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Cover photo: Female chewing louse (*Neotrichodectes interruptofasciatus*) from an American badger [Photo credit: Terry Galloway & Jillian Detwiler]

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Editors:

Kelsey L. Jones

Agriculture and Agri-food Canada

kelsey.jones@agr.gc.ca

Terry D. Galloway

Department of Entomology, University of Manitoba

terry.galloway@umanitoba.ca

Winnipeg, Manitoba

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Entomological Society of Manitoba

The *Entomological Society of Manitoba* was formed in 1945 “to foster the advancement, exchange and dissemination of Entomological knowledge.” This is a professional society that invites any person interested in entomology to become a member by application in writing to the Secretary. The Society produces the Newsletter, the *Proceedings*, and hosts a variety of meetings, seminars and social activities.

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Sarah Semmler
Secretary
Entomological Society of Manitoba
entsocmanitobasecretary@gmail.com

Contents

Obituary:

David M. Rosenberg	5
--------------------------	---

Submitted Paper:

Lice (Phthiraptera: Trichodectidae), fleas (Siphonaptera: Pulicidae, Ceratophyllidae) and ticks (Ixodida: Ixodidae) infesting American badger, <i>Taxidea taxus</i> (Mammalia: Mustelidae), in Manitoba, Canada	27
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Scientific Programme Abstracts for the 2020 Annual Meeting of the Entomological Society of Manitoba	37
---	----

Acknowledgements	49
------------------------	----

Minutes of the 76th Annual Business Meeting of the Entomological Society of Manitoba	50
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Appendices:

Appendix A: Agenda of the 76 th AGM	58
Appendix B: President's Report to the Membership	60
Appendix C: Financial Statements	62
Appendix D: Report of the ESC Regional Director	64
Appendix E: Report of the <i>Proceedings</i> Editor	65
Appendix F: Report on the Membership by the Secretary	67
Appendix G: Report of the Endowment Fund Board	68
Appendix H: Report of the ESM Newsletter	70
Appendix I: Youth Encouragement and Public Outreach Committee	71
Appendix J: ESM Student Awards and Scholarship Committee	72
Appendix K: Fundraising Report	75
Appendix L: ESM Website/ Archivist Report	76
Appendix M: Report of the Common Names of Insects Committee	77
Appendix N: Election Report	79

David M. Rosenberg

(1943-2021)

Tribute and Bibliography*

Donna Giberson¹, Allen Wiens², Terry Galloway², Vince Resh³, Trefor Reynoldson⁴, and Bob Newbury⁵

¹Sechelt, BC, ²Winnipeg, MB, ³Berkeley, CA, ⁴Canada Creek, NS, ⁵Lake Country, BC

Many will remember the summer of 2021 for our cautious overtures towards normalcy after many months of turmoil from the COVID-19 pandemic. It will be hard to think of life being normal, however, for friends and colleagues of David Rosenberg. Dave passed away on June 25. He is survived by his wife Trudy, brother Nathan, kids Tina and Scott, Lee and Sara and grandchildren Aaron, Rayne and Zoey. Dave was known for his honesty and integrity, his quick wit and sense of humour, his “salty” language, and his commitment to his family and his career.



David Rosenberg in Palm Springs (Photo: C. Resh)

Dave was an internationally known aquatic entomologist. He was a generous supervisor and mentor, and was recognized throughout his career with many awards, including The Gold Medal of the Entomological Society of Canada (1998), the North American Benthological Society (NABS, now Society for Freshwater Science) Distinguished Service Award (2000), The K.H. Doan Publication Award for the Most Significant Publication of the Freshwater Institute (1984, 1998, 1999) and The Canadian Department of Fisheries and Oceans Prix d'Excellence (2000). He presented many prestigious plenary and invited lectures and was involved in many national and international collaborations. He served as the President of NABS in 1986 and was active in the Entomological Societies of Manitoba and Canada. He played an important role in the establishment and ongoing projects of the Biological Survey of Canada (Terrestrial Arthropods). His professional legacy can be seen in his nearly 150

* This tribute, minus the Bibliography, first appeared in the *Bulletin of the Entomological Society of Canada* 53(3): 147–152, and is reprinted here with permission.

publications (see the list of publications at the end of this piece), and in the remembrances of his friends and colleagues.

Dave grew up in Edmonton, where his parents owned a home-made ice cream parlour. He worked part-time in the store, as well as for various relatives with businesses in Edmonton before attending the University of Alberta. He received his Bachelor's (1965) and PhD (1973) degrees from U of A. In his 2017 memoir (*A Funny Thing Happened on My Way to the Lab*), he described himself as a "failed veterinarian," as he had initially planned to attend vet college. Instead, he entered the Department of Entomology, and embarked on a decades-long career that would see him work on some of the most important environmental issues of our time, from pesticides (his Ph.D. work), to pipelines, impoundments, acidification, and river health. His career was characterized by participation in large projects, and it is worth spending some time exploring these, as well as the connections that arose from them.

In 1971, before he even finished his PhD, he was recruited to work on the Mackenzie Valley Pipeline Study, based out of the Freshwater Institute of the Department of Fisheries and Oceans (DFO) in Winnipeg. Dave and Trudy, his life partner of more than 55 years, packed up everything and moved to Winnipeg in preparation for heading north in the spring. This was to be a large study evaluating potential impacts of a proposed oil pipeline along the Mackenzie River from the Beaufort Sea to markets in the south and Dave's focus would be the benthic invertebrates in tributaries along the Mackenzie mainstem (from Great Slave Lake to the Delta; ~1738km!). He was tasked with identifying the main environmental problems associated with construction and operation of a pipeline (*e.g.*, increased sedimentation and oil spills), and to catalogue the species of freshwater plants and invertebrates in the area. Either one of these goals would be daunting to most people, much less both, and he carried them out while also finishing his dissertation work!

The Mackenzie River Pipeline Project introduced Dave to his long-time side-kick Allen Wiens, and set up a partnership that lasted more than 25 years. Al and Dave met at the Fisheries camp in Yellowknife, where Al was scouting locations for the benthic invertebrate studies, and Dave persuaded him to choose the Fort Simpson area as a study base, giving access to several Mackenzie River tributaries near there. This year on March 23rd, Dave and Al marked 50 years from the time that Al first began working as his Biologist. Trudy (a teacher) was able to



Dave and Al on Southern Indian Lake during the 1987 Whole Lake Survey. (Photo: D. Giberson)

join Dave in Fort Simpson each summer once the school term ended, and then returned with Dave to Winnipeg at the end of the summer.

In his 2017 memoir, Dave commented that his career-long partnership with Al stemmed from how well they complemented each other: Al's outdoor skills and ability to fix nearly anything made him a perfect companion to the more academically oriented Dave. In contrast, Al describes Dave as a "consummate camper" who had his priorities right on their trips to the field. Al remembers winter camping (on the ice in a double-walled tent) near Fort Simpson during one winter sampling trip. They took turns running and emptying the 24-hour drift nets set under the ice of the Martin River, but Dave took charge of the cooking. He arrived on site with pre-marinated T-bone steaks to cook on the Coleman stove. After digging out a large snowdrift to provide shelter for the stove, Dave cooked Al's steak first (it was delicious!) then set in on his own, which he liked very rare. It was almost done when one of the icicles attached to his moustache melted off and fell into the frying pan with a "pssss" sound. When he sliced into the steak he said, "Damn it all, the steam over-cooked my steak!" [though it should be noted that his language may have been a bit saltier than reported here].



Dave and Vince caught in a bit of an eddy while canoeing past another noted benthic biologist, Tom Waters who was trying his luck with the fishing. (Photo: D. Giberson)

It was during this period that Dave met Vince Resh, who became a longstanding collaborator and friend. Dave accepted an invitation to participate in a workshop on sampling benthic invertebrates at the ESC meeting in Banff (1973), to which Vince was also invited. They became fast friends, collaborating on several research projects and two major books (Resh and Rosenberg: *Ecology of Aquatic Insects*, 1984, and Rosenberg and Resh, *Freshwater Biomonitoring and Benthic Macroinvertebrates*, 1993). Donna Giberson remembers the

book collaborations as her introduction to Dave's well-known "salty language" when she was a grad student working with him at the Freshwater Institute in the 1980s. In May 1984, Vince persuaded Dave to join him on a post-conference canoe trip following the NABS meeting in Kansas, with Dave under the impression that they would be discussing the book along the way. That didn't happen, but at least no-one got wet! A quick perusal of the publication list at the end of this piece is testament to the extent and scope of their collaboration: they co-wrote or co-edited 30 publications over their career.

After the Mackenzie Pipeline project wound down, Dave moved his research focus to the Churchill Diversion project in northern Manitoba. This was another large project, assessing impacts of a Manitoba Hydro Megaproject impounding Southern Indian Lake (SIL) and diverting the Churchill River into the Nelson River to provide stable flows for the hydro-electric dams on the Nelson. The assessment project was a huge team effort involving researchers working on hydrology and fisheries as well as aquatic flora and invertebrates, and an important result from the study was identifying the link between mercury bioaccumulation and formation of permafrost-surrounded reservoirs. Dave and Al, along with groups of summer and grad students, made regular 13-hour treks to SIL from 1975 to 1991 to assess invertebrate responses to flooding in the lake and along the diversion route, as well as in the “dewatered” Churchill River downstream.

Donna remembers a life-lesson from her first trip collecting Ekman dredge samples from the lake with Dave and Al. These dredges, equipped with spring-loaded closable jaws, are designed to sink into the mud and snap shut when struck by a “messenger” sent down a rope to the trigger mechanism. Theoretically, the operator just pulls up the dredge and empties it into a net to strain out the invertebrates. In reality, the dredge was usually stuck tight in the mud, resisting all attempts to pull it up. After watching her struggle for a bit, Dave and Al told Donna to hold the rope tightly and brace herself, while they proceeded to gently rock the boat from side to side. In no time, the rocking motion of the boat broke the suction of the mud around the dredge, and it came free. Dave’s lesson? “The most important thing in life, Donna, is learning just when to rock the boat.”

The SIL project introduced Dave to another important collaborator and long-time friend – Bob Newbury. Bob is a hydrologist who, in addition to his work on the Churchill River Diversion study, has long been involved in river and stream restoration work. Bob remembers a camp they set up on the lake on one sampling trip. Bob’s young son Peter was with him and introduced Dave to hammering up a tent frame shelter leaving Bob to note that “his profound talents lay in other areas.” Making things for Dave became a small way to repay him for his affectionate friendship. They had a lot of laughs over the last one, a set of dreidels with buy, sell, hold, lose labels after Dave sent a copy of his investment advice book. Their lasting relationship was not in science.



Dave blowing bubbles at SIL. (Photo: R. Newbury)

As is clear from the reminiscences in this tribute, Dave’s strong sense of professionalism in research did not preclude light-hearted fun as well, and most of us whose lives were touched by

Dave remember many such moments. Dave himself includes many funny stories of his time



A “possible alternative career” for Dave, at the Wilson Creek Stream Hydrology workshop. From left: Dave Rosenberg, Bob Newbury, John Flannagan, Dave Burton, Donna Giberson, Brian Heise, Dave Benson?, Dale Wrubleski, Dan Soluk, and Margaret Friesen. (Photo: R. Newbury)

working on various projects in his 2017 memoir. Bob remembers Dave demonstrating his bubble blowing ability on a trip with visiting Russian and Chinese permafrost scientists to SIL. During one of Bob’s stream hydrology workshops at Wilson Creek (on the Manitoba Escarpment, near the town of McCreary), Dave noticed a Dave’s Septic Service truck on the road. He quickly staged a photo with the workshop participants, quipping that it could be a possible alternative career for him.

It was probably impossible for someone to work at the Freshwater Institute in Winnipeg and not also be drawn into work at the

Experimental Lakes Area (ELA), a research facility east of Winnipeg near the border with Ontario. Dave worked on two projects at ELA from 1991 to 1997: a peatland acidification project and a reservoir project. The peatland acidification project involved assessing chironomid responses to acidifying a poor fen, and was part of the larger group of studies on ecological effects of acidification. The Experimental Lakes Reservoir Project looked at the evolution of greenhouse gases and mercury release from flooded peatlands. Dave’s role in this study was assessing responses of benthic invertebrates to the flooding, and the role of benthic invertebrates in the uptake and concentration of methyl mercury.

While Dave was still working on ELA projects, Trefor Reynoldson (then with Environment Canada) invited him, along with Vince Resh, to participate in the Fraser River Biomonitoring Project, which became his last major project as a Canadian government researcher. Dave first met Trefor back in 1974, when Trefor was working to update the Alberta stream monitoring program; he remembers the interaction with Dave as “gracious and helpful to a couple of neophyte government biologists.” Fast forward to the 1990s, when they both participated in a workshop to develop a large reference condition study on the Great Lakes, defining biological indicators and numerical criteria using benthic invertebrates. The premise behind this approach is that a baseline or natural state can be defined through multivariate analysis of biotic and physical/chemical variables in a large number of undisturbed or “reference” sites. Other sites of interest can then be compared to the reference condition to identify disturbed sites, to determine the causes of perturbations, and suggest remediation.

The Fraser River Biomonitoring Project was part of the Fraser River Action Plan, a large Federal Government Green Plan initiative centred in British Columbia. The goal was to design and test a

river monitoring project similar to the Great Lakes project that could be applied elsewhere in the country; it ultimately resulted in the now widely applied CABIN (Canadian Aquatic Biomonitoring Network) protocol for assessing river health in Canada. Over 250 river sites were sampled annually by helicopter over a short period of time, resulting in long, tiring days for the teams. Dave was known for his work ethic and ability to spend long hours in the field or lab, but cheerfully reported in his 2017 memoir that grad student Stephanie Sylvestre (now Strachan) referred to Trefor, Vince, and Dave as the “Geriatric Team,” a possible reference to the fact that he was starting to slow down a bit.

Trefor remembers working closely with Dave between the project’s inception in 1994 to the final publication in 2001. Both Dave (in his memoir) and Trefor remember one day when they were scouting sites to use for their pilot study, when their guide (a technician lent to them from Environment Canada) said that he would have fired them if they had worked for him, as they kept stopping at restaurants, tourist shops, and sightseeing venues. Vince in particular was hunting for moccasins to take home to California. However, they were “re-hired” next day, after they put in a long day testing and ground-truthing their methods in their pilot stream, and left the technician exhausted in the process.

The story of Dave’s involvement in successive large bioassessment projects is also a story of collaborators that became firm friends with Dave and Trudy. In addition to Trefor, the large Fraser River project led to work with Richard Norris, who was involved in a similar large stream monitoring project in Australia and had helped with the planning of the Fraser River study. As a direct result of this project, Dave was invited to Australia in 1996 and to Oxford University in 1997 to present research on scientific collaboration and the Fraser River project. Trefor especially remembers the Oxford trip and the chance to show the team his home jaunts in north Wales.

Several common themes emerge from colleagues and friends when talking about Dave. Discussions were always lively and covered a variety of topics, and were endlessly entertaining (or at least, never boring!). Al Wiens notes that Dave had a very good memory and he read a lot, giving lots of scope for discussions in the plane going to Fort Simpson (or later, on the 13-hour drives to South Indian Lake in northern Manitoba). Trefor remembers falling off rocks into the stream when processing samples as he was laughing so hard from listening to Dave’s stories.

Another common theme in reminiscences was food. Dave enjoyed cooking and was a great cook (including camp cooking throughout his many field trips), and many of the stories in his 2017



Dave and Trefor processing samples on a tributary of the Fraser River. (Photo: Al Wiens)

memoir involved food. Both Dave (in his memoir) and Trefor recalled an excellent Italian restaurant in Lillooet, BC that they enjoyed for three nights. After complementing the chef on the meals, the chef offered to prepare them a special meal with ingredients that would have to be ordered from Vancouver, therefore requiring a commitment prior to the meal. Dave begged off and opted for Chinese (Dave remembers being teased for not wanting to exceed his meal per diem, but Trefor thought he had just had enough Italian meals after three nights in a row).

Dave was involved with students throughout his career, thanks to his long connection as Adjunct Professor in the Department of Entomology at the University of Manitoba. His input and advice in 1978 for Terry Galloway's incipient new course in Aquatic Entomology was instrumental in solidifying its content and direction. Dave was a regular invited speaker in the course over a span of almost 35 years. He served as supervisor or committee member on several student committees and was generous with his time and advice, often delivered in the pithy language for which he was famous. He was a strong believer in getting the results and the message out, and imparted that to his students, as can be seen in the many student papers in his publication list. In another example, a graduate course he taught in 1979 on environmental impact assessments during a sabbatical year at UC Berkeley resulted in a major article on the topic, with all the students in the class as co-authors.

Dave's other professional "hat," and arguably the one that had the greatest impact on freshwater science, was as an editor and mentor to students and colleagues on scientific writing. He served as a reviewer for many journals and government technical report series, and was on the editorial boards of the *Journal of the North American Benthological Society* (J-NABS, now *Freshwater Science*), *Canadian Journal of Fisheries and Aquatic Sciences*, *Freshwater Biology*, and *Journal of Aquatic Ecosystem Health*. As time went on, more people at the Freshwater Institute asked him to review the manuscripts of their work prior to sending it to a journal. Dave also offered his editorial instruction and services to any graduate student in the Department of Entomology at the University of Manitoba as they prepared their thesis and manuscripts. He viewed each submission as being the best work of a researcher who had spent considerable time and effort producing the manuscript, and therefore believed his best effort should be directed to examining the work. He edited the manuscripts for clarity, brevity, possible omissions, and alternate conclusions. His red pencil was busy, and many an author or student must have looked in dismay at the corrections and suggestions on their manuscript. But Dave was fair in his editing and was completely willing to listen to rebuttals by authors. His editing style was certainly extended to manuscripts submitted to him by AI or his students. Dave, having his name on the paper, wanted to make sure that everything was perfect, and he wore his red pencil to a nub on some of those papers. Vince noted that disagreements emerged in the many articles they wrote or edited together; generally, Dave wanted the writing to be more concise and Vince wanted to keep in what Dave disparagingly called "unnecessary flowers." Compromises resulted from a mixture of cajoling and ultimatums (and saltier language!), but always led to both being satisfied with the final product. Bob Newbury wrote a chapter on stream hydrology for the Resh and Rosenberg

book, *The Ecology of Aquatic Insects* (1984), and says that Dave introduced him to the art of editing in a draft of a chapter for the now famous book. To his amusement, Bob asked him if the mysterious editing symbols were doodles, perhaps brought on by the boring hydraulics topic. Dave was especially particular about reference citations. Donna remembers going through a massive stack of papers, one by one with Al (in the days before widespread pdf versions), for her PhD thesis and her research papers with Dave, checking each title, author, issue and page numbers for every reference listed.

In 1997, Dave became Managing Editor for J-NABS, a position he held until 2005. He worked with NABS Business Manager Irwin Polls (another firm friend), and the two of them could always be found holding court at the J-NABS table at society meetings. Dave remarked in his 2017 memoir that a Managing Editor needs the “wisdom of Solomon, the patience of Job, and a willingness to do little else but work on the Journal.” But David always went above and beyond in his work on the Journal, providing detailed suggestions on how to improve the clarity of manuscripts even after they were accepted, and mentoring Associate Editors to take on leadership roles in a variety of journals.

Dave retired from DFO in 2001, though he continued to go in to the Freshwater Institute for



Retirement dinner for Dave at the NABS meeting in Keystone Colorado. From left: Irwin Polls, Joseph Culp, Richard Norris, Rich Merritt, Gary Lamberti, Dave Rosenberg, Trudy Rosenberg, Jan Ciborowski, Donna Giberson, Vince Resh, Trefor Reynoldson. (Photo: D. Giberson)

several years as Scientist Emeritus, finishing up projects and continuing work on J-NABS. His NABS colleagues marked his retirement with a dinner at the NABS meeting in Keystone Colorado that brought together a diverse group of people whose lives Dave had touched over the years. After his retirement, Dave kept in touch with people through email and phone calls, through visits to Winnipeg, and through his regular winter travel to Palm Springs. He also wrote and self-published three memoirs, published in 2017, 2019, and 2020.

Sorting through our reminiscences of Dave has been a journey of sorts. Dave’s mentoring, personally and scientifically, has touched us all. The Dave we remember used humour, was known for salty talk, and could blow bubbles and cook steaks on the Coleman stove on an icy river. And he also set an example to generations of freshwater scientists on integrity, science communication, and above all, just when to rock the boat.

Bibliography of Scientific Publications

- Ayles, G.B., M. Dubé, and D.M. Rosenberg. 2004. Oil Sands Regional Aquatic Monitoring Program (RAMP) scientific peer review of the Five-Year Report (1997–2001). Report submitted to the RAMP Steering Committee February 13, 2004. G.B. Ayles and Associates, Winnipeg, Manitoba. 71 pp. and 4 appendices.
- Bailey, R., M. Barbour, F. Dyer, S. Nichols, V. Resh, T. Reynoldson, and D. Rosenberg. 2012. In Memoriam: Richard Norris (1951–2011). *Hydrobiologia* (on-line) DOI 10.1007/s10750-012-1098-9.
- Bodaly, R.A., J.D. Reist, D.M. Rosenberg, P.J. McCart, and R.E. Hecky. 1989. Fish and fisheries of the Mackenzie and Churchill River basins, northern Canada. In: *Proceedings of the International Large River Symposium*. Edited by: D.P. Dodge. Canadian Special Publications of Fisheries and Aquatic Sciences 106: 128–144.
- Bodaly, R.A. and D.M. Rosenberg. 1990. Retrospective analysis of predictions and actual impacts for the Churchill–Nelson hydroelectric development, northern Manitoba. In: *Joules in the Water – Managing the Effects of Hydroelectric Development*. Edited by: C.E. Delisle and M.A. Bouchard. *Proceedings of a symposium, Canadian Society of Environmental Biologists*, April 6–7, 1989, Montreal. *Collection Environnement et Géologie* 9: 221–242.
- Bodaly, R.A., D.M. Rosenberg, M.N. Gaboury, R.E. Hecky, R.W. Newbury, and K. Patalas. 1984. Case 7.4: Ecological effects of hydroelectric development in northern Manitoba, Canada: the Churchill–Nelson River diversion. In: *Effects of Pollutants at the Ecosystem Level*. Edited by: P.J. Sheehan, D.R. Miller, G.C. Butler, and Ph. Bourdeau. *Scientific Committee on Problems in the Environment (SCOPE)*. John Wiley and Sons, Ltd., New York, New York. pp. 273–309.
- Bodaly, R.A., V. St. Louis, M.J. Paterson, R.J.P. Fudge, B.D. Hall, D.M. Rosenberg, and J.W.M. Rudd. 1997. Bioaccumulation of mercury in the aquatic food chain in newly flooded areas. In: *Mercury and its Effects on Environment and Biology*. Edited by: H. Sigel and A. Sigel. Marcel Dekker, New York. pp. 259–287.
- Brunskill, G.J., D.M. Rosenberg, N.B. Snow, G.L. Vascotto, and R. Wagemann. 1973. Ecological studies of aquatic systems in the Mackenzie–Porcupine drainages in relation to proposed pipeline and highway developments. *Canada Task Force on Northern Oil Development, Environmental-Social Committee, Volume I. Report 73–40, Information Canada Catalogue Number R72–10073/1–1, QS–1533–010–EE–A1. 131 pp. Volume II. Appendices. Report 73–41. Information Canada Catalogue Number R72–10073/102, QS–1533–020–EE–A1. 345 pp.*

- Carter, J.L., V.H. Resh, D.M. Rosenberg, and T.B. Reynoldson. 2006. Biomonitoring in North American rivers: a comparison of methods used for benthic macroinvertebrates in Canada and the United States. In: *Biological Monitoring of Rivers: Applications and Perspectives*. Edited by: G. Zigliio, M. Siligardi, and G. Flaim. John Wiley and Sons. pp. 203–228.
- Cobb, D.G., J.F., Flannagan, D.M. Rosenberg, and A.P. Wiens. 1993. Emergence of Trichoptera from aquatic habitats in the Experimental Lakes Area, northwestern Ontario, Canada. In: *Proceedings of the Seventh International Symposium on Trichoptera, August 3–8, 1992, Umeå, Sweden*. Edited by: C. Otto. Backhuys Publishers, Leiden, The Netherlands. pp. 219–222.
- Cobb, D.G., D.M. Rosenberg, and A.P. Wiens. 1997. Responses of caddisflies to experimental flooding of a small peatland lake in northwestern Ontario, Canada. In: *Proceedings of the Eighth International Symposium on Trichoptera, July 9–15, 1995, Minneapolis/St. Paul and Lake Itasca, Minnesota*. Edited by: R. Holzenthal and O. Flint. Ohio Biological Survey, Columbus, Ohio. pp. 77–82.
- Crawford, P.J. and D.M. Rosenberg. 1984. The breakdown of conifer needle debris in a new northern reservoir, Southern Indian Lake, Manitoba. *Canadian Journal of Fisheries and Aquatic Sciences* 41: 649–658.
- Cullen, P.W., R.H. Norris, V.H. Resh, T.B. Reynoldson, D.M. Rosenberg, and M.T. Barbour. 1999. Collaboration in scientific research: a critical need for freshwater ecology. *Freshwater Biology* 42: 131–142.
- Danks, H.V. and D.M. Rosenberg. 1987. Aquatic insects of peatlands and marshes in Canada: synthesis of information and identification of needs for research. In: *Aquatic Insects of Peatlands and Marshes in Canada*. Edited by: D.M. Rosenberg and H.V. Danks. *Memoirs of the Entomological Society of Canada* 140: 163–174.
- Danks, H.V., G.B. Wiggins, and D.M. Rosenberg. 1987. Ecological collections and long-term monitoring. *Bulletin of the Entomological Society of Canada* 19: 16–18.
- Day, K.E., W.H. Clements, T. DeWitt, W.G. Landis, P. Landrum, D.J. Morrisey, M. Reiley, D.M. Rosenberg, and G.W. Suter. 1997. Work group summary report on critical issues of ecological relevance in sediment risk assessment. In: *Ecological Risk Assessment of Contaminated Sediments. Proceedings of the Pellston Workshop on Sediment Ecological Risk Assessment, April 23–28, 1995, Pacific Grove, California*. Edited by: C.G. Ingersoll, T. Dillon, and G.R. Biddinger. SETAC Special Publications Series. SETAC Press, Pensacola, Florida. pp. 167–198.
- Day, K.E., T.B. Reynoldson, and D.M. Rosenberg. 1996. The reference condition: implications for biomonitoring of water and sediment quality in Canada. *SETAC News* 16: 15–16.

- Fairchild, W.L., M.C.A. O'Neill, and D.M. Rosenberg. 1987. Quantitative evaluation of the behavioral extraction of aquatic invertebrates from samples of sphagnum moss. *Journal of the North American Benthological Society* 6: 281–287.
- Flannagan, J.F. and D.M. Rosenberg. 1982. Types of artificial substrates used for sampling freshwater benthic macroinvertebrates, In: *Artificial substrates*. Edited by: J. Cairns, Jr. Ann Arbor Science Publishers, Inc., Ann Arbor, Michigan. pp. 237–266.
- Giberson, D.J. and D.M. Rosenberg. 1992. Effects of temperature, food quantity, and nymphal rearing density on life-history traits of a northern population of *Hexagenia* (Ephemeroptera: Ephemeridae). *Journal of the North American Benthological Society* 11: 181–193.
- Giberson, D.J. and D.M. Rosenberg. 1992. Egg development in *Hexagenia limbata* (Ephemeroptera: Ephemeridae) from Southern Indian Lake, Manitoba: temperature effects and diapause. *Journal of the North American Benthological Society* 11: 194–203.
- Giberson, D.J. and D.M. Rosenberg. 1994. Life histories of burrowing mayflies (*Hexagenia limbata* and *H. rigida*, Ephemeroptera: Ephemeridae) in a northern Canadian reservoir. *Freshwater Biology* 32: 501–518.
- Giberson, D.J., D.M. Rosenberg, and A.P. Wiens. 1991. Changes in abundance of burrowing mayflies in Southern Indian Lake: lessons for environmental monitoring. *Ambio* 20: 139–142.
- Giberson, D.J., D.M. Rosenberg, and A.P. Wiens, A.P. 1992. Long-term abundance patterns of *Hexagenia* (Ephemeroptera: Ephemeridae) in Southern Indian Lake, Manitoba: responses to weather and hydroelectric development. *Canadian Technical Report of Fisheries and Aquatic Sciences* 1837. 16 pp.
- Grapentine, L.C. and D.M. Rosenberg. 1992. Responses of the freshwater amphipod *Hyaella azteca* to environmental acidification. *Canadian Journal of Fisheries and Aquatic Sciences* 49: 52–64.
- Hall, B.D., R.A. Bodaly, R.J.P. Fudge, J.W.M. Rudd, and D.M. Rosenberg. 1997. Food as the dominant pathway of methylmercury uptake by fish. *Water, Air, and Soil Pollution* 100: 13–24.
- Hall, B.D., D.M. Rosenberg, and A.P. Wiens, A.P. 1998. Methylmercury in aquatic insects from an experimental reservoir. *Canadian Journal of Fisheries and Aquatic Sciences* 55: 2036–2047.
- Hecky, R.E., P. Campbell, and D.M. Rosenberg. 1994. Experimental lakes and natural processes: 25 years of observing natural ecosystems at the Experimental Lakes Area. *Canadian Journal of Fisheries and Aquatic Sciences* 51: 2721–2722.

- Hecky, R.E., R.W. Newbury, R.A. Bodaly, K. Patalas, and D.M. Rosenberg. 1984. Environmental impact prediction and assessment: the Southern Indian Lake experience. *Canadian Journal of Fisheries and Aquatic Sciences* 41: 720–732.
- Hecky, R.E., D.M. Rosenberg, and P. Campbell. 1994. The 25th anniversary of the Experimental Lakes Area and the history of Lake 227. *Canadian Journal of Fisheries and Aquatic Sciences* 51: 2243–2246.
- Johnson, R.K., T. Wiederholm, and D.M. Rosenberg. 1993. Freshwater biomonitoring using individual organisms, populations, and species assemblages of benthic macroinvertebrates. In: *Freshwater Biomonitoring and Benthic Macroinvertebrates*. Edited by: D.M. Rosenberg and V.H. Resh. Chapman and Hall, New York. pp. 40–158.
- Jonasson, O.J. and D.M. Rosenberg. 1969. Preliminary studies on a method for dieldrin analysis in insects. Pesticide Research Report. Canada Committee on Pesticide Use in Agriculture. pp. 321–323.
- Lehmkuhl, D.M., H.V. Danks, V.M. Behan-Pelletier, D.J. Larson, D.M. Rosenberg, and I.M. Smith. 1984. Recommendations for the appraisal of environmental disturbance: some general guidelines and the value and feasibility of insect studies. *Bulletin of the Entomological Society of Canada* 16: 1–8.
- Madder, M.C.A., D.M. Rosenberg, and A.P. Wiens. 1977. Larval cocoons in *Eukiefferiella claripennis* (Diptera: Chironomidae). *The Canadian Entomologist* 109: 891–892.
- Mazor, R.D., T.B. Reynoldson, D.M. Rosenberg, and V.H. Resh. 2006. Effects of biotic assemblage, classification, and assessment method on bioassessment performance. *Canadian Journal of Fisheries and Aquatic Sciences* 63: 394–411.
- Mazor, R.D., D.M. Rosenberg, and V.H. Resh. 2019. Use of aquatic insects in bioassessment. In: *An Introduction to Aquatic Insects of North America*. 5th Edition. Edited by: R.W. Merritt, K.W. Cummins, and M.B. Berg. Kendall Hunt Publishers, Dubuque. pp. 143–164.
- Megraw, S., T. Reynoldson, R. Bailey, B. Burd, L. Corkum, J. Culp, C. Langlois, E. Porter, D. Rosenberg, D. Wildish, and F. Wrona. 1997. Benthic Invertebrate Community Expert Working Group. Technical Report on Pulp and Paper Environmental Effects Monitoring (EEM) Program. Review of Cycle 1 and recommendations for Cycle 2. EEM/1997/7. National EEM Office, Environment Canada, Ottawa, Ontario. 50 pp.
- Porter, T.R., D.M. Rosenberg, and D.K. McGowan. 1974. Winter studies of the effects of a highway crossing on the fish and benthos of the Martin River, N.W.T. Canada Department of Environment Fisheries Operations Directorate, Central Region, Technical Report Series, No. CEN/T-74-3. 50 pp.

- Quinn, F., J.C. Day, M. Healey, R. Kellow, D. Rosenberg, and J.O. Saunders. 2004. Water allocation, diversion and export. In: *Threats to Water Availability in Canada*. NWRI Scientific Assessment Report Series No. 3 and ACSD Science Assessment Report Series No. 1. National Water Research Institute, Environment Canada, Burlington, Ontario. pp. 1–8.
- Reece, P.F., T.B. Reynoldson, J.S. Richardson, and D.M. Rosenberg. 2001. Implications of seasonal variation for biomonitoring with predictive models in the Fraser River catchment, British Columbia. *Canadian Journal of Fisheries and Aquatic Sciences* 58: 1411–1418.
- Resh, V.H., T.B. Reynoldson, and D.M. Rosenberg. 2002. Trichoptera of the Fraser River catchment, British Columbia, Canada, and their applicability to a large-scale water quality monitoring program. *Proceedings of the Tenth International Symposium on Trichoptera*, Berlin, Germany. *Nova Supplementa Entomologica* 15: 551–558.
- Resh, V.H. and D.M. Rosenberg (Editors). 1979. *Innovative teaching in aquatic entomology*. Canadian Special Publications of Fisheries and Aquatic Sciences 43. 118 pp.
- Resh, V.H. and D.M. Rosenberg (Editors). 1981. *Enseignement novateur de l'entomologie aquatique*. Publications spéciales canadiennes des Sciences Halieutique et Aquatique, 43F. 122 pp.
- Resh, V.H. and D.M. Rosenberg (Editors). 1984. *The Ecology of Aquatic Insects*. Praeger Scientific, New York, New York. 626 pp.
- Resh, V.H. and D.M. Rosenberg. 1984. Introduction. In: *The Ecology of Aquatic Insects*. Edited by: V.H. Resh and D.M. Rosenberg. Praeger Scientific, New York, New York. pp. 1–8.
- Resh, V.H. and D.M. Rosenberg. 1989. Spatial-temporal variability and the study of aquatic insects. *The Canadian Entomologist* 121: 941–963.
- Resh, V.H. and D.M. Rosenberg. 2004. Water pollution and insects. In: *Encyclopedia of Entomology*, Vol. 3. Edited by: J.L. Capinera. Kluwer Academic Publishers: Dordrecht, The Netherlands. pp. 2501–2501.
- Resh, V.H. and D.M. Rosenberg. 2008. Water pollution and insects. In: *Encyclopedia of Entomology*. Vol 4. Edited by: J.L. Capinera. Springer, New York. pp. 4158–4168.
- Resh, V.H. and D.M. Rosenberg. 2010. Recent trends in life-history research on benthic macroinvertebrates. *Journal of the North American Benthological Society* 29: 207–219.
- Resh, V.H. and D.M. Rosenberg. 2015. Economic aspects of freshwater invertebrates. In: *Thorpe and Covich's Ecology and Classification of North American Freshwater Invertebrates*, Volume 1. Ecology and General Biology, 4th edition. Edited by: J.H. Thorpe and D.C. Rogers. Academic Press. pp. 93–109.

- Resh, V.H., D.M. Rosenberg, and J.W. Feminella. 1985. The processing of benthic samples: responses to the 1983 NABS questionnaire. *Bulletin of the North American Benthological Society* 2: 5–11.
- Resh, V.H., D.M. Rosenberg, and T.B. Reynoldson. 2000. Selection of benthic macroinvertebrate metrics for water quality monitoring of the Fraser River, British Columbia: implications for both multimetric approaches and multivariate models. In: *Assessing the biological quality of fresh waters: RIVPACS and other techniques*. Edited by: J.F. Wright, D.W. Sutcliffe, and M.T. Furse. Freshwater Biological Association, Ambleside, United Kingdom. pp. 195–206.
- Resh, V.H., D.M. Rosenberg, and A.P. Wiens. 1983. Emergence of caddisflies (Trichoptera) from eroding and non-eroding shorelines of Southern Indian Lake, Manitoba, Canada. *The Canadian Entomologist* 115: 1563–1572.
- Reynoldson, T.B., M. Bombardier, D.B. Donald, H. O'Neill, D.M. Rosenberg, H. Shear, T.M. Tuominen, and H.H. Vaughn. 1999. Strategy for a Canadian Aquatic Biomonitoring Network (CABIN). NWRI Contribution No. 99–248. National Water Research Institute, Environment Canada, Burlington, Ontario.
- Reynoldson, T.B., R.H. Norris, V.H. Resh, K.E. Day, and D.M. Rosenberg. 1997. The reference condition: a comparison of multimetric and multivariate approaches to assess water-quality impairment using benthic macroinvertebrates. *Journal of the North American Benthological Society* 16: 833–852.
- Reynoldson, T.B. and D.M. Rosenberg. 1996. Sampling strategies and practical considerations in building reference data bases for the prediction of invertebrate community structure. In: *Study design and data analysis in benthic macroinvertebrate assessments of freshwater ecosystems using a reference site approach*. Edited by: R.C. Bailey, R.H. Norris, and T.B. Reynoldson. 9th Annual Technical Information Workshop, June 4, 1996. 44th Annual Meeting of the North American Benthological Society, Kalispell, Montana. pp. 1–15.
- Reynoldson, T.B. and D.M. Rosenberg. 1998. Summary report on the development of a reference database on benthic invertebrates of the Fraser River: application of the reference-condition approach. NWRI Report No. 98–126. 19 pp.
- Reynoldson, T.B. and D.M. Rosenberg. 1999. 3.6. Benthic invertebrate community structure. In: *Health of the Fraser River aquatic ecosystem: a synthesis of research conducted under the Fraser River Action Plan*. Volume 1. Edited by: C. Gray and T. Tuominen. DOE FRAP 1998–11. Environment Canada, Vancouver. British Columbia. pp. 109–122.
- Reynoldson, T.B., D.M. Rosenberg, R.C. Bailey, M.G. Dubé, and J.L. Bailey. 2006. Indicators and protocols for data collection for monitoring watershed health for Yukon Placer Mining. Report Prepared for Fisheries and Oceans Canada by J. Bailey Consulting.

- Reynoldson, T.B., D.M. Rosenberg, and V.H. Resh. 2001. Comparison of models predicting invertebrate assemblages for biomonitoring in the Fraser River catchment, British Columbia. *Canadian Journal of Fisheries and Aquatic Sciences* 58: 1395–1410.
- Roeder, D.R., G.H. Crum, D.M. Rosenberg, and N.B. Snow. 1975. Effects of Norman Wells crude oil on periphyton in selected lakes and rivers in the Northwest Territories. *Canadian Fisheries and Marine Service Research Development Technical Report* 552. 31 pp.
- Rosenberg, D.M. 1965. The incidence of nematodes in larvae and adults of three genera of scarabaeid beetles in southeastern Manitoba, with observations on other parasites. *Forest Research Laboratory, Winnipeg, Manitoba; Internal Report MS-10*. 23 pp.
- Rosenberg, D.M. 1968. The occurrence of Collembola in relation to some physical characteristics of sandy beaches of the Eastern Tropical Pacific. *Report of Stanford Oceanographic Expedition* 18. pp. 143–172.
- Rosenberg, D.M. 1972. A chironomid (Diptera) larva attached to a libellulid (Odonata) larva. *Quaestiones entomologicae* 8: 3–4.
- Rosenberg, D.M. 1973. Effects of dieldrin on diversity of macroinvertebrates in a slough in Central Alberta. Ph.D. Thesis, Department of Entomology, University of Alberta, Edmonton. 282 pp.
- Rosenberg, D.M. 1974. The use of Chironomidae as indicators of macroinvertebrate diversity in a study of pesticide pollution. *Entomologisk Tidskrift* 95 (Supplement): 212–215.
- Rosenberg, D.M. 1975. Fate of dieldrin in sediment, water, vegetation, and invertebrates of a slough in central Alberta, Canada. *Quaestiones entomologicae* 11: 69–96.
- Rosenberg, D.M. 1975. Food chain concentration of chlorinated hydrocarbon pesticides in invertebrate communities: a re-evaluation. *Quaestiones entomologicae* 11: 97–110.
- Rosenberg, D.M. 1975. Sedimentation and freshwater biota: a comment prepared for the Berger Commission. 4 pp.
- Rosenberg, D.M. 1978. Book review: "Biological control of water pollution." J. Tourbier and R.W. Pierson, Jr. (Editors) 1976. University of Pennsylvania Press, Philadelphia, Pennsylvania. 340 pp. *Journal of the Fisheries Research Board of Canada* 35: 486–488.
- Rosenberg, D.M. 1978. Practical sampling of freshwater macrozoobenthos: a bibliography of useful texts, reviews, and recent papers. *Canadian Fisheries and Marine Service Technical Report* 790. 15 pp.
- Rosenberg, D.M. (Editor). 1979. Freshwater benthic invertebrate life histories: current research and future needs. *Journal of the Fisheries Research Board of Canada* 36: 289–345.

- Rosenberg, D.M. 1979. Introduction: freshwater benthic invertebrate life histories: current research and future needs. *Journal of the Fisheries Board of Canada* 36: 289–290.
- Rosenberg, D.M. 1981. Biological survey of Canada (Terrestrial Arthropods). Project on aquatic insects of freshwater wetlands. *Bulletin of the Entomological Society of Canada* 13: 151–153.
- Rosenberg, D.M. 1986. Resources and development of the Mackenzie system. In: *The Ecology of River Systems*. Edited by: B.R. Davies and K.F. Walker. Dr. W. Junk, The Hague, The Netherlands. pp. 517–540.
- Rosenberg, D.M. 1987. Book review: "An ecosystem approach to aquatic ecology. Mirror Lake and its environment" by G.E. Likens (Editor). Springer-Verlag, New York, 1985. 516 pp. *Journal of the North American Benthological Society* 6: 213–215.
- Rosenberg, D.M. 1987. Enriching the product. Presidential Address to the 35th Annual Meeting of the North American Benthological Society, Orono, Maine. *Bulletin of the North American Benthological Society* 4: 135–157.
- Rosenberg, D.M. 1990. Book review: "Rehabilitating damaged ecosystems" by J. Cairns, Jr. (Editor). CRC Press, Inc., Boca Raton, Florida, 1989., 2 volumes (Volume I: 192 pp., Volume II: 222 pp.). *Journal of the North American Benthological Society* 9: 91–94.
- Rosenberg, D.M. 1992. Book review: "Bioindicators and environmental management" by D.W. Jeffrey and B. Madden (Editors). Academic Press, London, 1991. 458 pp. *Freshwater Biology* 28: 287–288.
- Rosenberg, D.M. 1992. Freshwater biomonitoring and Chironomidae. *Netherlands Journal of Aquatic Ecology* 26: 101–122.
- Rosenberg, D.M. 1993. Book review: "Aquatic insects" by D.D. Williams and B.W. Feltmate. Centre for Agriculture and Bioscience International, Wallingford, United Kingdom. 1992. 358 pp. *Bulletin of the Entomological Society of Canada* 25: 34–36.
- Rosenberg, D.M. 1995. Book review: "Biomonitoring of trace aquatic contaminants" by D.J.H. Phillips and P.S. Rainbow. Elsevier Applied Science, London, United Kingdom. 1993. 371 pp. *Freshwater Biology* 33: 339–340.
- Rosenberg, D.M. 1996. Book review: "Use of biota to assess water quality. An international conference" by R.H. Norris, B.T. Hart, M. Finlayson, and K.R. Norris (Editors). *Australian Journal of Ecology* 20: 1–227. 1995. Blackwell Science, Australia. *Journal of the North American Benthological Society* 15: 262–264.
- Rosenberg, D.M. 1996. The Experimental Lakes Area (ELA) and international collaboration. In: *Managing collaboration for scientific excellence. A workshop held at the University of*

- Canberra, 8–9 February 1996. Cooperative Research Centre for Freshwater Ecology Discussion Paper, CRC for Freshwater Ecology, University of Canberra, Belconnen, Australian Capital Territory, Australia. pp. 16–26.
- Rosenberg, D.M. 1998. A national aquatic ecosystem health program for Canada: we should go against the flow. *Bulletin of the Entomological Society of Canada* 30: 144–152. [Gold Medal address to the joint meeting of the Entomological Society of Canada and the Entomological Society of Québec, November 1, 1998, Québec City, Québec].
- Rosenberg, D.M. 2003. Mercury in beluga whales in the Canadian Beaufort Sea: causes, consequences, and potential research. Canada/Inuvialuit Fisheries Joint Management Committee Technical Report 2003–2. Canada/Inuvialuit Fisheries Joint Management Committee, Inuvik, Northwest Territories. 32 pp.
- Rosenberg, D.M. 2017. *A Funny Thing Happened on the Way to the Lab: Reminiscences of a Life in Biology*. Self-published.
- Rosenberg, D.M. 2019. *A House of Plenty*. Self-published.
- Rosenberg, D.M. 2020. *For What It's Worth*. Self-published.
- Rosenberg, D.M., D.R. Barton, G.J. Brunskill, and P.J. McCart. 1986. The Mackenzie River system. In: *The Ecology of River Systems*. Edited by: B.R. Davies and K.F. Walker. *Monographiae Biologicae*, Volume 60. Springer, Dordrecht. pp. 425–540.
- Rosenberg, D.M., F. Berkes, R.A. Bodaly, R.E. Hecky, C.A. Kelly, and J.W.M. Rudd. 1997. Large-scale impacts of hydroelectric development. *Environmental Reviews* 5: 27–54.
- Rosenberg, D.M., B. Bilyj, and A.P. Wiens. 1984. Chironomidae (Diptera) emerging from the littoral zone of reservoirs, with special reference to Southern Indian Lake, Manitoba. *Canadian Journal of Fisheries and Aquatic Sciences* 41: 672–681.
- Rosenberg, D.M., R.A. Bodaly, R.E. Hecky, R.W. Newbury, and K. Patalas. 1985. Hydroelectric development in northern Manitoba: the Churchill-Nelson river diversion and flooding of Southern Indian Lake. *Bulletin of the Canadian Society for Environmental Biology*, 42: 31–42.
- Rosenberg, D.M., R.A. Bodaly, R.E. Hecky, and R.W. Newbury. 1987. The environmental assessment of hydroelectric impoundments and diversions in Canada. *Canadian Bulletin of Fisheries and Aquatic Sciences* 215: 71–104.
- Rosenberg, D.M., R.A. Bodaly, and P. Usher. 1995. Environmental and social impacts of large-scale hydroelectric development: who is listening? *Global Environmental Change* 5: 127–148.

- Rosenberg, D.M., P.A. Chambers, J.M. Culp, W.G. Franzin, P.A. Nelson, A.G. Salki, M.P. Stainton, R.A. Bodaly, and R.W. Newbury. 2005. Nelson and Churchill rivers. In: *Rivers of North America*. Edited by: A.C. Benke and C.E. Cushing. Academic Press, San Diego, California. pp. 853–901.
- Rosenberg, D.M. and H.V. Danks (Editors). 1987. Aquatic insects of peatlands and marshes in Canada. *Memoirs of the Entomological Society of Canada* 140. 174 pp.
- Rosenberg, D.M. and H.V. Danks. 1987. Aquatic insects of peatlands and marshes in Canada: Introduction. In: *Aquatic insects of peatlands and marshes in Canada*. Edited by: D.M. Rosenberg and H.V. Danks. *Memoirs of the Entomological Society of Canada* 140: 1–4.
- Rosenberg, D.M., H.V. Danks, J.A. Downes, A.P. Nimmo, and G.E. Ball. 1979. Procedures for a faunal inventory. In: *Canada and its Insect Fauna*. Edited by: H.V. Danks. *Memoirs of the Entomological Society of Canada* 108: 509–532.
- Rosenberg, D.M., H.V. Danks, and D.M. Lehmkuhl. 1986. Importance of insects in environmental impact assessment. *Environmental management* 10: 773–783.
- Rosenberg, D.M., I.J. Davies, D.G. Cobb, and A.P. Wiens. 1997. Ecological Monitoring and Assessment Network (EMAN) protocols for measuring biodiversity: benthic macroinvertebrates in fresh waters. Prepared for EMAN Office, Environment Canada, Burlington, Ontario. 54 pp. (EMAN website: www.cciw.ca/eman-temp/intro.html)
- Rosenberg, D.M. and D.J. Gamble. 1988. Mighty rivers of the world. *Magnificent Mackenzie*. *Geographical Magazine* 60: 24–29.
- Rosenberg, D.M., R.E. Hecky, and P. Campbell. 1995. Introduction to contaminants research at the Experimental Lakes Area. *Canadian Journal of Fisheries and Aquatic Sciences* 52: 2211–2212.
- Rosenberg, D.M., P. McCully, and C.M. Pringle. 2000. Global-scale environmental effects of hydrological alterations: introduction. *BioScience* 50: 746–751.
- Rosenberg, D.M. and V.H. Resh. 1982. The use of artificial substrates in the study of freshwater benthic macroinvertebrates. In: *Artificial Substrates*. Edited by: J. Cairns, Jr. Ann Arbor Science Publishers Inc., Ann Arbor, Michigan. pp. 175–235.
- Rosenberg, D.M. and V.H. Resh (Editors). 1993. *Freshwater Biomonitoring and Benthic Macroinvertebrates*. Chapman and Hall, New York, New York. 488 pp.
- Rosenberg, D.M. and V.H. Resh, V.H. 1993. Introduction. In: *Freshwater Biomonitoring and Benthic Macroinvertebrates*. Edited by: D.M. Rosenberg and V.H. Resh. Chapman and Hall, New York, New York. pp. 1–9.

- Rosenberg, D.M. and V.H. Resh. 1996. Use of aquatic insects in biomonitoring, In: An Introduction to Aquatic Insects of North America. 3rd Edition. Edited by: R.W. Merritt and K.W. Cummins. Kendall Hunt Publishers, Dubuque, Iowa. pp. 87–97.
- Rosenberg, D.M. and V.H. Resh. 2003. Pollution, Insect Response to. In: Encyclopedia of Insects. Edited by: V.H. Resh and R.T. Cardé. Elsevier, New York, New York. pp. 926–928.
- Rosenberg, D.M., V.H. Resh, S.S. Balling, M.A. Barnby, J.N. Collins, D.V. Durbin, T.S. Flynn, D.D. Hart, G.A. Lamberti, E.P. McElravy, and J.R. Wood. 1981. Recent trends in environmental impact assessment. *Canadian Journal of Fisheries and Aquatic Sciences* 38: 591–624.
- Rosenberg, D.M., V.H. Resh, and R.S. King. 2008. Use of aquatic insects in biomonitoring. In: An Introduction to Aquatic Insects of North America. 4th Edition. Edited by: R.W. Merritt, K.W. Cummins, and M.B. Berg. Kendall Hunt Publishers, Dubuque, Iowa. pp. 123–138.
- Rosenberg, D.M., T.B. Reynoldson, K.E. Day, and V.H. Resh. 1997. Role of abiotic factors in structuring benthic invertebrate communities in freshwater ecosystems. In: Ecological risk assessment of contaminated sediments. Edited by: C.G. Ingersoll, T. Dillon, and G.R. Biddinger. Proceedings of the Pellston Workshop on Sediment Ecological Risk Assessment, April 23–28, 1995, Pacific Grove, California. SETAC Special Publications Series. SETAC Press, Pensacola, Florida. pp. 135–155.
- Rosenberg, D.M., T.B. Reynoldson, and V.H. Resh. 1999. Establishing reference conditions for benthic invertebrate monitoring in the Fraser catchment, British Columbia, Canada. FRAP Report No. DOE–FRAP 1998–32. Fraser River Action Plan, Environment Canada, Vancouver, British Columbia. 149 pp.
- Rosenberg, D.M., T.B. Reynoldson, and V.H. Resh. 2000. Establishing reference conditions in the Fraser River catchment, British Columbia, Canada, using the BEAST (Benthic Assessment of SedimenT) predictive model. In: Assessing the Biological Quality of Fresh Waters: RIVPACS and Other Techniques. Edited by: J.F. Wright, D.W. Sutcliffe, and M.T. Furse. Freshwater Biological Association, Ambleside, United Kingdom. pp. 181–194.
- Rosenberg, D.M. and N.B. Snow. 1975. Effect of crude oil on zoobenthos colonization of artificial substrates in subarctic aquatic ecosystems. *Verhandlungen der Internationalen Vereinigung für Theoretische und Angewandte Limnologie* 19: 2172–2177.
- Rosenberg, D.M. and N.B. Snow. 1975. Ecological studies of aquatic organisms in the Mackenzie and Porcupine River drainages in relation to sedimentation. Development Technical Report 547, Canadian Fisheries and Marine Services Research, Winnipeg, Manitoba. 86 pp.

- Rosenberg, D.M. and N.B. Snow. 1977. A design for environmental impact studies with special reference to sedimentation in aquatic systems of the Mackenzie and Porcupine River drainages. In: Proceedings of the Circumpolar Conference on Northern Ecology, September 15–18, 1975, Ottawa. National Research Council, Ottawa, Ontario. pp. III–65–III–78.
- Rosenberg, D.M. and A.P. Wiens. 1975. Experimental sediment addition studies on the Harris River, N.W.T., Canada: the effect on macroinvertebrate drift. *Verhandlungen der Internationalen Vereinigung für Theoretische und Angewandte Limnologie* 19: 1568–1574.
- Rosenberg, D.M. and A.P. Wiens. 1976. Community and species responses of Chironomidae (Diptera) to contamination of freshwaters by crude oil and petroleum products, with special reference to the Trail River, Northwest Territories. *Journal of the Fisheries Research Board of Canada* 33: 1955–63.
- Rosenberg, D.M. and A.P. Wiens. 1978. Effects of sediment addition on macrobenthic invertebrates in a northern Canadian river. *Water Research* 12: 753–763.
- Rosenberg, D.M. and A.P. Wiens. 1980. Responses of Chironomidae (Diptera) to short-term experimental sediment additions in the Harris River, Northwest Territories, Canada. *Acta Universitatis Carolinae-Biologica* 1978: 181–192.
- Rosenberg, D.M. and A.P. Wiens. 1983. Efficiency of modifications in the design and use of submerged funnel traps for sampling Chironomidae (Diptera). *Hydrobiologia* 98: 113–118.
- Rosenberg, D.M., A.P. Wiens, and B. Bilyj. 1980. Sampling emerging Chironomidae (Diptera) with submerged funnel traps in a new northern Canadian reservoir, Southern Indian Lake, Manitoba. *Canadian Journal of Fisheries and Aquatic Sciences* 37: 927–936.
- Rosenberg, D.M., A.P. Wiens, and B. Bilyj. 1988. Chironomidae (Diptera) of peatlands in northwestern Ontario, Canada. *Ecography* 11: 19–31.
- Rosenberg, D.M., A.P. Wiens, B. Bilyj, and L. Armstrong. 1995. Experimental acidification of a poor fen in northwestern Ontario: effects on emergence of Chironomidae (Diptera). *Canadian Journal of Fisheries and Aquatic Sciences* 52: 2229–2237.
- Rosenberg, D.M., A.P. Wiens, B. Bilyj, and L. Armstrong. 2001. Peatland Chironomidae (Diptera): effects of flooding on emergence from Lake 979, Experimental Lakes Area, Ontario. *Journal of the North American Benthological Society* 20: 448–467.
- Rosenberg, D.M., A.P. Wiens, and J.F. Flannagan. 1980. Effects of crude oil contamination on Ephemeroptera in the Trail River, Northwest Territories, Canada. In: *Advances in Ephemeroptera Biology*. Edited by: J.F. Flannagan and K.E. Marshall. Proceedings of the 3rd International Conference on Ephemeroptera. Plenum Publishing Co., New York, New York. pp. 443–455.

- Rosenberg, D.M., A.P. Wiens, and O.A. Sæther. 1977. Life histories of *Cricotopus* (*Cricotopus*) *bicinctus* and *C. (C.) mackenziensis* (Diptera: Chironomidae) in the Fort Simpson area, Northwest Territories. *Journal of the Fisheries Board of Canada* 34: 247–253.
- Rosenberg, D.M. A.P. Wiens, and O.A. Sæther. 1977. Responses to crude oil contamination by *Cricotopus* (*Cricotopus*) *bicinctus* and *C. (C.) mackenziensis* (Diptera: Chironomidae) in the Fort Simpson area, Northwest Territories. *Journal of the Fisheries Board of Canada* 34: 254–261.
- Sebastien, R.J., R.A. Brust, and D.M. Rosenberg. 1989. Impact of methoxychlor on selected nontarget organisms in a riffle of the Souris River, Manitoba. *Canadian Journal of Fisheries and Aquatic Sciences* 46: 1047–1061.
- Sebastien, R.J., D.M. Rosenberg, and A.P. Wiens. 1988. A method for subsampling unsorted benthic macroinvertebrates by weight. *Hydrobiologia* 157: 69–75.
- Snow, N.B. and D.M. Rosenberg. 1975. Experimental oil spills on Mackenzie Delta Lakes I. Effect of Norman Wells crude oil on Lake 4. Canadian Fisheries and Marine Service Technical Report No. 548. Environment Canada. 44 pp.
- Snow, N.B. and D.M. Rosenberg. 1975. Experimental oil spills on Mackenzie Delta Lakes. II. Effect of two types of crude oils Lakes 4C and 8. Canadian Fisheries and Marine Service Technical Report No. 549. Environment Canada. 19 pp.
- Snow, N.B. and D.M. Rosenberg. 1975. The effects of crude oil on the colonization of artificial substrates by zoobenthos organisms. Canadian Fisheries and Marine Service Technical Report No. 551. 35 pp.
- Snow, N.B., D.M. Rosenberg, and J. Moenig. 1975. The effects of Norman Wells crude oil on the zoobenthos of a northern Yukon stream, one year after an experimental spill. Canadian Fisheries and Marine Service Technical Report No. 550. 8 pp.
- St. Louis, V.L., C.A. Kelly, E. Duchemin, J.W.M. Rudd, and D.M. Rosenberg. 2000. Reservoir surfaces as sources of greenhouse gases to the atmosphere: a global estimate. *BioScience* 50: 766–775.
- Wagemann, R., N.B. Snow, D.M. Rosenberg, D.M. Lutz, A. 1978. Arsenic in sediments, water and aquatic biota from lakes in the vicinity of Yellowknife, Northwest Territories, Canada. *Archives of Environmental Contamination and Toxicology* 7: 169–191.
- Wiens, A.P. and D.M. Rosenberg. 1984. Effect of impoundment and river diversion on profundal macrobenthos of Southern Indian Lake, Manitoba. *Canadian Journal of Fisheries and Aquatic Sciences* 41: 638–648.

- Wiens, A.P. and D.M. Rosenberg. 1991. Surveys of benthic macroinvertebrates in Playgreen and Kiskittogisu lakes, northern Manitoba. Canadian Technical Report of Fisheries and Aquatic Sciences. 1814. 21 pp.
- Wiens, A.P. and D.M. Rosenberg. 1994. Churchill River diversion: effects on benthic invertebrates in lakes along the lower Churchill and the diversion route. Canadian Technical Report of Fisheries and Aquatic Sciences. 2001: iv + 29 pp.
- Wiens, A.P., D.M. Rosenberg, and K.W. Evans. 1975. *Symbiocladius equitans* Claassen (Diptera: Chironomidae), an ectoparasite of Ephemeroptera in the Martin River, Northwest Territories, Canada. *Entomologica Germanica* 2: 113–120.
- Wiens, A.P., D.M. Rosenberg, and N.B. Snow. 1975. Species list of aquatic plants and animals collected from the Mackenzie and Porcupine River watersheds from 1971 to 1973. Canadian Fisheries and Marine Service Technical Report No. 557. 39 pp.
- Wrubleski, D.A. and D.M. Rosenberg. 1984. Overestimates of Chironomidae (Diptera) abundance from emergence traps with polystyrene floats. *American Midland Naturalist* 111: 195–197.
- Wrubleski, D.A. and D.M. Rosenberg. 1990. The Chironomidae (Diptera) of Bone Pile Pond, Delta Marsh, Manitoba, Canada. *Wetlands* 10: 243–275.

Submitted Paper

Lice (Phthiraptera: Trichodectidae), fleas (Siphonaptera: Pulicidae, Ceratophyllidae) and ticks (Ixodida: Ixodidae) infesting American badger, *Taxidea taxus* (Mammalia: Mustelidae), in Manitoba, Canada

Terry D. Galloway

Department of Entomology, University of Manitoba, Winnipeg, Manitoba, Canada, R3T 2N2

Corresponding Author: Terry.Galloway@umanitoba.ca

Abstract — One juvenile and nine adult American badgers, *Taxidea taxus* (Schreber), from Manitoba were examined for ectoparasites by whole body washing or visual inspection. Five of seven adults washed from the Shoal Lake area were infested with one species of chewing louse, *Neotrichodectes interruptofasciatus* (Kellogg and Ferris) (mean intensity – 539); females were significantly more abundant than males. The ratio of nymphs to females was 2.5. The washed juvenile badger was infested with 6384 specimens of *N. interruptofasciatus*, but males (n=286) and females (n=287) were almost equal in number, and the ratio of nymphs to females was 20.3. Adult badgers were infested with five species of fleas: *Pulex irritans* Linnaeus, *Oropsylla rupestris* (Jordan), *O. bruneri* (Baker), *O. tuberculata* (Baker), and *O. arctomys* (Baker). All seven adult badgers from the Shoal Lake area were infested with adult American dog ticks, *Dermacentor variabilis* (Say). Mean intensity was 63.4, with a total of 258 males and 186 females.

Introduction

The American badger (Mammalia: Mustelidae: *Taxidea taxus* (Schreber)) is a superbly adapted fossorial predator of North America's central and western plains and grasslands. In Canada, its range extends from Ontario (*T. t. jacksoni* Schantz), throughout the Prairie Region (*T. t. taxus* (Schreber)) to central British Columbia (*T. t. jeffersonii* (Harkan)) (Naughton 2012). Although some subspecies are listed as endangered in British Columbia and Ontario (COSEWIC 2012), the subspecies in Manitoba, *T. taxus taxus*, remains on the list of fur bearers in the province.

There have been numerous reports of ectoparasites from badgers in North America. Most accounts were tabulated by Wittrock and Wilson (1974). There have been no dedicated studies of ectoparasites of badgers in Canada, though various taxonomic groups have been recorded. Perhaps the most extensively listed for Canada are the fleas, summarized by Holland (1985). Ticks are common ectoparasites of badgers, as cited by Cooley and Kohls (1945), Brown and Kohls (1950), Gregson (1956), and Lindquist *et al.* (2016). Although the chewing louse, *Neotrichodectes interruptofasciatus* (Kellogg and Ferris) is known to infest American badger (Wittrock and Wilson 1974), there are no published records of this louse in Canada (Kennedy and Newman 1986).

I recently had the opportunity to examine a small sample of American badgers from Manitoba that allowed a thorough, quantitative assessment of ectoparasites. These are the first data of their kind collected from this host.

Materials and Methods

Seven badgers were collected during a predator control program conducted by the Delta Waterfowl Foundation in the area of Shoal Lake, southwest of Minnedosa, Manitoba. Seven badgers (three males; four females) were trapped and individually bagged immediately after being euthanized during the period 15 March to 15 July, 2008–2010 and 2013. Precise dates and locations of each badger were not available. Badgers were kept frozen until they were processed for ectoparasites in the laboratory. Each adult badger was thawed overnight at room temperature, to the point where limbs and head were flexible, then washed three times in a plastic garbage can (75-litre capacity), twice containing warm soapy water and once with clean water (Galloway and Lamb 2014, 2016). If ectoparasites were seen on the surface of the last wash in clean water, the animal was returned for subsequent washes in soapy water until no ectoparasites were evident. Badgers were agitated vigorously to dislodge ectoparasites and examined visually and by manual palpation after each wash, especially to detect attached ticks. The water from each wash was passed through a 90 μ sieve and the residual preserved in 95% ethanol. Samples were sorted under a dissecting microscope and ectoparasites preserved in 95% ethanol. Representative specimens of lice and all fleas were mounted in Canada balsam using the method described by Richards (1964). Lice were identified using descriptions in Kellogg and Ferris (1915) and Werneck (1948); fleas were identified using keys in Holland (1985); identity of ticks was confirmed using Lindquist *et al.* (2016). Infestation parameters are defined according to Bush *et*

al. (1997) and were calculated using Quantitative Parasitology (QPweb 1.0.15; Reiczigel *et al.* 2019). In addition to the Shoal Lake badgers, one male young-of-the-year badger (1712.4g) from Brandon, Manitoba was submitted to Wildlife Haven (Manitoba Wildlife Rehabilitation Organization) on 22 July, 2021 but it died overnight, 23 July. It was processed as described above for adult badgers, but was washed in a smaller plastic pail (26-litre capacity). One road-killed badger was examined by visual inspection in 1990 during a survey of mammals for the blacklegged tick, *Ixodes scapularis* Say. One additional road-killed badger was similarly examined in 2005 as part of a long-term study on ectoparasites infesting wildlife in Manitoba.

Voucher specimens for all collections were deposited in the J.B. Wallis/R.E. Roughley Museum of Entomology in the Department of Entomology, University of Manitoba, Winnipeg.

Results

Results of collections from the Shoal Lake badgers are presented in Table 1. Five of seven badgers (prevalence = 71.4%) were infested with one species of chewing louse, *N. interruptofasciatus* (Phthiraptera: Trichodectidae). A total of 2695 chewing lice were collected. Sex ratio of total males (n=232) to females (n=714), 0.33, was significantly less than 1.0 ($P < 0.05$, χ^2 goodness of fit, df = 1). The ratio of total nymphs to females was 2.5. Mean intensity of infestation was 539.0 (174–1500; 95% confidence interval, BCa method, 2000 bootstrap replications). The juvenile badger from Brandon was infested only with chewing lice, 6384 *N. interruptofasciatus* (males – 286; females – 287; nymphs – 5811). The sex ratio was almost exactly 1:1, and the ratio of nymphs to females was 20.3.

Four species of fleas were collected from the Shoal Lake badgers: *Pulex irritans* Linnaeus (Siphonaptera: Pulicidae), *Oropsylla (Oropsylla) rupestris* (Jordan), *Oropsylla (Opisocrostis) bruneri* (Baker), and *Oropsylla (Opisocrostis) tuberculata* (Baker) (all three species, Ceratophyllidae) (Table 1). Although all but two badgers were infested with fleas, none of the species of fleas were present in large numbers. Total numbers of fleas never exceeded eight on one host.

One species of tick, *Dermacentor variabilis* (Say) (Ixodida: Ixodidae), was collected from the Shoal Lake badgers. All seven of the badgers were infested with a total of 444 *D. variabilis*. Sex ratio of total males (n=258) to females (n=186), 1.39, was significantly greater than 1.0 ($P < 0.05$, χ^2 goodness of fit, df = 1). Mean intensity of infestation was 63.4 (37.3–103.0; 95% confidence interval, BCa method, 2000 bootstrap replications). No mites were collected from any of the badgers.

Additional records for fleas from two road-killed American badgers in Manitoba include the following: Elm Creek, 18.vii.1990, *Pulex irritans* – 2♂, 3♀, J.E. Christie/D.M. Mitchell; 5 km. south, 5 km. west of Morris, 7.xii.2005, *Oropsylla arctomys* (Baker) – 1♂, 1♀, *Oropsylla bruneri* – 1♀, T.D. Galloway/J.E. Christie. No ticks or lice were collected from any of the road-killed badgers.

Table 1. Summary of ectoparasites collected from seven American badgers (*Taxidea taxus*) from the Shoal Lake area, Manitoba, southwest of Minnedosa, 15 March–15 July, 2008–2010, 2013. Numbers were arbitrarily assigned to individual badgers, and correspond to slides and collection vials in the Wallis/Roughley Museum of Entomology.

Host	Ectoparasites
Badger #1 ♀ 6.9kg	<i>Neotrichodectes interruptofasciatus</i> – 40♂; 177♀; 54n <i>Dermacentor variabilis</i> – 30♂; 15♀
Badger #2 ♂ 8.4kg	<i>Neotrichodectes interruptofasciatus</i> – 27♂; 58♀; 142n <i>Oropsylla bruneri</i> – 1♀ <i>Oropsylla tuberculata</i> – 1♀ <i>Oropsylla rupestris</i> – 2♂; 1♀ <i>Dermacentor variabilis</i> – 19♂; 21♀
Badger #3 ♂ 11.3kg	<i>Pulex irritans</i> – 1♂ <i>Oropsylla tuberculata</i> – 1♂; 5♀ <i>Oropsylla rupestris</i> – 1♂ <i>Dermacentor variabilis</i> – 27♂; 9♀
Badger #4 ♀ 6.7kg	<i>Neotrichodectes interruptofasciatus</i> – 33♂; 123♀; 166n <i>Dermacentor variabilis</i> – 7♂; 8♀
Badger #5 ♀ 5.9kg	<i>Pulex irritans</i> – 1♀ <i>Oropsylla rupestris</i> – 2♂ <i>Dermacentor variabilis</i> – 59♂; 50♀
Badger #6 ♂ 9.1kg	<i>Neotrichodectes interruptofasciatus</i> – 129♂; 343♀; 1352n <i>Oropsylla rupestris</i> – 2♀ <i>Oropsylla tuberculata</i> – 1♀ <i>Dermacentor variabilis</i> – 91♂; 54♀
Badger #7 ♀ 6.6kg	<i>Neotrichodectes interruptofasciatus</i> – 3♂; 13♀; 35n <i>Pulex irritans</i> – 1♂ <i>Dermacentor variabilis</i> – 25♂; 29♀

Discussion

This is the first published record of *N. interruptofasciatus* in Canada, though there is one male specimen in the Canadian National Collection of Insects, Acari and Nematodes in Ottawa, collected by Stuart Criddle at Aweme, Manitoba, 15.i.1914. There are also specimens of *O. arctomys*, and *O. bruneri* collected by S. Criddle on the same date, presumably from the same badger (Holland 1949). The Aweme records are of interest because they were collected during

winter, as were the specimens collected from a road-killed badger near Morris in the present study. American badgers do not hibernate, but they are active throughout winter with intermittent periods of torpor, and will emerge above ground during periods of mild weather (Naughton 2012).

The present study is the first dedicated attempt to quantify infestation parameters of this louse. American badgers are rather large, with coarse thick fur, making collection of chewing lice a challenge. Wittrock and Wilson (1974) reported the numbers of male and female lice from nine of 13 infested badgers (69.2%) in Iowa, comparable to the prevalence of infestation in the current study (71.4%). They reported that some badgers were infested with “extremely large numbers” of lice, but collected only a few. They did not describe their collection methods, nor whether they attempted to randomize their collections. Females of *N. interruptofasciatus* outnumbered males on all five infested Shoal Lake badgers. Males represented 24.5% of total adult lice in the current study. This relationship is not unusual for lice (Marshall 1981), but Wittrock and Wilson (1974) considered males to be “relatively scarce” in their samples, represented by 25.5% of the total adult lice. Wittrock and Wilson (1974) cited records of *N. interruptofasciatus* from badgers in California (Kellogg and Ferris 1915), Colorado (Werneck 1948) and their own study in Iowa. Wilson and Oliver (1979) reported *N. interruptofasciatus* from a badger in Hebronville, Texas. As in the previous account (Wittrock and Wilson 1974), they found females to outnumber males, 42 to 31. Whitaker and Goff (1979) collected four *N. interruptofasciatus* from two badgers in Indiana, presumably by means of visual inspection, though this is uncertain based on their description of methods. Emerson *et al.* (1984) reported this louse from badgers in Oregon, but provided no quantitative information. Hampton (2005) reported the presence of specimens of *N. interruptofasciatus* from Idaho, deposited in the Idaho National Collection. The infestation on the juvenile badger from Brandon offers some interesting insight, despite being from only one animal. Where male lice had generally been considered “scarce” (Wittrock and Wilson 1974), or were at least significantly outnumbered by females on adult badgers (the current study), this juvenile badger was infested with an almost identical number of males and females, 286 and 287, respectively. In addition, it appears the louse population was in a stage of logarithmic increase, as indicated by the large number of nymphs (5811), with a nymph to female ratio (20.3) considerably greater than seen on any of the infested adult badgers. This juvenile badger would likely have been born in April, making it no more than about three months of age (Drescher 1974). This juvenile may still have been closely associated with its mother, or was in early stages of having been weaned and dispersing from the family group (Naughton 2012). Given the method of collection of lice in this study, it is possible that the sex ratio in *N. interruptofasciatus* approximates 1:1 at the time of hatch, and that the observed female bias in sex ratio on adult badgers in this and other studies is largely the result of subsequent disparity in survival in male versus female lice. However, this hypothesis is dependent on the degree of separation from its mother and siblings. As long as there was intimate association with family members prior to its dispersal, there would have been an avenue for dynamic louse transfer from one individual to another, consequently affecting sex ratio in adult lice and proportion of nymphs relative to females. Although no attempt was made to

estimate the number of eggs on this juvenile badger, there were many present in the sample after washing.

Although there have been no dedicated studies on the ectoparasites of *T. taxus* in Canada, there are scattered records of fleas infesting badgers, perhaps because of their association as vectors of the plague bacillus, *Yersinia pestis* (Lehmann & Neumann) van Loghem (Brown 1944). The badger is not known to have any specific flea parasites, but Brown (1944) and Holland (1949, 1985) listed five species of fleas recorded from badgers in Canada: *P. irritans*, *O. arctomys* (Manitoba), *O. rupestris* (Alberta), *O. bruneri* (Manitoba), and *Oropsylla (Opisocrostitis) labis* (Jordan & Rothschild) (Alberta). All but *O. labis* were collected from badgers in the present study. The latter species is known to occur in Manitoba (Galloway and Christie 1990), but only in the southwest corner of the province. These *Oropsylla* spp. are all parasites of fossorial sciurids, the woodchuck, *Marmota monax* (Linnaeus) in the case of *O. arctomys* (Holland 1985) and the various species of ground squirrels in the province (*Urocitellus richardsonii* (Sabine), *Poliocitellus franklinii* (Sabine), and *Ictidomys tridecemlineatus* (Mitchill)) (Galloway and Christie 1990) for the other three species of fleas. These species of sciurids are all important sources of food for badgers (Messick and Hornocker 1981) and the association with their fleas is likely the result of predatory activity. Benton (1980) reported the pocket gopher flea, *Foxella ignota* (Baker) from an American badger in Minnesota, probably the result of predation. Four specimens of *P. irritans* were collected in the present study from the road-killed badgers near Elm Creek. *Pulex irritans* has also been reported in Canada as infesting badgers in Alberta (Brown 1944) and Saskatchewan (Holland 1985), and adjacent U.S. states, North Dakota (Woods and Larson 1970; Larson 1997) and Montana (Jellison *et al.* 1943). This flea has a very wide geographical distribution and host range (Hopla 1980; Holland 1985), but in Manitoba, most often infests canids, especially red fox, *Vulpes vulpes* (Linnaeus) (Galloway, personal observation). Its association with badgers in the present study is likely accidental. I know of no published records of fleas from subspecies of badgers in either British Columbia or Ontario.

American badgers tend to be solitary (Minta 1993), with adults occupying quite large home range sizes, 3 to 30 km² in Wisconsin (Doyle *et al.* 2019), and ranges even greater where prey is less abundant, up to 300 km² for males in the Kootenay Region of British Columbia (Kinley and Newhouse 2008). All seven Shoal Lake badgers were infested with *D. variabilis*, at an average of about 63 adult ticks per host. *Dermacentor variabilis* is the most abundantly encountered tick in Manitoba (Dergousoff *et al.* 2013), so it is not surprising to record its prevalence (100%) and intensity of infestation (in some Shoal Lake badgers >100 adult ticks) on *T. taxus* well within the range of this tick in the province. American dog ticks present an ever increasing pattern of expansion in distribution during their life cycle, from the initial focal egg mass, to larvae, to nymphs (both stages infesting small mammal hosts) and then to adults on medium-sized and large mammals (Burachynsky and Galloway 1985). Badgers, especially males, are known to disperse considerable distances, more than 100 km in some cases (Messick and Hornocker 1981). Depending on the time of the year when dispersal takes place, badgers in Manitoba clearly offer considerable potential as important agents of dispersal for adult American dog ticks. In southern grassland regions of Manitoba and Saskatchewan, badgers may contribute to the

expanding ranges of *D. variabilis* and *D. andersoni* (Dergousoff *et al.* 2013). Lindquist *et al.* (2016) cited three additional species of ticks infesting badgers in Canada, none of which were collected in the present study: *Dermacentor andersoni* Stiles (but see Wilkinson (1970)), *Ixodes kingi* Bishopp, and *Ixodes sculptus* Neumann. *Dermacentor andersoni* is not known to occur in Manitoba, *I. kingi* is rarely encountered, and *I. sculptus* is known only from the southwest corner of the province (Lindquist *et al.* 2016).

Among the three subspecies of American badger in Canada, two are considered endangered: *T. taxus jacksoni* in Ontario, and both designatable units of *T. taxus jeffersonii* (East and West Kootenay) (COSEWIC 2012). *Taxidea taxus taxus*, the subspecies examined in the present study, was designated as being of Special Concern by COSEWIC (2012), though it is still categorized as a fur-bearing animal and harvest is permitted in Alberta, Saskatchewan and Manitoba. *Taxidea taxus jacksoni* is the only subspecies in Canada that is isolated from potential gene flow from contiguous populations in the United States, and perhaps therefore of greatest concern. None of the fleas or ticks known to infest badgers are specific parasites of this host. However, the chewing louse, *N. interruptofasciatus*, is a monoxenous parasite of American badger, and completes its entire life cycle on the body of its host. Perèz *et al.* (2013) discussed issues surrounding conservation of parasites, especially where they pose a threat to health and well being of an endangered species of host. The chewing louse, *Trichodectes canis* is known to be associated with hair loss in wild canids in North America (Foreyt *et al.* 1978; Mech *et al.* 1985; Jimenez *et al.* 2010), but I know of no such reports which involve *N. interruptofasciatus* infestations of badgers. Consequently, the conservation status of the various subspecies of American badger in Canada should also be applied appropriately, at least provincially, to *N. interruptofasciatus*. This is especially the case in populations of *T. t. jacksoni* and *T. t. jeffersonii* where the occurrence and status of *N. interruptofasciatus* in Canada are unknown.

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References

- Benton, A.H. 1980. An atlas of the fleas of the eastern United States. Marginal Media, Fredonia, New York. xv + 177 pp.
- Brown, J.H. 1944. The fleas (Siphonaptera) of Alberta, with a list of known vectors of sylvatic plague. *Annals of the Entomological Society of America* 37: 207–213.
- Brown, J.H. and G.M. Kohls. 1950. The ticks of Alberta with special reference to distribution. *Journal of Research* 28D: 197–205.
- Burachynsky, V.I. and T.D. Galloway. 1985. Seasonal dynamics and distribution of the American dog tick, *Dermacentor variabilis* (Say), larvae and nymphs at Birds Hill Park, Manitoba. *Canadian Journal of Zoology* 63: 2748–2755.
- Bush, A.O., K.D. Lafferty, J.M. Lotz, and A.W. Shostak. 1997. Parasitology meets ecology on its own terms: Margolis *et al.* revisited. *Journal of Parasitology* 83: 575–583.
- Cooley, R.A. and G.M. Kohls. 1945. The genus *Ixodes* in North America. *National Institute of Health Bulletin* 184: 1–246.
- COSEWIC. 2012. COSEWIC assessment and status report on the American Badger *Taxidea taxus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. iv + 63 pp. www.registrelep-sararegistry.gc.ca/default_e.cfm
- Dergousoff, S.J., T.D. Galloway, L.R. Lindsay, P. Curry, and N.B. Chilton. 2013. Range expansion of *Dermacentor variabilis* and *Dermacentor andersoni* (Acari: Ixodidae) near their northern distributional limits. *Journal of Medical Entomology* 50: 510–520.
- Drescher, H.-E. 1974. On the status of the badger, *Taxidea taxus*, in Manitoba (Canada). *Zoologische Anzeiger* 3/4: 222–228.
- Doyle, J.C., D.W. Sample, L. Long, and T.R. van Deelen. 2019. Space use and habitat selection of American badgers (*Taxidea taxus*) in southwestern Wisconsin. *American Midland Naturalist* 182: 63–74.
- Emerson, K.C., C. Maser, and J.O. Whittaker, Jr. 1984. Lice (Mallophaga and Anoplura) from mammals of Oregon. *Northwest Science* 58: 153–161.
- Foreyt W., G.G. Long, and N.L. Gates. 1978. *Trichodectes canis*: severe pediculosis in coyotes. *Veterinary Medicine/Small Animal Clinician* 73: 503–505.
- Galloway, T.D. and J.E. Christie. 1990. Fleas (Siphonaptera) associated with ground squirrels (*Spermophilus* spp.) in Manitoba, Canada. *The Canadian Entomologist* 122: 449–458.
- Galloway, T.D. and R.J. Lamb. 2014. Abundance and stability are species traits for four chewing lice (Phthiraptera: Menoponidae, Philopteridae) on feral pigeons, *Columba livia* Gmelin (Aves: Columbiformes: Columbidae). *The Canadian Entomologist* 146: 444–456.

- Galloway, T.D. and R.J. Lamb. 2016. Chewing lice (Phthiraptera: Amblycera and Ischnocera) infesting woodpeckers, flickers and sapsuckers (Aves: Piciformes: Picidae) in Manitoba, Canada. *The Canadian Entomologist* 148: 520–531.
- Gregson, J.D. 1956. The Ixodoidea of Canada. Publication 930. Entomology Division, Science Service, Canada Department of Agriculture. 92 pp.
- Hampton, N. 2005. Insects of the Idaho National Laboratory: a compilation and review. USDA Forest Service Proceedings, RMRS-P-38: 116–130.
- Holland, G.P. 1949. The Siphonaptera of Canada. Dominion of Canada, Department of Agriculture, Publication 817, Technical Bulletin 70. 306 pp.
- Holland, G.P. 1985. The fleas of Canada, Alaska and Greenland (Siphonaptera). *Memoirs of the Entomological Society of Canada*, No. 130. 631 pp.
- Hopla, C.E. 1980. A study of the host associations and zoogeography of *Pulex*. In: Fleas. Edited by: R. Traub and H. Starcke, A.A. Balkema/Rotterdam. Pp. 185–207.
- Jellison, W.L., G.M. Kohls, and H.B. Mills. 1943. Siphonaptera: species and host list of Montana fleas. *Montana State Board of Entomology, Miscellaneous Publication No. 2*: 1–22.
- Jimenez, M.D., E.E. Bangs, M. Drew, S. Nadeau, V.J. Asher, and C. Syme. 2010. Dog lice (*Trichodectes canis*) found on wolves (*Canis lupus*) in Montana and Idaho. *Northwestern Naturalist* 91: 331–333.
- Kellogg, V.L. and G.F. Ferris. 1915. The Anoplura and Mallophaga of North American mammals. Stanford University Press, California. ix + 320 pp.
- Kennedy, M.J. and R.A. Newman. 1986. Synopsis of the parasites of vertebrates of Canada. Ectoparasites of terrestrial mammals. Alberta Agriculture, Animal Health Division. 109 pp.
- Kinley, T.A. and N.J. Newhouse. 2008. Ecology and translocation-aided recovery of an endangered badger population. *Journal of Wildlife Management* 72: 113–122.
- Larson, O.R. 1997. North Dakota fleas. X. An atlas of the state's siphonapterans. University of North Dakota Research Institute for Ecological Studies, Report No. 47. vii + 77 pp.
- Lindquist, E.E., T.D. Galloway, H. Artsob, L.R. Lindsay, M. Drebot, H. Wood, and R.G. Robbins. 2016. A handbook to the ticks of Canada (Ixodida: Ixodidae, Argasidae). Illustrations by K.W. Wu and B. Flahey. Maps by T. Naughton. *Biological Survey of Canada Monograph Series No. 7*. v + 317 pp.
- Marshall, A.G. 1981. The sex ratio in ectoparasitic insects. *Ecological Entomology* 6: 155–174.
- Mech, L.D., R.P. Thiel, S.H. Ferris, and W.E. Berg. 1985. Presence and effects of the dog louse *Trichodectes canis* (Mallophaga: Trichodectidae) on wolves and coyotes from Minnesota and Wisconsin. *American Midland Naturalist* 114: 404–405.

- Messick, J.P. and M.G. Hornocker. 1981. Ecology of the badger in south-western Idaho. Wildlife Monographs 76: 1–53.
- Minta, S.C. 1993. Sexual differences in spatio-temporal interaction among badgers. Oecologia 96: 402–409.
- Naughton, D. 2012. The Natural History of Canadian Mammals. Canadian Museum of Nature and University of Toronto Press, Toronto, Ontario, Canada. xi + 784 pp.
- Pérez, J.M., I. Sánchez, and R.L. Palma. 2013. The dilemma of conserving parasites: the case of *Felicola (Loriscicola) isidoroï* (Phthiraptera: Trichodectidae) and its host, the endangered Iberian lynx (*Lynx pardinus*). Insect Conservation and Diversity 6: 680–686.
- Reiczigel J., M. Marozzi, I. Fabian, and L. Rozsa. 2019. Biostatistics for parasitologists – a primer to Quantitative Parasitology. Trends in Parasitology 35: 277–281.
- Richards, W.R. 1964. A short method for making balsam mounts of aphids and scale insects. The Canadian Entomologist 96: 963–966.
- Werneck, F.L. 1948. Os Malófagos de mamíferos. Part 1. Amblycera e Ischnocera (Phloptera e parte de Trichodectidae). Edição da Revista Brasileira de Biologia, Rio de Janeiro. 243 pp.
- Whitaker, Jr., J.O. and R.J. Goff. 1979. Mallophaga of wild mammals in Indiana. Entomological News 90: 23–25.
- Wilkinson, P.R. 1970. *Dermacentor* ticks on wildlife and new records of paralysis. Journal of the Entomological Society of British Columbia 67: 24–29.
- Wilson, N. and G.V. Oliver, Jr. 1979. New records of chewing lice (Mallophaga: Boopidae and Trichodectidae) from native mammals in Texas. The Southwestern Entomologist 4: 156–162.
- Wittrock, D.D. and N. Wilson. 1974. Ectoparasites of the badger, *Taxidea taxus* (Schreber, 1778), in northwestern Iowa with a list of species recorded from North America. Iowa State Journal of Research 49: 9–15.
- Woods, C.E. and O. R. Larson. 1969 (1970). North Dakota fleas. II. Records from man and other mammals. Annual Proceedings of the North Dakota Academy of Science 23: 31–40.

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Abstracts

THE ENDANGERED MOTTLED DUSKYWING OF CANADA'S WESTERN POPULATION: LARVAL BIOLOGY, RANGE AND SUITABLE FOREST MANAGEMENT TECHNIQUES

J. Henault and A.R. Westwood, Department of Biology, University of Winnipeg, Winnipeg, Manitoba, R3B 2E9.

The mottled duskywing (*Erynnis martialis*) is an endangered butterfly that lives in pine forests in Manitoba and Ontario in Canada and similar habitats in the eastern United States. The adult and immature biology and required habitat components of this Canadian population west of the great lakes are poorly understood. Additionally, the current population size and distribution of this butterfly in Manitoba is unclear. In this region, mottled duskywing populations occur in commercial forestry areas that are periodically harvested. We investigated the current range of this skipper in Manitoba, documented habitat requirements and investigated adult and immature biology. An updated distribution of this skipper includes records that extend its range. Mottled duskywing occurs in jack pine forest openings at specific forest age classes with abundant host, plant redroot (*Ceanothus herbaceus*). Observations of larval behaviour on host food plants in the western range are reported for the first time. Commercial forest harvesting and regeneration strategies to create and support optimal habitat conditions for mottled duskywing are discussed.



Erynnis martialis on its host plant, *Ceanothus herbaceous*.

EVALUATING THE AGE LIMIT FOR EFFECTIVE DNA RECOVERY USING HISTORICAL INSECT SPECIMENS FROM THE BUCKEYE BUTTERFLIES (GENUS *JUNONIA*)

M.M.L. Lalonde and J.M. Marcus, Department of Biological Sciences, University of Manitoba, Winnipeg, Manitoba, R3T 2N2.

Museum collections hold a plethora of specimens useful for many different morphological and molecular studies. Data from these specimens allow for investigations that require data collection over long time series, including invasion biology-based questions. Invasion biology examines how non-native species integrate into new habitats. The buckeye butterflies (genus *Junonia*) were used to explore invasion events in Florida using the three *Junonia* species that occur in Florida, USA: *J. coenia*, *J. neildi*, and *J. zonalis*. Two of these species are resident in Florida, whereas *J. zonalis* was first detected in 1981. Currently there are diagnostic molecular and morphological markers for identifying *Junonia* specimens with Caribbean ancestry, which has permitted the documentation of the invasion and creation of a secondary contact zone in Florida over space and time. We have developed techniques to determine mitochondrial genotypes rapidly, inexpensively, and reliably from museum specimens collected from Florida and the Caribbean over the last 150 years. We reconstructed the recent invasion of *J. zonalis* into Florida using museum specimens collected between 1866 to 2016, including some of the oldest insect museum specimens ever genotyped. To validate and test the limits of this technique, we obtained tissues from some of the oldest buckeye specimens still extant, collected prior to 1813. We

successfully obtained mitochondrial haplotypes and sequenced DNA from the target mitochondrial genes from these specimens. The validation of this genotyping technique in *Junonia* enhances its use as a model species for understanding the process of adaptation in the invasion of new habitats.

NEW AND LITTLE-KNOWN CANADIAN *LASIOGLOSSUM (DIALICTUS)*
(HYMENOPTERA: HALICTIDAE) AND AN AMENDED KEY TO SPECIES

J.D. Gardner and J. Gibbs, Department of Entomology, University of Manitoba, Winnipeg, Manitoba, R3T 2N2.

The first thorough revision of the *Lasioglossum (Dialictus)* in Canada was completed by Gibbs in 2010, a work which has facilitated additional discoveries. Since that time, several species new to Canada have been discovered and taxonomic and nomenclatural changes have been proposed. One undescribed species, two species are newly recorded from Canada, three new synonymies are proposed, two species are resurrected from a synonymy, and previously unknown males of six species are diagnosed and figured. An updated key to species is given incorporating all changes since 2010.



Lasioglossum (Dialictus) laevissimum (Smith) on *Geranium*.



Lateral habitus of an undescribed *Lasioglossum* (*Dialictus*) from the Canadian Prairies.

A TAXONOMIC REVISION OF THE SUBGENUS *PROTANDRENA* (*PTEROSARUS*)
(HYMENOPTERA: ANDRENIDAE) IN AMERICA NORTH OF MEXICO.

S. Robinson and J. Gibbs, Department of Entomology, University of Manitoba, Winnipeg, Manitoba, R3T 2N2.

The bee subgenus, *Protandrena* (*Pterosarus*) (Hymenoptera: Andrenidae), occurs throughout North America and consists of rarely collected small, dark bees that specialize on plants in the family Asteraceae. *Protandrena* (*Pterosarus*) has a complicated taxonomic history, having been treated as its own genus, and as subgenera of *Pseudopanurgus*, *Heterosarus*, and *Protandrena*. A comprehensive revision has never been completed for the 44 species in America North of Mexico. Species boundaries will be delimited using a combination of morphology, geography, ecology (*e.g.*, floral host records), and available molecular data. Preliminary results will be presented. This revision will provide taxonomic and evolutionary context for the diversity, distribution, and host plant use of *P.* (*Pterosarus*). This information can then be used to improve bee conservation, faunistics, and pollination studies.



Protandrena (Pterosarus) andrenoides (Smith) collecting pollen from its host plant *Solidago* (Asteraceae).



Facial view of *Protandrena (Pterosarus) aestivalis* (Provancher) male showing distinctive yellow markings.

LET IT BEE? UNDISTURBED REMNANT SITES SUPPORT GREATER WILD BEE RICHNESS AND DIVERSITY THAN GRAZED SITES IN THE ENDANGERED TALL GRASS PRAIRIE ECOSYSTEM IN MANITOBA.

Reid Miller and Jason Gibbs, Department of Entomology, University of Manitoba, Winnipeg, MB, R3T 2N2.

Less than 0.05% of tallgrass prairie remains in Manitoba, with declines continuing. A large portion of the remaining prairie is concentrated in the Manitoba Tall Grass Prairie Preserve. In the preserve, prairie is managed by prescribed burns, mowing/haying, and cattle grazing. To test what effects burning and grazing have on wild bees, we conducted an experiment in the preserve using prairie sites that had in the past 10 years experienced either: 1) a burn, 2) cattle grazing, or 3) no burning/grazing management. We collected wild bees in ground level and elevated bowl traps over a period of two years and compared the abundance, species richness, and Hill's Shannon diversity of the three different treatments. We further tested how land cover type, landscape diversity, and landscape configuration affect wild bee communities in tall grass prairie. Grazed sites supported a reduced diversity of bees compared to unmanaged sites. Diversity of the stem nesting guild of wild bees was particularly negatively impacted by both burning and grazing. Finally, we touch on some of the potentially important implications for tall grass prairie land managers/owners seeking to safeguard Manitoba's wild bee diversity and the pollination services that this diversity provides.

POLLINATOR COMMUNITY COMPOSITION AND NETWORK STRUCTURE IN ROADSIDE VERGES AND POWERLINE EASEMENT CORRIDORS OF MANITOBA

M. Martini and Kyle Bobiwash, Department of Entomology, University of Manitoba, Winnipeg, Manitoba, R3T 2N2.

As human activity continues to modify wild habitats, preservation of undisturbed ecosystems is insufficient to achieve sustainability. Linear rights-of-way such as roadside verges and power line easement corridors occupy a vast, ever-increasing area with high ecological impact. The effects of these linear habitats on invertebrate communities and the ecological functions they provide are poorly studied. Studies in Manitoba are confined to butterflies in urban rights-of-way, and the ecological knowledge provided by most research is limited to simple biodiversity metrics or to specific endangered species. To manage these habitats for the benefit of entire biological communities, more detailed ecological information is needed. Our project involved: (1) sampling bee and flowering plant biodiversity in roadside verges in southeastern Manitoba, and (2) sampling pollination networks in a bipole line easement corridor along a 2.5° latitudinal gradient. We assessed the pollinator and plant biodiversity within these habitats, and determined

the health and robustness of the pollination community by tracking biotic interactions and resource use. We analysed local and landscape-scale factors such as vegetation management strategy and surrounding land-use to understand which environmental variables affect pollinator biodiversity and the robustness of the networks within these corridors. Here we report on my bee data and preliminary results from the first project and discuss the ongoing work for the second one.

FLEA BEETLE CONSUMPTION BY CARABIDAE AND LYCOSIDAE PREDATORS IN A PETRI DISH STUDY

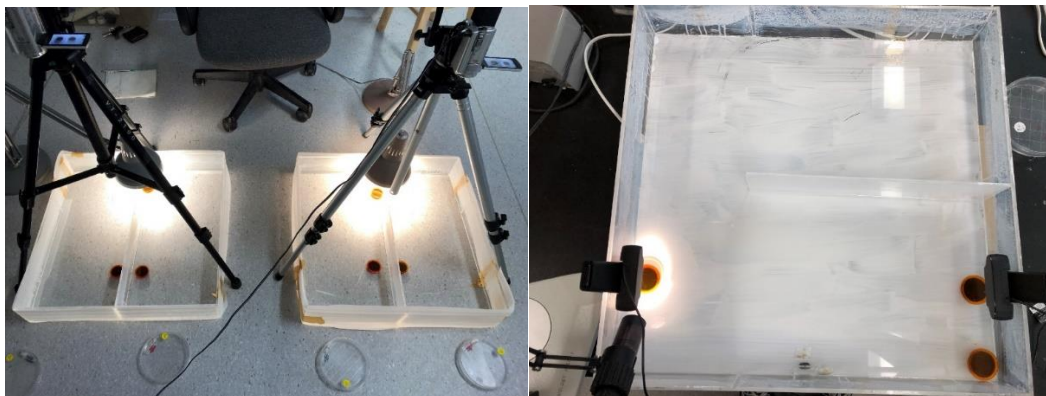
S. Storozuk and A.C. Costamagna, Department of Entomology, University of Manitoba, Winnipeg, Manitoba, R3T 2N2.

The crucifer flea beetle, *Phyllotreta cruciferae* (Goeze) (Coleoptera: Chrysomelidae), and the striped flea beetle, *Phyllotreta striolata* (Fabricius) (Coleoptera: Chrysomelidae), are invasive pests to canola crops, *Brassica napus* (L.) (Brassicaceae), in North America. Generalist predators may be an important factor in flea beetle mortality, but the direct effects are unclear due to a limited number of previous studies. Determining potential ground predators and the direct effect they have on flea beetles is a critical step to further our understanding in natural control methods in canola fields. We tested the effectiveness of several species of ground beetles (Coleoptera: Carabidae) and wolf spiders (Araneae: Lycosidae) as predators to flea beetles in a laboratory study using Petri dishes. Each Petri dish contained two canola cuttings in the cotyledon stage, three striped flea beetles, three crucifer flea beetles and one predator. A total of nine trials took place over nine weeks that consisted of 100 predators and 20 predator-free controls that were kept at 16 h light at 23°C and 8 h dark at 18°C for 48 hours. The proportion of live flea beetles was measured, and the cotyledons were photographed to assess flea beetle damage. Thirteen of the predator taxa consumed flea beetles in our trials and cotyledons with 12 predator taxa showed lower damage than controls.

OPTIMIZATION OF RAIDING PREFERENCE RELATIVE TO TEMPERATURE AND HOST DEFENSIVE CAPABILITY BY THE KIDNAPPER ANT, *TEMNOTHORAX AMERICANUS*

N.C. Novotny and J.F. Hare, Department of Biological Sciences, University of Manitoba, Winnipeg, Manitoba, R3T 2N2.

Kidnapper ants raid host-species colonies, abscond with brood, and raise host workers which work for the colony. *Temnothorax americanus* kidnaps *T. ambiguus* and *T. longispinosus*. Free-living *T. ambiguus* colonies occur in warm microhabitats while *T. longispinosus* colonies occupy cooler microhabitats, presumably achieving optimal performance at those respective temperatures. In choice tests, *T. americanus* preferentially selects pupae of the host species whose temperature optimum is opposite to the temperature conditions of the *T. americanus* colony, possibly reflecting a preference to retrieve the least well defended host species relative to temperature. We tested whether *T. americanus* has a preference for the host species pupae outside its thermal optimum extends to raiding preference for whole colonies and whether the defensive capability of *T. ambiguus* and *T. longispinosus* against *T. americanus* raids depends on temperature. We acclimatized *T. americanus* colonies and their hosts to 25°C or 15°C in controlled environment chambers and offered simultaneous choices of colonies of the two host species to assess any effect of temperature on host species raiding preference. We also allowed *T. americanus* to raid each host species within either temperature and recorded the numbers of host species casualties, kidnapper casualties, salvaged brood and captured brood to assess any effects of temperature and species on defensive capability. There was no effect of temperature or host species on raiding preference or host defensive capability, suggesting that host species are raided without preference and are equally well defended. Defensive capability does not appear to drive the documented temperature-dependent pupal retrieval preference.



Left: Experimental set up for choice tests of *T. americanus* to assess any effect of temperature on host species raiding preference and to assess any effects of temperature and species on defensive capability of *T. ambiguus* and *T. longispinosus*. Right: Close up of the experimental arena.

SWIMMING IN DIVERSITY: HIGHLIGHTING THE IMPRESSIVE STAPHYLINOID AND SCARABAEOID DIVERSITY IN A NORTHERN WET TALL GRASS PRAIRIE

Reid Miller¹, Jason Gibbs¹, and Adam Brunke². ¹Department of Entomology, University of Manitoba, Winnipeg, MB, R3T 2N2. ²Canadian National Collection of Insects, Arachnids, and Nematodes, Ottawa, ON, K1A 0C6.

The tall grass prairie is an increasingly rare ecosystem that houses a vast assortment of flora and fauna. Through a project to determine the effects of different management practices on prairie beetles, several exciting finds were present in the pitfall traps. Among these are several new provincial records, as well as two newly discovered species awaiting description, one of which has so far been found nowhere else. This highlights the need to properly preserve remnant prairie, as well as the importance of recruiting suitable habitat for restoration, to safeguard Manitoba's hidden arthropod diversity. I discuss the biology of some of these fascinating beetle species.



Dorsal habitus of *Staphylinus ornaticauda* LeConte from the Manitoba Tall Grass Prairie Preserve.



Dorsal habitus of *Rhyssalus sonatus* LeConte from the Manitoba Tall Grass Prairie Preserve.

LONG-RANGE DISPERSAL BEHAVIOUR AND SPATIAL DISTRIBUTION MODELLING OF ADULT MOSQUITOES IN THE WINNIPEG REGION

M.E. Balcaen and A.R. Westwood, Department of Biology, University of Winnipeg, Winnipeg, Manitoba, R3B 2E9.

Mark-release-recapture studies and biogeographic analysis of mosquito surveillance records were used to examine environmental drivers of dispersal in adult mosquitoes (primarily *Aedes vexans*). Larvae were collected and reared to adulthood in the field and marked with fluorescent dust. Following release, marked mosquitoes were recaptured in light traps up to 30 km from their site of emergence. Flight ranges upwards of several kilometres were observed in many common mosquito species. *Aedes vexans* may be using riverine corridors for dispersal. A spatial analysis of city surveillance records corroborates this in *Ae. vexans*. Distribution maps produced in this analysis also offer insights about potential habitats for *Culex* spp. in the Winnipeg area. These findings are valuable for local mosquito surveillance and control operations and contribute to a growing understanding of mosquito dispersal behaviour.



Emergence cages for release of adult mosquitoes.



Aedes vexans female.

LANDSCAPE EFFECTS ON FLEA BEETLE POPULATIONS IN THE CANADIAN PRAIRIES

Maxime Damien¹, Tharshi Nagalingam¹, Héctor A. Cárcamo², Jennifer Otani³, Tyler Wist⁴, Jordan A. Bannerman¹, John Gavloski⁵, and Alejandro C. Costamagna¹. ¹University of Manitoba, Winnipeg, Manitoba, R3T 2N2. ²Agriculture and Agri-Food Canada, Lethbridge, Alberta, T1J 4B1. ³Agriculture and Agri-Food Canada, Beaverlodge, Alberta, T0H 0C0. ⁴Agriculture and Agri-Food Canada, Saskatoon, Saskatchewan, S7N 0X2. ⁵Manitoba Agriculture and Resource Development, Carman, Manitoba, R0G 0J0.

Canola fields are a major component of agricultural landscapes across the Canadian prairies and seedlings are highly susceptible to crucifer-feeding flea beetles, requiring farmers to apply foliar

insecticides in addition to seed treatments. Herbivore abundance and plant damage are affected by landscape complexity, but this has not been investigated for flea beetles feeding on canola. In this study, we sampled flea beetle populations in canola across four regions of the Canadian prairies using sticky cards, during the seedling stage, from 2015 to 2017. By using digital land-use maps, landscape variables were calculated in four circular sectors every 500 metres radius, and their association with flea beetle abundance was explored through their relative importance, using an information-theoretic approach. The two main flea beetle species were the crucifer and striped flea beetles. The abundance of striped flea beetles was relatively low and highly variable, and no landscape predictors were consistently associated with it across the regions studied. Conversely, regardless of spatial scale, crucifer flea beetle abundances decreased as the proportion of host crops increased. Relative importance values identified a positive effect of both woodland and grass border proportion, and a negative effect of grassland proportion, at 500, 1000 and 2000 m, respectively. Mean host crop size had positive effect on crucifer flea beetle abundances up to 1500 m. Further studies should be conducted to determine landscape factors affecting striped flea beetles in areas where this species is more abundant in order to develop pest management strategies effective for both flea beetle species.

Acknowledgements

*The Entomological Society of Manitoba Wishes to
Thank the Following Sponsors for Their Generous
Support of the 76th Annual Meeting*

Orkin Canada Corporation

Poulin's Pest Control

City of Winnipeg Insect Pest Control

Bayer Crop Science Canada

Gilles Lambert Pest Control

North/South Consultants

Cano Pest Control

Canadian Centre for Mosquito Management

The Entomological Society of Manitoba

76th Annual Business Meeting Minutes

4 December 2020, 1:30 PM

Zoom

Attendance:

President	Alejandro Costamagna	
President-elect	Jeffrey Marcus	
Past President	Erica Smith	
Regional Director (ESC)	Kateryn Rochon & Jason Gibbs	
Treasurer	Kathy Cano	
Member at Large	Jason Gibbs	
<i>Proceedings</i> Editor	Terry Galloway	
Secretary	Sarah Semmler	
Common Names	Jason Gibbs	
Endowment Fund	Richard Westwood	
Newsletter	Kelsey Jones & Kateryn Rochon	
Youth Encouragement	Shayla Storozuk	
Webpage and Archives	Jordan Bannerman	
Scrutineer	John Gavloski	
Barry Konzelman	Martine Balcaen	Emily Hanuschuk
Massimo Martini	Bridget White	Nolan Novotny
Bob Lamb	Melanie Lalonde	Pat MacKay
Maxime Damien	Byron von Nest	Justis Henault
Bob Wrigley	Michael Killewald	Paul Fields
Megan Cowell	David Wade	Katherine Morgan
Jade Tanner	Neil Holliday	Phoenix Nakagawa

Kyle Bobiwash

Steve Robinson

Laura Burns

Reid Miller

Rob Currie

1. Acceptance of the Agenda

Motion to accept the agenda (**Appendix A**) – R. Currie/T. Galloway Carried.

2. Acceptance of the Minutes from the last Annual Business Meeting (26 October 2019)

Motion to accept the minutes of the 75th business meeting – R. Currie/J. Marcus Carried

3. Business Arising from the Minutes

No new business.

4. Reports – Executive

Appendix B – President

Presented by A. Costamagna.

Appendix C – Treasurer

Presented by K. Cano.

- Shared that the Executive now has access to a credit card, and that it had taken a year to receive the card due to delays from the bank.
- ESM will be receiving \$500.00 for Youth Encouragement from the ESC.
- There are some bank fees that resulted from changing accounts, but it allows for e-transfers and access to a debit card.

R. Currie – Is there a budget projection for next year? It would be good to include it in the report.

K. Cano – Expects that the account should be similar to current year.

R. Currie – Sought clarification on the \$2000 to the endowment fund.

K. Cano – It was the top-up of GICs.

J. Bannerman – Clarified that these funds are included in the first paragraph of the Endowment Fund Report.

Appendix D – Regional Director

Presented by K. Rochon.

- Co-signed the report because according to bylaws the Directors need to be elected by the membership, and the regional society puts the name forward. The ESC needs to vote on who is in Manitoba.
- The ESC meeting was postponed, so having one ESM candidate ended up being a good thing – only had one candidate to put forward.
- EDI statement from ESC – members wanted the lack of diversity to be addressed, and concrete actions to increase diversity.
- The ESC made a donation to EntoPOC, and has now had more members supported through EntoPOC that the amount that was pledged.

Appendix E – Editor of the *Proceedings*

Presented by T. Galloway.

- The Criddle manuscript was discovered by N. Holliday as a hand-written document.
- N. Holliday and L. Donald carefully reviewed and submitted this manuscript, which should be truer to the original intent.
- T. Galloway announced that he will be stepping down as Editor after serving for 19 years.
- He will continue as acting editor while a new editor is trained.

Many verbal thanks for T. Galloway's dedication to his post.

N. Holliday – Noted that the Criddle paper should have been one of three papers, including eggs and egg sacks, and nymphs. There should be photos but no idea where they are (T. Galloway has some slides but they're in poor condition). Cannot find the paper on nymphs, doesn't seem to exist.

A. Costamagna – final thanks to T. Galloway on behalf of ESM.

Appendix F – Membership

Presented by S. Semmler.

- Added that the number of members yet to renew had decreased by 10 since the report was written.

T. Galloway – Asked that we make a note of new members so that they can be recognized ex. New Members Social.

R. Currie – Inquired about the number of honorary members on list, asked if Reiny Brust was included. Also said there used to be a place on the website that listed honorary members.

S. Semmler – Would have to look at the membership list for the names.

Action Item: S. Semmler to follow-up with N. Holliday, T. Galloway, and R. Currie to make sure that all Honorary members are accounted for.

5. Reports - Committees

Appendix G - Endowment Fund

Presented by R. Westwood.

- A GIC was reinvested for 180 days because the interest rate was so low.

Scientific Program (No Report)

Comments from J. Gibbs.

- The decision to host the virtual meeting was made fairly late, the Executive worked together to make it happen
- Directed everyone to the program for details of symposium, and the gave credit to the students for participating

R. Currie – Were there any funds raised? Didn't see sponsors in the program – good for next Scientific Committee to see.

J. Gibbs – This could be included with the abstracts that will be published in the next *Proceedings*.

K. Cano – I. Wise is still collecting funds from donors, so complete list will be available soon.

A. Costamagna – Could add logos to the program for records.

Action Item: Executive to ensure that symposium funders are acknowledged.

Appendix H – Newsletter

Presented by K. Jones.

- Encouraged student articles: Contributions can be listed as interest pieces on CVs.

Appendix I – Youth Encouragement

Presented by S. Storozuk.

- The insect colonies for outreach are very well cared for and ready for next year.

Social Committee (No Report)

Action Item: A. Costamagna/S. Semmler to contact L. Ganesan about report.

Appendix J – Scholarships and Awards

Presented by J. Gibbs on behalf of D. Vanderwel.

- Award winners were announced for each category.
- A. Costamagna added that the committee had a difficult time deciding between such qualified applicants, which is why two recipients were selected for the Graduate Student Scholarship.
- Students were given an opportunity to say their thanks.

Appendix K – Fundraising

Presented by K. Rochon on behalf of I. Wise.

Appendix L – Webpage and Archives

Presented by J. Bannerman.

- The recent newsletter and current *Proceedings* had been posted on the website since the submission of the report.
- Paul Fields is retiring, so there is a need to find a new home for the website in 2021.

R. Currie – Can look into hosting the site. Wants to be given advance notice because more storage space may be needed for all of the page content.

J. Bannerman – The PDFs are fairly large, but the old website had a huge number of hidden files. The current site is dramatically smaller than the old site.

A. Costamagna – Thanked J. Bannerman for taking care of the website, and noted that it looks great.

Appendix M – Common Names

Presented by J. Gibbs.

- ESC – there was discussion regarding the Canadian Wildlife Society handling common names, so they were wondering if it was something the ESC still needed to do. They decided to continue to include it.

6. Election Results – Scrutineer (Appendix N)

Presented by J. Gavloski.

President Elect	Kateryn Rochon
Member-at-large	Joel Gardner
Regional Director	Jason Gibbs

Motion to destroy the ballots – R. Currie/J. Gibbs Carried.

P. MacKay – Found that Survey Monkey didn't allow two members of a household to vote, was blocked after one.

S. Semmler – Believe that the voter ID is based on the IP address. Tried to utilize every setting; if we wanted to provide voters with a unique link, then we may need a paid account.

Board discussed alternatives to this scenario, such as voting from a different location (at work, coffee shop), or from a different device.

7. New Business

- The ESM had an Honourary Member Committee in 1997, but it may not have been appointed since R. Currie's sabbatical at that time.
- We can have 10% of our members as Honourary.
- This committee may have merged with Archives, but was left vacant.
- There are many deserving candidates, so we should begin to nominate members.
- N. Holliday remembered that the ESM also used to nominate honourary members for the ESC.
- R. Currie thought that the honourary members used to be posted on the ESM website.
- P. MacKay noted that Joel Gosselin had been put forward at a past AGM to recognize his years of service.

Action Item: Executive to consider the status of the Honourary Member Committee, and discuss candidates for this membership status.

Action Item: S. Semmler to follow up on the status of J. Gosselin, share with Executive.

8. Moment of Silence for Deceased Members

No members were brought forward.

9. Transfer of Office

- A. Costamagna thanked the Society for keeping things going, and said that it was a pleasure to work with everyone.
- J. Marcus thanked A. Costamagna for all that's been done. He noted that he's learned a few tricks, and is looking forward to the work that will be taking place in the future.
- Reminded members that the Executive is there to support them, and to bring forward any issues that need attention so that they can be addressed.
- J. Marcus and S. Semmler attempted to arrange delivery of the gavel, but timing did not work out. Had a symbolic transfer of office.
- J. Marcus thanked the students for their presentations and thanked the audience for attending.
- Also thanked everyone for supporting the ESM through COVID-19.

10. Other Business

No other business.

11. Adjournment.

By consensus.

Appendix A
Agenda of the Entomological Society of Manitoba
76th Annual General Meeting
Friday, 4 December 2020, 1:30 PM
Zoom

1. Acceptance of Agenda
2. Acceptance of the Minutes of the last Annual Meeting (26th October, 2019)
3. Business Arising from the Minutes
4. Reports of the Executive
 - President** – Alejandro Costamagna
 - Treasurer** – Kathy Cano
 - Regional Director(s) to the ESC** – Kateryn Rochon-Jason Gibbs
 - Editor of the *Proceedings*** – Terry Galloway
 - Membership** – Sarah Semmler
5. Reports of the Committees
 - Endowment Fund** – Richard Westwood
 - Scientific Program** – Jason Gibbs/Kateryn Rochon/Jeffery Marcus
 - Newsletter** – Kelsey Jones & Kateryn Rochon
 - Youth Encouragement/Public Education** – Shayla Storozuk
 - Social** – Vacant
 - Scholarship and Awards** – Desiree Vanderwel
 - Fundraising** – Ian Wise
 - Archives and Web Page** – Jordan Bannerman

Common Names – Jason Gibbs

6. Election Results – Scrutineer: John Gavloski

7. New Business

8. Moment of Silence for Deceased Members

9. Transfer of Office

10. Other Business

11. Adjournment

Appendix B
Entomological Society of Manitoba
President's Report to the Membership
Annual Business Meeting - 4 December, 2020

There were three meetings of the Executive Committee of the Entomological Society of Manitoba in 2019/20:

First Executive Meeting –21 February, 2020 – Entomology Library, University of Manitoba

- The possibility of extending the Member-at-Large term to two years was discussed. The board agreed on a change of policy and the next Member-at-Large will be encouraged to serve for two years. The board will draft the new policy for two-year Member-at-Large terms, to be circulated and approved.
- Some small discrepancies in the financial report were assessed by Kathy Cano with the help of Ian Wise. Rob Currie will assist the Finance Committee.
- The new ESC revenue sharing policy documents were discussed. The consensus was that the changes will be in general favorable for ESM, but the board requested clarifications to ESC regarding inflation, the creation of a governing document for the bylaws, the meaning of thresholds and “exceptional years,” and issues relating to differing amounts of sponsorship support.
- The board approved a motion to set the Undergraduate Student Achievement Award to \$300.00, to establish the Student Service Award and set the amount to \$300.00, and to set the Graduate Student Scholarship to \$2000.00.
- Mahmood Iranpour stepped down from the Social Committee. A call for a new Social Committee Chair was initiated.

Second Executive Meeting –3 July, 2020 – Virtual Meeting using Zoom

- The issue of developing a photo consent form for ESM was discussed. The board will look into various existing models to adapt them to ESM needs.
- Kathy Cano presented a financial update and the status on the ESM credit card application
- Kateryn Rochon is concluding her second three-year term as ESM representative to ESC and the board initiated the search for a new representative.
- The development of a policy against racial discrimination and in support of Equity, Diversity and Inclusion (EDI) practices for ESM was discussed. The board agreed to develop a statement to represent the EDI values of ESM.
- The format of the ESM annual meeting 2020 was discussed. The board suggested to leave the format up to the Chair, but most likely it will need to be a virtual meeting.

Third Executive Meeting –7 October, 2020 – Virtual Meeting using Zoom

- This was a special meeting called to discuss planning of the AGM and symposium.
- Several individuals were approached to serve as Meeting Chairs, but they all declined. Due to the difficulties imposed by the COVID-19 pandemic, it became evident that it will be unlikely to find a Chair for the Scientific Meeting with a full program. Jason Gibbs graciously volunteered to organize a “Student Showcase Symposium” for 2020, to provide students with the possibility to share their research. The date and format of the Student Symposium were discussed.
- The board developed and approved a statement against racial discrimination and outlining ESM support for Equity, Diversity, and Inclusion practices. The statement was posted on the ESM main webpage. The board discussed broader future actions, including the creation of a Committee that looked into more concrete actions to foster EDI at ESM.

I would like to sincerely thank all the members of the executive board and the Committee Chairs for their generous service to ESM. It was a pleasure to work with such a dedicated group of people and I am looking forward to continuing working with them as Past- President.

Ale Costamagna

4 December 2020

Appendix C
Entomological Society of Manitoba
Financial Statements
Year Ending August 31, 2020

NOTE: These Financial statements have not been audited. The accounts, bank statements and receipts were provided by the treasurer.

Treasurer: Kathy Cano

Date: December 4, 2020

NOTE: This report does not reflect the 2 recent purchases of GIC's that will be reported on the Endowment report. ENTOMOLOGICAL SOCIETY OF MANITOBA INC.

Statement of Financial Position

August 31, 2020	2020	2019	2018	2017
ASSETS				
CURRENT				
Cash	15,827.20	16,304	16,011	4,468
TERM DEPOSITS	48,000.00	46,000	46,000	46,000
TOTAL	63,827.20	62,304	62,011	50,628
LIABILITIES				
CURRENT	NIL	NIL	NIL	NIL
NET ASSETS				
Unrestricted net assets	15,827.20	16,304	16,011	4,468
Internally restricted	48,000.00	46,000	46,000	46,000
	63,827.20	62,304	62,011	50,628

	2020	2019	2018	2017
REVENUES				
Annual Meeting	765	1233	0	825
Donations	1875	1175	0	1450
ESC	0	0	11167	0
Interest income	924.50	925	925	908
Membership fees	1340	1420	887	1467
Miscellaneous			160	2762
Proceedings	0	0	0	0
Youth	0	0	400	0
encouragement & Public Education				
Total	4904.50			
EXPENDITURES				
Awards and Scholarships	1550	1550	1350	2450
Donations	0	0	0	0
General	0	74	151	38
Meetings:				
ESC			347	4000
ESM	1408.80	2191	147	2179
Newsletter	0	0	0	0
Proceedings	0	0	0	0
Social Committee	0	0	0	220
Youth	0	0	0	0
Encouragement & Public Education				
Bank Fees	46.51	23		
Investments	2000			
TOTAL	5005.31		1995	8887
EXCESS (DEFICIENCY) OF REVENUES OVER EXPENDITURES	(100.81)	926	11,384	(1475)

Appendix D

Entomological Society of Manitoba

Report of the ESC Regional Director

The Entomological Society of Canada (ESC) held its Annual General Meeting online on 20 October 2020. The previously scheduled Joint Annual Meeting (JAM) with the Entomological Society of Alberta was cancelled due to the COVID-19 pandemic. The ESC's new President is Dr. Bill Riel (Natural Resources Canada, Pacific and Yukon Region).

This year brought forward the need to reflect on our Society and its role in promoting entomology for all. The ESC issued a statement on Equity, Diversity and Inclusion (<https://esc-sec.ca/the-society/statement-of-diversity-and-inclusion/>) and instituted measures to remove barriers limiting the participation of underrepresented minority groups in the entomological community. The first step was to establish an Equity, Diversity and Inclusion (EDI) committee and create a new Director position to ensure EDI principles remain an integral part of the decisions approved by the Board of Directors. The ESC will support all the regional Societies in their efforts to make future JAMs and regional meetings accessible and welcoming by removing barriers that affect marginalized groups.

To promote healing and reconciliation, the ESC held a sharing circle open to all members on 31 August 2020. A sharing circle is a tradition common to many North American indigenous peoples. It serves as a mechanism by which a community can address a question or problem and reach mutual understanding. Jake Freeman (Agriculture and Agri-Food Canada, Winnipeg, and co-chair of AAFC's Indigenous Network Circle) facilitated the ESC sharing circle.

To foster the participation of Black, Indigenous, and People of Colour in the entomological community, the ESC has also donated \$1,000 to EntoPOC (*Entomologists of Color*, <https://www.entopoc.org>). This independent, not-for-profit charity supports People of Colour entomologists to become members of entomological societies.

The Board of Directors will also now include Director for Student and Early Professionals. The new position will ensure the students and early professionals have a stronger voice in the Society's affairs.

The next JAM is scheduled for 14–17 November 2021 in Niagara Falls, ON.

Kateryn Rochon (outgoing) & Jason Gibbs (incoming)

Regional Director (Manitoba), Entomological Society of Canada

Appendix E

Entomological Society of Manitoba

Report of the *Proceedings* Editor

Volume 75 (2019) of the *Proceedings of the Entomological Society of Manitoba* was produced exclusively in electronic format. It has been sent by the Secretary, Sarah Semmler, to all members of the ESM with electronic access and posted on the ESM website by Jordan Bannerman. Volume 75 is 109 numbered pages in length. It contains one scientific note on new records for earwigs in the province, including evidence for the first time of establishment in the province for two species. Appropriately enough, Pat McKay kindly submitted a beautiful photo of a European earwig together with an aphid, *Uroleucon rudbeckiae*, taken in their yard. Thanks to Pat for that. There are also two submitted papers. One is on feeding damage to navy beans caused by *Lygus lineolaris*. The other seems to me most appropriate for the 75th *Proceedings*. Neil Holliday and Lynda Donald resurrected an obscure paper by Norman Criddle on the biology of North American grasshoppers, something I think many orthopterists will appreciate. Volume 75 also includes abstracts from papers and posters presented at the Annual Meeting of the Entomological Society of Manitoba held in the Freshwater Institute and the Department of Entomology on 25 and 26 October, 2019, and Minutes and Committee Reports from the 75th Annual Business Meeting held in Room 219 Animal Science/Entomology Building on the University of Manitoba campus on 26 October, 2019.

I encourage everyone to consider submitting Scientific Notes and full Scientific Papers. The *Proceedings* is a terrific place to publish new distribution records and faunal lists for insects and related arthropods in Manitoba, as well as the results of a wide variety of entomological study. I already have promises from several people to submit a number of very interesting papers, which I hope will appear in the 2020 *Proceedings*. All submitted manuscripts are peer-reviewed; all published papers are available as PDF reprints on the website. Thanks very much to Jordan Bannerman for posting Volume 75 and to Kateryn Rochon who sorted out what for me was an unsurmountable format problem. Issues of the *Proceedings* are fully accessible using on-line search engines. There are no page charges to authors for published manuscripts, and with our electronic format, colour images can be included in manuscripts. In theory, there are no practical limits to manuscript length. There are no formal instructions for authors, other than to adopt manuscript format consistent with previously published papers. All issues of the *Proceedings* are freely available to entomologists around the world. If you have something of relevance to entomology in Manitoba, I encourage you to consider submitting it to the *Proceedings*. Thanks to Sarah Semmler for providing me with committee reports, and to Jeff Marcus who submitted the abstracts.

During this strange year of corona virus disruption, I took the opportunity to review some of my own activities. I discovered that I have been editor of the *Proceedings* since 2001. I think it is time for me to step aside to allow someone with fresh ideas and greater technological skill to take over the *Proceedings*. I hereby tender my resignation as editor. I am willing to stay on until a new editor can be found, and to assist in the transition in any ways needed. I thank the Society for allowing me to carry on in this position for as long as I have.

Respectfully,

Terry Galloway

Proceedings Editor
24 November, 2020

Appendix F
Entomological Society of Manitoba
Report on Membership by the Secretary

The Entomological Society of Manitoba currently has 89 members (79 in 2019). Our membership is composed of 28 student status, 56 regular status, and 5 lifetime members. Of the 89 members, 31 are currently due to renew.

The presence of COVID-19 led to a change in how we accept membership renewals. Members consistently requested the ability to provide an e-transfer rather than paper transactions. Our Treasurer worked to ensure that this was made possible, and now ESM members can send their fees efficiently and safely via email. This change has also greatly improved our ability to track payments and member information.

Our website has been updated to reflect new payment options, as well as instructions for e-transfers and submitting membership forms.

I would like to thank our members for standing by the Society despite these challenging times. I also welcome our new members and thank them for joining our entomological fold.

I encourage our members to get in touch when there are insect related events or activities that would be of interest to our group. I'm happy to share, and to help by sending out calls for volunteers.

Please continue to encourage students and colleagues to join, and thank you for continuing to support the ESM.

Sarah Semmler

Appendix G

Entomological Society of Manitoba

Report of the Endowment Fund Board for 2019 – 2020

A summary of investments and projected interest income for the fiscal year is attached (Table 1). Interest generated by the Endowment Fund provides a basis for funding the Society activities. The Endowment Fund principal is \$50,000.

On November 17, 2019 GIC 900055611-0017 matured and was reinvested on November 19, 2019 for 5 years with an additional \$1,000.00 at an interest rate of 2.0 % (GIC 00920196133-0006). On Dec 12, 2019 GIC 900053611–0016 matured and \$1,000.00 was added to the GIC and was re-invested on Dec 13, 2019 for a 5-year term at an interest rate of 2.25% (GIC 00920196133-0007). On October 30, 2020 a GIC for \$1,000.00 was purchased so that the ESM would be able to obtain a credit card. On November 19, 2020 GIC 900055611-0018 matured and was reinvested on November 19, 2020 with an addition of \$1,000.00 for 180 days at an interest rate of 0.4% (GIC 00920196133-0009)

Richard Westwood

Kathy Cano, Treasurer

Endowment Fund Guaranteed Investment Certificates

Table 1: Account information as of November 27, 2020.

Certificate No.	Principal \$	Interest Rate (%)	Term	Maturity Date (Purchase Date)	Anticipated interest (\$)
00920196133-0006 (November 17, 2019)	10000.00	2	5 yrs	November 19, 2024	1000.00
00920196133-0007 (December 12, 2019)	10000.00	2.25	5 yrs	December 13, 2024	1125.00
00920196133-0008 (October 30, 2020)	1000.00	0.15	1 yr	October 30, 2021	15.00
00920196133-0009	10000.00	0.4	180 days	May 18, 2021	19.73

(November 19, 2020)

00920196133-0001 9000.00 2.25 5 yrs November 10, 2022 1012.00

(November 10, 2017)

00920196133-0002 10000.00 1.73 5 yrs December 2, 2021 865.00

(December 2, 2016)

Total 50000.00

Appendix H

Entomological Society of Manitoba

Report of the ESM Newsletter Committee

Marjorie Smith stepped down from her position on the Newsletter Committee in 2020, and Kelsey Jones took over her role. The committee only produced one issue of Volume 46. This was due to the COVID-19 pandemic making it difficult to pass information on how the newsletter was run from Marjorie to Kelsey. Additionally, there was a delay in getting articles due to authors being overwhelmed with tasks during this confusing time! We look forward to getting back to more frequent releases of the newsletter in 2021.

There were not any funds used by the Newsletter Committee due to distribution of the newsletter occurring through an electronic format.

Thank you to all of the members that contributed to the ESM Newsletter. We look forward to seeing more interesting articles in the near future! If anyone has any interest in submitting an article to the newsletter, please do not hesitate to contact Kelsey Jones (kelsey.jones@canada.ca).

Kelsey Jones (Co-editor)

Kateryn Rochon (Co-editor)

Newsletter Committee

Appendix I
Entomological Society of Manitoba
Youth Encouragement and Public Outreach Committee
November 2019 – December 2020

This year, the YEPOC was involved in two outreach events (see table below). Due to the COVID-19 global pandemic, the outreach programs have been limited since March 2020. A department booth with insect activities was scheduled to occur in May for Science Rendezvous, which is typically the highest-reaching event, but was unfortunately cancelled for COVID-19. The Winkler water festival was scheduled to occur in May and was cancelled as well. The pandemic has impacted the amount of outreach available since school activities and summer events could not happen. In spite of this, virtual outreach was able to occur in two events both led by Shayla Storozuk. The first being a presentation on the importance of insects in our natural world and career opportunities in entomology. This event was for youth with the WILD Outside Winnipeg programme, ages 15–18. Approximately 25 young people attended virtually. The second presentation was about pollinators and general facts about insects for 5–7-year-olds who were apart of the Beaver Scouts in Winnipeg. There were approximately 10 children who attended with adult scout leaders. Events were all requested through email to the committee chairperson (Shayla Storozuk).

In addition, Shayla is collaborating on a career booklet with the other provincial members of the Public Outreach Committee across Canada for the ESC. The booklet is set to be completed in 2021.

Shayla Storozuk

Date	Presenter	Event	Audience (approx.)	Ages
27-April-20	Shayla Storozuk	WILD Outside	25	15-18
11-June-20	Shayla Storozuk	Beaver Scouts	10	5-7

Total: 35

Appendix J

Entomological Society of Manitoba

Report of the ESM Student Awards and

ESM Scholarship Committee

Last year the ESM created a new award open to both undergraduate and graduate students: the ESM Student Service Award, to encourage and reward student service to the entomological community in Manitoba. The award, valued at \$300, was to be presented to a student who promoted the goals of the ESM through their volunteer activities.

The ESM Executive also approved an increase in the support of both the ESM Achievement Award (to \$300) and the ESM Graduate Student Scholarship (to \$2000).

Applications were accepted for the four scholarships and awards offered: the ESM Student Achievement Award, the ESM Student Service Award, the Orkin Student Award, and the ESM Graduate Student Scholarship. The committee deciding the first three awards included Jeffrey Marcus, Taz Stuart, and Désirée Vanderwel (Chair). The committee deciding the ESM Graduate Student Scholarship included Richard Westwood (Past-Chair), Taz Stuart, and Désirée Vanderwel (Chair). There was an exceptionally strong crop of applicants/nominees this year, which made the work of the committee very difficult. The committee would like to thank the referees who participated in the process: your input was invaluable.

ESM Student Achievement Award: Awarded to a student who is in or recently completed a Bachelor's degree program. This award recognizes students who have shown exceptional interest in entomology as evidenced by their insect collections, insect photography, published articles of entomological interest, insect experiments and/or outstanding contributions during summer employment.

This year's winner of the ESM Student Achievement Award is Jade Tanner (University of Manitoba), who will soon graduate with a B.Sc. with a minor in Entomology. Jade worked for Agriculture and Agri-food Canada surveying pollinators in southern Manitoba, and most recently held an NSERC-USRA to work in the lab of Jason Gibbs. Jade is currently working towards on her Honours thesis in the same lab. Jade has been studying the nesting biology of solitary bees at Birds Hill Provincial Park, while also collecting data to better understand the patterns of diversity in the park's bee. Her supervisor notes that she has much to contribute, given her broad interest and knowledge of plant and insect diversity.

ESM Student Service Award: Awarded to a student at the graduate or undergraduate level. This award recognizes students who have promoted the goals of the Entomological Society of Manitoba (*i.e.*, to foster the exchange of information on entomology and to further the spread of entomological knowledge) through their volunteer activities.

The inaugural winner of this award is Emily Hanuschuk (Department of Entomology, University of Manitoba). Emily is nearing completion of her M.Sc. During her degree studying “the effects of human disturbance on wild bee communities and pollination networks in southern Manitoba” in the lab of Jason Gibbs. Emily’s list of contributions is too long to list here, but highlights include serving as the Youth Encouragement and Public Outreach coordinator for the ESM, the President of the Department of Entomology Graduate Students Association, the student representative for the Biological Survey of Canada, and playing active roles in public outreach with the Forte Whyte Alive Bumble Bee Survey and Science Rendezvous Science and Engineering Fair.

Orkin Student Award: This award is designed to foster and encourage student interest in general Entomology including natural methods of insect pest control and the proper use of insecticides. Candidates must have a demonstrated interest in entomology, superior scholastic ability, high research potential, originality and industriousness in their university courses and/or summer work.

This year’s winner of the Orkin award is Katherine Hunt, a third year Biology major at Brandon University. Katherine is an academically gifted student, who was awarded an NSERC USRA to work in the lab of Bryan Cassone (Brandon University). Her project involved the integrated pest management of wireworm, which included province-wide surveillance and assessment of insecticide applications for control. According to her supervisor, Katherine was “incredibly enthusiastic and truly loved spending time in the lab learning about entomology and all of the research techniques” and is an “incredible oral communicator.” Katherine has indicated that she is keen to complete her Honours degree and then proceed to graduate school. The committee agreed with the nominator that Katherine has great potential as an Entomologist.

The ESM Graduate Scholarship: This scholarship is awarded to students in a M.Sc. or Ph.D. program related to entomology at the University of Manitoba, University of Winnipeg or University of Brandon. Students must be enrolled in their graduate program for at least 12 months prior to Oct 1 of the award year. This award recognizes superior scholastic ability, high research potential, and excellent communication skills.

This year the committee felt that there were two extremely deserving applicants, so the ESM Executive agreed to support a tie with each winner being awarded the full value of the scholarship. The two winners are Cody Koloski (Brandon University) and Melanie Lalonde (University of Manitoba).

Cody Koloski has been working towards his M.Sc. (Environmental and Life Sciences) at Brandon University since 2018 under the supervision of Bryan Cassone. His project is a continuation of his Honours project, exploring the genetic basis of DEET's mode of action in ticks. Cody is the recipient of numerous prestigious awards including the Silver Medal in Biology (BU) and a Fredrick Banting/Charles Best Canada Graduate Scholarship. Cody has already published some of his work in refereed journals and presented at an international conference. While continuing his M.Sc. work, Cody also served as the project leader of a Public Health Agency of Canada funded surveillance program for California serogroup viruses in Manitoba. Cody is also a gifted communicator, and served as the coordinator of the Let's Talk Science program at BU.

Melanie Lalonde earned an M.Sc. from the University of Manitoba (Biological Sciences) in 2017 and has been working towards her Ph.D. (Biological Sciences) at the UofM since then, under the supervision of Jeffrey Marcus. The title of her thesis is "The New World diversification and origins of the Buckeye butterflies (genus *Junonia*, Nymphalidae: Nymphalini)." Melanie is the recipient of numerous prestigious awards, including the E. Scherer Memorial Scholarship (UofM) and the Doctoral Award for Indigenous Students (UofM). Melanie shows much promise as a researcher and already has an impressive publication record and has made numerous presentations at local, national, and international meetings. She is also a generous volunteer, donating her time to the discipline (including reviewing manuscripts; participating in a survey for the Nature Conservancy of Canada, and curating the family Nymphalidae from a large insect collection donated to the museum at the Wallis Rughly Museum of Entomology) and to outreach activities (including many public talks, demonstrations, and interviews).

Respectfully,

ESM Student Awards and ESM Scholarship Committee

Jeffrey Marcus

Taz Stuart

Richard Westwood

Désirée Vanderwel (Chair)

Appendix K

Entomological Society of Manitoba

Fundraising Report

The Entomological Society of Manitoba received a total \$1175 in donations this past year from eight sponsors. The sponsors were Orkin Canada Corporation, Poulin's Pest Control, the City of Winnipeg Insect Pest Control, Bayer CropScience Canada, Gilles Lambert Pest Control, North/South Consultants, Cano Pest Control and the Canadian Centre for Mosquito Management. Donations have fallen by about 30% over the past few years because of agricultural divestment by former sponsors Dupont and Dow AgroSciences and the shifting of sponsorships by the Canadian Grain Commission to marketing oriented groups.

Ian Wise

Fundraising Committee

Appendix L
Entomological Society of Manitoba
ESM Website/Archivist Report – 2019-2020

In the past year there have been minimal changes to the ESM website. I added a statement on equity, diversity, and inclusion on the home page, updated the terms of reference for the ESM student awards, and added lists of past winners of the various student awards. I also updated the meetings page with information on the 2020 AGM to the website and updating various student award documents as required.

If members have news announcements that they would like to appear on the ESM home page, please send them to me. This may include information on graduate or post-doc position, meetings and/or presentations, or other items of general interest to the membership.

Other archival material relevant to the Society is maintained in a filing cabinet in a room located within 008 in the Animal Science/Entomology building basement. No new additions have been made since I assumed the archivist duties.

Jordan Bannerman

ESM Webmaster and Archivist

Appendix M
Entomological Society of Manitoba
26 October 2020

Report of the Common Names of Insects Committee

Prepared by Jason Gibbs; jason.gibbs@umanitoba.ca

1) Common names proposed but not yet accepted by ESC

Hyles euphorbiae (Linnaeus 1758)

Lepidoptera: Sphingidae

Current English names: leafy spurge hawkmoth or spurge hawk-moth

Suggested English name: leafy spurge hawkmoth

Suggested French name: sphinx du l'euphorbe

Criteria of inclusion:

Hyles euphorbiae is a biological control agent introduced to control leafy spurge, *Euphorbia virgata* Waldst. & Kit. (Batra 1983), a noxious weed in Canada. The caterpillar is large and easily recognizable and the adult moth is quite distinctive. The species therefore has cultural and social value in protecting natural areas from encroachment of an invasive species and could easily be identified by the general public.

Reason for suggestion:

Leafy spurge is a noxious weed in Canada. There are substantial efforts to control it. *Hyles euphorbiae* is an important entomological component of that control program. An official common name would facilitate communication of its role and importance.

Batra SWT (1983) NY Entomol Soc 91(4): 304-311.

Response from ESC:

ESC questioned justification for 'leafy spurge hawkmoth' rather than 'spurge hawkmoth'. The latter is used in the native range. I didn't express a strong preference, but justified the possible use of 'leafy spurge hawkmoth' due to its use in controlling 'leafy spurge', *Euphorbia virgata*.

2) Notes to ESC on classification

I pointed out that Acari is no longer accepted as an Order, but is rather a Subclass (*e.g.* Krantz, Gerald W.; Walter, D. E., eds. (2009). *A Manual of Acarology* (3rd ed.). 74 mites and ticks on the list were affected.

Response from ESC: committee adopted the changes and moved ‘Acari’ to the Notes field to allow searches using the old classification.

I also noted that Isoptera is listed as the Order for termites, although they are now classified in the Blattodea.

Response from ESC: Adopted change and moved ‘Isoptera’ to Notes field as above.

Appendix N
Entomological Society of Manitoba
Election Report 2020/21

December 4, 2020

Elections closed October 1, 2020 for the Entomological Society of Manitoba offices of President-Elect, Regional Director to the Entomological Society of Canada (ESC) and Member-at-Large. There were 82 ballots issues, 51 ballots returned, and there were no spoiled ballots.

The successful candidate for President-Elect is **Kateryn Rochon**.

The successful candidate for Regional Director to the ESC is **Jason Gibbs**.

The successful candidate for Member-at-Large is **Joel Gardner**.

This was the third year using an electronic voting process. All votes were done through Survey Monkey again this year. Responses are anonymous. The source of the vote is not visible or collected. Survey Monkey is also set to only allow one vote per respondent.

We thank all candidates for their willingness to participate in the election. Formal announcement and commencement of terms will be at and after the ESM Annual Business Meeting, respectively.

John Gavloski, Chair

Scrutineer Committee



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