Factors related to diversification rates, associated hypotheses, taxa in which they were studied, and whether we have data available to test them

Factor	Hypothesis /mechanism of diversification	Taxa tested on	Data to be used
	Rate of molecular evolution		
Body size	Taxa with small body size have high diversification rate. High metabolic rate (in smaller animals) linked to high mutation rate and shorter generation times.	Squamates: (Feldman et al. 2016); Birds: (Owens et al. 1999); Mammals (Isaac et al. 2005)	(Meiri 2018; Feldman et al. 2016; Meiri 2008)
Body temperature	Taxa with high body temperature have high diversification rate. High body temperatures lead to fast metabolism which in turn is linked to high rate of mutation rates, early maturity, short generation time, and high diversification rate.	Salamander and Mammals: (Machac et al. 2012); Insects and vertebrates (Gillooly et al. 2005)	(Meiri et al. 2013; Meiri 2018)
Life history	Taxa with fast life histories (large litters, early maturity, short generation time) have high diversification rate due to high rate of evolution and population growth.	Plants: (Igea et al. 2017); Invertebrates (Thomas et al. 2010); Mammals (Isaac et al. 2005)	(Meiri, et al. 2012; Meiri 2018)
Diel activity	Diurnal lineages have faster speciation and diversification rate. High metabolic rate in diurnal lineages might increase mutation and diversification rate when compared to nocturnal lineages.	Vertebrates: (Anderson and Wiens 2017)	(Anderson and Wiens 2017; Meiri 2018)
	Rate of trait/niche evolution		
Rate of body size evolution	Faster rate of body size evolution should correlate to high net diversification rate. Rates of morphological evolution are linked to speciation processes and hence high trait diversity will be coupled to high diversification rates.	Fishes: (Rabosky et al. 2013); Salamanders: (Adams et al. 2009); Birds: (Ricklefs 2004); Insects: (S. L. Price, Etienne, and Powell 2016)	(Meiri 2018; Feldman et al. 2016; Meiri 2008)
Rate of clutch size / brood frequency evolution	Faster rate of clutch size/number evolution should correlate to high diversification rate. Rates of morphological evolution are linked to speciation processes and hence high trait diversity will be coupled to high diversification rates.	Plants: (Igea et al. 2017)	(Meiri, Brown, and Sibly 2012; Meiri 2018)
Rate of climatic niche evolution	Faster rate of climatic niche evolution across clades should correlate to high net taxic diversification rate. Divergence in climatic niche promote speciation and faster adaption buffers species from extinction.	Amphibians: (Kozak and Wiens 2010); Birds: (Cooney, Seddon, and Tobias 2016); Mammals: (Castro-Insua et al. 2018)	(Roll et al. 2017; Fick and Hijmans 2017)
	Sexual selection		
Sexual size dimorphism (SSD)	Sexually dimorphic species have high net diversification rate. Dimorphism allows sexes to explore larger portions of the morphospace reducing extinction rates.	Amphibians: (De Lisle and Rowe 2015); Fishes: (Cooper, Gilman, and Boughman 2011)	(Tarr et al. 2018 in press) Meiri, unpublished

Factor	Hypothesis /mechanism of diversification	Taxa tested on	Data to be used
Sexual dichromatism	Sexually dichromatic species have high net diversification rate. Proxy for strength of sexual selection. Divergence in mate preference for sex-limited visual signal promote faster diversification in dichromatic species (i.e. by promoting reproductive isolation via assortative mating).	Amphibians: (Portik et al. 2018); Fishes :(Wagner, et al. 2012); Agamid lizards: (Stuart-Fox and Owens 2003); Birds: (Huang and Rabosky 2014)	to be collected
Femoral pores (Chemical communication)	Taxa using chemical communication for mate choice should have high net diversification rate. Divergence in mate preference for sex-limited chemical signal promote faster diversification in chemically signaling species (i.e. by promoting reproductive isolation via assortative mating).	Insects: (Mullen et al. 2007); Vertebrates and Insects: (Smadja and Butlin 2009)	(García-Roa et al. 2017)
	Key innovation		
Reproductive mode	Viviparous taxa will have high net diversification rate. Viviparous lineages in cold climate have access to previously unoccupied niche space, enhancing diversification rates. Alternatively, it could be a dead-end leading to low diversification rates at cold, marginal habitats, leading to slow diversification.	Squamates: (Pyron and Burbrink 2014)	(Pyron and Burbrink 2014; Feldman et al. 2015; Meiri 2018)
Microhabitat	Arboreal lineages have faster speciation and net diversification rate. The diversity of available niche space in arboreal reptiles, which can divide the habitat between them (e.g., crown, trunk, twig and grass/bush anole ectomorphs), when compared to other habitats allows for faster diversification. Adaptation to fossorial environment may be associated with lower diversification rates, because of the specialized nature of this niche. Alternatively, fossorial lineages may have high diversification rate due to low dispersal rates and strong geographic barriers to dispersal promoting evolution of peripheral isolates	Squamates: (Bars-Closel et al. 2017); Amphibians (Moen and Wiens 2017)	(Meiri 2018; Bars-Closel et al. 2017)
Diet type	Omnivores have lower net diversification compared to other guilds. Omnivores have competitive disadvantage because of niche overlap and competition asymmetry compared to other guilds (Burin et al. 2016). Alternatively, Omnivores have higher net diversification compared to other guilds because they have access to previously unoccupied niche space and thus promoting species diversification.	Birds: (Burin et al. 2016), Mammals: (S. A. Price et al. 2012)	(Meiri 2018)
Forging mode	Active foragers have higher net diversification rate compared to sit-and-wait foragers. Active foragers may have boarder dietary niche breadth and faster rate of dietary divergence leading to increased diversification.	none	(Meiri 2018)

Factor	Hypothesis /mechanism of diversification	Taxa tested on	Data to be used
Subdigital lamellae (toe-pads)	Lineages with subdigital lamellae have higher net diversification rate. Presence of subdigital lamellae will help occupy previously inaccessible niches (e.g. arboreal).	Not supported in Geckos: (Gamble et al. 2012)	Geckos: (Gamble et al. 2012) and will be collected for other groups
	Escape and radiate hypothesis		
Caudal autotomy	Taxa with caudal autotomy will have higher speciation rate. Evolution of novel defensive trait against predation leads to exploration of new niche spaces (because of relaxed selective pressure from predation) increasing speciation rate.	none	(Murali, Merilaita, and Kodandaramaiah 2018)
Chemical defense / Aposematism (including Batesian and Mullerian mimics)	Taxa with chemical defense or aposematism (chemical defense with warning signals) will have higher speciation rate. Evolution of novel defensive trait against predation leads to exploration of new niche spaces (because of relaxed selective pressure from predation) increasing speciation rate. (a) Mullerian mimicry may increase diversification via spatial sorting and expansion of niche (b) Batesian mimicry may lower species diversification because of geographic constraint imposed by models	Amphibians: (Arbuckle and Speed 2015); Vertebrates: (Harris and Arbuckle 2016)	(Harris and Arbuckle 2016)
	Niche breadth and trait polymorphism		
Climatic niche width	Lineages with broad climatic niche will have high net diversification rate. Broader niche increase diversification via increased niche divergence.	Amphibians: (Gómez-Rodríguez, et al. 2015); Mammals, Birds and Amphibians: (Rolland and Salamin 2016)	(Roll et al. 2017; Fick and Hijmans 2017)
Dietary niche width	Lineages with broad dietary niche will have high net diversification rate. Broader niche increase diversification via increased niche divergence.	Insects:(Hardy and Otto 2014; Wiens, Lapoint, and Whiteman 2015); Lizards: (Gainsbury and Meiri 2017)	(Costa et al. 2008; Gainsbury and Meiri 2017)
Colour polymorphism	Colour polymorphic lineages have lower extinction and high speciation rate. Colour polymorphism as a proxy for high genetic diversity and /or existence of alternative strategy in polymorphic species buffers species from extinction (due to rapidly changing environment) and promote diversification	Birds: (Hugall and Stuart-Fox 2012; Ducatez et al. 2017); Insects: (Gillespie et al. 2018). Reviewed in (McLean and Stuart-Fox 2014).	to be collected
	Spatio-temporal factors		
Latitude	High diversification rate in lineages at tropics. Higher net primary productivity and carrying capacity in the tropics increase diversification rate	Supported in Amphibians: (Pyron and Wiens 2013) and Mammals (Rolland et al. 2014). Not supported in- Birds and Mammals: (Rabosky and Huang	(Roll et al. 2017)

Factor	Hypothesis /mechanism of diversification	Taxa tested on	Data to be used
		2015;Weir and Schluter 2007); Ants: (Economo et al. 2018); Fishes: (Rabosky et al. 2018)	
Insularity	Insular species should have high net diversification rate compared to mainland species. Geographic isolation and genetic drift promote diversification, but lower selection intensity. On the other hand, islands (especially small ones) may lead only to anagenetic change and be evolutionary dead-ends.	Plants: (Comes, Tribsch, and Bittkau 2008); Birds: (Jønsson and Holt 2015). Reptiles (Ali and Meiri, under review)	(Novosolov, Raia, and Meiri 2013; Meiri 2018)
Clade age	Older lineages will have high species richness when compared to younger ones. Older clades will have more time to accumulate species. However, as clades start with single species, accumulate them, and then decline into extinction, we may expect a hump-shaped relationship between richness and diversification, and clade age.	Eukaryotes: (Rabosky, Slater, and Alfaro 2012)	(Tonini et al. 2016)

References

1. Adams, Dean C., Chelsea M. Berns, Kenneth H. Kozak, and John J. Wiens. 2009. “Are Rates of Species Diversification Correlated with Rates of Morphological Evolution?” *Proceedings of the Royal Society of London B: Biological Sciences*, rspb–2009.

2. Anderson, Samantha R., and John J. Wiens. 2017. “Out of the Dark: 350 Million Years of Conservatism and Evolution in Diel Activity Patterns in Vertebrates.” *Evolution* 71 (8): 1944–1959.

3. Arbuckle, Kevin, and Michael P. Speed. 2015. “Antipredator Defenses Predict Diversification Rates.” *Proceedings of the National Academy of Sciences* 112 (44): 13597–13602.

4. Bars-Closel, Melissa, Tiana Kohlsdorf, Daniel S. Moen, and John J. Wiens. 2017. “Diversification Rates Are More Strongly Related to Microhabitat than Climate in Squamate Reptiles (Lizards and Snakes).” *Evolution* 71 (9): 2243–2261.

5. Burin, Gustavo, W. Daniel Kissling, Paulo R. Guimarães Jr, Çağan H. Şekercioğlu, and Tiago B. Quental. 2016. “Omnivory in Birds Is a Macroevolutionary Sink.” *Nature Communications* 7: 11250.

6. Castro-Insua, Adrián, Carola Gómez-Rodríguez, John J. Wiens, and Andrés Baselga. 2018. “Climatic Niche Divergence Drives Patterns of Diversification and Richness among Mammal Families.” *Scientific Reports* 8 (1): 8781.

7. Comes, Hans Peter, Andreas Tribsch, and Christiane Bittkau. 2008. “Plant Speciation in Continental Island Floras as Exemplified by Nigella in the Aegean Archipelago.” *Philosophical Transactions of the Royal Society of London B: Biological Sciences* 363 (1506): 3083–3096.

8. Cooney, Christopher R., Nathalie Seddon, and Joseph A. Tobias. 2016. “Widespread Correlations between Climatic Niche Evolution and Species Diversification in Birds.” *Journal of Animal Ecology* 85 (4): 869–878.

9. Cooper, Idelle A., R. Tucker Gilman, and Janette Wenrick Boughman. 2011. “Sexual Dimorphism and Speciation on Two Ecological Coins: Patterns from Nature and Theoretical Predictions.” *Evolution: International Journal of Organic Evolution* 65 (9): 2553–2571.

10. Costa, Gabriel C., Laurie J. Vitt, Eric R. Pianka, Daniel O. Mesquita, and Guarino R. Colli. 2008. “Optimal Foraging Constrains Macroecological Patterns: Body Size and Dietary Niche Breadth in Lizards.” *Global Ecology and Biogeography* 17 (5): 670–677.

11. De Lisle, Stephen P., and Locke Rowe. 2015. “Independent Evolution of the Sexes Promotes Amphibian Diversification.” *Proceedings of the Royal Society of London B: Biological Sciences* 282 (1803): 20142213.

12. Ducatez, Simon, Mathieu Giraudeau, Christophe Thébaud, and Lisa Jacquin. 2017. "Colour Polymorphism Is Associated with Lower Extinction Risk in Birds." *Global Change Biology* 23 (8): 3030–3039.

13. Economo, Evan P., Nitish Narula, Nicholas R. Friedman, Michael D. Weiser, and Benoit Guénard. 2018. "Macroecology and Macroevolution of the Latitudinal Diversity Gradient in Ants." *Nature Communications* 9 (1): 1778.

14. Feldman, Anat, Aaron M. Bauer, Fernando Castro-Herrera, Laurent Chirio, Indraneil Das, Tiffany M. Doan, Erez Maza, Danny Meirte, Cristiano de Campos Nogueira, and Zoltán Tamás Nagy. 2015. "The Geography of Snake Reproductive Mode: A Global Analysis of the Evolution of Snake Viviparity." *Global Ecology and Biogeography* 24 (12): 1433–1442.

15. Feldman, Anat, Niv Sabath, R. Alexander Pyron, Itay Mayrose, and Shai Meiri. 2016. "Body Sizes and Diversification Rates of Lizards, Snakes, Amphisbaenians and the Tuatara." *Global Ecology and Biogeography* 25 (2): 187–197.

16. Fick, Stephen E., and Robert J. Hijmans. 2017. "WorldClim 2: New 1-Km Spatial Resolution Climate Surfaces for Global Land Areas." *International Journal of Climatology* 37 (12): 4302–4315.

17. Gainsbury, Alison, and Shai Meiri. 2017. "The Latitudinal Diversity Gradient and Interspecific Competition: No Global Relationship between Lizard Dietary Niche Breadth and Species Richness." *Global Ecology and Biogeography* 26 (5): 563–572.

18. Gamble, Tony, Eli Greenbaum, Todd R. Jackman, Anthony P. Russell, and Aaron M. Bauer. 2012. "Repeated Origin and Loss of Adhesive Toepads in Geckos." *PLoS One* 7 (6): e39429.

19. García-Roa, Roberto, Manuel Jara, Simon Baeckens, Pilar López, Raoul Van Damme, José Martín, and Daniel Pincheira-Donoso. 2017. "Macroevolutionary Diversification of Glands for Chemical Communication in Squamate Reptiles." *Scientific Reports* 7 (1): 9288.

20. Gillespie, Rosemary G., Suresh P. Benjamin, Michael S. Brewer, Malia Ana J. Rivera, and George K. Roderick. 2018. "Repeated Diversification of Ecomorphs in Hawaiian Stick Spiders." *Current Biology* 28 (6): 941–947.

21. Gillooly, James F., Andrew P. Allen, Geoffrey B. West, and James H. Brown. 2005. "The Rate of DNA Evolution: Effects of Body Size and Temperature on the Molecular Clock." *Proceedings of the National Academy of Sciences* 102 (1): 140–145.

22. Gómez-Rodríguez, Carola, Andrés Baselga, and John J. Wiens. 2015. "Is Diversification Rate Related to Climatic Niche Width?" *Global Ecology and Biogeography* 24 (4): 383–395.

23. Hardy, Nate B., and Sarah P. Otto. 2014. "Specialization and Generalization in the Diversification of Phytophagous Insects: Tests of the Musical Chairs and Oscillation Hypotheses." *Proceedings of the Royal Society of London B: Biological Sciences* 281 (1795): 20132960.

24. Harris, Richard J., and Kevin Arbuckle. 2016. “Tempo and Mode of the Evolution of Venom and Poison in Tetrapods.” *Toxins* 8 (7): 193.

25. Huang, Huateng, and Daniel L. Rabosky. 2014. “Sexual Selection and Diversification: Reexamining the Correlation between Dichromatism and Speciation Rate in Birds.” *The American Naturalist* 184 (5): E101–E114.

26. Hugall, Andrew F., and Devi Stuart-Fox. 2012. “Accelerated Speciation in Colour-Polymorphic Birds.” *Nature* 485 (7400): 631.

27. Igea, Javier, Eleanor F. Miller, Alexander ST Papadopulos, and Andrew J. Tanentzap. 2017. “Seed Size and Its Rate of Evolution Correlate with Species Diversification across Angiosperms.” *PLoS Biology* 15 (7): e2002792.

28. Isaac, Nick JB, Kate E. Jones, John L. Gittleman, and Andy Purvis. 2005. “Correlates of Species Richness in Mammals: Body Size, Life History, and Ecology.” *The American Naturalist* 165 (5): 600–607.

29. Jønsson, Knud A., and Ben G. Holt. 2015. “Islands Contribute Disproportionately High Amounts of Evolutionary Diversity in Passerine Birds.” *Nature Communications* 6: 8538.

30. Kozak, Kenneth H., and John J. Wiens. 2010. “Accelerated Rates of Climatic-Niche Evolution Underlie Rapid Species Diversification.” *Ecology Letters* 13 (11): 1378–1389.

31. Machac, A., J. Zrzavỳ, J. Smrckova, and D. Storch. 2012. “Temperature Dependence of Evolutionary Diversification: Differences between Two Contrasting Model Taxa Support the Metabolic Theory of Ecology.” *Journal of Evolutionary Biology* 25 (12): 2449–2456.

32. McLean, Claire A., and Devi Stuart-Fox. 2014. “Geographic Variation in Animal Colour Polymorphisms and Its Role in Speciation.” *Biological Reviews* 89 (4): 860–873.

33. Meiri, Shai. 2008. “Evolution and Ecology of Lizard Body Sizes.” *Global Ecology and Biogeography* 17 (6): 724–734.

34. ———. 2018. “Traits of Lizards of the World: Variation around a Successful Evolutionary Design.” *Global Ecology and Biogeography*.

35. Meiri, Shai, Aaron M. Bauer, Laurent Chirio, Guarino R. Colli, Indraneil Das, Tiffany M. Doan, Anat Feldman, Fernando-Castro Herrera, Maria Novosolov, and Panayiotis Pafilis. 2013. “Are Lizards Feeling the Heat? A Tale of Ecology and Evolution under Two Temperatures.” *Global Ecology and Biogeography* 22 (7): 834–845.

36. Meiri, Shai, James H. Brown, and Richard M. Sibly. 2012. “The Ecology of Lizard Reproductive Output.” *Global Ecology and Biogeography* 21 (5): 592–602.

37. Moen, Daniel S., and John J. Wiens. 2017. “Microhabitat and Climatic Niche Change Explain Patterns of Diversification among Frog Families.” *The American Naturalist* 190 (1): 29–44.

38. Mullen, Sean P., Tamra C. Mendelson, Coby Schal, and Kerry L. Shaw. 2007. “Rapid Evolution of Cuticular Hydrocarbons in a Species Radiation of Acoustically Diverse Hawaiian Crickets (Gryllidae: Trigonidiinae: Laupala).” *Evolution* 61 (1): 223–231.

39. Murali, Gopal, Sami Merilaita, and Ullasa Kodandaramaiah. 2018. “Grab My Tail: Evolution of Dazzle Stripes and Colourful Tails in Lizards.” *Journal of Evolutionary Biology*.

40. Novosolov, Maria, Pasquale Raia, and Shai Meiri. 2013. “The Island Syndrome in Lizards.” *Global Ecology and Biogeography* 22 (2): 184–191.

41. Owens, Ian PF, Peter M. Bennett, and Paul H. Harvey. 1999. “Species Richness among Birds: Body Size, Life History, Sexual Selection or Ecology?” *Proceedings of the Royal Society of London B: Biological Sciences* 266 (1422): 933–939.

42. Portik, Daniel M., Rayna C. Bell, David C. Blackburn, Aaron M. Bauer, Christopher D. Barratt, William R. Branch, Marius Burger, Alan Channing, Timothy J. Colston, and Werner Conradie. 2018. “Sexual Dichromatism Drives Diversification Within a Major Radiation of African Amphibians.” *BioRxiv*, 372250.

43. Price, Samantha A., Samantha SB Hopkins, Kathleen K. Smith, and V. Louise Roth. 2012. “Tempo of Trophic Evolution and Its Impact on Mammalian Diversification.” *Proceedings of the National Academy of Sciences* 109 (18): 7008–7012.

44. Price, Shauna L., Rampal S. Etienne, and Scott Powell. 2016. “Tightly Congruent Bursts of Lineage and Phenotypic Diversification Identified in a Continental Ant Radiation.” *Evolution* 70 (4): 903–912.

45. Pyron, R. Alexander, and Frank T. Burbrink. 2014. “Early Origin of Viviparity and Multiple Reversions to Oviparity in Squamate Reptiles.” *Ecology Letters* 17 (1): 13–21.

46. Pyron, R. Alexander, and John J. Wiens. 2013. “Large-Scale Phylogenetic Analyses Reveal the Causes of High Tropical Amphibian Diversity.” *Proceedings of the Royal Society of London B: Biological Sciences* 280 (1770): 20131622.

47. Rabosky, Daniel L., Jonathan Chang, Pascal O. Title, Peter F. Cowman, Lauren Sallan, Matt Friedman, Kristin Kaschner, Cristina Garilao, Thomas J. Near, and Marta Coll. 2018. “An Inverse Latitudinal Gradient in Speciation Rate for Marine Fishes.” *Nature* 559 (7714): 392.

48. Rabosky, Daniel L., and Huateng Huang. 2015. “Minimal Effects of Latitude on Present-Day Speciation Rates in New World Birds.” *Proc. R. Soc. B* 282 (1809): 20142889.

49. Rabosky, Daniel L., Francesco Santini, Jonathan Eastman, Stephen A. Smith, Brian Sidlauskas, Jonathan Chang, and Michael E. Alfaro. 2013. “Rates of Speciation and Morphological Evolution Are Correlated across the Largest Vertebrate Radiation.” *Nature Communications* 4: 1958.

50. Rabosky, Daniel L., Graham J. Slater, and Michael E. Alfaro. 2012. "Clade Age and Species Richness Are Decoupled across the Eukaryotic Tree of Life." *PLoS Biology* 10 (8): e1001381.

51. Ricklefs, Robert E. 2004. "Cladogenesis and Morphological Diversification in Passerine Birds." *Nature* 430 (6997): 338.

52. Roll, Uri, Anat Feldman, Maria Novosolov, Allen Allison, Aaron M. Bauer, Rodolphe Bernard, Monika Böhm, Fernando Castro-Herrera, Laurent Chirio, and Ben Collen. 2017. "The Global Distribution of Tetrapods Reveals a Need for Targeted Reptile Conservation." *Nature Ecology & Evolution* 1 (11): 1677.

53. Rolland, Jonathan, Fabien L. Condamine, Frederic Jiguet, and Hélène Morlon. 2014. "Faster Speciation and Reduced Extinction in the Tropics Contribute to the Mammalian Latitudinal Diversity Gradient." *PLoS Biology* 12 (1): e1001775.

54. Rolland, Jonathan, and Nicolas Salamin. 2016. "Niche Width Impacts Vertebrate Diversification." *Global Ecology and Biogeography* 25 (10): 1252–1263.

55. Smadja, C., and R. K. Butlin. 2009. "On the Scent of Speciation: The Chemosensory System and Its Role in Premating Isolation." *Heredity* 102 (1): 77.

56. Stuart-Fox, Devi, and Ian PF Owens. 2003. "Species Richness in Agamid Lizards: Chance, Body Size, Sexual Selection or Ecology?" *Journal of Evolutionary Biology* 16 (4): 659–669.

57. Tarr, Simon, Shai Meiri, James J. Hicks, and Adam C.Algar. 2018. "A Biogeographic Reversal in Sexual Size Dimorphism along a Continental Temperature Gradient." *Ecography*, In Press.

58. Thomas, Jessica A., John J. Welch, Robert Lanfear, and Lindell Bromham. 2010. "A Generation Time Effect on the Rate of Molecular Evolution in Invertebrates." *Molecular Biology and Evolution* 27 (5): 1173–1180.

59. Tonini, João Filipe Riva, Karen H. Beard, Rodrigo Barbosa Ferreira, Walter Jetz, and R. Alexander Pyron. 2016. "Fully-Sampled Phylogenies of Squamates Reveal Evolutionary Patterns in Threat Status." *Biological Conservation* 204: 23–31.

60. Wagner, Catherine E., Luke J. Harmon, and Ole Seehausen. 2012. "Ecological Opportunity and Sexual Selection Together Predict Adaptive Radiation." *Nature* 487 (7407): 366.

61. Wiens, John J., Richard T. Lapoint, and Noah K. Whiteman. 2015. "Herbivory Increases Diversification across Insect Clades." *Nature Communications* 6: 8370.