



Point to Ponder

The “*Martes* Complex” — An Opportunity to Bring Together Marten, Fisher, Sable, Wolverine, and Tayra Biologists

Gilbert PROULX¹ and Keith B. AUBRY²

¹ Alpha Wildlife Research & Management Ltd., 229 Lilac Terrace, Sherwood Park, Alberta, T8H 1W3, Canada. Email: gproulx@alphawildlife.ca

² USDA Forest Service, Pacific Northwest Research Station, 3625 93rd Ave. SW Olympia, Washington 96512, USA. Email: kaubry.fs.fed.us

Abstract

Recent phylogenetic studies have shown that the genus *Martes* is polyphyletic with respect to the Fisher (*Pekania pennanti*), which is more closely related to the Wolverine (*Gulo gulo*) and Tayra (*Eira barbara*) than it is to the martens. We refer to the 11 species in the genera *Martes*, *Pekania*, *Gulo*, and *Eira* as the “*Martes* Complex”. Because the species comprising the *Martes* Complex share many physical, behavioural, and ecological traits, we believe that biologists and managers interested in any of these species would benefit from meeting with colleagues and exchanging information and ideas to address challenging conservation issues.

Key Words: Fisher, *Pekania pennanti*, martens, *Martes*, *Martes* Complex, Sable, Tayra, *Eira barbara*, Wolverine, *Gulo gulo*.

During the last 20 years, fossil records and molecular genetic studies have provided the scientific community with new insights about the *Martes* lineage. Hughes (2012:15) described its evolutionary history as “a series of dispersals and speciations against a backdrop of cooling climates, sea-level changes, mountain uplifts, aridification, and cyclical glacial events, all creating barriers to gene flow.” Until recently, the genus *Martes* included the American Marten (*Martes americana*) and Fisher (*M. pennanti*) in northern North America; the European Pine Marten (*M. Martes*) and Stone (Beech, House) Marten (*M. foina*) in Europe and south-central Asia; the Sable (*M. zibellina*) in northern and eastern Asia; the

Japanese Marten (*M. melampus*) in Japan and the Korean Peninsula; the Yellow-throated Marten (*M. flavigula*) in southeast Asia; and the Nilgiri Marten (*M. gwatkinsii*) in southern India (Proulx *et al.* 2004; Aubry *et al.* 2012). However, a series of phylogeographic and morphometric studies have provided compelling evidence for the existence of another species in the genus *Martes* – the Pacific Marten (*M. caurina*) of the western United States and southwestern Canada (Carr and Hicks 1997; Stone and Cook 2002; Stone *et al.* 2002; Small *et al.* 2003; Dawson and Cook 2012).

Recent phylogenetic studies of the Mustelidae (Koepli *et al.* 2008) and Musteloidea (Sato *et al.* 2012) have shown, however, that the genus *Martes* is polyphyletic with respect to the Fisher. This species is indeed more closely related to the Wolverine (*Gulo gulo*) and Tayra (*Eira barbara*) than it is to the martens. It was the only extant species in the sub-genus *Pekania* within the genus

Martes; consequently, both sources recommended that *Pekania* be elevated to the genus level, and that the Fisher be reclassified as *Pekania pennanti*. Thus, it is now clear that the genera *Martes*, *Pekania*, *Gulo*, and *Eira* include all extant species within a larger genetic lineage (Hosoda *et al.* 2000; Koepfli *et al.* 2008; Sato *et al.* 2012). However, no currently recognized subfamily encompasses this lineage. Previously, the subfamily Martinae included the genera *Martes*, *Gulo*, and *Eira* (e.g., Koepfli *et al.* 2008); on the other hand, Sato *et al.* (2012) referred to the subfamily Guloninae when describing phylogenetic relationships among *Martes*, *Gulo*, and *Pekania* (their work did not include *Eira*). Although much has been learned during the last 20 years about the phylogeny and evolutionary history of these mustelids, further investigations will be needed to resolve these uncertainties. Accordingly, we propose that the term “*Martes* Complex” be used to describe the 11 species that comprise the genera *Martes*, *Pekania*, *Gulo*, and *Eira*.

Although one can find common traits between any two species, whether related or not, we believe that the species in the *Martes* Complex share many physical, behavioural, and ecological traits (e.g., Kucera and Zielinski 1995; Presley 2000; Proulx *et al.* 2004) that justify considering them as a distinct group from a research and conservation perspective. Wildlife biologists can benefit from analysing commonalities among these species to develop more effective multi-species conservation action plans where they live in sympatry (Carroll *et al.* 2001; Proulx 2005) or far apart but in similar ecosystems (e.g., Yellow-throated Marten and Tayra). Nearly 80 years ago, the Tayra was described as a large mustelid similar in appearance to Nearctic members of the genus *Martes* that was believed to play similar ecological roles in Neotropical regions (Scott 1937). Like most *Martes* species, Tayras are solitary, forest-dwelling mesocarnivores with large spatial requirements. Like Yellow-throated Martens, they are frugivorous, but they supplement their diet with small vertebrates and insects (Presley 2000; Zhou *et al.* 2011). Like Stone Martens, Tayras have adjusted to living near human habitations, and take advantage of food provided by humans (Hall and Dalquest 1963; Hershkovitz 1972; Genovesi *et al.* 2009).

The American Marten, Pacific Marten, Pine Marten, Sable, Fisher, and Wolverine, are valuable furbearers that are susceptible to over-harvest because of their relatively low reproductive rates and large home ranges (Bakeyev and Simitsyn 1994; Banci and Proulx 1999; Helldin 2000). The Wolverine occupies a broader range of habitat conditions than other members of the *Martes* Complex, due to its primary need for cold climatic conditions (Copeland *et al.* 2010). In the boreal regions of Canada and the United States, however, they occupy large areas of mature timber (Hornocker and Hash 1981), much like American, Pacific, and Japanese Martens, and the Sable (Buskirk *et al.* 1996). In addition, the composition of winter diets of Fishers and Wolverines in the southern boreal forests of British Columbia reveals similarities in forest habitat use

(Weir *et al.* 2005; Lofroth *et al.* 2007). Thus, managing winter habitats of American and Pacific Martens and the Fisher would also benefit Wolverines (Proulx 2005).

On the basis of these and other commonalities, we believe that biologists working on any of these species would share many topics of mutual interest. Consequently, the *Martes* Complex provides an opportunity for wildlife biologists from different academic institutions, public agencies, and NGOs to network and exchange ideas for developing management or conservation programs that include similar species. Given their smaller size and ability to thrive in diverse habitats, mesocarnivores are usually more abundant than large carnivores, yet their impact within communities is generally assumed to be relatively minor (Roemer *et al.* 2009). In the absence of large carnivores, however, mesocarnivore populations may expand in density or distribution and serve as apex predators in ecosystems (Prugh *et al.* 2009). Anyone who has studied species in the *Martes* Complex know that they play important roles in the ecosystems they occupy, yet the public often has limited knowledge or experience about these cryptic species. Consequently, we believe that the biologists and managers who work on these species should make a concerted effort to increase public awareness and ensure that they are not overlooked in wildlife management or conservation plans. It is also important to meet with colleagues on a regular basis to exchange information and ideas. There is no doubt that some marten and Fisher specialists will find it difficult to create new relationships with colleagues who specialize on the Wolverine or Tayra, and *vice versa*. Moreover, some professionals may argue that the Wolverine is so different from the Stone Marten that there is no point in considering them together. However, we believe that we can overcome such difficulties and develop a network of *Martes*-related specialists that will provide substantial benefits to its members. Such a network can only be beneficial to the long-term persistence of species in the *Martes* Complex. We believe it would lead to better understandings of conservation issues, and a desire to work collaboratively on common problems.

A good example of such networking opportunities is provided by the *Martes* Working Group (MWG), which was founded in 1993 soon after the first symposium on the biology and conservation of martens, sables, and fishers was convened in 1991 (Proulx and Santos-Reis 2012; see Buskirk *et al.* 1994). By the early 1990s, most species in the genus *Martes* had experienced range reductions or population declines, but very little was known about their biology, ecological relations, or conservation status. The MWG organized four international symposia which led to the publication of four textbooks on martens, sables, and fishers (Proulx *et al.* 1997; Harrison *et al.* 2004; Santos-Reis *et al.* 2006; Aubry *et al.* 2012) that updated the scientific community about the evolution, taxonomy, morphophysiology, genetics, population dynamics, habitat and predator-prey relations, food preferences, parasites, and diseases of these species (Proulx and Santos-Reis 2012). The MWG publishes

a Newsletter each year in which the members share their findings or preliminary results, and discuss the biology and conservation of their species of interest. In addition, members of the *Martes* Working Group meet every 4-5 years to discuss their concerns and share information about their research programs. In accordance with the information presented here, the MWG recently expanded its taxonomic scope to include the Wolverine and Tayra, and to recognize the new generic designation for the Fisher (Proulx 2013). Thus, we hope that the MWG will help bring together biologists and managers working on Martens, Sables, Fishers, Wolverines, and Tayras, so they can share their knowledge and experiences, and find new ways to address challenging conservation issues.

INTRODUCTION

This paper benefited from discussions with members of the *Martes* Working Group, and the comments of Associate Editor Pauline Feldstein and three anonymous referees.

LITERATURE CITED

- Aubry, K. B., W. J. Zielinski, M. G. Raphael, G. Proulx, and S. W. Buskirk, editors. 2012. Biology and conservation of martens, sables, and fishers: A new synthesis. Cornell University Press, Ithaca, New York, USA.
- Bakeyev, N. N., and A. A. Simitsyn. 1994. Status and conservation of sables in the Commonwealth of Independent States. Pages 246-254 in S. W. Buskirk, A. S. Harestad, M. G. Raphael, and R. A. Powell, editors. Martens, sables, and fishers: Biology and conservation. Cornell University Press, Ithaca, New York, USA.
- Banci, V., and G. Proulx. 1999. Resiliency of furbearers to trapping in Canada. Pages 175-203 in G. Proulx, editor. Mammal trapping, Alpha Wildlife Publications, Sherwood Park, Alberta, Canada.
- Buskirk, S. W., A. S. Harestad, M. G. Raphael, and R. A. Powell, editors. 1994. Martens, sables and fishers: Biology and conservation. Cornell University Press, Ithaca, New York, USA.
- Buskirk, S. W., M. Yiqing, X. Li, and J. Zhaowen. 1996. Winter habitat ecology of sables (*Martes zibellina*) in relation to forest management in China. Ecological Applications 6: 318-325.
- Carr, S. M., and S. A. Hicks. 1997. Are there two species of marten in North America? Genetic and evolutionary relationships within *Martes*. Pages 15-28 in G. Proulx, H. N. Bryant, and P. M. Woodard, editors. Martes: Taxonomy, ecology, techniques, and management. Provincial Museum of Alberta, Edmonton, Canada.
- Carroll, C., R. F. Noss, and P. C. Paquet. 2001. Carnivores as focal species for conservation planning in the Rocky Mountain Region. Ecological Applications 11: 961-980.
- Copeland, J. P., K. S. McKelvey, K. B. Aubry, A. Landa, J. Persson, R. M. Inman, J. Krebs, E. Lofroth, H. Golden, J. R. Squires, A. Magoun, M. K. Schwartz, J. Wilmot, C. L. Copeland, R. E. Yates, I. Kojola, and R. May. 2010. The bioclimatic envelope of the wolverine (*Gulo gulo*): Do climatic constraints limit its geographic distribution? Canadian Journal of Zoology 88: 233-246.
- Dawson, N. G., and J. A. Cook. 2012. Behind the genes: Diversification of North American martens (*Martes americana* and *M. caurina*). Pages 23-38 in K. B. Aubry, W. J. Zielinski, M. G. Raphael, G. Proulx, and S. W. Buskirk, editors. Biology and conservation of martens, sables, and fishers: A new synthesis. Cornell University Press, Ithaca, New York, USA.
- Genovesi, P., M. Secchiand, and L. Boitani. 1996. Diet of stone martens: An example of ecological flexibility. Journal of Zoology 238: 545-555.
- Hall, E. R., and W. W. Dalquest. 1963. The mammals of Veracruz. University of Kansas Publication, Museum of Natural History 14: 165-362.
- Harrison, D. J., A. K. Fuller, and G. Proulx, editors. 2004. Martens and fishers (*Martes*) in human-altered environments: An international perspective. Springer Publishers, New York, New York, USA.
- Helldin, J.-O. 2000. Population trends and harvest management of pine marten *Martes martes* in Scandinavia. Wildlife Biology 6: 111-120.
- Hershkovitz, P. 1972. The recent mammals of the Neotropical region: A zoogeographical and ecological review. Pages 311-431 in A. Keast, F. Erk and B. Glass, editors. Evolution, mammals, and southern continents. State University of New York Press, Albany, New York, USA.
- Hornocker, M. G., and H. S. Hash. 1981. Ecology of the wolverine in northwestern Montana. Canadian Journal of Zoology 59: 1286-1301.
- Hosoda, T., H. Suzuki, M. Harada, K. Tsuchiya, S-H. Han, Y. P. Zhang, A. P. Kryukov, and L. K. Lin. 2000. Evolutionary trends of the mitochondrial lineage differentiation inspecies of genera *Martes* and *Mustela*. Genes & Genetic Systems 75:259-267.
- Hughes, S. S. 2012. Synthesis of Martes evolutionary history. Pages 3-22 in K. B. Aubry, W. J. Zielinski, M. G. Raphael, G. Proulx, and S. W. Buskirk, editors. Biology and conservation of martens, sables, and fishers: A new synthesis. Cornell University Press, Ithaca, New York, USA.
- Koepfli, K-P., K. A. Deere, G. J. Slater, C. Begg, K. Begg, L. Grassman, M. Lucherini, G. Veron, and R. K. Wayne. 2008. Multigene phylogeny of the Mustelidae: Resolving relationships, tempo and biogeographic history of a mammalian adaptive radiation. BMC Biology 6:10.
- Kucera, T. E., and W. J. Zielinski. 1995. The case of forest carnivores: Small packages, big worries. Endangered Species

- UPDATE 12(3): 1-7.
- Lofroth, E. C., J. A. Krebs, W. L. Harrower, and D. Lewis. 2007. Food habits of wolverine *Gulo gulo* in montane ecosystems of British Columbia, Canada. *Wildlife Biology* 13 (Suppl. 2): 31-37.
- Presley, S. J. 2000. *Eira barbara*. *Mammalian Species* 636: 1-6.
- Proulx, G. 2005. Integrating the habitat needs of fine- and coarse-filter species in landscape planning. In T. D. Hooper, editor. *Proceedings of the Species at Risk 2004 Pathways to Recovery Conference*. B.C. Species at Risk 2004 Pathways to Recovery Conference Organizing Committee, Victoria, B.C. Available at: http://www.llbc.leg.bc.ca/Public/PubDocs/bcdocs/400484/proulx_edited_final_march_17.pdf
- Proulx, G. 2013. Full survey results: What does the MWG membership want? *Martes Working Group Newsletter* 20: 5-9.
- Proulx, G., K. B. Aubry, J. Birks, S. W. Buskirk, C. Fortin, H. C. Frost, W. B. Krohn, L. Mayo, V. Monakhov, D. Payer, M. Saeki, M. Santos-Reis, R. Weir, and W. J. Zielinski. 2004. World distribution and status of the genus *Martes* in 2000. Pages 21-76 in D. J. Harrison, A. K. Fuller, and G. Proulx, editors. *Martens and fishers (Martes) in human-altered landscapes: An international perspective*. Springer, New York, New York, USA.
- Proulx, G., H. N. Bryant, and P. M. Woodard, editors. 1997. *Martes: Taxonomy, ecology, techniques and management*. Provincial Museum of Alberta, Edmonton, Alberta, Canada.
- Proulx, G., and M. Santos-Reis. 2012. A century of change in *Martes* research and management. Pages 471-489 in K. B. Aubry, W. J. Zielinski, M. G. Raphael, G. Proulx, and S. W. Buskirk, editors. *Biology and conservation of martens, sables, and fishers: A new synthesis*. Cornell University Press, Ithaca, New York, USA.
- Prugh, L. R., C. J. Stoner, C. W. Epps, W. T. Bean, W. J. Ripple, A. S. Laliberte, and J. S. Brashares. 2009. The rise of the mesopredator. *BioScience* 59: 779-791.
- Roemer, G. W., M. E. Gompper, and B. Van Valkenburgh. 2009. The ecological role of the mammalian mesocarnivore. *BioScience* 59:165-172.
- Sato, J. J., M. Wolsan, F. J. Prevosti, G. D'Elia, C. Begg, K. Begg, T. Hosoda, K. L. Campbell, and H. Suzuki. 2012. Evolutionary and biogeographic history of weasel-like carnivores (Musteloidea). *Molecular Phylogenetics and Evolution* 63: 745-757.
- Santos-Reis, M., J. D. S. Birks, E. C. O'Doherty, and G. Proulx, editors. 2006. *Martes* in carnivore communities. Alpha Wildlife Publications, Sherwood Park, Alberta, Canada.
- Scott, W. B. 1937. *A history of land mammals in the Western Hemisphere*. Hafner Publishing Company, New York, New York, USA.
- Small, M. P., K. D. Stone, and J. A. Cook. 2003. American marten (*Martes americana*) in the Pacific Northwest: Population differentiation across a landscape fragmented in time and space. *Molecular Ecology* 12:89-103.
- Stone, K. D., and J. A. Cook. 2002. Molecular evolution of Holarctic martens (genus *Martes*, Mammalia: Carnivora: Mustelidae). *Molecular Phylogenetics and Evolution* 24: 169-179.
- Stone, K. D., R. W. Flynn, and J. A. Cook. 2002. Post-glacial colonization of northwestern North America by the forest-associated American marten (*Martes americana*, Mammalia: Carnivora: Mustelidae). *Molecular Ecology* 11: 2049-2063.
- Weir, R. D., A. S. Harestad, and R. C. Wright. 2005. Winter diets of fishers in British Columbia. *Northwestern Naturalist* 86: 12-19.
- Zhou, Y-B., C. Newman, C. D. Buesching, A. Zalewski, Y. Kaneko, D. W. Macdonald, and Z.-Q. Xie. 2011. Diet of an opportunistically frugivorous carnivore, *Martes flavigula*, in subtropical forest. *Journal of Mammalogy* 92: 611-619.

ABOUT THE AUTHORS

Gilbert Proulx is Director of Science at Alpha Wildlife Research & Management, Editor-in Chief of the *Canadian Wildlife Biology & Management* journal, and Chair of the *Martes Working Group* since 1995. He has published more than 120 scientific articles, and 13 textbooks and field guides. His main research interest focuses on mammals, particularly in forest and agriculture ecosystems, and on technology development, mainly on mammal trapping and detection methods.



Keith B. Aubry is a Research Wildlife Biologist with the USDA Forest Service, Pacific Northwest Research Station in Olympia, Washington. He has been studying the ecology of terrestrial wildlife in the Pacific Northwest for more than 35 years. His recent and current research on mesocarnivores include field studies of the Fisher, Canada Lynx (*Lynx canadensis*), and Wolverine in the Pacific Northwest; the historical zoogeography and genetic affinities of the Fisher, Wolverine, and Red Fox (*Vulpes vulpes*) in North America; and the application of genetic information to wildlife research and conservation.

