●	●	○	●	●	○	○	6	●	●	●	○	○	3	9
	Number of Species:	**16**	**14**	**13**	**12**	**11**	**10**	**10**	**8**	**5**	99	**25**	**25**	**19**	**11**	**19**	99	**198**

rarest beetles in North America. It is unfortunate the USFWS does not provide it the protection it deserves given the threat to its habitat by suburbanization within its small geographic range, comparable to some of the listed butterfly species in the Puget Sound area.

Carabids are closely related to a number of common aquatic beetle groups that are often used for water quality and aquatic habitat assessments (halipids, gyrinids, dytiscids, noterids). Carabid beetles can be excellent tools for habitat assessment and environmental monitoring research because of: 1) high species richness and abundance, 2) well-known and stable taxonomy, 3) availability of good keys to the species, 4) wide variety of life histories, and 5) many of the species are habitat specialists. However their use in wetland assessment and monitoring programs in the USA has not been applied much compared to many other insect taxa. Dufrene & Legendre (1997) provide an example of how carabid beetle faunas can be assessed to determine indicator species and characteristic species assemblages.

Acknowledgements

My field work on Puget Sound bogs has benefited from the support of many people representing the Royal British Columbia Museum, Washington State Department of Natural Resources Natural Heritage Program and Tiger Mountain State Forest, Washington State Parks, British Columbia Parks, University of Washington, University of British Columbia, Western Washington University, Seattle Pacific University, the surface water management departments of King and Snohomish counties, City of Seattle, City of SeaTac, and Weyerhaeuser's Snoqualmie Tree Farm. Over many decades George Ball (University of Alberta), Jim Liebherr (Cornell University), and David Kavanaugh (California Academy of Science) have helped with the determination of difficult carabid species in my collection. Josh Dunlap, Henri Goulet, Rick Westcott, the Idaho Department of Fish & Game, and the Washington State Department of Natural Resources kindly allowed the use of photos.

References

Bergdahl, J. C. 1997. Carabid beetles (Coleoptera: Carabidae) of Puget Sound lowland Sphagnum bogs. Pp. 11–21, in: Gretchen Hayslip (ed.), Proceedings of the 8th Northwest Biological Assessment Workgroup Conference, McCall, Idaho, 4–6 November 1997, U. S. Environmental Protection Agency, Seattle, WA.

Bousquet, Y. 2012. Catalogue of Geadephaga (Coleoptera: Adephaga) of America, north of Mexico. ZooKeys 245: 1–1722. (Download the PDF from <https://zookeys.pensoft.net/lib/ajax_srv/generate_pdf.php?document_id=4003&readonly_preview=1&file_id=0>.)

Dufrene, M. & P. Legendre. 1997. Species assemblages and indicator species: the need for a flexible asymmetrical approach. Ecological Monographs 67(3): 345–366. (Read the abstract at <https://doi.org/10.1890/0012-9615(1997)067[0345:SAAIST]2.0.CO;2>.)

Johnson, P. J. 1979. A report on a survey for Beller's ground beetle on the North Fork of the Snoqualmie River, King County, Washington. Report No. DACW67–79–M–1189, U.S. Army Corps of Engineers, Seattle District, Seattle, WA. 19 p.

Lindroth, C. H. 1966. The ground-beetles (Carabidae, excl. Cicindelinae) of Canada and Alaska, Part 4. Opuscula Entomologica Supplement 29: 409–648.

Pyle, R., M. Bentizen & P. Opler. 1981. Insect conservation. Annual Review of Entomology 26: 233–258.

U. S. Fish & Wildlife Service (USFWS). 1978. U. S. Department of the Interior: 10 North American beetles: proposed endangered species or threatened species status and identification of critical habitat. Part III. Federal Register 43(155), 10 August, p. 35636–35643. (Download the PDF from <https://ecos.fws.gov/docs/federal_register/fr234.pdf>.)

Washington Department of Fish & Wildlife (WA-DFW). 1995. Management Recommendations for Washington's Priority Species Volume I: Invertebrates. E. M. Larsen, E. Rodrick & R. Milner, (eds.), Olympia, WA. (Download the revised PDF from <https://wdfw.wa.gov/publications/00024>.)

Weathers, L. 1983. 100 years of cranberry farming in Pacific County. The Sou'wester (Quarterly Publication of the Pacific County Historical Society) 18(3): 43–60. (Download a PDF of the issue from <http://pacificcohistory.org/SouWester/1983%20Autumn.pdf>.)

Update on the Katydid, *Tessellana tessellata*, in Oregon

Ron Lyons

Recently, I had occasion to visit the Singing Insects of North America website (Walker and Cooper 2020), and check out their new map for the distribution of *Tessellana tessellata* (<https://orthsoc.org/sina/316m.htm>), a small tan-colored European katydid, first reported from Oregon in 2004, but actually here much earlier. For more information on its presence in Oregon see my earlier report (Lyons 2012); at that time it had not been reported east of the Cascades.

On the updated map there was a record from Union County. Checking further I found a number of additional records from last year and this year on iNaturalist (<https://www.inaturalist.org/observations?place_id=10&subview=table&taxon_id=318470> – not all the records have been verified but the ones I saw were clearly correctly identified) for Union County. It probably reached there along the Columbia Gorge but it could have spread eastwards over the mountains using open grassy areas. Now that it is reached eastern Oregon I imagine it will probably extend its distribution not only into eastern Oregon but into eastern Washington as well. Perhaps it already has.

I was a bit surprised to see that this katydid had not yet been recorded in southwestern British Columbia.

While this insect has a distinct appearance, it can easily be overlooked as just a small grasshopper. Its tan color blends in well with dead or dried up grass.

References

Lyons, R. 2012. *Tessellana tessellata* in Oregon (Orthoptera: Tettigoniidae). Bulletin of the Oregon Entomological Society 2012(3, Fall): 5–6.

Walker, T. & T. Cooper. 2020. Singing Insects of North America (SINA), <https://orthsoc.org/sina/index.htm>. [accessed November 2020]

Adult female *Tessellana tessellata* photographed in Woodruff Meadows, Jackson County, Oregon on August 22, 2019. Note the characteristic bars on the wings and the short upturned ovipositor.

First record of *Scaphinotus hoodooensis* from Idaho, first records of *Scaphinotus regularis* from Montana, review of the geography of species in subgenus *Pseudonomaretus* (Coleoptera, Carabidae, Cychrini), with comments on the endemic forest invertebrate fauna of the Clearwater Refugium

James C. Bergdahl[1]

Key words: insects, ground beetles, cychrines, biogeography, endemics, Pacific Northwest, inland temperate rainforest, conservation

"The taxonomist's work is often considered dull and dry and requiring but little imagination. By serious naturalists it is sometimes referred to as "hair counting" . . . The species concept is unique among taxonomic categories because it corresponds to a real natural entity. Almost no pair of species, however closely related, are distinguished by a single morphological character, though it may seem so, but rather by a total of peculiar qualities that often escape every verbal translation but all of them contribute to the habitus of the species. This to grasp, and to keep as a mental picture, is a matter of instinct rather than logic. No taxonomist can do a first class work without a touch of this innate instinct—which adds to the task a good deal of excitement, indeed, and makes our science far from 'dull and dry' ".

Carl H. Lindroth (1969: xxxii)

Introduction

Beetles are one of the most species-rich groups of animals on Earth, and the family Carabidae (aka ground beetles) is one of the most diverse groups of beetles. There are about 720 formally described and recognized carabid species and subspecies known in the Pacific Northwest today (PNW=British Columbia, Washington, Idaho & Oregon; Bergdahl 1995, 2013), about 27% of the carabid fauna in North American north of Mexico (~2685 species + subspecies; Bousquet 2012). Such a large number of species provides PNW carabidologists much inspiration and many challenges created by so much diversity to work with, opportunities for taxonomic confusion, excitement associated with the search for many rare or little known species, and the discovery of new species despite the fact our fauna is actually very well defined. The median date of description of the 533 carabid species whose modern range suggests they are indigenous to the PNW is ~1909 (Bergdahl 2019). By 1914 one half of these indigenous species had been described. "The closer one looks the more diversity one finds" (Wake 2009), but the longer carabidologists have looked the harder it is to find new species. Thirty-five new carabid species have been described from the PNW over the last 30 years (since 1990), and 13 in the last 10 years. I am aware of ~20 species from the region that are known but undescribed in the Bembidiini subtribe Anillina, and in the genera *Nipponomebria*, *Bembidion* and *Pterostichus*, based on my own observations and reliable reports, and surely there are others I have not heard about. No doubt many others await discovery, including cryptic species hiding in already existing collections that will eventually be discovered by molecular-genetic techniques [e.g., see mini-review on cryptic species by Camp & Wooten (2016)].

This paper discusses the recently described carabid, *Scaphinotus (Pseudonomaretus) hoodooensis* Kavanaugh & Angel, 2015, at high elevation in northwest Montana (on the crest of the Bitterroot Range of the Rocky Mountains, along its border with Idaho). *S. hoodooensis* is the first *Pseudonomaretus* species to be described in almost 100 years. I report the first record of *S. hoodooensis* in Idaho, and the first three locality records of *S. (P.) regularis* in Montana. This is a closely related species that is found almost

Photo 1: *Scaphinotus (Brennus) marginatus*, a classic carabid beetle of the Vancouveran Faunal Region. The species is widespread and usually common in both coastal and interior forests, and can be expected to co-occur with all of the *Scaphinotus (Pseudonomaretus)* species in the Inland Rainforest Region. There it is usually black in color, sometimes with a very slight purple and blue iridescence on the elytra. There are six species of *Brennus* and five species of *Pseudonomaretus* in the Pacific Northwest ground beetle fauna.
Source: Wikimedia Commons <https://commons.wikimedia.org/wiki/File:Scaphinotus_marginatus.jpg>. License: CC BY 3.0 <https://creativecommons.org/licenses/by/3.0>, via Wikimedia Commons,. David R. Maddison (OSU) photo.

1 – Conservation Biology Center, 919 S. Adams St., Spokane, WA 99204, USA. email <jcbergdahl@gmail.com>.
urn:lsid:zoobank.org:author:7727AE64-B4B9-45EF-9BEA-67611A9C203B; ORCID id: <https://orcid.org/0000-0003-1263-9760>.

exclusively in Idaho, but has been suspected of occurring in Montana since it was already known from many locales close to the ID/MT border (Bergdahl 2014). Since many of the species in the subgenus are rarely collected and poorly understood, I provide a review of the key characteristics and ranges of all *S. (Pseudonomaretus)* species. I also call attention to an interesting population of what appears to be *S. regularis* at high elevation in Idaho's Seven Devils Mountains, which I refer to as *S. reg. septemdiabolus*. The five *Scaphinotus (Pseudonomaretus)* species, plus *Cychrus hemphillii* Horn, *S. (Brennus) marginatus* (Fischer), and *S. (Stenocantharus) angusticollis* (Mannerheim), are the only cychrines known to occur in the *interior* Columbia River basin in British Columbia, Washington, Idaho, northwest Montana, and northeast Oregon.

Some Basic Carabidology

Tribe Cychrini – The tribe Cychrini is represented by some of the most distinctive and attractive carabid beetles; they are typically fairly large beetles with bulbous abdomens, and long thin heads and jaws (Photo 1). Some of them have brightly iridescent coloration, and many impressive photos of them are available online. The older instar larvae are quite distinctive (Photo 2). There are ~200 known species (in four genera) worldwide, found in the temperate and boreal zones of the Northern Hemisphere (Bousquet 2012: 191). The center of diversity for the tribe today is Palearctic Asia (Busato 2009). Analysis of mitochondrial DNA indicates the tribe originated at least 70 million years ago (Late Cretaceous), with comparatively little morphological differentiation in spite of their long evolutionary history (Su et al. 2004; Imura et al. 2018). Whether they originated in the Old or New World is unclear. According to Su et al. (2004) the oldest genus in the tribe Cychrini is *Scaphinotus*, which is only found in North America today.

In North America the tribe is represented by 64 described species in three genera: *Sphaeroderus* (6 spp), *Cychrus* (2 spp), and *Scaphinotus* (56 spp) (Bousquet 2012). Only two of these (*Scaphinotus* spp) range as far south as the mountains of northern Mexico. The westernmost ranging cychrine is the extremely versatile *S. marginatus* (Photo 1), which is at the doorstep of the Palearctic on many of the surveyed Aleutian islands as far west at Adak Island (Bergdahl 2019). This species' occurrence in coastal regions of south-central Alaska is also the most northern range extent of the tribe in North America. The tribe provides many excellent examples of species radiations in mountainous terrain.

Although the richness of *Scaphinotus* species is about equally distributed between eastern and western North America, there are many more subspecies recognized in the East, especially in Appalachia, where some species have very small geographic ranges. Although *Sphaeroderus* species are almost exclusively found east of the Mississippi River mainstem, both of the *Cychrus* species are only found in the Vancouveran Faunal Region. All cychrines are apterous and the adults have fused elytra; they are therefore totally flightless. They usually have long legs and some of them are probably fairly competent long-distance hikers for insects; yet mountain ranges, dry unforested mountain valleys, large rivers, predators or competitors may be significant barriers to local dispersal. Some of the widespread species "break up to a certain degree into more or less well defined races or subspecies, each of which is confined to a definite territory. In the [West]. . .where the mountains are more or less isolated from each other, the species which are restricted to them are more or less limited in their distribution to them, sometimes confined to a single mountain range" (Van Dyke 1938: 95). Although this sky island* type biogeography is more obvious in the southwest USA [e.g., *S. petersi*, which has seven described subspecies narrowly restricted to montane forest habitats in southeast Arizona alone (Ball 1966; Ober et al. 2011; Bousquet 2012; Mitchell & Ober 2013)], it applies also to the Pacific Northwest, especially the drier inland ecoregions where valley bottoms are more significant dispersal barriers for flightless forest insects. As an example of the taxonomic confusion the regional variation within some cychrine species can cause, in the early 1900s Thomas L. Casey, who was very productive but an infamous splitter**, described at least a couple dozen *Scaphinotus* species from western states and provinces that are only considered synonyms today, seven for what are now considered just variations of *S. marginatus* (Gidaspow 1968; Bousquet 2012: 221). Gidaspow (1968: 138) suggests the variant of *S. marginatus* from the "eastern Washington" region (primarily black in color) may be a valid subspecies. Molecular analysis may eventually prove that some of these Casey synonyms are actually valid (cryptic) species (Maddison & Sproul 2020). In Europe, where the cychrine diversity is limited to 14 *Cychrus* species, the fauna is fairly well documented and as many subspecies are recognized (<https://www.fauna-eu.org>).

As a general rule, the phenology of the life history of cychrine species has a hibernating larva that hatches in late summer/fall (Lindroth 1961: 14; Larochelle 1972a; Green 1975), develops as long as the climatic conditions (especially temperatures) are favorable, and then completes development in the spring when the snow starts to melt (Busato 2009). There are 3 larval (grub) instars. The larvae may be active to some extent during the winter under the snow (Photo 2). Pupation occurs in late spring. Teneral adults often can be found in summer, with breeding taking place in late summer. In low elevation xeric habitats adults may aestivate

* Footnote: Sky island=high elevation, unglaciated, ancient topographic landform surface. One of the key elements of a sky island is the separation by physical distance (and significantly different life zones/climates) from other mountain ranges, resulting in a habitat island, such as a montane forest surrounded by xeric, lower elevation, valley bottoms. Because of the insular nature of sky-island habitats, they have special biodiversity management needs (e.g. Voller & MacKinnon 2000; Moore et al. 2013).

**Footnote: T. L. Casey published descriptions of 107 of the 533 valid species and subspecies known to be indigenous in the Vancouveran Faunal Region today, 18 more than the next most productive coleopterist, John L. LeConte, in the late 1800s (Bergdahl 2019).

Photo 2: Late instar cychrine larva on snow, probably *Scaphinotus relictus*, elev. ~1350 m (4430 ft), Mt. Spokane State Park, northeast Washington. Holly Weiler photo.

for part of the summer. Some old adults overwinter and can be found active on the soil surface again in the spring. A few species have been shown to have fall emerging adults and overwintering eggs (Bousquet & Pilon 1980), such as the PNW's *Scaphinotus angulatus* (*pers. observ.* on San Juan Islands).

Pacific Northwest Cychrini – There are 34 tribes of Carabidae recognized today in the Pacific Northwest (PNW) fauna, and 97 genera (Bergdahl 1995). The tribe Cychrini is represented by 19 species in the Pacific Northwest, all of which are indigenous to the Vancouveran Faunal Region (as defined by Van Dyke 1919, 1926, 1940, 1944; Bergdahl 2019): *Cychrus* Fabricius, 1794 (2 species), and *Scaphinotus* Dejean, 1826 (17 species). Cychrini is no doubt a very old group, the members of which have probably been flightless for 10s of millions of years. Therefore, due to their longevity over geologic time scales, and limited power of dispersal, they are indicators of ancient centers of diversification and dispersal barriers, two key features that help define the most unique feature of the PNW's insect fauna—its regionally endemic species.

The etymology of *Cychrus* is unclear (Bousquet 2012). *Scaphinotus* get their genus name from the shape of their carapace (fused elytra, or forewings), which, when turned upside down, is shaped-like and floats like a boat (scaphos=barque, skiff or boat in Latin, and notos=back or upper surface). The caudal end of the carapace is invariably pointed like a bow, the sides are flared outward, and the proximal end narrows to where it is attached to the pronotum, and then flattened like a transom of a boat. Species of *Scaphinotus* are only found in Canada, the USA, and northwest Mexico (Durango), where they are typically associated with upland forested habitats (mesophiles), both on the east coast and west coast. Some species are closely associated with riparian zones, and may therefore be best described as hygrophiles. Most of the PNW species have subdued coloration, however a few of them are usually brilliant iridescent in color, such as the widespread *S. marginatus* (Fischer) (Photo 1), *S. angulatus* (Harris) and *S. johnsoni* Van Dyke (purplish coastal species), and *S. hatchi* Beer (from the central Oregon Cascades), which has brilliant iridescent red, copper and purple highlights. There are 4 subgenera of *Scaphinotus* represented in the PNW: *Brennus* (7 spp), *Stenocantharus* (3 spp), *Neocychrus* (2 spp), and *Pseudonomaretus* (5 spp). Placing a specimen in the correct subgenus can sometime be a challenge itself since "in every subgenus of *Scaphinotus* are species that share characteristics of another, probably closely related, subgenus" (Gidaspow 1973: 54). Our endemic *S. johnsoni* was placed in the subgenus *Brennus* by Lindroth (1961), Gidaspow (1968), Perrault (1973), and Bousquet & Larochelle (1993), and then Bousquet (2012) recently moved it to *Stenocantharus*. The confusion of shared and unshared character states in *Pseudonomaretus* in comparison to the other subgenera is outlined by Kavanaugh & Angel (2015: 395).

Cychrines are often described as specialized predators of snails and slugs. While such claims make good headlines for popular natural history articles, and many of the species may at times and places prefer to consume mollusks if they are available, this should be considered a gross generalization. In my experience in the field, their food habits are probably best described as opportunistic omnivores, like many other carabid beetles, unless proven otherwise. Larochelle's (1972b) and Green's (1975) review of the literature on this topic confirm my field observations. There are published reports of the PNW's *Scaphinotus angusticollis* preying on amphibians (Ovasaka & Smith 1988). At the other end of the food spectrum, Lavallee (2006) found *S. angusticollis*, one of the Pacific Northwest's most abundant forest carabids, preferred to eat lettuce in her lab. I have observed many times while night collecting all three *Scaphinotus* species in the San Juan Islands eating ripe berries that had fallen to the ground. *S. angusticollis* can occur at such high density on many small forested islands in the Puget Sound area it is ecologically impossible for them to be narrow mollusk specialists. Cychrines are apparently able to regurgitate digestive fluids onto masticated food items and then consume the results later. This helps explain why individuals can be observed preoccupied with the same prey item for long periods of time. Many collectors use ripe bananas placed along forest trails to attract them. Mitchell & Ober (2013) claim that *S. petersi* is limited in distribution to moist montane coniferous forests because that is "where the snails live." Whether or not a *Scaphinotus* species is a mollusk specialist, or an opportunistic omnivore, would of course affect its abundance, dispersal power, the extent of its geographic range at both local and regional scales, food competition with other organisms, and many other aspects of their population biology, including possible co-evolution with co-occurring mollusks. On some rare, small forest islands in the San Juan and Gulf Archipelago (Salish Sea) where *S. angusticollis* does not occur, the less common *S. angulatus*, *S. marginatus* or *Cychrus tuberculatus* Harris often occur at higher activity-density in long-term traplines, suggesting there may be some competition among these cychrines. Van Dyke (1944) notes that some Pacific Northwest *Stenocantharus* species are "arboreal," i.e., capable of climbing up tree trunks.

Scaphinotus subgenus *Pseudonomaretus*

The subgenus *Pseudonomaretus* includes five described species [Table 1; see photos in Bergdahl (2014), Kavanaugh & Angel (2015), and below]. Culpepper's (2011) molecular analysis suggests *Pseudonomaretus* is monophyletic and represents a clade near the base of the radiation of *Scaphinotus* in North America. Kavanaugh & Angel (2015) provide a morphological assessment that compares them with other *Scaphinotus* subgenera. A reasonable, very general, historical scenario for their evolution is: their immediate ancestor was resident in mild, mesic-forest habitats across northern North America in the mid-Tertiary, then, as climates cooled in the late Tertiary, they moved south, and as the Rocky Mountains uplifted and created the rain shadow that produced the Great Plains, eastern and western North American stocks became isolated. No one has yet proposed a phylo–tree for the *Pseudonomaretus* species. All of the *Pseudonomaretus* species were probably in existence, and limited in distribution to the Rocky Mountains, before the onset of the Pleistocene. *S. hoodooensis* is likely to be the youngest of the five species; its male genitalia (median lobe) suggest it is probably derived from *S. regularis*.

The subgenus is endemic to the Pacific Northwest, being found almost exclusively on the west slope of the Rocky Mountains in southeastern British Columbia, eastern Washington, north and central Idaho, northwest Montana, and the northeasternmost corner of Oregon. Members of the subgenus are found only in interior regions, and almost exclusively in the upper Columbia River basin. The northernmost records are of *S. relictus* from Revelstoke (51°0' N) and Yoho National Park (51°30' N), British Columbia. The only records east of the Continental Divide are a few reliable reports of the same species in the Banff/Jasper area of Alberta. None of the species is known to occur west of the crest of the Coast and Cascades mountains, and none of them are known to occur in California or Nevada. Gidaspow (1973: 77) mentions a record of *S. relictus* from the southwest corner of Oregon, but this should be considered a mistake unless proven otherwise. The westernmost records are for *S. relictus* in the Penticton (BC) area of the Okanogan River watershed just north of the US border. The south end of the range of the subgenus is at about the latitude of Boise (~44°0' N), in south-central Idaho.

Pseudonomaretus species are primarily collected in forest regions, however *S. regularis* and *S. mannii* have been taken in shrub-steppe habitats associated with the canyons of the lower Snake River in the Lewiston (ID)/Clarkston (WA) area. These sites are not very far from the Ponderosa pine forest zone, and may have been forested during the Last Ice Age. *S. relictus*, which is by far the most common and ecologically eurytypic of all the species, can easily be found in dry and open Ponderosa pine forest, such as the isolated forested buttes on the Palouse Grassland ecoregion, but it reaches its maximum density in the wetter forest zones in the mountains at higher elevations (e.g., Mt. Spokane). In these dry ecoregions, populations probably have significant early and late season activity to avoid the intense summer drought (July through September).

The only other cychrines in these interior regions are *Scaphinotus (Brennus) marginatus* (Photo 1) and *Cychrus hemphilli*i, and north of the Kootenay River mainstem in southeast British Columbia *S. relictus* must face significant competition from *S. (Stenocantharus) angusticollis*, a coastal disjunct species that can reach a very high density at low and middle elevations in the inland temperate rainforest of the central Columbia Mountains, e.g., Lavallee (1999). Despite an intensive search, I have never encountered *S. angusticollis* south of the Kootenay River mainstem in the interior. (It does not appear to have been able to colonize the South Selkirk Range of British Columbia, northern Idaho, or northeast Washington, suggesting the Kootenay River by Nelson has been a terminal dispersal barrier.) The center of diversity of the subgenus is the Clearwater River Basin of central Idaho, where all five species can be found (Figure 1). If they did not actually originate in or near central Idaho, historical factors, such as the Last Ice Age, must have forced their geographic ranges to concentrate there.

First Record of *Scaphinotus hoodooensis* From Idaho

What appears to be the first record of *S. hoodooensis* from Idaho is one male I collected in only one of many hundreds of surveys of small creeks in forest regions of central Idaho for carabid beetles

Table 1. *Scaphinotus (Pseudonomaretus)* species and their occurrence in states and provinces.
(Locations in parentheses are suspected but not confirmed.)

S. (P.) relictus (G. H. Horn, 1881) [AB, BC, ID, MT, WA, (sw & neOR?)]
S. (P.) regularis (LeConte, 1884) [BC, ID, WA, MT, (neOR?)]
S. (P.) merkelii (G. H. Horn, 1890) [BC, ID, MT, (neWA?)]*
S. (P.) mannii Wickham, 1919 [OR, WA, ID]**
S. (P.) hoodooensis Kavanaugh & Angel, 2015 [MT, ID]

*Assessed S1S3 in British Columbia, but has no special status. On the Committee on the Status of Endangered Wildlife in Canada's (COSEWIC) list of candidate species.
**Assessed S1 by Oregon State and a candidate for listing in Washington State, due to rarity and possible vulnerability to extinction, although neither state provides any special habitat protection for the species.

Photo 3: Looking south towards Pearl Lake (MT) from ID/MT border near Hoodoo Pass, on the crest of the Bitterroots, 24 July 2009. Holly Weiler photo.

Photo 4: Looking north down on Saint Joe Lake (ID) from near ID/MT border near Hoodoo Pass, 24 July 2009. Holly Weiler photo.

over a twelve year period 2000–2012. The label on the specimen reads:

> Hoodoo Peak Creek @ Hoodoo Pass Road; ~5.2 MP USFS Rd. 250; 44 miles NE of Headquarters; Long Creek/NF Clearwater R. Watershed; Shoshone County, n-c Idaho, USA; 46.958867, –115.013522; elev. 1636 m (5366 ft); 19 Sept. 2000, #44-2000; J. C. Bergdahl & G. J. McIntyre, coll."

Apparent body length (ABL)=11.5 mm (excluding antennae). The specimen has the unique distinguishing characteristics that Kavanaugh & Angel (2015) use to separate it from the most similar *Pseudonomaretus* species, *S. merkelii*.

This small creek descends a steep, southwest-facing hillside near the timberline. It was overgrown with a thicket of slide alder (*Alnus sinuata*), and difficult to survey. Hoodoo Pass is perched at the edge of one of the most interesting geomorphic features of the region: the steep escarpment that defines the east slope of the Bitterroot Mountains—an abrupt, long, and straight mountain front overlooking Montana's Bitterroot Valley (Missoula area).

The only other reported locale for *S. hoodooensis* is the type locality in Montana (46.97875° N, 115.03700° W; ~5900 ft), Hoodoo Pass Meadows, only 1000 meters due east of the Idaho border. The site (see photo in Kavanaugh & Angel 2015) is a subalpine meadow with a small creek running along the south side of its forested edge. Since the Idaho locale is along a small forested creek, *S. hoodooensis* should probably be considered a hygrophile unless proven otherwise. As such it joins the special group of carabid species that are narrowly endemic to the Pacific Northwest region and are flightless hygrophiles; ~53% of the carabid beetle species in the Pacific Northwest are hygrophiles, and only ~8% of them are flightless (Bergdahl 1995, 2013).

It appears as though *Scaphinotus hoodooensis* may be a periglacial relic since current records suggest it is restricted in distribution to the crest of the Bitterroot Mountains ca. Hoodoo Pass. Although the extent of glaciers in the Clearwater Basin during the Last Glacial Maximum has not been accurately mapped and is rarely indicated on maps (e.g., Figure 2), it is clear the crest of the Bitterroots was glaciated. The patchy distribution of local glaciers in the North Fork Clearwater Basin is exemplified by that of the Selway–Bitterroot Wilderness area (Middle Fork Clearwater Basin) determined by Dingler & Breckenridge (1982). In the immediate vicinity of Hoodoo Pass, past glaciations are indicated by the numerous glacial cirque lakes both to the north of the Pass (Trail, Saint Joe, the three Oregon Lakes, and Missoula Lake), and to the south (Hidden, Heart, Pearl, Dalton, and the three Trio Lakes) (Photos 3 & 4).

The flightless, ripicolous, hygrophilic, carabid beetle *Nebria carri* Kavanaugh is another rare, high-elevation, periglacial relic in this area with a very patchy distribution in Idaho, with populations nearby in the Clearwater Basin in the Selway Crags area and on Pot Mountain.

Other carabid species collected in this area associated with **streams** are as follows (*=endemic to greater inland temperate rainforest region): *Nebria gouleti**, *N. arkansana*, *N. gyllenhali*, *N. gebleri*, *N. carri**, *Nippononebria* sp.* (Weng et al. 2019), *Scaphinotus merkelii**, *S. regularis**, *Lionepha probata*, *L. kavanaughi**, *L. disjuncta*, *Bembidion platynoides*, *B. iridescens*, *B. lividulum*, *B. geopearlis**, *B. quadrifoveolatum*, *B. kuprianovi*, *Trechus coloradense*, *Diplous atterimus*, *Metrius explodens**, *Pterostichus (Pseudoferonina) spathifer**, *P. (P.) lolo**, *Pterostichus (Melvilleus) amadeus** and *Pterostichus (Cryobius) riparius*. Some of the **upland forest** species in the area are: *Amerizus oblongulum*, *Zacotus matthewsii*, *Pterostichus (Hypherpes) ecarinatus**, *Pterostichus (H.) neobrunneus**, *Pterostichus (Leptoferonia) sphodrinus**, *P. (L.) beyeri**, *P. (L.) idahoae**, *Notiophilus directus*, *Cychrus hemphillii**, *Scaphinotus marginatus*, and *S. relictus**.

First records of *Scaphinotus regularis* from Montana

Neither Hatch (1953), Lindroth (1961), Russell (1968), Edwards

(1975), Bousquet & Larochelle (1993), Bousquet (2012), Bergdahl (2014), nor Kavanaugh & Angel (2015) score *S. regularis* as occurring in Montana. I have collected carabids along many small creeks on the Montana side of the Bitterroot Crest, and have two *S. regularis* in my collection that I overlooked in my 2014 paper on *Pseudonomaretus*.

The specimen labels read:

1) Two Mile Creek @ ~MP 2 Two Mile Creek Road, USFS Rd. 431 Gold Summit Rd., 900 masl (2950 ft), 5.4 mi WSW of St. Regis, 1037 m (3400 ft), 47.280281, –115.211716, Mineral Co., nwMT, USA, 07 June 2001, #19-2001, J. C. Bergdahl, coll." One male.

   This locale is about six miles from the Idaho border, within a couple miles of Interstate 90, and not very far from Lookout Pass. Gold Summit Road runs parallel to I–90 for quite a ways in this area.

2) Small Roadside Spring on Steep Burnt Hillside, MP 15.4 USFS Rd 250, 12 Mile SW of Superior, 1254 m (4113 ft), 47.031751, –114.961355, Mineral Co., nwMT, USA, 18 Sept 2000, #39-2000, J. C. Bergdahl, coll." One male.

   USFS Rd. 250 is Hoodoo Pass Road; the Pass is only about 5 miles SW of this site.

The Global Biodiversity Information Facility website (GBIF; 2020) lists 14 records for *S. regularis*, 5 of which are geo-referenced. Four of them are from Idaho (two from the Clearwater Basin, one from near North Fork and one from by Challis), and one from Montana. There is photo of the Montana specimen (Photo 5); its label reads: "Missoula Co., Mont.; 03 May 1969; W. Clements." The specimen's identity was determined by J.C. Burns in 1981. This beetle, which does appear to be *S. regularis* (large female?), is at the University of Arizona Insect Collection (UAIC No. 1009033).

Photo 5: *Scaphinotus regularis* specimen from Montana.
Source: University of Arizona Insect Collection (2020). University of Arizona Insect Collection. Occurrence dataset <https://doi.org/10.15468/hzkbpg> accessed via GBIF.org on 2020-12-26. Image at <https://www.gbif.org/occurrence/1932541650>

Some Distinguishing Characteristics of the *Scaphinotus (Pseudonomaretus)* Species

Gidaspow (1973: 25) provides a key to the genera of Cychrini of North America, and a key to the subgenera of *Scaphinotus* that occur in the Pacific Northwest (*Neocychrus*, *Stenocantharus*, *Brennus*, and *Pseudonomaretus*). Among other key features, *Pseudonomaretus* have "elytra quite completely striated" (Hatch 1953: 45), the striations numbering 13 to 16, and the males have broadly dilated protarsi (see photos 4–7 in Kavanaugh & Angel 2015). Unlike most other Pacific Northwest *Scaphinotus*, most *Pseudonomaretus* specimens have 2 pairs of long setae near the lateral margin of the pronotum, with one exception—*S. (P.) mannii*. The following comparisons may be useful for determining the identity of *Pseudonomaretus* species.

If one has access to a collection with a series of specimens of all five *Pseudonomaretus* species to compare, the following distinguishing characteristics become apparent. Some of these are mentioned by Kavanaugh & Angel (2015) in their key to all five species. There are of course gradations and some overlap should be expected. Lindroth's (1961: 20) key only includes *S. relictus* and *S. merkelii*.

The variation in the macrosculpture of the elytra of both *S. relictus* and *S. regularis* may cause some confusion regarding the placement of some of the specimens. Regarding *S. regularis*, Hatch (1953: 45) considers it a variety of the "typical form" of *S. relictus*. Similarly, Lindroth (1961: 20) states: "The highly inconstant elytral sculpture induced Leconte to describe one extreme as *regularis*, named after its regular punctuation of the intervals between the striae (except at apex)….Webb (1901, p. 134–136) found all transitions in Idaho." Lindroth therefore did not recognize it as a species either. Based on a comparison of male aedeagi, Gidaspow (1973) corrected this oversight, and subsequent authors have recognized *S. regularis* as a valid species (Bousquet & Larochelle 1993: 81; Bousquet 2012: 215). The striae Lindroth refers to are the obvious linear impressions running fore and aft on the upper surface of the elytra (see below). Large *S. regularis* in my collection are noticeably larger and wider than *S. relictus*, approaching even the size of *S. mannii*, the largest species in the subgenus. (Note: I have only one specimen of *S. mannii* in my collection, which is in excellent condition, but limits my understanding of the variation within the species.)

Apparent Body Size:

[ABL: length, from tip of mandibles to tail of carapace (fused elytra): average & range in mm; from Gidaspow (1973) and Kavanaugh & Angel (2015).]

S. merkelii—smallest overall body size (**median ABL=10.0**, range=9.9–12.2 mm)

S. hoodooensis—a little larger than *merkelii* (**median ABL=11.3**, range=10.1–12.4 mm)

S. relictus—this is the mid-size species in the genus, but it is quite variable (**median ABL=16.7**, range=13.0–20.3 mm). Kavanaugh & Angel (2015) indicate range of males=13.0–16.6

mm, and females=4.7–20.3 mm.

S. regularis—this species is especially variable. Typical *regularis* in my large collection are longer than *relictus*, with a wider carapace. Some *regularis* are quite large and approach the length of *mannii*, however their carapace is also usually proportionally wider. Gidaspow (1973) assessed *S. regularis'* ABL mean=16.4, and range=12–17.5 mm. Kavanaugh & Angel (2015) determined: males=14.0–16.6, and females=14.9–21.2 mm. I have many specimens >17.5 mm, including one ♀ collected by Eric van den Berghe from the Lowell (ID) area that measures 22 mm, and another ♀ the same length I collected along a small stream on South Lotus Peak by St. Maries, near Lake Coeur d'Alene (ID). Combining all these observations gives a **median of 17.5 mm** and a range of 13–22 mm.

S. mannii—this is clearly the largest species in the subgenus (**ABL=19.2**, range=16.5–22.5 mm)

Gidaspow (1973) indicates the females of *S. relictus*, *regularis* and *merkelii* are usually slightly larger than males, and *S. mannii* males and females do not differ much, whereas Kavanaugh & Angel (2015) indicate males of *S. hoodooensis* are slightly larger than females.

[Note: *Scaphinotus (Brennus) marginatus* (average ABL=14 mm) (Photo 1), which occurs throughout the range of *Pseudonomaretus*, is typically similar in size to *S. merkelii* and *S. hoodooensis*, however it is quite variable (range is 10–19 mm). *Scaphinotus (Stenocantharus) angusticollis* (ABL=18 mm; 16.5–24 mm) which co-occurs with *S. relictus* and *S. regularis* in BC's Selkirk and Monashee ranges, is similar in size to the three largest *Pseudonomaretus*. *Cychrus hemphillii* is another large cychrine that is found within the geo-range of *Pseudonomaretus* (ABL range=17–24 mm). How these body size differences affect their food habits and possible competition for food resources is unknown. The competitive landscape among cychrine species, if any exist, it probably quite variable even on a local scale.]

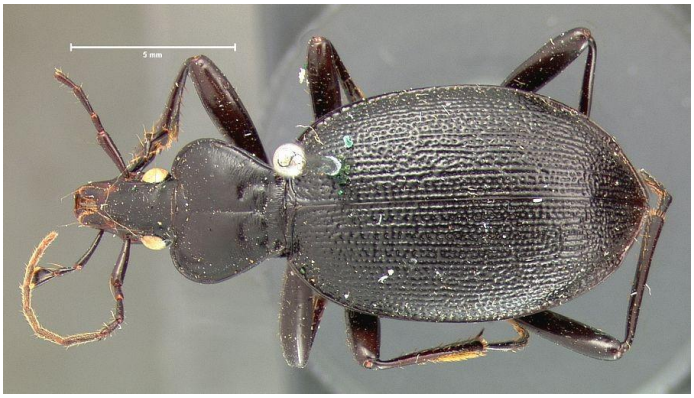

Photo 6: *Scaphinotus (Pseudonomaretus) relictus* (Horn, 1881) holotype specimen (Spokane, WA) showing haphazardly placed elytral punctuation and confused elytral striae, which usually easily separates it from *S. regularis*. Source: Harvard University M, Morris P J (2020). Museum of Comparative Zoology, Harvard University. Version 162.242. Museum of Comparative Zoology, Harvard University. Occurrence dataset <https://doi.org/10.15468/p5rupv> accessed via GBIF.org on 2020-12-26. Image MCZ:Ent:33480 *Cychrus relictus* habitus dorsal view at <https://www.gbif.org/occurrence/863599076>.

Basic ground color of body:

Typical mature adults of *S. merkelii* and *S. hoodooensis* are primarily dark brown or rufotestaceus, whereas *S. relictus* and *S. regularis* are more or less black. Teneral (immature) adult specimens are of course various shades of brown.

Elytra:

There are some differences in the macrosculpture of the elytra between some of the species:

S. relictus—can usually be identified by an abundance of punctures on the intervals (raised sections) between the linear striations on the elytra. These punctures, which are irregularly (haphazardly) arrayed in *relictus*, cause the intervals to be chaotically convoluted. This is often apparent in good light without the use of a scope. Hatch (1953: 45) describes this as "these [punctures] and the regular striae more or less confused, giving the typical examples about twenty very irregular and much interrupted striae." [Small *S. (P.) relictus* look very similar to large *S. (B.) marginatus*, which can be expected to co-occur with *relictus* throughout its range. They both usually have wavy elytral striae, and in interior regions *marginatus* are often black (instead of iridescent purple, green, etc.; Photo 1), like *relictus*. They can be usually be separated by the presence (*relictus*) or absence (*marginatus*) of a seta near each hind corner of the pronotum, best observed from an oblique view.]

S. regularis—punctures on the intervals limited primarily to those associated with a handful of setae (as with the other species), and a few punctures regularly placed on the intervals. Elytral striae also catenated (periodically joined to form a chain-like impression) in a few spots on 4th and 8th intervals (Hatch 1953: 45). These regularly arrayed features are also often apparent in good light without the use of a scope.

S. merkelii and *S. hoodooensis*—punctures limited to those in the striae, catenations few.

S. hoodooensis—punctures limited to those in the striae, catenations primarily associated with the area near the fovea where setae are inserted on intervals (Kavanaugh & Angel 2015: Fig. 1).

S. mannii—punctures limited to those in the striae and on interval 8, catenation primarily limited to the intervals just above the outside margin of the elytra.

Microsculpture:

The nuisance of the microsculpture of the exoskeleton of the dorsal surface of the pronotum and elytra is often a convenient and reliable trait for differentiation of closely related carabid species (Lindroth 1974; Ball 1985). Thorough assessments require a good scope and illumination, a keen eye, the patience to do a complete exam, and knowledge of the full range of possible variation. The nature of the microsculpture, which typically varies across the body of an individual, plays an important role in determining the sheen (and iridescence) of a beetle—e.g., a course/rough microsculpture produces a dull sheen (Seago et al. 2009). Erwin & Kavanaugh (1981: Fig. 7), Sproul & Maddison

(2018: Fig. 13), Maddison & Sproul (2020: Figs. 15, 16 & 17) provide photos of the range of variability in microsculpture in some closely related carabid taxa and terms to describe them. The microsculpture on the pronotum is typically similar to that on the elytra in *Pseudonomaretus* species.

Significant differences in microsculpture across *Pseudonomaretus* species have not been defined very well except for the following regarding the elytra:

S. mannii, *S. regularis* and *S. relictus*—dorsal surface of interval entirely etched by a fairly distinct, mostly isodiametric microsculpture, giving the carapace a slightly dull appearance.

S. merkelii and *S. hoodooensis*—more faint, slightly stretched microsculpture, giving the carapace a more shiny appearance.

Iridescence of elytra (luminous colors that seem to change when seen from different angles; metallic):

Iridescence is caused by the reflection of light, as determined primarily by the exoskeleton's surface microsculpture (Seago et al. 2009). There are no pigments involved. Iridescence within a species can be quite variable among individuals; therefore it does not by itself provide an adequate basis for designation of a specimen's identity (Lindroth 1961; Gidaspow 1973: 154).

S. merkelii and *S. hoodooensis*—elytra slightly iridescent; a small percentage obviously so (see Kavanaugh & Angel 2015: Fig. 1). *S. merkelii* is sometimes slightly metallic bronze or purplish (especially in more brownish colored specimens), whereas *S. hoodooensis* usually shows some purple highlights, in addition to bronze, in mature specimens. Hatch (1953: 45) refers to such coloration and iridescence as "cupreoviolaceous luster." One *merkelii* in my collection from near Powell (elev. 3775 ft; ID) has slight iridescence of a golden-green color.

S. relictus, *S. regularis* and *S. mannii*—not iridescent. (Note: extremely rare specimens of what appear to be *S. regularis* in my collection have a very slight purplish sheen.)

Pronotal setae (long stiff hairs):

The number of pairs of setae on the pronotum is regularly used in keys to *Scaphinotus* subgenera and species. The options are: one pair along the outside margin of the pronotum near its mid-section, and in some species another pair near the outside margin of the pronotum a little forward of the hind angle.

S. mannii—according to keys in Gidaspow (1973) and Kavanaugh & Angel (2015) this species does not have lateral setae at the base of the pronotum, a little forward of each of the hind corners of the pronotum, like, supposedly, all of the other *Pseudonomaretus* species. If this is correct, it would be any easy character to rely on to differentiate *S. mannii* from very large individuals of *S. regularis*, which are not uncommon.

Note: rare specimens of *S. relictus* and *regularis* do not have both setae at the hind corners of the pronotum. Also, one of the specimens of *Pseudonomaretus* from Seven Devils Mountains in my collection has double setae at each of the four locations on the pronotum, where most species in the subgenus have only one. Regarding *S. hoodooensis*, Kavanaugh & Angel (2015) observed "one specimen seen with a second midlateral seta unilaterally." As indicated clearly by this key characteristic in *S. mannii*, the occurrence of pronotal setae along the margin of the pronotum is variable in *Pseudonomaretus* and should be used with some discretion. Van Dyke (1938: 95) concludes the presence and absence of pronotal setae among *Scaphinotus* "are of less diagnostic value than was previously thought."

Lateral bead (piping along outer edge) and latero-basal fovea of the pronotum:

S. relictus and *S. regularis*—lateral bead widens somewhat, and is more elevated at rear corner. The latero-basal fovea just inboard on the lateral bead at the hind corners is well developed.

S. mannii, *S. merkelii* and *S. hoodooensis*—lateral bead is more or less the same size or widens only very slightly towards hind angle, and is not noticeably more elevated at rear corner. Less developed latero-basal fovea just inboard from the lateral bead at the hind corners.

Protarsi of front legs of males:

S. merkelii—protarsomeres 1 through 4 with a pad of adhesive setae ventrally.

S. relictus, *S. regularis*, *S. mannii*, and *S. hoodooensis*—protarsomeres 1 through 3 with a pad of adhesive setae ventrally; protarsomere 4 without adhesive pad.

Labrums (Kavanaugh & Angel 2015: Fig. 2):

S. mannii and *S. merkelii*—The labrums of these two species are noticeably longer and narrower than the other *Pseudonomaretus*.

S. relictus, *S. regularis* and *S. hoodooensis*—The labrums of these three are very similar and appear to be of little use for differentiating them. (*S. hoodooensis* are similar in body size to many *S. marginatus*, which occur in the same area; the *marginatus* in my collection from Idaho have noticeably longer labrums than *hoodooensis*.)

Comparison of the Geographic Ranges of the *Pseudonomaretus* Species

Ball & Bousquet (2001) state: "subgenus *Pseudonomaretus* Roeschke 1907. This group includes four species which collectively occupy the mountains of eastern Oregon, eastern Washington, Idaho, western Montana, southeastern British Columbia, and western Alberta, on the eastern slopes of the Rocky Mountains (Gidaspow 1973: 73–78)."

Our knowledge of the extent of the geographic ranges of the five *Pseudonomaretus* species is limited because no one has published a thorough review of the specimens in collections since Gidaspow's (1973) excellent monograph of *Scaphinotus* and *Cychrus* species, and she apparently did not list all the locales known to her. Neither Hatch (1953: 45) nor Lindroth (1961: 20) treated *S. relictus*. Contributions to our knowledge of *Pseudonomaretus* species since Gidaspow (1973) are limited to Greene's (1975) review of aspects of the ecology of the cychrine species at his study

sites in southeast Washington, Westcott et al.'s (2006) confirmation of Hatch's (1953: 46) record of *S. mannii* in northeast Oregon, Culpepper's (2011) thesis on the phylogeny of *Scaphinotus (Brennus)* species which includes data for *S. mannii* and *S. regularis*, Bergdahl's (2014) review of the four *Pseudonomaretus* species known at the time, and Kavanaugh & Angel (2015). Bousquet & Larochelle (1993), Bousquet (2012) and Bergdahl (2014) score each of the species for their occurrence in states and provinces. Table 1 updates current knowledge. These data are too coarse to shed much light on the nuances of the extent of the range of each species.

In their discussion on the geographical relationship of *S. hoodooensis* with the other species, Kavanaugh & Angel (2015: 389) state: "*Almost all locality records for other* Pseudonomaretus *species are from areas to the north and west of the type locality of* S. hoodooensis *and all are at lower elevations. Excluding [*S. hoodooensis*], the only records for the subgenus from Montana are for* S. merkelii *and* S. relictus*… While it is possible that the geographical ranges of* S. merkelii *and/or* S. relictus *may eventually be found to overlap with that* S. hoodooensis*, these species are likely restricted to elevations below the altitudinal range of* S. hoodooensis *and so are not likely to occur in the same habitat.*"

The last clause of the last sentence in this statement suggests *S. hoodooensis* is not only one the most southern of the *Pseudonomaretus* species, but also occurs at elevations higher than the other species. Records indicate this is incorrect on both accounts. Regarding elevation, *S. relictus* is common in the subalpine forest at the summit of Mt. Spokane (~5890 feet) and other peaks in the South and Central Selkirk ranges of the USA and Canada. The highest elevation record I have for *Pseudonomaretus* is *S. merkelii* from "Bend Cow Camp, MP 3.3 USFS Rd. 444, Gospel Hump Road, **2075 m (6810 ft)**, MF Slate/Salmon River watershed, 20 mi. SSE of Grangeville, 45.646552, –115.971982, Idaho County, c Idaho, USA, 16 August 2006, #109-2009, J.C. Bergdahl & G.J. McIntyre, coll." This is a forested (sub-alpine) site on a hillside with a very small creek running through it. The south escarpment of the Gospel Range defines the north side of the gorge of the main stem of the Salmon River east of Riggins. The southernmost record I have for *Pseudonomaretus* is *S. regularis* from 6065 ft in the Seven Devils Mountains by Riggins (ID). This locale is ~64 km (102 miles) SSW of Hoodoo Pass and 975 feet higher in elevation. I also have one record of *S. regularis* from near North Fork (ID). Furthermore, Gidaspow (1973: 61) indicates on her range map (Fig. 5) records of *S. regularis* as far south in the Bitterroot ranges as the Salmon/Challis area in Idaho, ~250 km (155 miles) SSE of Hoodoo Pass. According to GBIF (2020), *S. relictus*, and *S. merkelii*, have also been taken as far south as the Salmon area.

Table 2. Elevation range of *Scaphinotus (Pseudonomaretus)* species.
No species are known to occur above timberline. Low elevation=shrub/steppe and Ponderosa pine forest. Mid-elevation forest=Douglas-fir, Western red-cedar, western hemlock, and larch. High-elevation forest=mountain hemlock, fir, and spruce.

Species	LOW	MID	HIGH
S. mannii	+	+	–
S. relictus	+	+	+
S. regularis	+	+	+
S. merkelii	–	+	+
S. hoodooensis	–	–	+

The full range of the habitats utilized by all of the species is poorly known except *S. relictus*, which is an upland forest habitat generalist. Although they may all have slightly different habitat requirements, as suggested by Greene's (1975) limited observations, I would not be surprised if *S. merkelii*, *S. relictus*, *S. regularis*, *S. marginatus*, possibly even *Cychrus hemphillii*, were all found in the vicinity of *S. hoodooensis* at Hoodoo Pass.

Table 1 scores each *Pseudonomaretus* species for occurrence in the USA states and Canadian providences. Figure 1 provides a rough approximation of the geographic range of each of the *Pseudonomaretus* species. The map is based primarily on Lindroth (1961), Gidaspow (1973), GBIF (2020), and my own collection. What is known about the details of the ranges of each species is as follows, in order from *S. relictus*, with the most extensive range, to *S. hoodooensis*, which is at this time known only from a couple localities within a very small area. Geo-range notes can also be found in Bergdahl (2014). Van Dyke (1936) indicates the subgenus occupies the higher ranges of eastern Washington and Idaho, but it is actually much more extensive than this. Table 2 scores each species for elevation range.

The two species with significantly smaller body size (*merkelii* and *hoodooensis*) occur at higher elevations, possibly an adaptation of beetles with an obligate annual life cycle to a shorter growing season (activity period) and lower ecosystem productivity (Sota 1996). Species in the subgenus *Pterostichus (Pseudoferonina)*, which have also radiated in situ in central Idaho, are also not found in alpine habitats, and have some species specialized in either high and low elevation habitats, and some that are more generalized with regard to elevation range. It is tempting to speculate the specialists in each of these subgenera are derived evolutionarily from the generalists.

Scaphinotus relictus—The northernmost records are in British Columbia's North Selkirk Range in the Revelstoke area and in the Canadian Rockies in Yoho National Park (Lindroth 1961: 20). Gidaspow (1973) reports a few locales in Alberta just across the BC border from Yoho in the Jasper/Banff area. These are the only locale records I have seen from Alberta even though it is regularly reported in the literature as occurring in western Alberta. David Langor (*pers. comm.*, 19 Nov 2020) indicates he has never collected it in pitfall traps at his study sites on the east slope of the Rockies in southern Alberta, and there is only one (1968) specimen from Alberta (Banff) in the large carabid beetle collection at the University of Alberta (Edmonton). I have

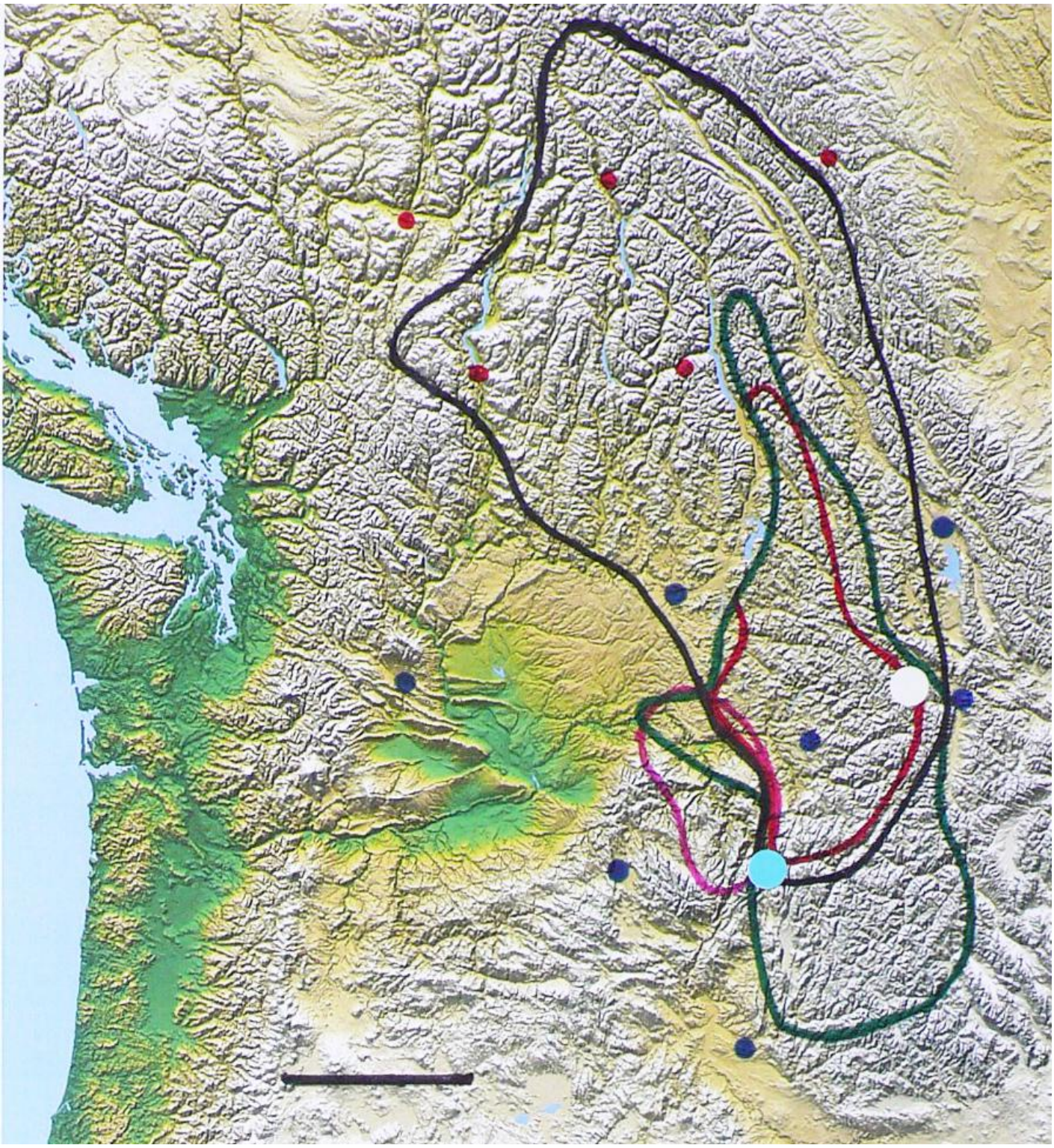

Figure 1: Rough approximation of the geographic ranges of *Scaphinotus (Pseudonomaretus)* species based on various sources of locality records. Black=*S. relictus*, dark green=*S. regularis*, red=*S. merkelii*, pink=*S. mannii*, white dot=*S. hoodooensis*, and light-blue dot=*S. reg. septemdiabolus*.

Cites: Canada (red dots)=BC: Penticton, Nelson, Kamloops, Revelstoke; AB: Banff; USA (blue dots)= OR: La Grande; ID: Boise, Pierce; WA: Ellensburg, Spokane; MT: Missoula, Kalispell. Pierce is situated in the heart of the so-called Clearwater Refugium. Scale bar=150 km.

Note: species populations are patchily distributed within their range limits due to many factors including the mountainous topography and convoluted courses of the many large rivers in the region.

collected *relictus* not too far from Alberta in northwest Montana (Stryker) in the Flathead River drainage north of Whitefish (Bergdahl 1999), but Edwards (1975) did not find it in the USA's Glacier National Park. Russell (1968) reports it from Sanders (NE of St. Regis) and Mineral (Lookout Pass) counties in Montana near the Idaho border. It is probably well establish in Montana's Yaak Valley and along the crest of the Bitterroots ca. Missoula. The westernmost records for the species are reliable records from just north of the International Border in the Penticton/Oliver area (Lindroth 1961:20). Stace Smith's records (Lindroth 1961: 20) from Copper Mountain (Princeton, BC) are near the crest of the Cascade Mountains. This beetle is probably common along the forested International Border between the Okanogan River and North Fork Flathead River. There is a record from Ellensburg (WA) at GBIF (2020), which is due south of the Penticton area on the east slope of the Cascade Mountains, but this point record on their map appears to be a mistake because it is associated with the holotype (Spokane, WA) (Photo 6). It is unclear how far south *S. relictus* ranges in Idaho. Gidaspow's (1973) range map does not show locales south of about Kooskia (Middle Fork Clearwater River). Kavanaugh & Angel (2015: Fig. 6) mention a locale on the lower Selway River near Lowell, which is in the Kooskia area, where I have also collected it. I have an old carapace that appears to be *S. relictus* I collected under a rock along a small creek at elev. 3600 ft, 12 mi SE of Idaho City (Boise County), in the Boise Mountains about 20 mile NE of Boise. This is not that far south from Banks, the southernmost site I know of for *S. regularis* in western Idaho (see below). Although I have seen no records from the upper Salmon River area near North Fork and Salmon, it may occur there since *S. regularis* has been able to establish populations that far to the southeast. A significantly outlying record from the upper Snake River basin near Pocatello (ID) at GBIF (2020) is suspect, and I have not included it in the range map (Figure 1). The information on the label of this single specimen, which is at the Monte L. Bean Life Science Museum, Brigham Young University, states: "IDAHO, Bannock Co., Pocatello, 15 June 1980; M. Hahn," determined by Jonathan W. Quist. Surveys should look for this beetle in southeast Idaho in montane forests between the town of Salmon and Bear Lake.

Gidaspow (1973: 77) mentions a record of *S. relictus* from the Siskiyou Mountains in the southwest corner of Oregon (Kerby, ca. Cave Junction, Josephine County), which is recognized by Bousquet (2012), but should be considered a mistake unless proven otherwise. These three specimens (dated "VII-18-30") are in the Van Dyke Collection at the California Academy of Sciences. Interestingly, the coastal disjunct arionid slug, *Prophysaon coeruleum* (blue-gray taildropper), has two especially noteworthy disjunct populations: 1) in the interior from Lake Coeur d'Alene south to Lapwai Creek in Nez Perce County by Lewiston, Idaho (Ovaska et al. 2002), and 2) in the Siskiyou Mountains in southwest Oregon (Wilke & Duncan 2004).

Scaphinotus relictus is by far the most common and widespread of the five *Pseudonomaretus* species. I have run pitfalls in the inland temperate rainforest region from BC's Central Selkirks to the forested buttes of the Washington Palouse south of Spokane. At most of my forested study sites it was the dominant carabid species. For instance, with a 9 cup trapline along Burping Brook on Mt. Spokane at elevation 1190 m (3900 ft) in a late successional, mixed hemlock-cedar-fir-latch grove, I caught 205 individuals between 01 June–22 August 1994. The same trapline captured 662 individuals between 07 July–23 October 1995. Other carabids at this site are *Zacotus matthewsii*, *Pterostichus herculaneus*, *Amerizus oblongulum*, *Trechus tenuiscapus*, *Notiophilus directus*, and the undescribed ice crawler *Grylloblatta* "spokanistan" (Bergdahl 2013), all of which occur at a much lower activity-density. *S. relictus* is also common in the sub-alpine forest near the summit of Mt. Spokane at elev. 5890 feet. It is also found in open dry Ponderosa pine forests bordering the Palouse grasslands, and its forested buttes, e.g., Turnbull National Wildlife Refuge (Cheney, WA).

S. regularis—Since Lindroth (1961) considered *S. regularis* synonymous with *relictus* he did not provide any collecting localities for it. The northernmost record I am aware of is in British Columbia at Mt. Kaslo in the Purcell Range (Gidaspow 1973). This is directly across the north arm of Kootenay Lake from the town of Kaslo, which is in the Central Selkirk Range. The records from BC further south near Creston are also in the Purcell Range. Both Charlene Wood and I have surveyed (independently) widely for carabids in the West Kootenay recently and have not found the species anywhere in BC. The westernmost records for *S. regularis* are in the Penticton/Oliver area in the Okanogan Valley just north of the US/Washington border. This is a long way westward from other records; since they are suspect I have not included them on the range map. Despite having surveyed hundreds of sites in the northeast sector of Washington where I have suspected *regularis* to occur, I have never collected it there. Gidaspow (1973: 78) claims *regularis* has almost the same range as *relictus* in eastern Washington, however this is incorrect since *relictus* is common in the northeast sector. Gidaspow (1973) does not mention any records from Washington except at Almota in the lower Snake River Canyon southwest of Pullman. Webb (1901) reports records a short distance up the Snake at Wawawai (WA). As with *S. relictus*, the species may occur south of the Snake in the southeast corner of Washington and the northeast corner of Oregon, an area I have not collected much. I have many specimens of *S. regularis* from Idaho, and the vast majority of records previously reported by others are also from Idaho. It is regularly encountered in the St. Joe, and North, Middle and South Fork Clearwater basins. In Idaho it probably ranges from the BC border all the way south to the Seven Devils Range east of Hells Canyon, in the South Fork Payette River drainage by Banks, and east to the mountains in Challis, Salmon and North Fork area in the upper Salmon River drainage by the Montana border. These upper Salmon sites appear to be significant southeastern outliers, however I have personally collected the beetle along small streams by North Fork. This area is essentially an extension of the Bitterroot Range; the species seems to occur universally on the forested west slope of the Bitterroots in Idaho especially at low and middle elevations. The only records I know of from Montana were

reported earlier in this paper; however it has probably crossed the Idaho border into Montana at a number of locations along the long reach of the Bitterroot Range.

S. merkelii—This species has a geographic range similar to *S. regularis*, however there are no records of it in Washington and its range in British Columbia appears to be limited to the Creston area (first collected there by the indefatigable beetle hunter Gordon Stace Smith), which is only ~15 miles north of the US/Idaho border [e.g., Goat/Arrow Mt. Lakes, 49.126298, –116.485233, 1435 m (4707 ft); in Lindroth (1961: 20)]. It can be found in the numerous small mountain ranges in Idaho just east of the Washington border in Latah, Benewah and Kootenai counties, including in the forested hills in the Moscow, St. Maries, and Coeur d'Alene areas, but I have never been able to find it on Mica Mountain or Mount Spokane, in Washington in the same area near the stateline. In Idaho it occurs all the way east to the crest of the Bitterroot Range, with one record of it in Montana at upper elevation on the east slope of the Bitterroots near Lookout Pass by St. Regis (Russell 1968). I have a specimen taken in Idaho at elevation 3725 ft near Lolo Pass, so it is probably also in Montana south of Missoula. The southernmost record I have for it is the locality I have already mentioned at high elevation in the Gospel Range on the north slope of the Salmon River Gorge. The Museum of Comparative Zoology lists a record at GBIF (2020) from 45.217105°, –114.780273° (south of the Salmon River mainstem in the Middle Fork of the Salmon River); but this must be a mistake since it is attached to the holotype specimen that should be from Coeur d'Alene in northern Idaho. Webb (1901) mentions he had three specimens reported from Collins (ID) dated 1898, one of which resides today at the Washington State University insect collection. No county is indicated. There are a number of towns in Idaho of this name but the most likely locale is "an area north of Bovill", in Latah County on the Potlatch River, according to the Potlatch Historical Society website. This is in the heart of *S. merkelii* country, in the unglaciated forested foothills in the western approach to the Bitterroot Mountains. It should be noted that the southernmost extent of the Pleistocene's Cordilleran Ice Sheet is approximately Interstate 90 (Silver Valley, South Fork Coeur d'Alene River) in northern Idaho; some species of flightless carabid beetles in Idaho have been unable to move much north of this line [e.g., both *Pterostichus (Pseudoferonina)* and *P. (Melvilleus)* species].

Photo 7: *Scaphinotus (Pseudonomaretus) merkelii* (Horn, 1890) holotype specimen (Coeur d'Alene, ID).
Source: Harvard University M, Morris P J (2020). Museum of Comparative Zoology, Harvard University. Version 162.242. Museum of Comparative Zoology, Harvard University. Occurrence dataset <https://doi.org/10.15468/p5rupv> accessed via GBIF.org on 2020-12-26. Image MCZ:Ent:34934 *Cychrus merkelii* habitus dorsal view at <https://www.gbif.org/occurrence/863597467>.

S. mannii—The geographic range of *S. mannii*, the largest species in the subgenus, is poorly known. Its type locality is Wawawai, Whitman Co., Washington, not too far from Pullman and Washington State University. For decades it has only been known from this area, and from Asotin, a little south of Clarkston (WA) near the north end of Hells Canyon, in Asotin Co. (southeasternmost corner of Washington). Hatch (1953) mentions a record from northeast Oregon but does not mention any locales. Westscott et al. (2006) reported the first specific Oregon collection from a riparian site near Troy (Wallowa Co.), in the Grande Ronde River watershed 3 miles south of the WA border, on the northeast slope of the Blue Mountains.

As mentioned before (Bergdahl 2014), it seemed inevitable *S. mannii* would eventually be found in Idaho in the lower Clearwater River basin or along the Snake River south of Lewiston, since the ecoregion the species associates with (Canyons and Dissected Uplands) extents into these areas. The topography is rather extreme in this area, the forest zones are highly fragmented due to xeric conditions, and the main rivers are very large and occupy deep convoluted canyons, hence numerous dispersal barriers to this flightless beetle should be expected to create a very patchy local distribution.

This is not the easiest area to collect; however in 2017 and 2018 biologists from Washington and Idaho state wildlife agencies surveyed for the species and substantially extended its known range. They were able to: 1) verify its occurrence in the Asotin Creek watershed (Asotin Co.,WA; Photo 9); and 2) extend its range to: a) the Tucannon River watershed on the northwest slope of the Blue Mountains above Dayton (Columbia Co., WA), b) south of the mainstem Grande Ronde into its tributary Joseph Creek, c) Craig Mountain Wildlife Management Area across from the mouth of the Grande Ronde (Nez Perce Co., ID), d) up Hells Canyon all the way to 16 km below Hells Canyon Dam (Granite Creek, Idaho Co., ID), and e) up the lower Salmon River Canyon to Slate Creek south of Whitebird (Idaho Co., ID) (Mark Vekasy, WA Dept. Fish & Wildlife, *pers. comm.*, 10 April & 20 November 2020). These are the first records of the beetle in Idaho; it probably also occurs in the lower Clearwater River basin east of Lewiston. Their Tucannon (WA) locale was also noteworthy because it pushes the elevation range for the species up to 870 m (2854 ft).

S. hoodooensis— Currently known only from the area in the vicinity of Hoodoo Pass near the crest of the Bitterroot Range on

Photo 8: *Scaphinotus (Pseudonomaretus) mannii* Wickhamm, 1919 specimen. This may be the holotype.
Source: Orrell T (2020). NMNH Extant Specimen Records. Version 1.38. National Museum of Natural History, Smithsonian Institution. Occurrence dataset <https://doi.org/10.15468/hnhrg3> accessed via GBIF.org on 2020-12-26. Image Scaphinotus_mannii_Wickham_D.tif at <https://www.gbif.org/occurrence/1320487909>.

either side of the ID/MT border at ca. elev. 5350–5900 ft (1630–1800 m), USFS Rd. 250, 16 miles SSE of Superior, Montana. See photo of Hoodoo Pass Meadows in Kavanaugh & Angel (2015).

Scaphinotus (Pseudonomaretus) regularis in Idaho's Seven Devils Mountains

In Bergdahl (2014) I mentioned I had found *Scaphinotus regularis* common at high elevation in the Seven Devils Mountains. Upon closer examination of the long series of specimens I collected there (14 ♀, 20 ♂), they appear to be subtly but consistently different from typical *S. regularis*. I refer to this population as *S. reg. septemdiabolus*.

My labels read:

1) ~10.0 MP USFS Rd. 517, elev. 6065 feet (1849 m), Nez Perce National Forest, South Fork Shingle Creek/Rapid River watershed, 10 miles SW of Riggins, Idaho Co., 45.388846, –116.455461, IDAHO, USA, 25 August 1998, #80–1998, J. C. Bergdahl, coll.

and

2) ~11.0 MP USFS Rd. 517, elev. 6360 feet (1939 m), 26 August 1998, #83–1998.

Total time spent collecting at these two sites was 2.0 hours. The end of USFS 517, trailhead to the Seven Devils Wilderness Area, is at Milepost 17; this is a steep road that climbs 5800 ft in this distance.

The source of the water in these roadside ditches was Papoose Creek, which was more or less dry when I was there. My samples in this area at high elevations also include: *Scaphinotus marginatus*, *S. relictus*, *Nebria carri*, *Pterostichus sphodrinus*, *P. ecarinatus*, *P. protractus*, and *Trechus* sp. The three samples I took along creeks at lower elevation in parched terrain along Seven Devils Road yielded no carabids whatsoever. Some of the interesting aspects of this series of *S. regularis* are: 1) I caught a lot of them with comparatively little effort; *S. regularis* is not uncommon in the area, but individuals are usually hand-collected infrequently and one or two in each sample, 2) although some of them are obviously teneral, the darkest of them are dark brown, not black, 3) the range of their body size is smaller than typical *regularis* and the mean ABL is slightly smaller, 4) the population seems to be extremely isolated at high elevation in the Seven Devils Mountains. The median lobe of the aedeagi I examined look very similar to *S. regularis*. Hence the differences are small in comparison to the similarities. I recommend anyone who does gene analysis of this species in the future include some specimens from this population in the samples. It should be noted that this Seven Devils population, and *S. hoodooensis* (whose aedeagi suggest the species is derived from *S. regularis*), are both situated geographically at the margin of the range of *S. regularis* (Figure 1),

Photo 9: Looking across Snake River gorge and *Scaphinotus mannii* habitat from Craig Mountain Wildlife Management Area (south of Lewiston, Idaho) towards Asotin/Grande Ronde area (southeast corner of Washington). Idaho Department of Fish & Game photo (cropped to fit).

Photo 10: View across Hells Canyon from Oregon towards the western escarpment and crags of Seven Devils Range, in west-central Idaho, a sky island defined by the canyons of the Salmon and Snake rivers. Stephen G. Dowlan photo.

providing, perhaps, an example of peripatric speciation on a mountainous landscape.

Concluding Statement

Hunting for *Pseudonomaretus* is one of the great pleasures of carabid beetling in Idaho—one the most remote, undeveloped, rugged, difficult to access, large and poorly collected wilderness areas in the lower 48 states. The challenges a collector must confront due to the size and topographic complexity of the region are hard to appreciate until one attempts to make significant inroads. Compared to coastal regions west of the Cascades Mountains, the density of carabid beetles in Idaho is very low, and trying to find them can be very frustrating. This is probably because of the much drier summers than coastal regions, more severe winters, more extreme and frequent forest fires, and competition with (and predation by) ants, which are especially abundant. The climate is much wetter in north Idaho, and even wetter in British Columbia's Columbia Mountains, where one can find a number of coastal carabid species with noticeably disjunct geographic distributions co-occurring with classic Rocky Mountain species. The northernmost range of *Pseudonomaretus* is in the Roger Pass area (Glacier National Park, BC), in the heart of the Inland Temperate Rainforest (aka Interior Wetbelt) region (ITR), which consistently has the highest recorded winter snowfall of any location in Canada (average max = 45.5 feet per year). The ITR reaches its southern extent in the South Fork Clearwater River basin in central Idaho (Daubenmire 1956, 1975; Björk 2010; Coxson et al. 2019). Between there and the St. Joe River basin near Interstate 90, the terrain largely escaped Pleistocene glaciations except for comparatively small local alpine glaciers (ice caps) associated with the some of the highest ranges (Dingler & Breckenridge 1982). North of the St. Joe, especially in British Columbia, any refugia are likely to have been limited to small alpine nunataks (Figure 2).

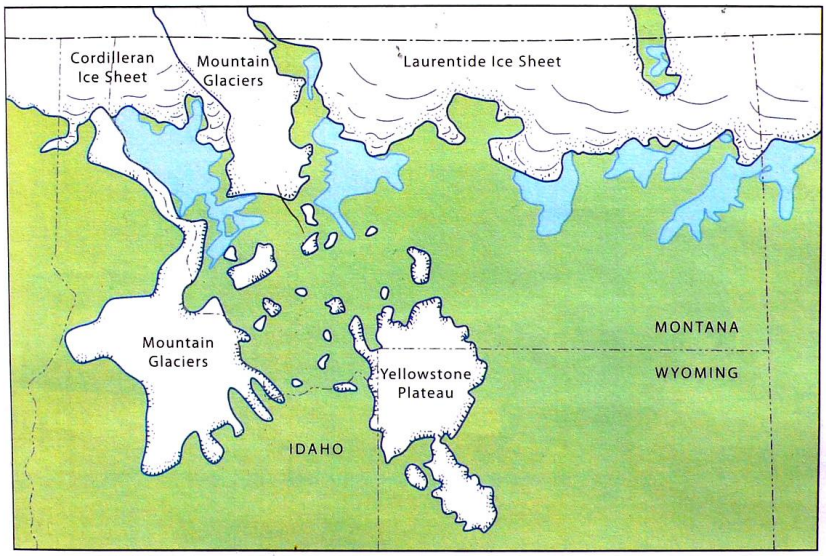

Figure 2: Extent of glaciers in the central Rocky Mountains complex along the International Border during the Last Glacial Maximum ~25,000 years ago, based on Hill (2001). This map focuses on glaciations in Montana; there were many small ice caps in north-central Idaho associated with the high ranges just west of the Bitterroot Crest (ID/MT border) that are not indicated on this map. Dingler & Breckenridge (1982) identify dozens of them in the Middle Fork Clearwater basin between the Lochsa and Selway rivers alone. The Seven Devils Ice Cap is the westernmost thumb on the lower left, but the ice free gorge of the mainstem Salmon River a little to the east is not indicated. Spokane (and Interstate Highway 90) is at the end of the dangling narrow glacial tongue in the upper left hand corner of the map. From: Kerry R. Foresman (2012), Mammals of Montana. (Reprinted with permission of the author.)

There is an abundance of evidence that the ITR survived in many different ("compartmented") climatic refugia in Idaho in the many protected valleys and deep canyons in the St. Joe and Clearwater River basins, the so-called Clearwater Refugium (Daubenmire 1956: 150; Brunsfeld et al. 2001, 2006, 2007; Carstens et al. 2005a; Rankin et al. 2019). In addition to forest refugia in sheltered regions on the flanks of the Bitterroots, western Idaho has many never-glaciated sky island mountains ranges that allowed for in situ (local) elevational migration of species to compensate for the climatic variation, and many forest expansion and contraction cycles, that cycled through the Pleistocene glacial and interglacial periods (Bergdahl 2013, 2020). One of the best lines of evidence in this regard is the long list of plants and animals species that are endemic to the ITR region in Idaho (e.g., plants: Daubenmire 1956; Björk 2010; terrestrial slugs and snails: Wilke & Duncan 2004; Lucid et al. 2018a, 2018b, Rankin et al. 2019, Ovaska et al. 2019; amphibians: giant salamanders, Steele et al. 2005, Carstens et al. 2005b; plethodontid salamanders, Carstens et al. 2004; and tailed frogs, Nielson et al. 2001). Björk (2010) itemized 112 vascular plants with coastal disjunct distributions across the full extent of the ITR in the USA and Canada, and 95 endemic vascular plants species (46 of these endemics are forest species), and showed they were concentrated in northern and central Idaho. According to Daubenmire (1956: 150), many of these endemics are "remnants of Miocene populations that became extinct elsewhere in the Rocky Mountain region" and are now associated with mild-wet climatic refugia associated with the west slope (windward) of the Bitterroot Mountains in the greater Clearwater River basin area. In the discussion above about the new *S. hoodooensis* record I mentioned a number of regional endemic carabid species found in the Clearwater River area. Although a list of insect species that are coastal disjunct or endemic in the ITR region has not been published, it is clear that the center of diversity of the *Scaphinotus* subgenus *Pseudonomaretus*, which is only found in interior regions of the Pacific Northwest, is central Idaho. The PNW endemic carabid subgenus *Pterostichus (Pseudoferonina)* (Bergdahl & Kavanaugh 2011) has also radiated in the ITR, with at least 13 species in central Idaho, some undescribed, and all of them only occurring south of the southern limit of the Cordilleran Ice Sheet in northern Idaho (Bergdahl, *in prep.*). Molecular-genetic studies of many *Pseudonomaretus* and *Pseudoferonina* populations will someday indicate whether there are any cryptic species, and the species' history of the survival in multi-compartmentalized refugia or on the numerous

unglaciated sky islands, and subsequent post-Pleistocene dispersal into their current geographic ranges.

Hopefully this will be accomplished soon so as to inform state and federal "best practices" conservation priorities before the commercial timber industry's destruction of the many exceptional and largely unknown ITR endemic invertebrate species, and their unique habitats, reaches a point of no return. There are many local small-range endemics yet to be discovered (e.g., Bergdahl & Kavanaugh 2011). For instance, the terrestrial mollusk fauna of the region is fairly well known (Frest & Johannes 1995), yet Leonard et al. (2011) recently described a new genus and species of arionid axetail slug (*Securicauda hermani*) from mid elevations in the St. Joe River basin by Lake Coeur d'Alene. The habitats of flightless hygrophilic endemic species of invertebrates, especially those whose habitat is the margins of small (0-2 order) streams, are especially at risk because of standard forest practices, especially on private timberlands, which generally prescribe no-harvest buffers that range from very narrow to non-existent to "preserve" the riparian-zone biota in their care. A much better understanding of the ecology and distribution of small-range endemics is key to maximizing the benefits of our efforts to conserve biodiversity in the Pacific Northwest (Harvey et al. 2011).

George Ball (1926–2019), one of North American's most experienced and inspirational carabidologists of the last 50 years (Rice 2017; Spence et al. 2019), published on *Scaphinotus* biogeography in the American West early in his career (Ball 1965, 1966). He also provided some astute observations many years ago (Ball 1973) on the impacts of logging on endemic carabid beetles on forested sky islands in Mexico, where "the destruction of native forests is proceeding at an incredible rate", that apply equally well to the Pacific Northwest in my experience: "For those who want to obtain a sample of the Mexican beetle fauna, the time to go is now. If the destruction continues at present rates, I imagine a few more years will see the elimination of most of the native vegetational formations, and with them a substantial portion of the fauna…Montane faunas are especially interesting because study of them has contributed so much to our understanding of evolution at the species level. Although Mexico is richly endowed with mountains, most of the more or less accessible ones have lost their native habitats. Therefore it is impossible to know much about the distribution and interrelationships of their biota. Consequently, it is especially important to sample as thoroughly as possible those mountains that still have a more or less continuous cover of native vegetation." Guarnieri (2015) recently documented significant declines and loss of some *Scaphinotus* species from the State of Maryland.

There are 114 named mountain ranges in Idaho alone (<https://en.wikipedia.org/wiki/List_of_mountain_ranges_in_Idaho>), and no comprehensive insect survey of any of them (e.g., Moore et al. 2013). The great extent and intensity of clearcut logging practices in the "operable forest" regions of the upper Columbia River basin of the interior PNW is easily observable by close examination of satellite images at the website Google Earth (<https://www.earth.google.com>). The impacts of standard logging operations on the terrestrial invertebrate fauna of the region are reviewed by Jordan & Black (2012). The region's montane life zones are also at risk of an unsettling re-organization caused by the continuing trend in climate change (e.g., Daubenmire 1956; Brusca et al. 2013; Fave et al. 2015; Herring & Gavin 2015), yet we really have no idea how these impacts are likely to affect the region's unique forest invertebrate fauna.

Montane sky islands require special forest management programs due to their physical isolation from other ranges with similar habitat, and the many species that depend on them with limited dispersal power (Voller & MacKinnon 2000). Two examples are the vulnerability of many of the last remaining Western red-cedar and mountain hemlock groves at the south end of their range in the Rockies in central Idaho (Mathys et al. 2017). Mitchell & Ober (2013) show that predicted changes to the climate may result in the disappearance of *Scaphinotus* from some of the lower ranges in the West by the end of this century. Commercial logging in these montane, sky-island forests is likely to exasperate the problem. The trend in climate warming and drying will certainly increase the frequency of stand replacing fires in a region that is already very fire prone; Pierce et al. (2004) estimate large fires burned 50% of the forest canopy in the Boise National Forest between 1908–2000. Changes in foraging substrate, prey availability, stream hydrographs, landslide frequency, or microclimatic conditions caused by fire interact with life history characteristics to influence the abundance and diversity of forest carabids (Harris & Whitcomb 1974: Niwa & Peck 2002), including the local extirpation of some old-forest dependent species (Holliday 1992; Saint-Germain et al. 2005). The distribution of *Pseudonomaretus* in the southern half of their range, where their genetic diversity is likely to be the highest, is probably already negatively influenced by historic forest fire frequencies. To put the great conservation needs of many of Idaho's endemic forest insects in perspective, it is worth noting that in 2013 the U.S. Forest Service (Boise National Forest) intentionally burned one of only two known sites (of many surveyed) of the very small-

Photo 11: Pine Flat Creek just above confluence with South Fork Payette River, near Lowman, Boise County, Idaho, 29 May 2013. This is a *Scaphinotus regularis* locality and *Pterostichus bousqueti*'s type locality. See Bergdahl & Kavanaugh (2011: Fig. 6B) for a photo of this sparsely wooded creek taken before the controlled burn. J. C. Bergdahl photo.

range endemic, flightless, hygrophilic carabid beetle, *Pterostichus bousqueti* Bergdahl, at the Pine Flat Creek campground area despite their wildlife biologists in the Lowman Range Station knowing about this beetle's acute habitat specialization and extreme rarity. This is a very dry, south facing hillside. They made no effort to buffer the small creek from their controlled burn. The area was also partially logged after the burn. Both practices fail to meet basic standards consistent with the precautionary principle for extremely rare, locally endemic species. If our goal is to both log forests commercially and conserve biodiversity, then we will need to make a much better effort to fully appreciate what exactly we are responsible for protecting, and do a better job of getting resource managers to take special care of our most sensitive and localized at-risk species.

Acknowledgements

Glada McIntyre has driven many 1000s of miles of logging roads with me in the ITR region of Canada and the USA to survey small creeks for carabid beetles since 2000, focusing on Idaho. Holly Weiler (Spokane, WA) provided the photos of the larva and two cirque lakes near Hoodoo Pass. Steve Dowlan provided the photo of the Seven Devils Range. Mark Vekasy (WA Department of Fish & Wildlife, Walla Walla) was kind enough to provide a little information on the State's recent surveys for *S. mannii*. Claudia Copley and Charlene Wood (Royal British Columbia Museum, Victoria), Karen Needham (University of British Columbia Spencer Entomological Museum, Vancouver), and Dave Langor (Canadian Forest Service, Edmonton) helped with records from British Columbia and Alberta. Shawn Clark (Monte L. Bean Life Science Museum, Brigham Young University, Provo) helped with the *S. relictus* specimen purported to be from the Pocatello area, and Chris Grinter (California Academy of Sciences) helped with the suspect *S. relictus* from Kerby, Oregon. Kerry R. Foresman kindly allowed reprinting of Figure 2. George Ball (University of Alberta), Jim Liebherr (Cornell University), and Dave Kavanaugh (California Academy of Sciences) helped with some carabid species identifications. Some of my early work on the ITR carabid fauna was supported by the University of Washington, the Montana State Natural Heritage Program, the Valhalla Wilderness Society, and the Yellowstone–to–Yukon Conservation Initiative. Ron Lyons provided many helpful suggestions to improve this paper; it is unfortunate he will no longer be the editor of this great little journal.

References

Ball, G.E. 1965. The genus *Scaphinotus* (Coleoptera: Carabidae) and the Pleistocene Epoch in southwestern United States. Pp. 460–461, in: P. Freeman (ed.), Proceedings of the XII International Congress of Entomology (1964), London, UK. 842 p.

Ball, G.E. 1966.The taxonomy of the subgenus *Scaphinotus* Dejean with particular reference to subspecies of *Scaphinotus petersi* Roeschke (Coleoptera: Carabidae: Cychrini). Transactions of the American Entomological Society 92: 687–722.

Ball, G.E. 1973. Collecting in Mexico. The Coleopterists' Bulletin 27(3): 154–156.

Ball, G.E. 1985. Characteristics and evolution of elytral sculpture in the tribe Galeritini (Coleoptera: Carabidae). Quaestiones Entomologicae 21: 349–367.

Ball, G.E. & Y. Bousquet. 2001. Family 6. Carabidae Latreille, 1810. Pp. 32–132 in: R. H. Arnett & M. C. Thomas (eds.), American Beetles. Volume 1. Archostemata, Myxophaga, Adephaga, Polyphaga: Staphyliniformia. CRC Press, Boca Raton, FL. 443 p.

Bergdahl, J.C. 1995. Ecology and biogeography of the ground beetles (Coleoptera: Carabidae) of the Pacific Northwest of North America. Washington Research Foundation Hall-Ammerer Interdisciplinary Science Fellowship Report, Institute of Environmental Studies, University of Washington, Seattle, WA. 234 p.

Bergdahl, J.C. 1999. Carabid beetle fauna (Coleoptera, Carabidae) associated with wetlands of the Flathead River Valley of northwest Montana. Nature Conservancy/Montana Natural Heritage Program, Helena, MT. 23p.

Bergdahl, J.C. 2012. Carabid beetles of Oregon, USA: 1. Some general characteristics of the fauna. Bulletin of the Oregon Entomological Society Winter 2012/2013: 1–4.

Bergdahl, J.C. 2013. Two lost undescribed ice crawler species from the Pacific Northwest – *Grylloblatta* "*olympica*" and *G.* "*vancouverensis*", species incognitus (Insecta, Notoptera, Grylloblattidae). Bulletin of the Oregon Entomological Society Winter 2013/2014: 1–13.

Bergdahl, J.C. 2014. Carabid beetles (Coleoptera, Carabidae) of the Pacific Northwest, USA: *Scaphinotus (Pseudonomaretus) mannii* Wickham (Cychrini). Bulletin of the Oregon Entomological Society Winter 2014/2015: 1–12.

Bergdahl, J.C. 2019. Carabid beetles (Coleoptera, Carabidae) from Pacific coastal regions of south Alaska and Haida Gwaii (British Columbia), with comments on the biological legacy of the Kodiak Island Refugium. Report No. 2019–3, Conservation Biology Center, Spokane, Washington, USA.

Bergdahl, J. C. 2020. The indigenous ground-beetle fauna of North America's Pacific Northwest Vancouveran Region (Coleoptera: Geadephaga: Carabidae, Trachypachidae, Rhysodidae): species composition, diversity patterns, ecology, evolution, and conservation. Report No. 2020–2. Conservation Biology Center, Spokane, WA.

Bergdahl, J.C. & D.H. Kavanaugh. 2011. Two new species of *Pterostichus* Bonelli subgenus *Pseudoferonina* Ball (Coleoptera: Carabidae: Pterostichini) from the mountains of central Idaho, USA. ZooKeys 104: 77–96.

Björk, C.R. 2010. Distribution patterns of disjunct and endemic vascular plants in the interior wetbelt of northwest North America. Botany 88: 409–428.

Bousquet, Y. 2012. Catalogue of Geadephaga (Coleoptera: Adephaga) of America, north of Mexico. ZooKeys 245: 1–1722.

Bousquet, Y. & A. Larochelle. 1993. Catalogue of the Geadephaga (Coleoptera: Trachypachidae, Rhysodidae, Carabidae including Cicindelini) of America north of Mexico. Memoirs of the Canadian Entomological Society No. 16. 397 p.

Bousquet, Y. & J. Pilon. 1980. Habitat et cycle biologique des *Sphaeroderus* du Quebec (Coleoptera; Carabidae: Cychrini). Les Naturaliste Canadien 107: 175–184.

Brunsfeld, S.J., J. Sullivan, D.E. Soltis & P.S. Soltis. 2001. Comparative phylogeography of northwestern North America: a synthesis. Pp. 319–339, in: J. Silvertown & J. Antonovics (eds.), Integrating ecology and evolution in a spatial context. Blackwell Publ., Williston, VT. 423 p.

Brunsfeld, S.J. & J. Sullivan. 2006. A multi-compartmented glacial refugium in the northern Rocky Mountains: evidence from the phylogeography of *Cardamine constancei* (Brassicaceae). Conservation Genetics 6(6): 895–904.

Brunsfeld, S.J., T.R. Miller & B.C. Carstens. 2007. Insights into the biogeography of the Pacific Northwest of North America: evidence from the phylogeography of *Salix melanopsis*. Systematic Botany 32(1): 129–139.

Brusca, R.C., J.F. Wiens, W.M. Meyer, J. Eble, K. Franklin, J. T. Overpeck & W. Moore. 2013. Dramatic response to climate change in the Southwest: Robert Whittaker's 1963 Arizona Mountain plant transect revisited. Ecology and Evolution 3(10): 3307–3319.

Busato, E. 2009. Biological cycle and larval morphology of *Cychrus cordicollis* Chaudoir 1835 (Coleoptera: Carabidae). Annales de la Société Entomologique de France 45(2): 177–186.

Camp, C.D. & J.A. Wooten. 2016. Hidden in plain sight: cryptic diversity in the Plethodontidae. Copeia 104(1): 111–117.

Carstens, B.C., A.L. Stevenson, J.D. Degenhardt & J. Sullivan. 2004. Testing nested phylogenetic and phylogeographic hypotheses in the *Plethodon vandykei* species group. Systematic Biology 53(5): 781–792.

Carstens, B.C., S.J. Brunsfeld, J.R. Demboski, J.M. Good & J. Sullivan. 2005a. Investigating the evolutionary history of the Pacific Northwest mesic forest ecosystem: hypothesis testing within a comparative phylogeographic framework. Evolution 59(8): 1639–1652.

Carstens, B.C., J.D. Degenhardt, A.L. Stevenson & J. Sullivan. 2005b. Accounting for coalescent stochasticity in testing phylogeographical hypotheses: modelling Pleistocene population structure in the Idaho giant salamander *Dicamptodon aterrimus*. Molecular Ecology 14(1): 255–265.

Coxson, D., T. Goward & J.R. Werner. 2019. The Inland Temperate Rainforest and Interior Wetbelt Biomes of Western North America. Encyclopedia of the World's Biomes. 88–102.

Culpepper, M.S. 2011. Phylogeny of the ground beetles belonging to *Scaphinotus*, subgenus *Brennus* (Coleoptera: Carabidae). Unpublished M.Sc. Thesis, San Francisco State University, San Francisco, California, USA. 94 p.

Daubenmire, R., 1952. Forest vegetation of northern Idaho and adjacent Washington, and its bearing on concepts of vegetation classification. Ecological Monographs 22(4): 301–330.

Daubenmire, R. 1956. Climate of as determinant of vegetation distribution in eastern Washington and northern Idaho. Ecological Monographs 26(2): 131–154.

Daubenmire, R. 1975. Floristic plant geography of eastern Washington and northern Idaho. Journal of Biogeography 2(1): 1–18.

Dingler, C.M. & R.M. Breckenridge. 1982. Glacial reconnaissance of the Selway-Bitterroot Wilderness Area, Idaho. Pp. 645–652, in: B. Bonnichsen & R. Breckenridge (eds.), Cenozoic Geology of Idaho. Idaho Bureau of Mines and Geology Bulletin 26, Boise, ID. 740 p.

Edwards, J.G. 1975. The Carabidae of Glacier National Park, Montana. The Coleopterists' Bulletin 29(1): 47–58.

Erwin, T.L. & D.H. Kavanaugh. 1981. Systematics and zoogeography of *Bembidion* Latreille: 1. The *carlhi* and *erasum* groups of western North America (Coleoptera: Carabidae, Bembidiini). Entomologica Scandinavica Supplement 15: 33–72.

Favé, M.-J., R.A. Johnson, S. Cover, S. Handschuh, B.D. Metscher, G.B. Müller, S. Gopalan & E. Abouheif. 2015. Past climate change on Sky Islands drives novelty in a core developmental gene network and its phenotype. BMC Evolutionary Biology 15: 183.

Foresman, K.R. 2012. Mammals of Montana. 2nd Edition. Mountain Press Publishing Co., Missoula, MT. 429 p.

Frest, T.J. & E.J. Johannes 1995. Interior Columbia Basin mollusk species of special concern. Final Report Contract #43-0E00-4-9112. Washington: Interior Columbia Basin Ecosystem Management Project. 274 p.

Global Biodiversity Information Facility (GBIF). 2020. (see below.)

Gidaspow, T. 1968. A revision of the ground beetles belonging to *Scaphinotus*, subgenus *Brennus* (Coleoptera, Carabidae). Bulletin of the American Museum of Natural History 140: 135–192.

Gidaspow, T. 1973. Revision of ground beetles of American genus *Cychrus* and four subgenera of genus *Scaphinotus* (Coleoptera, Carabidae). Bulletin of the American Museum of Natural History 152: 53–98.

Greene, A. 1975. Biology of the five species of Cychrini (Coleoptera: Carabidae) in the steppe region of southeastern Washington. Melandria 19: 1–41.

Guarnieri, F.G. 2015. Notes on the historical distribution of species in the genus *Scaphinotus* Dejean (Coleoptera: Carabidae: Cychrini), the snail-eating ground beetles, in Maryland. The Maryland Entomologist 6(3): 2–11.

Harris, D.L. & W.H. Whitcomb. 1974. Effects of fire on populations of certain species of ground beetles (Coleoptera: Carabidae). The Florida Entomologist 57(1): 97–103.

Harvey, M.S., M.G. Rix, V.W. Framenau, Z.R. Hamilton, M.S. Johnson, R.J. Teale, G. Humphreys & W.F. Humphreys. 2011. Protecting the innocent: studying short-range endemics taxa enhances conservation outcomes. Invertebrate Systematics 25: 1–10.

Hatch, M.H. 1953. The Beetles of the Pacific Northwest. Part 1: Introduction and Adephaga. University of Washington Press, Seattle, Washington, USA. 340 p.

Herring, E.M. & D.G. Gavin. 2015. Climate and vegetation since the Last Interglacial (MIS 5e) in a putative glacial refugium, northern Idaho, USA. Quaternary Science Reviews 117: 82–95.

Hill, C.L. 2001. Pleistocene mammals of Montana and their geologic context. Pp. 127–143. in: C. L. Hill (ed.), Mesozoic and Cenozoic Vertebrate Paleontology in the Western Plains

and Rocky Mountains (61st Meeting of the Society of Vertebrate Paleontology), Museum of the Rockies Occasional Paper No 3, Montana State University, Bozeman, MT.

Holliday, N.J. 1992. Carabid fauna (Coleoptera: Carabidae) during postfire regeneration of boreal forest: properties and dynamics of species assemblages. Canadian Journal of Zoology 70: 440–452.

Imura, Y., O. Tominaga, Z.-H. Su, N. Kashiwai, M. Okamota & S. Osawa. 2018. Evolutionary history of carabid ground beetles with special reference to morphological variations of the hind-wings. Proceedings of the Japanese Academy (Series B) 94(9): 360–371.

Jordan, S.F. & S.H. Black. 2012. Effects of forest land management on terrestrial mollusks: A literature review. Prepared for Interagency Special Status and Sensitive Species Program, USDA Forest Service, Region 6 and USDI Oregon/Washington Bureau of Land Management. 87 pp.

Kavanaugh, D.K & A.W. Angel. 2015. A taxonomic review of the northwestern Nearctic subgenus *Pseudonomaretus* Roeschke 1907, including description of the new species *Scaphinotus hoodooensis* (Coleoptera: Carabidae: Cychrini) from the Bitterroot Mountains of Montana. Proceedings of the California Academy of Sciences, Series 4, Vol. 62, Part 2, No. 14: p. 381–396.

Larochelle, A. 1972a. On the biology of some *Scaphinotus* and *Sphaeroderus* (Coleoptera: Carabidae). Proceedings of the Entomological Society of Washington 74: 474.

Larochelle, A. 1972b. Notes on the food of Cychrini (Coleoptera: Carabidae). The Great Lake Entomologist 5(3): 81–83.

Lavallee, S.L. 2006. Ecology and condition of the ground beetle *Scaphinotus angusticollis* and distribution of it prey in Pacific Northwest riparian forests. Ph. D. Dissertation, Department of Forest Sciences, University of British Columbia, Vancouver, BC. 115 p.

Leonard, W.P., L. Chichester, C.H. Richart & T.A. Young. 2011. *Securicauda hermani* and *Carinacauda stormi*, two new genera and species of slug from the Pacific Northwest of the United States (Gastropoda: Stylommatophora: Arionidae), with notes on *Gliabates oregonius* Webb 1959. Zootaxa 2746(1): 43–56.

Lindroth, C.H. 1961. The ground-beetles (Carabidae, excl. Cicindelinae) of Canada and Alaska. Part 2. Opuscula Entomologica Supplementum 20: 1–200.

Lindroth, C.H. 1969. The ground-beetles (Carabidae, excl. Cicindelinae) of Canada and Alaska, Part 1. Opuscula Entomologica Supplementum *35:* I–XLVIII.

Lindroth, C.H. 1974. On elytral microsculpture of carabid beetles (Coleoptera: Carabidae). Entomologica Scandinavica 5: 251–264.

Lucid, M.K., A. Rankin, A. Espindola, L. Chichester, S. Ehlers, L. Robinson & J. Sullivan. 2018a. Taxonomy and biogeography of *Hemphillia* (Gastropoda: Pulmonata: Arionidae) in North American rainforests, with description of a new species (Skade's jumping-slug, *Hemphillia skadei* sp. nov.). Canadian Journal of Zoology 96: 305–316.

Lucid, M.K., S. Ehlers, L. Robinson & S.A. Cushman. 2018b. Beer, brains, and brawn as tools to describe terrestrial gastropod species richness on a montane landscape. Ecosphere 9(12): e02535.10.1002/ecs2.2535.

Maddison, D.R. & J.S. Sproul. 2020. Species delimitation, classical taxonomy and genome skimming: a review of the ground beetle genus *Lionepha* (Coleoptera: Carabidae). Zoological Journal of the Linnean Society 189(4): 1313–1358.

Mathys, A.S, N.C. Coops & R.H. Waring. 2017. An ecoregion assessment of projected tree species vulnerabilities in western North America through the 21st century. Global Change Biology 23(2): 920-932.

Mitchell, S. & K.A. Ober. 2013. Evolution of *Scaphinotus petersi* (Coleoptera: Carabidae) and the role of climate and geography in the Madrean sky islands of southeastern Arizona, USA. Quaternary Research 79: 274–283.

Moore, W., W.M. Meyer, J.A. Eble, K. Franklin, J.F. Wiens & R.C. Brusca. 2013. Introduction to the Arizona Sky Island Arthropod Project (ASAP): Systematics, biogeography, ecology, and population genetics of arthropods of the Madrean Sky Islands. Pp: 144–168, in: G.J. Gottfried, P.F. Ffolliott, B.S. Gebow, L.G. Eskew & L.C. Collins (eds.), Merging science and management in a rapidly changing world: Biodiversity and management of the Madrean Archipelago III, and Proceedings of the 7th Conference on Research and Resource Management in the Southwestern Deserts; 2012 1–5 May 2012, Tucson, AZ. RMRS-P-67, Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO, USA.

Nielson, M., K. Lohman & J. Sullivan. 2001. Phylogeography of the tailed frog (*Ascaphus truei*): implications for the biogeography of the Pacific Northwest. Evolution 55(1): 147–160.

Niwa, C.G. & R.W. Peck. 2002. Influence of prescribed fire on carabid beetle (Carabidae) and spider (Araneae) assemblages in forest litter in southwestern Oregon. Environmental Entomology 31(5): 785–796.

Ober, K., B. Matthews, A. Ferrieri & S. Kuhn. 2011. The evolution and age of populations of *Scaphinotus petersi* Roeschke on Arizona Sky Islands (Coleoptera, Carabidae, Cychrini). ZooKeys 147: 183–197.

Ovaska, K. & M.A. Smith. 1988. Predatory behavior of two species of ground beetles (Coleoptera: Carabidae) towards juvenile salamanders (*Plethodon vehiculum*). Canadian Journal of Zoology. 66(3): 599–604.

Ovaska, K., W.P. Leonard, L. Chichester, T.E. Burke, L. Sopuck & J. Baugh. 2004. *Prophysaon coeruleum* Cockerell, 1890, blue-gray taildropper (Gastropoda: Arionidae): new distributional records and reproductive anatomy. Western North American Naturalist 64(4): 538–543.

Ovaska, K., L. Sopuck & J. Heron. 2019. Surveys for terrestrial gastropods in the Kootenay region of British Columbia, with new records and range extensions. Canadian Field-Naturalist 133(3): 221–234.

Perrault, G.G. 1973. A new species of *Scaphinotus* from the Olympic Peninsula (Coleoptera: Carabidae). The Coleopterists' Bulletin 27(1): 47–50.

Pierce, J.L., G.A. Meyers & A.J.T. Jull. 2004. Fire-induced erosion and millennial scale climate change in northern Ponderosa pine forests. Nature 432: 87–90.

Rankin, A.M., T. Wilke, M. Lucid, W. Leonard, A. Espíndola,

M.L Smith, B.C Carstens & J. Sullivan. 2019. Complex interplay of ancient vicariance and recent patterns of geographical speciation in north-western North American temperate rainforests explains the phylogeny of jumping slugs (*Hemphillia* spp.), Biological Journal of the Linnean Society 127(4): 876–889.

Rice, M.E. 2017. George E. Ball: Ground Beetles, Mexican bandits, and a purple heart. American Entomologist 63: 8–16.

Roeschke, H. 1907. Monographie der Carabiden-tribus Cychrini mit Bemerkungen über Typen und Lokalrassen der amerikanischen Arten von Dr. med. Edwin C. Van Dyke. Annales Historico-Naturales Musei Nationalis Hungarici 5: 99–277.

Russell, L.K. 1968. The faunal relationships of the Coleoptera of Montana, west of the continental divide, with a list of the species known to occur there. Unpublished M.Sc. Thesis, University of Washington, Seattle, Washington, USA. 208 p.

Saint-Germain, M., M. Larrive & P. Drapeau. 2005. Short-term response of ground beetles (Coleoptera: Carabidae) to fire and logging in a spruce-dominated boreal landscape. Forest Ecology and Management 212: 118–126.

Seago, A.E., P. Brady, J.P. Vigneron & T.D. Schultz. 2009. Gold bugs and beyond: a review of iridescence and structural colour mechanisms in beetles (Coleoptera). Journal of the Royal Society Interface 6(Suppl 2): S165–S184.

Sota, T. 1996. Altitudinal variation in life cycles of carabid beetles:life-cycle strategy and colonization in alpine zones. Arctic and Alpine Research 28(4): 441–447.

Spence. J.R., D.R. Maddison & F.A.H. Sperling. 2019. George Eugene Ball (25 September 1926 –12 January 2019). Bulletin of the Entomological Society of Canada 50(2): 102–107.

Sproul, J.S. & D.R. Maddison. 2018. Cryptic species in the mountaintops: species delimitation and taxonomy of the *Bembidion breve* species group (Coleoptera: Carabidae) aided by genomic architecture of a century-old type specimen. Zoological Journal of the Linnean Society 183(3): 556–583.

Steele, C.A., B.C. Carstens, A. Storfer & J. Sullivan. 2005. Testing hypotheses of speciation timing in *Dicamptodon copei* and *Dicamptodon aterrimus* (Caudata: Dicamptodontidae). Molecular Phylogenetics and Evolution 36(1): 90–100.

Su, Z.-H., Y. Imura, M. Okamoto & S. Osawa. 2004. Pattern of phylogenetic diversification of the Cychrini ground beetles in the world as deduced mainly from sequence comparisons of the mitochondrial genes. Gene 326: 43–57.

Van Dyke, E.C. 1919. The distribution of insects in western North America. Annals of the Entomological Society of America 12: 1–12.

Van Dyke, E.C. 1926. Certain peculiarities of the coleopterous fauna of the Pacific Northwest. Annals of the Entomological Society of America 19(1): 1–12.

Van Dyke, E.C. 1938. Review of the genus *Scaphinotus*, subgenus *Scaphinotus* Dejean (Coleoptera, Carabidae). Entomologica Americana 18(3): 93–133.

Van Dyke, E.C. 1940. The origin and distribution of the coleopterous insect fauna of North America. Pp. 255–268, in: Proceedings of the 6th Pacific Science Congress, Pacific Science Association. University California Press, Berkeley, CA.

Van Dyke, E.C. 1944. Review of the subgenera *Stenocantharus* Gistel and *Neocychrus* Roeschke of the genus *Scaphinotus* Dejean (Coleoptera, Carabidae). Entomologica Americana 24: 1–18.

Voller, J. & A. MacKinnon 2000. Forest management for biodiversity in montane "islands". Pp. 369–374, in: L. M. Darling (ed.), 2000. Proceedings of a Conference on the Biology and Management of Species and Habitats at Risk, Kamloops, B.C., 15–19 February 1999. Vol. 1. B.C. Ministry of Environment, Lands and Parks, Victoria, BC and University College of the Cariboo, Kamloops, BC. 490 p.

Wake, D.B. 2009. What salamanders have taught us about evolution. Annual Review of Ecology, Evolution, and Systematics 40: 333–352.

Webb, J.L. 1901. Notes on *Cychrus*, with a description of a new species. Entomological News 12: 133–136.

Weng, Y.-M., B.M. Veire, R.Y. Dudko, M.J. Medeiros, D.H. Kavanaugh & S.D. Schoville. 2020. Rapid speciation and ecological divergence into North American alpine habitats: the *Nippononebria* (Coleoptera: Carabidae) species complex. Biological Journal of the Linnean Society 130(1): 18–33.

Westcott, R.L., J.R. Labonte, G.L. Parsons & P.J. Johnson. 2006. New records and other notes for Oregon Coleoptera. Zootaxa 1142: 1–33.

Wilke, T. & Duncan, N. (2004), Phylogeographical patterns in the American Pacific Northwest: lessons from the arionid slug *Prophysaon coeruleum*. Molecular Ecology 13: 2303–2315.

Datasets

Global Biodiversity Information Facility (GBIF; <www.gbif.org>)

The following GBIF dataset (4 entry points) was accessed during the preparation of this article. The habitus images were taken from institutional datasets contained therein and are referenced with the relevant images. The dates presented here and with the images are the dates when the datasets were accessed for the final edit of this article.

Scaphinotus mannii Wickham, 1919 in GBIF Secretariat (2019). GBIF Backbone Taxonomy. Checklist dataset <https://doi.org/10.15468/39omei> accessed via GBIF.org on 2020–12–26.

Scaphinotus merkelii (G.Horn, 1890) in GBIF Secretariat (2019). GBIF Backbone Taxonomy. Checklist dataset <https://doi.org/10.15468/39omei> accessed via GBIF.org on 2020–12–26.

Scaphinotus regularis (LeConte, 1884) in GBIF Secretariat (2019). GBIF Backbone Taxonomy. Checklist dataset <https://doi.org/10.15468/39omei> accessed via GBIF.org on 2020–12–26.

Scaphinotus relictus (G.Horn, 1881) in GBIF Secretariat (2019). GBIF Backbone Taxonomy. Checklist dataset <https://doi.org/10.15468/39omei> accessed via GBIF.org on 2020–12–26.

Moths of Malheur National Wildlife Refuge Harney County, Oregon

Dana Ross

The summary printed below is from a report submitted in late 2020 of moth survey work done on the refuge July 20–24, 2020. The table below was prepared for the more extensive table supplied in the report. Links to an earlier report (Ross 2013) and some additional material on moths of the refuge are indicated below.

A total of 6,425 individuals from 157 moth species were sampled from 28 single-night light traps on the nights of July 20–24, 2020. These totals were the highest to date for a Malheur NWR field survey event and added 73 new species to the refuge checklist.

On a broader scale, 29 of those species were documented in Harney County for the first (12), second (11) or third (6) time. At least one first-time Oregon state record was captured (*Lacanobia atlantica*: Noctuidae), and second Oregon locations were discovered for *Plusia venusta* and *Euxoa ustulata* (both Noctuidae). Moth abundance and species richness varies significantly from month to month and from year to year based largely on weather patterns and environmental conditions. Given the impressive results acquired here, the 2020 field sampling was indeed well-timed. The largest remaining gap in seasonal sampling is for the May through early July time period when a large number of spring-flying species have yet to be recorded.

Light trap at Malheur National Wildlife Refuge. Photo by Dana Ross.

Table 1: Species Documented for the First Time in Harney County (12 species)

Geometridae	*Macaria helena*	few Oregon records
Noctuidae	*Apamea cogittata*	
Noctuidae	*Caradrina morpheus*	
Noctuidae	*Cucullia eulepis*	
Noctuidae	*Cucullia eurekae*	
Noctuidae	*Euxoa olivalis*	
Noctuidae	*Euxoa ustulata*	second Oregon record
Noctuidae	*Globia oblonga*	
Noctuidae	*Lacanobia atlantica*	first record for Oregon
Noctuidae	*Plusia venusta*	second Oregon locality
Noctuidae	*Properigea albimacula*	
Noctuidae	*Xestia plebeia*	

Information Links

Ross, D. 2013. Moths of the Malheur National Wildlife Refuge: Results from 10 sites sampled 5-8 August 2013. (Download the PDF from <https://www.fws.gov/uploadedFiles/Region_1/NWRS/Zone_2/Malheur/Sections/What_We_Do/Science/reports/malheur_moth_report.pdf>.

Ross, D. 2019. <https://malheurfriends.org/2019/09/moths-of-malheur-part-1/>.

Ross, D. 2019. <https://malheurfriends.org/2019/11/discovering-the-moths-of-malheur/>.

Recent Additions to Oregon's Lepidoptera Fauna

Steve Berliner reported *Pyrausta inornatalis* (Southern Pink Moth) on salvias from the Portland area (Sellwood and Milwaukie) (see images on the Butterflies and Moths of America website, <https://www.butterfliesandmoths.org/species/Pyrausta-inornatalis>). A related non-native, *Pyrausta laticlavia* (Southern Purple Mint Moth), is established in southern Oregon (see <https://www.butterfliesandmoths.org/species/Pyrausta-laticlavia> for images).

Jim Johnson noticed a picture of *Hemithea aestivaria* (Common Emerald), a non-native from Europe which has been in southwestern British Columbia and the Puget Sound area of Washington for a while, from Cannon Beach in Clatsop County posted by Erik Ostrander on iNaturalist (<https://www.inaturalist.org/observations/53184678>). Moth expert Paul Hammond indicated that this moth had not been reported previously in Oregon.

Moths of America North of Mexico News

The Wedge Entomological Research Foundation made its Moths of America North of Mexico fascicles published before 2015 available as free PDFs (most of them have pretty big file sizes.) See <http://wedgefoundation.org/publications_paypal.asp> for details. Thanks to Jim Johnson for finding this.

2020 Northwest Lepidopterists' Virtual Workshop

Preparations for this year's in-person Northwest Lepidopterists' Meeting were delayed due to the uncertainty around the pandemic and eventually, like a lot of other events around Oregon, the meeting was cancelled. From this, arose a virtual gathering via ZOOM which took place on Friday, December 11 between 8 am and 3 pm involving just over 100 participants. The presentations began at 10 am and lasted until approximately 2 pm. Chat rooms were open before and after the presentation period.

The list of presenters and the titles of their presentations are:

David Maddison – Welcome

Christopher J. Marshall – Tales of masks, moving vans and morphos – phase 1 of the Oregon State Arthropod Collection (OSAC) renovation during a pandemic.

Jon Shepard, Dana Ross, Neil Bjorklund, John Pelham – New/noteworthy Lepidoptera records for the Pacific Northwest

Andrew D. Warren – From the Pacific Northwest to the Atlantic Southeast; an update

Akito Kawahara – Bat-moth ultrasound interactions in the night sky

Merrill Peterson – PNW Moths: website updates and new directions

Richard Worth – Recent moth happenings from the Oregon Department of Agriculture

Luc LeBlanc – Discover the University of Idaho's Lepidoptera gems

Jim Reed – Slate Peak (Washington); It did not disappoint

Jason Reilly – Preliminary investigations on two sensitive butterfly species: survey results for the Gray-blue (*Plebejus podarceae*) and the Coronis Fritillary (*Speyeria coronis* nr. *coronis*) butterflies in southwestern Oregon.

David Lee Meyers – High elevation *Icaricia* and other 2020 photo highlights

David and Carol Specht – Butterflies seen on our March 2020 Anza-Borrego trip

Jon Shepard – Pacific Northwest Geometridae and the enigmatic genus *Venusia*

Christopher J. Marshall – Recent OSAC Donation: the Vern Covlin Butterfly Collection

Dana Ross – 2020 results from seven refuges and a monument

Paul Hammond and David McCorkle (presenter) – A study of hybrid crosses among *Speyeria* species

Jonathan P. Pelham – Migratory movements of *Speyeria coronis* and *Nymphalis californica*, with graphics

Bob Pyle – The Dark Divide (movie)

US National Native Bee Monitoring Network

The following write-up can be found on the home page of the network, <http://www.usnativebees.com/>.

"There are more than 4,000 native bee species in the United States, with many species yet to be described. These native bees pollinate our native plants and agricultural crops, add beauty to our world, and are deserving of protection. The US National Native Bee Monitoring Research Coordination Network (RCN) is a USDA-funded effort to coordinate and support efforts to monitor native bee populations in the US, with the broader goal of conserving our nation's native bee fauna.

From 2020–2023, native bee biologists from across the US will work together to develop a national plan for native bee monitoring. The plan will include components such as monitoring protocols and the designation of priority areas for monitoring. The RCN will also develop new educational and training opportunities in areas that are fundamental to native bee monitoring."

Some background and other information can be found in a November 19, 2020 article written by Jules Bernstein at the University of California, Riverside titled "Grant enables first nationwide effort to save native bees: Bee research alliance to gather key data." Visit <https://news.ucr.edu/articles/2020/11/19> to access this article. (There are a number of articles on this subject from different sources on the web.)

On the monitoring network's website four members, with their contact information, are currently listed from Oregon:

Andony Melathopoulos, Assistant Professor in Pollinator Health Extension, Oregon Bee Atlas, Master Melittologist Program, Oregon State University

Lauren Ponisio, Institute of Ecology and Evolution, University of Oregon

Charles Schelz, Ecologist, Cascade-Siskiyou National Monument

Stefanie Steele, MS student, Portland State University Biology

Note: This is a good citizen science project. People in Oregon are already working on the Oregon Bee Atlas (<https://extension.oregonstate.edu/bee-atlas>) as well as the PNW Bumble Bee Atlas (<https://www.pnwbumblebeeatlas.org/>). Both efforts offer training.

OSAC News

The west side of Cordley Hall, the former site of the Oregon State Arthropod Collection (OSAC), is now under reconstruction/renovation. Over the late spring and summer, the OSAC was relocated to a temporary location on Research Way. Given the pandemic, the relocation process has taken longer than hoped, but the cabinets and specimens are safe and sound. There is more to unpack and set up, and the collection is still closed to non-staff. The exact date when it will be re-open to researchers and the public has not been determined and depends to a certain extent on developments associated with the pandemic. If you are interested in using the collection or need access to specimens, please contact the Curator and Collections Manager Dr. Christopher Marshall (<christopher.marshall@oregonstate.edu>). Don't expect access anytime soon (at least a few months). Check the university website for updates on its COVID policy.

US Fish and Wildlife Service Section 6 Opportunity—Oregon

The US Fish and Wildlife Service have requested proposals for rare invertebrate research projects to be funded under their Section 6 program for fiscal year 2021. Acceptable proposals will be limited to federally listed, proposed, and candidate invertebrate species, or those having a state status similar to the federal equivalent. The money will be used for projects in the 2022 field season, and projects are expected to be completed by December 31, 2022. Proposals need to be submitted to Noel Bacheller, Ecologist/Natural Resource Coordinator, Oregon Parks and Recreation Department, 725 Summer St., Ste. C, Salem, OR 97301 by February 8, 2021. If you would like to submit a proposal, please contact her for full submission details. If you have submitted before please note that there is a new submission form this year.

From the Outgoing Editor

Ron Lyons

My impending retirement as editor of the Bulletin of the Oregon Entomological Society was announced at the end of September and again in the Fall Bulletin. As of this time, only one person has seriously considered the position but had to decline due to new and ongoing commitments. (I do want to thank her for her consideration.) At the moment then there is no one to take on this position. In all likelihood, this is the last online issue of the Bulletin, at least for the time being. With it, Jim and I mark the completion of the 10th volume/year of issues.

I would like to take this opportunity to thank those people who have contributed material directly or who have notified me of items for inclusion that would be of interest to the readers. I am grateful for the opportunity I have had to interact with them if only, in many cases, through email. I would like to thank them personally for helping expand my entomological knowledge and interests as well as those of the readers and broadening the coverage of the articles contained in the Bulletin.

I would like to thank the people who have, from time to time, personally expressed their appreciation of the Bulletin.

I would like to thank Jim Johnson for his help, thoughts, and advice regarding the Bulletin and other matters over the past 10 years. Jim is responsible for the mailing list and hosting the online version. Initially Jim also took care of the layout of the Bulletin. Jim established the format for the online Bulletin. He also patiently kept revising the copy as I would send in revisions to the material after sending over the "final" copy. I did not realize the amount of extra work that my method of making changes caused. It took a while before Jim informed me how the layout process actually worked and I revised my method for making revisions. When he returned to school, I took over the layout task. Not being an InDesign guru like Jim and not having that particular program, he informed me of a free open source layout program, Scribus, which I downloaded and used for the duration.

I thank Jim for hosting the Bulletin over the years, where for the moment, it will remain. We have discussed moving the Bulletin to a more permanent site in the future. In particular I have talked to Chris Marshall about eventually moving everything over to the OSAC website. Hopefully any move can be accomplished in 2021.

I want to thank you all for being on the mailing list and being readers (including those of you who just picked the Bulletin up off the internet) and remind you that there are lots of projects covered in the Bulletin that need your research efforts. There are also a number of organizations and initiatives that offer opportunities for education and citizen research here in Oregon and elsewhere.

I wish you the best in your current and future entomological endeavors.

Ron Lyons, December 2020

Reminder – New Editor Wanted

There is still time to become the new editor of the Bulletin of the Oregon Entomological Society. The next issue will be the Spring 2021 issue due out near the beginning of April. If you are interested in this volunteer position, please contact Ron Lyons at <pondhawk@integra.net> for details. Thank you.