**S1.** Empirical examples linking temporal drivers of metacommunity structure (disturbance, seasonality, multi-year temporal dynamics, and dormancy) to biological processes of (dispersal “Disp.”, environmental filtering “Env. Filt.” and species interactions “Sp. Int.”) that influence metacommunity structure. The table includes both studies in which authors applied a metacommunity framework of analysis to test for changes in metacommunity structures over time, and studies in which potential temporal metacommunity effects can be inferred. Ecological scope of the study: A, an assemblage, M is multiple interacting species, O is one (or multiple single) focal species, and number of species is given in parentheses. "Metacomm. Context?" is whether a study was placed in a metacommunity context. For species interactions (Sp. Int.), C indicates competition, P indicates predation, and D indicates disease.

| Focal Taxa | Ecological Scopea (# species) | Biome | Region | Temporal  Drivers | Biological Processes | | | Metacomm. Context? | Citations |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Disp. | Env. Filt. | Sp. Intb. |
| Protists | M (13) | Freshwater | Europec | Disturbance | ✓ | ✓ |  | Yes | Warren, 1996 |
| Protists, Rotifers | M (8) | Freshwater | N. Americac | Disturbance | ✓ |  |  | Yes | Altermatt et al., 2011b |
| Macroinvertebrates | A (163) | Coniferous Forest | N. America | Disturbance | ✓ |  |  | Yes | Starzomski and Srivastava, 2007 |
| Protists | M (5) | Freshwater | N. Americac | Disturbance | ✓ |  |  | Yes | Ojima and Jiang, 2017 |
| Protists, Rotifers | A (~20) | Freshwater | N. America | Disturbance | ✓ | ✓ |  | Yes | Östman et al., 2006 |
| Macroinvertebrates | A (34) | Freshwater | Africa | Disturbance | ✓ | ✓ |  | Yes | Vanschoenwinkel et al., 2013 |
| Protists, Rotifers | M (7 protists, 1 rotifer) | Freshwater | N. Americac | Disturbance | ✓ | ✓ |  | Yes | Altermatt et al., 2011a |
| Macroinvertebrates | A (89) | Freshwater | Europe | Disturbance | ✓ | ✓ |  | No | Sarremejane et al., 2018 |
| Plants | M (25) | Grassland | Oceania | Disturbance |  | ✓ |  | Yes | Laliberté et al., 2013 |
| Macroinvertebrates | A (not specified) | Freshwater | Oceania | Disturbance |  | ✓ |  | Yes | Campbell et al., 2015 |
| Protists | M (5) | Freshwater | Europec | Disturbance |  | ✓ |  | Yes | Limberger and Wickham, 2012 |
| Macroinvertebrates, Amphibians, Zooplankton, Algae, Macrophytes | A (71) | Freshwater | N. America | Disturbance |  | ✓ |  | No | Chase, 2007 |
| Protists, Rotifers | M (13) | Freshwater | N. Americac | Disturbance | ✓ |  | C | Yes | Cadotte, 2007 |
| Macroinvertebrates | A (25 families) | Intermittent and perennial rivers | Europe | Seasonality | ✓ | ✓ |  | Yes | Sarremejane et al. 2017 |
| Mammals | A (33) | Tropical Forest | Central America | Seasonality |  |  | C | Yes | Cisneros et al. 2015 |
| Mammals | M (16) | Savanna | Africa | Seasonality |  |  | P | No | Owen-Smith 2008 |
| Mammals | M (5) | Taiga | N. America | Seasonality |  | ✓ | P | No | Metz et al. 2012 |
| Bacteria | A (7 clades) | Marine | E. Asia | Seasonality |  | ✓ | C | Yes | Ren et al. 2018 |
| Insects | A (32) | Boreal Forest | N. America | Seasonality | ✓ | ✓ | C | Yes | Marrec et al. 2018 |
| Mammals | A (19) | Tropical Forest | S. America | Seasonality | ✓ |  |  | Yes | Delciellos et al. 2018 |
| Macroinvertebrates | A (12 families) | Freshwater | Europe | Seasonality | ✓ | ✓ |  | Yes | Csercsa et al. 2019 |
| Reptiles, Birds | M (3) | Terrestrial | N. America | Seasonality |  |  | P | No | Sperry et al. 2008 |
| Mammals | M (not specified) | Grassland | Africa | Seasonality |  |  | C, P, D | No | Talbot and Talbot 1963, Sinclair 1985, Holdo et al. 2011 |
| Mammals | O (1) | Alpine | N. America | Seasonality |  | ✓ |  | No | Inouye et al. 2000, Lane et al. 2012 |
| Birds, Insects | M (2) | Woodland | Europe | Seasonality |  |  | P | No | Visser et al. 2006 |
| Plants | M (4+) | Alpine | Europe | Seasonality |  |  | C | No | Alexander et al. 2015 |
| Algae, Zooplankton | A (443, 353) | Freshwater | S. America | Seasonality, Multi-year Variation | ✓ | ✓ |  | Yes | Pineda et al., 2019 |
| Protists | A (78) | Freshwater | S. America | Seasonality, Multi-year Variation | ✓ | d |  | Yes | Pineda et al., 2019 |
| Macroinvertebrates | A (~85/site) | Marine benthic | S. America | Multi-year Variation | ✓ | ✓ | P | Yes | Camus, 2008 |
| Zooplankton | O (1) | Freshwater | Europe | Multi-year Variation | ✓ | ✓ |  | No | Jeffries, 2005 |
| Fishes | M (3) | Marine pelagic | Europe | Multi-year Variation | ✓ |  | P | Yes | Lindegren et al., 2014 |
| Mammals | A (10) | Terrestrial | S. America | Multi-year Variation |  | ✓ | ✓ | No | Meserve et al., 2003 |
| Plants | O (2) | Terrestrial | N. America | Dormancy | ✓ |  |  | No | Alexander et al., 2012 |

a Ecological scope of the study: A indicates that a habitat-defined assemblage of species was the focal unit of analysis, M indicates that multiple interacting species were considered, and O indicates that only a single focal species was studied; single species studies represent potential mechanisms that might be present in metacommunities.

b C indicates competition, P indicates predation, and D indicates disease.

c Study took place in laboratory setting

d Study tested for environmental filtering but no effects of environmental variables on species richness were found.