

Appendix from T. E. Miller et al., “A Critical Review of Twenty Years’ Use of the Resource-Ratio Theory” (Am. Nat., vol. 165, no. 4, p. 000)

Articles That Purport to Test Resource-Ratio Theory Predictions

Peer-reviewed articles that purport to test predictions of the resource-ratio theory, as it is presented by Tilman (1980) or Tilman (1982). The 26 articles that meet our criteria for experimental design are marked with asterisks and followed by an evaluation of whether the predictions support the resource-ratio hypothesis. Prediction numbers (e.g., P1) follow table 1.

- Anderson, M. R., and J. Kalff. 1986. Regulation of submerged aquatic plant distribution in a uniform area of a weedbed. *Journal of Ecology* 74:953–961.
- Bush, J. K., and O. W. Van Auken. 1986. Light requirements of *Acacia smallii* and *Celtis laevigata* in relation to secondary succession on floodplains of south Texas. *American Midland Naturalist* 115:118–122.
- Carney, H. J. 1987. Field tests of interspecific resource-based competition among phytoplankton. *Proceedings of the National Academy of Sciences of the USA* 84:4148–4150.
- Ciros-Perez, J., M. J. Carmona, and M. Serra. 2001. Resource competition between sympatric sibling rotifer species. *Limnology and Oceanography* 46:1511–1523.
- *Codeco, C. T., and J. P. Grover. 2001. Competition along a spatial gradient of resource supply: a microbial experimental model. *American Naturalist* 157:300–315. YES-P2; NO-P4.
- Escaravage, V., T. C. Prins, A. C. Smaal, and J. C. H. Peeters. 1996. The response of phytoplankton communities to phosphorus input reduction in mesocosm experiments. *Journal of Experimental Marine Biology and Ecology* 198:55–79.
- Fairchild, G. W., R. L. Lowe, and W. B. Richardson. 1985. Algal periphyton growth on nutrient-diffusing substrates: an in situ bioassay. *Ecology* 66:465–472.
- Fox, J. W. 2002. Testing a simple rule for dominance in resource competition. *American Naturalist* 159:305–319.
- Fox, J. W., and D. C. Smith. 1997. Variable outcomes of protist-rotifer competition in laboratory microcosms. *Oikos* 79:489–495.
- *Grover, J. P. 1991. Dynamics of competition among microalgae in variable environments: experimental tests of alternative models. *Oikos* 62:231–243. YES-P1.
- Hansson, L. A., and H. Hakansson. 1992. Diatom community response along a productivity gradient of shallow Antarctic lakes. *Polar Biology* 12:463–468.
- Hillebrand, H., and U. Sommer. 2000. Diversity of benthic microalgae in response to colonization time and eutrophication. *Aquatic Botany* 67:221–236.
- Hough, R. A., and R. L. Thompson Jr. 1996. The influence of a dissolved inorganic nitrogen gradient on phytoplankton community dynamics in a chain of lakes. *Hydrobiologia* 319:225–235.
- *Hu, S., and D. Y. Zhang. 1993. The effects of initial population density on the competition for limiting nutrients in two freshwater algae. *Oecologia (Berlin)* 96:569–574. NO-P1.
- *Huisman, J., R. R. Jonker, C. Zonneveld, and F. J. Weissing. 1999. Competition for light between phytoplankton species: experimental tests of mechanistic theory. *Ecology* 80:211–222. NO-P1.
- *Inouye, R. S., N. J. Huntly, D. Tilman, J. R. Tester, M. Stillwell, and K. C. Zinnel. 1987. Old-field succession on a Minnesota sand plain. *Ecology* 68:12–26. NO-P2.
- Interlandi, S. J. 2002. Nutrient-toxicant interactions in natural and constructed phytoplankton communities: results of experiments in semi-continuous and batch culture. *Aquatic Toxicology* 61:35–51.
- Interlandi, S. J., and S. S. Kilham. 2001. Limiting resources and the regulation of diversity in phytoplankton communities. *Ecology* 82:1270–1282.
- Kautsky, L., and H. Kautsky. 1989. Algal species diversity and dominance along gradients of stress and disturbance

- in marine environments. *Vegetatio* 83:259–267.
- *Kilham, S. S. 1986. Dynamics of Lake Michigan natural phytoplankton communities in continuous cultures along a Si-P loading gradient. *Canadian Journal of Fisheries and Aquatic Sciences* 43:351–360. YES-P1, P2, P3, P6.
- *Kirk, K. L. 2002. Competition in variable environments: experiments with planktonic rotifers. *Freshwater Biology* 47:1089–1096. YES-P1.
- *Kirkham, F. W., J. O. Mountford, and R. J. Wilkins. 1996. The effects of nitrogen, potassium and phosphorus addition on the vegetation of a Somerset peat moor under cutting management. *Journal of Applied Ecology* 33:1013–1029. YES-P2.
- Koutroubas, S. D., D. S. Veresoglou, and A. Zounos. 2000. Nutrient use efficiency as a factor determining the structure of herbaceous plant communities in low-nutrient environments. *Journal of Agronomy and Crop Science* 184:261–266.
- Kreutzer, C., and W. Lampert. 1999. Exploitative competition in differently sized *Daphnia* species: a mechanistic explanation. *Ecology* 80:2348–2357.
- *Leibold, M. A. 1999. Biodiversity and nutrient enrichment in pond plankton communities. *Evolutionary Ecology Research* 1:73–95. NO-P2.
- Leibold, M. A., and G. Mikkelsen. 2002. Coherence, species turnover, and boundary clumping: elements of meta-community structure. *Oikos* 97:237–250.
- Levine, S. N., and D. W. Schindler. 1999. Influence of nitrogen to phosphorus supply ratios and physicochemical conditions on cyanobacteria and phytoplankton species composition in the Experimental Lakes Area, Canada. *Canadian Journal of Fisheries and Aquatic Sciences* 56:451–466.
- Long, Z. T., and I. Karel. 2002. Resource specialization determines whether history influences community structure. *Oikos* 96:62–69.
- *Makulla, A., and U. Sommer. 1993. Relationships between resource ratios and phytoplankton species composition during spring in five north German lakes. *Limnology and Oceanography* 38:846–856. YES-P2.
- Mamolos, A. P., D. S. Veresoglou, and N. Barbayiannis. 1995. Plant species abundance and tissue concentrations of limiting nutrients in low-nutrient grasslands: a test of competition theory. *Journal of Ecology* 83:485–495.
- *Marks, J. C., and R. L. Lowe. 1993. Interactive effects of nutrient availability and light levels on the periphyton composition of a large oligotrophic lake. *Canadian Journal of Fisheries and Aquatic Sciences* 50:1270–1278. YES-P2.
- McGraw, J. B., and F. S. Chapin III. 1989. Competitive ability and adaptation to fertile and infertile soils in two *Eriophorum* species. *Ecology* 70:736–749.
- McIlraith, A. L., G. G. C. Robinson, and J. M. Shay. 1989. A field study of competition and interaction between *Lemna minor* and *Lemna trisulca*. *Canadian Journal of Botany* 67:2904–2911.
- Morris, D. W., and T. W. Knight. 1996. Can consumer-resource dynamics explain patterns of guild assembly? *American Naturalist* 147:558–575.
- Owen, J. G. 1988. On productivity as a predictor of rodent and carnivore diversity. *Ecology* 69:1161–1165.
- Pidwirny, M. J. 1990. Plant zonation in a brackish tidal marsh: descriptive verification of resource-based competition and community structure. *Canadian Journal of Botany* 68:1689–1697.
- *Roelke, D. L., L. A. Cifuentes, and P. M. Eldridge. 1997. Nutrient and phytoplankton dynamics in a sewage-impacted gulf coast estuary: a field test of the PEG-model and equilibrium resource competition theory. *Estuaries* 20:725–742. NO-P2.
- *Rothhaupt, K. O. 1988. Mechanistic resource competition theory applied to laboratory experiments with zooplankton. *Nature* 333:660–662. YES-P1, P4, P5.
- *Rothhaupt, K. O. 1996. Laboratory experiments with a mixotrophic chrysophyte and obligately phagotrophic and phototrophic competitors. *Ecology* 77:716–724. YES-P2.
- Smith, V. H. 1992. Effects of nitrogen: phosphorus supply ratios on nitrogen fixation in agricultural and pastoral ecosystems. *Biogeochemistry* 18:19–35.
- Smith, V. H. 1993. Applicability of resource-ratio theory to microbial ecology. *Limnology and Oceanography* 38:239–249.
- *Sommer, U. 1985. Comparison between steady state and non-steady state competition: experiments with natural phytoplankton. *Limnology and Oceanography* 30:335–346. YES-P2, P4.
- *Sommer, U. 1986. Nitrate- and silicate-competition among Antarctic phytoplankton. *Marine Biology* 91:345–351. YES-P1, P2, P4, P5.
- *Sommer, U. 1986. Phytoplankton competition along a gradient of dilution rates. *Oecologia (Berlin)* 68:503–506.

YES-P1, P2, P4, P6.

- Sommer, U. 1988. The species composition of Antarctic phytoplankton interpreted in terms of Tilman's competition theory. *Oecologia* (Berlin) 77:464–467.
- Sommer, U. 1991. Comparative nutrient status and competitive interactions of two Antarctic diatoms (*Corethron criophilum* and *Thalassiosira antarctica*). *Journal of Plankton Research* 13:61–75.
- *Sommer, U. 1993. Phytoplankton competition in Plussee: a field-test of the resource-ratio hypothesis. *Limnology and Oceanography* 38:838–845. YES-P2.
- *Sommer, U. 1994. Are marine diatoms favored by high Si-N ratios? *Marine Ecology Progress Series* 115:309–315. NO-P3.
- *Sommer, U. 1994. The impact of light intensity and daylength on silicate and nitrate competition among marine phytoplankton. *Limnology and Oceanography* 39:1680–1688. YES-P2.
- Sommer, U. 1996. Nutrient competition experiments with periphyton from the Baltic Sea. *Marine Ecology Progress Series* 140:161–167.
- *Spijkerman, E., and P. F. M. Coesel. 1996. Competition for phosphorus among planktonic desmid species in continuous-flow culture. *Journal of Phycology* 32:939–948. NO-P1.
- Stelzer, R. S., and G. A. Lamberti. 2001. Effects of N : P ratio and total nutrient concentration on stream periphyton community structure, biomass, and elemental composition. *Limnology and Oceanography* 46:356–367.
- Stemberger, R. S., and E. K. Miller. 1998. A zooplankton-N : P-ratio indicator for lakes. *Environmental Monitoring and Assessment* 51:29–51.
- Sterner, R. W. 1989. Resource competition during seasonal succession toward dominance by Cyanobacteria. *Ecology* 70:229–245.
- *Tilman, D. 1981. Tests of resource competition theory using four species of Lake Michigan algae. *Ecology* 62: 802–815. YES-P1, P4.
- *Tilman, D. 1983. Plant succession and gopher disturbance along an experimental gradient. *Oecologia* (Berlin) 60: 285–292. YES-P2.
- Tilman, D. 1987. Secondary succession and the pattern of plant dominance along experimental nitrogen gradients. *Ecological Monographs* 57:189–214.
- Tilman, D., and H. Olff. 1991. An experimental study of the effects of pH and nitrogen on grassland vegetation. *Acta Oecologica* 12:427–441.
- *Tilman, D., and R. W. Sterner. 1984. Invasions of equilibria: tests of resource competition using two species of algae. *Oecologia* (Berlin) 61:197–200. NO-P1.
- *Tilman, D., and D. Wedin. 1991. Dynamics of nitrogen competition between successional grasses. *Ecology* 72: 1038–1049. NO-P1.
- Tilman, D., M. Mattson, and S. Langer. 1981. Competition and nutrient kinetics along a temperature gradient: an experimental test of a mechanistic approach to niche theory. *Limnology and Oceanography* 26:1020–1033.
- Tilman, D., R. Kiesling, R. Sterner, S. S. Kilham, and F. A. Johnson. 1986. Green, bluegreen and diatom algae: taxonomic differences in competitive ability for phosphorus, silicon and nitrogen. *Archiv für Hydrobiologie* 106: 473–485.
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- Tilman, G. D. 1984. Plant dominance along an experimental nutrient gradient. *Ecology* 65:1445–1453.
- Twolan-Strutt, L., and P. A. Eddy. 1996. Above- and belowground competition intensity in two contrasting wetland plant communities. *Ecology* 77:259–270.
- *van Donk, E., and S. S. Kilham. 1990. Temperature effects on silicon- and phosphorus-limited growth and competitive interactions among three diatoms. *Journal of Phycology* 26:40–50. YES-P1.
- Wang, G., Q. Zhou, W. Zhong, C. Sun, and Z. Chen. 2001. Species richness: primary productivity relationship of plants and small mammals in the Inner Mongolian steppes, China. *Journal of Arid Environments* 49:477–484.
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