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A functional approach to understanding how temperature and habitat dimensionality drive universality and variation in ecological systems

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For Ian & Shelley

Abstract

Understanding the processes that form, drive and maintain ecological systems is fundamental to understanding basic and applied biology. In particular, identifying mechanisms that regulate the structure and functioning of ecological systems over a variety of levels, from individuals and populations, through communities and ecosystems, is a central goal of ecology. Understanding how the physical environment influences these mechanisms, and therefore why communities differ between habitats, is also a key goal. Significant advances on these research fronts have been made, but scientists are still a long way from a mechanistic understanding of ecological systems. The aim of this thesis is to improve understanding how local-scale interactions of individuals unite to drive and stabilise patterns at higher levels of ecological organisation, and to determine what role the physical environment plays. Using an approach that combines meta-analysis of published data, eco-informatics, and mechanistic theory, this thesis explores how the physical environment drives universality and variation in ecological systems.

I begin in Chapter 1 with a brief overview of ecological systems and approaches to identifying, studying and understanding mechanisms that determine their organisation. Ecological communities are the framework within which life operates, while individuals and their interactions with each other and the physical environment are the fundamental building blocks of communities. Consumer–resource interactions are especially important because they determine energy flow between individuals, and fluxes and stability in communities. The physical environment can have profound effects on ecological organisation, at the local scale (e.g., species interactions) and on entire systems (e.g., body size and abundance distribution, food web architecture). Together, these factors demand a functional approach, which explicitly links mechanisms acting across multiple levels of organisation, to understanding ecological systems and their dependence on the physical environment.

Environmental temperature has strong and systematic effects on biological processes at all levels of organisation, ranging from cells to ecosystems, so it is surprising that little is known about the general mechanisms by which temperature affects biological systems. In

Chapter 2 I present a dataset on how diverse biological rates and times respond to temperature, which I then analyse in two subsequent chapters to aid in the search for general mechanisms of thermal dependence. For nearly a century, intraspecific studies (within single species' populations) of thermal responses have been conducted on a wide range of organismal traits. Comparative studies of these data are essential for elucidating mechanisms underlying thermal response curves. However, such comparative intraspecific studies have been limited because of a lack of a comprehensive database that organizes these data with consistent units and trait definitions. I present a database of 2,352 thermal responses for 220 traits for microbes, plants, and animals compiled from 270 published sources. This represents the most diverse and comprehensive thermal response dataset ever compiled. The traits in this database span levels of biological organisation from internal physiology to species interactions, and were measured in marine, freshwater, and terrestrial habitats for 411 species. Although I include some physiological rates, most data are for ecological traits, which I define to mean any organismal trait that directly determines interactions between individuals within or between species. Analyses of this dataset should provide new insights into generalities and deviations in the thermal dependence of biological traits, and thus how biological systems, from cells to ecosystems, respond to temperature change. Such insights are essential for understanding how natural biological systems function, and for how life is responding to Earth's complex and rapidly changing thermal landscape.

In Chapter 3 I analyse this database to understand patterns in the temperature dependence of physiological and ecological traits. After removal of data to only retain high quality thermal responses, I analyse responses ranging over 66°C and representing 112 traits, 309 species, and spanning 15 orders of magnitude in body size. I analyse three components of the thermal response: the initial increase in the trait value with temperature (rise), its ultimate decrease at higher temperatures (fall), and the transition between the rise and fall components (unimodal). The diversity and number of traits, species, and habitats allows me to identify and quantify novel features of the temperature response of biological traits. Analysis of the rising component of within-species (intraspecific) responses reveals that 87% fit the Boltzmann-Arrhenius model. The Boltzmann-Arrhenius model is a model of the thermal dependence of traits based on chemical reaction kinetics, and can be used to estimate the activation energy required for biochemical reactions. The rate of rise (or fall) of a Boltmann-Arrhenius model is described by an activation energy, which is essentially the amount of energy required for biochemical reactions to occur with a higher activation energy meaning that the temperature dependence is stronger (see Chapter 3 for more detail). I found that the mean activation energy for rises is 0.66±0.05 eV, similar to the often-reported across-species (interspecific) value of 0.65 eV. However, systematic variation in the distribution of activation energies is evident, including previously unrecognised right-skewness. This right-skewness exists across levels of organisation, taxa, trophic groups, and habitats, and can be partly explained by a thermal version of the life-dinner principle—stronger selection to run for your life than to run for your dinner. For unimodal responses, habitat (marine, freshwater, or terrestrial) largely explains the mean temperature at which trait values peak but not the variation around this mean. Results of this chapter highlight generalities and deviations in the temperature response of biological traits and help provide a basis to better predict how ecological systems, from individuals to communities, respond to temperature.

In Chapter 4 I combine the empirical thermal scaling's of ecological traits (Chapter 3) with consumer-resource allometric theory to present a mechanistic model for the thermal response of consumer-resource interactions. I focus on how temperature affects species interactions via key traits—body velocity, detection distance, search rate, and handling time—that underlie per-capita consumption rate. The model is general because it applies to all foraging strategies: active-capture (both consumer and resource velocity are important), sit-and-wait (resource velocity dominates), and grazing (consumer velocity dominates). The model predicts that temperature influences consumer-resource interactions primarily through its effects on body velocity (either of the consumer, resource, or both), which determines how often consumers and resources encounter each other, and that asymmetries in the thermal responses of interacting species can introduce qualitative, not just quantitative, changes in consumer-resource dynamics. Using the model, I also derive predictions for the effect of temperature on equilibrium population densities. Using the database described in Chapter 2, I analyse temperature responses for 309 species that span 15 orders of magnitude in body size and live in terrestrial, marine, and freshwater habitats, and find extensive evidence for asymmetries in consumer-resource thermal responses. In particular, I identify three general types of asymmetries: i) different magnitude of response, ii) different rates of response (e.g., activation energies), and iii) different peak temperatures. Such asymmetries should occur more frequently as the climate changes and species' geographical distribution and phenology are altered, such that previously non-interacting species come into contact. By using characteristics of trophic interactions that are often well known, such as body size, foraging strategy, thermy, and environmental temperature, this framework should allow more accurate predictions about the thermal dependence of food-web and ecosystem dynamics, including how natural systems will respond to current and future temperature change.

Spatial dimensionality is a fundamental physical property of all environments, and is probably one of the most important differences between aquatic and terrestrial habitats. Therefore, in Chapter 5 I use additional data obtained from the literature, combined with the database described in Chapter 2, to explore in detail how habitat dimensionality influences ecological organisation. I show how substantial variation in consumption rate data, and thus trophic interaction strengths, arises because (for a given resource density) consumers generally encounter resources more frequently in three dimensions (3D) than two dimensions (2D). By extending the allometric theory developed in Chapter 4, and literature data for 376 species, I show that consumption rates scale sub-linearly with consumer body mass (exponent ~0.85) for 2D interactions, but super-linearly (~1.06) in 3D, contrasting with the current usage of a single exponent (~0.75) in food web research. A further analysis of 2,930 consumer-resource interactions shows that interaction dimensionality is potentially a major driver of species coexistences, population stability, and abundances in local communities.

In the final chapter (Chapter 6) I synthesize the results of previous chapters, and suggest directions for future research. Each chapter provides insights into how the physical environment constrains the organisation of ecological systems. Detailed analysis of how the environment constrains species interactions, specifically temperature (Chapter 2 – Chapter 4) and habitat dimensionality (Chapter 5), show how physical drivers can alter the nature of species interactions, which are central to community organisation. These results clearly show that constraints on species interactions, such as from environmental drivers, can drive the organisation of populations and communities. These processes are central for understanding how natural ecosystems will respond to natural and anthropogenic-caused variation in the physical environment.

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Kina Winoto helped to port the original dataset described in Chapter 2 to mySQL and, together with William King, aided with developing the website where this dataset is currently available (www.biotraits.ucla.edu). Discussions with D. Allen, M. Angielletta, P. Amarasekare, J. Brown, N. Connolly, E. Economo, C. Estrada, R. Huey, C. Johnson, M. Johnson, K. Lafferty, W. King, J.B. Mackenzie, A. Mikheyev, K. Okamoto, S. Pawar, D. Reuman, V.M. Savage, C. Webb greatly improved many parts of this thesis

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Chapter 1. Introduction

1.1. Ecological Systems

1.1.1. The Hierarchy of Life

Life exists as a complex hierarchical system, with many discrete levels of organisation. Levels emerge when simpler components integrate to form progressively more complex and coordinated systems: molecules form proteins, cells form individuals, individuals form populations, and populations form communities. Interactions within levels of organisation are integral to the behaviour and persistence of biological systems, but so are interactions between levels of organisation (Brown *et al.* 2004; Poertner *et al.* 2006). A central problem in biology is the identification of general principles governing the evolution of form, function and diversity across different levels of biological organisation (Levin 1992).

Ecological systems are levels of biology more emergent than an individual, so they exist toward the more complex and integrative end of life's hierarchy. An ecological system can be as simple as a solitary bacterium moving through an otherwise lifeless environment, or it can be as complex as the entire biosphere. Because individuals necessarily interact with their biotic and abiotic environment at least occasionally throughout their lives, ecological systems are the overarching and obligatory framework within which all life operates (Davies 1998; Maurer 1999; McGill *et al.* 2006).

Consistent properties and processes within and across levels of biological organisation suggest deep universalities in the way ecological systems are organised. A clear example of linkage across levels is the role that organismal physiology plays in structuring the ecology of populations, communities, and ecosystems (West *et al.* 1997; Brown *et al.* 2004). Much of the variation among ecosystems, including their biological structures, chemical compositions, energy and material fluxes, population processes, and species diversities, have been shown to depend on the metabolic characteristics of the organisms that are present (Enquist & Niklas 2001; Gillooly *et al.* 2001; Allen *et al.* 2002; Brown *et al.* 2004; Savage *et al.* 2004). Metabolism is the biological processing of energy and materials and it determines the demands that organisms place on their environment for resources, and constrains the allocation of resources to their fitness. Examples of consistency within levels of biological organisation include apparent universality of many aspects of community organisation, such as their feeding interactions (Williams & Martinez 2000; Williams *et al.* 2002), body size distributions (Schmid *et al.* 2000; Gaston *et al.* 2001; White *et al.* 2007; Reuman *et al.* 2009) and phylogenetic relationships (Webb *et al.* 2002; Agrawal 2003). Combined, these results suggest universality in the way biological, and particularly ecological, systems are structured. Identification of the mechanisms responsible for these patterns is a primary goal of biologists.

1.1.2. Ecological Communities

Communities are assemblages of two or more populations of different species occupying the same geographical area at the same time. Complex communities emerge when abundant and diverse forms of life interact with each other and with their physical environment to create recognisable systems like rainforests, coral reefs, and savannah grasslands. More depauperate communities exist in harsher environments, such as deserts, polar landscapes, and the deep sea. Because all organisms necessarily interact with other individuals at least occasionally throughout their lives – for example with predators, prey, competitors or reproductive partners – communities are a key level of biological organisation. In other words, organisms only exist within ecological communities. Therefore, understanding mechanisms that influence community properties (e.g., diversity, body-size distributions, species-abundance distributions, food web) is important to ecologists (Finney *et al.* 2002; Kearney & Porter 2006; McGill *et al.* 2006; Buckley & Jetz 2007; Savage *et al.* 2007b; Buckley *et al.* 2008) and to the general public because of practical concerns about global change (e.g., climate change, habitat loss, pollution) (Davis *et al.* 1998; Post *et al.* 1999; Sanford 1999; Parmesan & Yohe 2003; Root *et al.* 2003).

The temporal and spatial scales of communities vary enormously, and include any unit of habitat (within defined spatial and temporal boundaries) that contains multiple species. Thus, a drop of water from a lake contains a community (of microorganisms) and so does the entire lake. This variation in scale makes ‘community’ a rather loosely defined term, which cannot be avoided because of the heterogeneous distribution of life across earth. Throughout this thesis community is defined to mean life within a spatially and temporally defined unit of habitat.

Biologists are becoming increasingly aware of deep universality in the organisation of ecological communities (Peters 1983; Schmidt-Nielsen 1984; Marquet *et al.* 1990; West *et al.* 1997; Schmid *et al.* 2000; Enquist & Niklas 2001; Gaston *et al.* 2001; Brown *et al.* 2004; Brose *et al.* 2005; Woodward *et al.* 2005a; White *et al.* 2007), but an understanding of how these patterns correlate with the physical environment and how they relate to each other across different levels of ecological complexity remains elusive (McGill *et al.* 2006; White *et al.* 2007).

If such a thing as a building block of communities exists, and perhaps of ecological systems in general, then the level of the individual organism is a prime candidate. Individuals are living systems that have, or can develop, the ability to act or function independently and to grow, reproduce, and die. The concept of an individual is readily applicable to most forms of life, like trees, birds, grasshoppers, and microbes, and even colonial forms like corals and fungi can be accommodated as either individual units or the whole colony. It is the interactions of individuals with each other and with the physical environment that ultimately drives population and community organisation.

The physiological, behavioural and morphological attributes (traits) of an individual constrain its ecological interactions. These traits are influenced by intrinsic factors, such as the individual's genetic makeup, and by extrinsic factors, such as the physical environment it experiences throughout its life. Because no two individuals are ever likely both to have the same DNA and to experience exactly the same environmental conditions, none are ever likely to interact with and respond to their environment in precisely the same way. Therefore, the sheer numbers of individuals that make up most natural communities, and the diversity of ways these individuals interact with each other and their physical environment, make communities extraordinarily complex.

The complexity and diversity of ecological systems, especially at higher levels of organisation like communities and ecosystems, mean it is unlikely that biologists can ever make precise predictions at fine spatial and temporal scales, such as the exact position and behaviour of individuals within a community. In much the same way that climatologists cannot make accurate predictions about the weather at fine scales, but have some success over longer and larger scales, ecologists are likely to be most successful when they focus on broad-scale patterns in ecological systems. In fact, it is possibly for equivalent reasons that climatologists and ecologists find it difficult or impossible to make predictions at fine scales: many of the drivers underlying both meteorological and ecological systems appear to be fundamentally chaotic (Gleick 1987; Stone & Ezrati 1996; Williams & Martinez 2004). Nonetheless, although no two communities are ever going to be identical in every way, community organisation is certainly not entirely random. The topology of food webs, for example, is much more accurately predicted by models that include non-random constraints, such as body size and trophic hierarchy, than they are by random models of connectance (Cohen *et al.* 1990; Solow & Beet 1998; Williams & Martinez 2000).

1.1.3. Ecological Interactions and the Importance of Trophic Interactions

Individual organisms sustain life through complex biotic and abiotic interactions with the outside world (Davies 1998; Maurer 1999). Interactions can be simple, such as the passive diffusion of oxygen across the surface of a bacterium, or they can be very complex. For example, the pursuit of an antelope by a cheetah involves a remarkable integration of sense and stimuli, and bodily functions, by both the consumer and the resource.

Because organisms require energy to live, grow, and reproduce, the most common ecological interactions for many individuals concern obtaining food and avoiding being someone else’s food. These interactions are enormously diverse. Such consumer-resource interactions drive the flux of nutrients and materials in ecological systems and provide links between different levels of ecological organisation. Consumer-resource interactions are therefore central to the stability and functioning of communities and ecosystems (Tilman 1986; McCann *et al.* 1998; Sih *et al.* 1998; Buckley & Roughgarden 2005; Pawar 2009). Obtaining a mechanistic understanding of how energy moves between organisms, and of how these consumer-resource interactions integrate collections of species into functioning communities, is a major goal of ecological research.

1.1.4. Physiology, a Key Link Between Levels of Biological Organisation

The integrated nature of life means there is a need for integrated approaches that explore mechanistic links between levels of biological organisation that span the molecule to the ecosystem (Acinas *et al.* 2004; Poertner *et al.* 2006). One of the clearest and most important examples of the links between levels of organisation is shown by the influence of physiology, or metabolism, on other levels of ecological organisation. Metabolism is the fundamental driver for consumer-resource interactions and, ultimately, the survival and reproduction of individuals. Therefore, there is a strong link between physiology and ecological interactions—metabolism drives the functioning of individuals and determines the complex role these individuals play in populations, communities and ecosystems.

In the past decade the metabolic theory of ecology has emerged as a powerful method for setting a baseline for rates, times, and lengths for traits at the individual, population, and community levels that are apparently driven by metabolic rate (West *et al.* 1997, 1999; Brown *et al.* 2004). It has broad predictive power in explaining life-history traits, population parameters, and even broader-scale ecosystem processes (Enquist *et al.* 1999; Enquist *et al.* 2000; Enquist & Niklas 2001; Gillooly *et al.* 2001; Allen *et al.* 2002; Brown *et al.* 2004; Savage *et al.* 2004; Allen *et al.* 2006; Anderson-Teixeira *et al.* 2008). Inclusion of physiological constraints into mathematical models about ecological systems, as accomplished by metabolic theory, has the potential to yield a theoretical framework that is applicable across habitats and across the diversity of life.

1.2. A Functional, Integrated, Approach to Understanding Ecological Systems

1.2.1. Insights From a 'Complex Systems' Approach

Research on the behaviour of a variety of physical and biological systems composed of many interacting components, like schools of fish (Reynolds 1987), the economy (Arthur 1999), and the human brain (Morowitz & Singer 1995), show that complex behaviour at the group level (e.g., schooling, inflation and consciousness) can emerge from the simple actions and interactions of the agents that compose them. In each of these examples, agents that make up the system (fish, economic agents, and neurons) interact with each other and the physical environment to drive the emergent behaviour of the system as a whole. In other words, system-scale patterns result from local-scale processes. Determination of system-level behaviour by the simple actions of component parts appears to be a universal property of complex systems (Anderson 1972; Arthur 1999; Wolfram 2002; Newman 2003)[1]. Therefore, understanding what drives the actions of agents within any complex system is necessary to understand the organisation of higher levels of organisation.

Organised from molecule to cell to individual to population to community, ecological systems share many similarities with other biological, and even non-biological, complex systems (Brown 1995; Hartvigsen *et al.* 1998; Levin 1998; Wilson 1998; Leibold & Norberg 2004; Norberg 2004; McAllister *et al.* 2006; Peacor *et al.* 2006; Mahon *et al.* 2008). This is unsurprising given that ecological systems are clearly influenced by the same set of physical laws that constrain all other complex systems (Wilson 1998). Application of ideas borrowed from complex systems should, therefore, be very rewarding when applied to ecological systems (Brown 1995). The agents within ecological systems are individual organisms, and it is their combined daily activities that produce emergent community types such as rainforests and coral reefs. As described above, research on a variety of other complex systems suggests that understanding the controls and constrains on individuals, which operate at a local scale, is necessary to understanding mechanisms behind the formation, maintenance and evolution of the complex systems they form. Once local-scale constraints are understood, biologists can begin to rigorously reconstruct communities from the bottom up. Doing so within a quantitative theoretical framework based on solid biological principles will allow predictions to be made about the dynamics of entire communities. Therefore, a mechanistic

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[1] This is not to the exclusion of top-down effects, where system-level constraints ultimately drive and constrain local-level processes.

understanding of community organisation will only come from a synthesis of data and theory regarding processes acting at different levels of biological organisation.

1.2.2. Traits and Intraspecific Variation

There are complex interactions between the physiological, morphological and behavioural traits of individuals and their external environment, and these interactions ultimately drive population and community organisation. Traits are well-defined, measurable properties of individuals (e.g., body size, escape body velocity, visual acuity, foraging strategy) that are linked to their ecological performance (e.g., attack success, detection distance) and ultimately their reproductive fitness (McGill *et al.* 2006; Green *et al.* 2008). A focus on traits provides a common currency with which to develop and test theory across the diversity of life (Green *et al.* 2008). Therefore, whereas focus on species identity alone tends toward highly contingent rules and special cases, statements about traits tend to be more general and mechanistic because of their focus on function (McGill *et al.* 2006). This is especially true for broad-level traits like body size that are common to a wide range of taxa. Continuous, rather than categorical, measures of traits are important to avoid arbitrary delineation of continuous variation into categorical groups that often occurs when assigning species to functional groups (Petchey & Gaston 2002). Clearly, each individual's traits are closely integrated and it is difficult to determine how much any one trait contributes to its performance or fitness (Vermeij 1987). Variation in traits may be interspecific, intraspecific, or ontogenetic. Even clones, with equivalent genes, exhibit trait variation because of differences in development or experience (Loaring & Hebert 1981; Carvalho 1987; Weider & Hebert 1987).

Allometric theory reveals that physiological processes, such as excretion, ingestion, growth and reproduction, are scaled to the body size of an individual (Peters 1983). Therefore, within communities, the distribution of body size, and rates of production and respiration are inherently linked (Stead *et al.* 2005). Body size often plays a significant role in community assembly through its impacts on the life history and ecological attributes of species. An organism's body size correlates with a host of biological and ecological traits that are central to its life (Peters 1983; Schmidt-Nielsen 1984; Brown *et al.* 2004; Woodward *et al.* 2005a). Patterns in body mass distributions can therefore suggest mechanisms responsible for community structure and dynamics (Schmidt-Nielsen 1984; Woodward *et al.* 2005a; White *et al.* 2007).

In general, individuals that share traits tend to act similarly within the community. For example, individuals of equivalent thermy (i.e., endotherm or ectotherm) interact with their biotic (e.g., predators or prey) and abiotic (e.g., temperature) environment in similar and systematic ways (Bennett 1991; Poertner *et al.* 2006; Buckley *et al.* 2008; Buckley *et al.* 2012), as do individuals with similar body or gape size (Persson *et al.* 1996; Wahlstrom *et al.*

2000; Woodward & Hildrew 2002; Lord 2004; Woodward *et al.* 2005a). Of course, not all trait variation is likely to result in community-wide effects, and it is the job of biologists to identify which traits, and therefore which mechanisms, are more important.

Historically, the most common way for biologists to group individuals is by taxonomy and evolutionary relatedness. Knowing the taxonomic identity of an individual can reveal a lot about its traits. Despite the historical focus on species as the level of biological organisation most central to the organisation of ecological systems, more recent research is revealing the importance to community organisation of intraspecific variation in traits (Hubbell 2001; Cohen *et al.* 2005; Bolnick *et al.* 2011). Because of ontogenetic or environmental effects, individuals within a species often differ substantially in body size, diet, predators, speed, agility, and other traits. In some cases these differences are probably greater than those among species. In any case, if trait variation is important to how ecological systems operate, then taxonomy may not be the ideal way to categorise individuals in order to understand the mechanisms that structure ecological communities.

Because of its focus on function and adaptation, a trait-based approach should be useful in identifying general mechanisms that shape and constrain ecological systems. Patterns in the distribution of functional traits across the landscape can be used to understand complex phenomena, including why organisms live where they do, how many taxa can coexist in a place, and how they will respond to environmental change (Green *et al.* 2008). The challenge is to determine which characteristics of organisms are linked most closely to fitness or performance. By understanding how traits interact with the physical environment, biologists can begin to make predictions about how community organisation, such as its food web, or body size distribution, will respond to the earth's changing environment.

1.2.3. The Components of Consumer-Resource Interactions

Processes at lower levels of organisation predominantly shape ecological systems, like many other physical and biological systems. Therefore, breaking down systems to determine how their components drive their organisation is an approach that biologists can use to better understand emergent levels of ecology. When the system is a physical object, like a tree or the leg of a lizard, this approach seems straightforward enough. However, biological processes themselves can also be examined in this way. Similar attempts have been made to break down consumer-resource interactions into their component parts (Endler 1986).

One approach is to determine how each part of an ecological interaction works, and then to build a mechanistic model of how the entire interaction, and groups of interactions, are driven and constrained. For example, to understand how the physical environment affects species interactions would involve determining how each component of the interaction is constrained by the environment (I take this approach in the theory I develop in Chapter 4 and Chapter 5).

Endler (1986) broke the predation process down into the five stages of detection, identification, approach, subjugation and consumption. Using this approach, even very different types of interactions (e.g., active-capture, sit-and-wait, grazing) can be categorised in functionally equivalent ways. Once functional components have been identified, one can start to look more closely at the mechanisms structuring each of them.

1.3. Environmental Control of Ecological Organisation

Understanding how the environment shapes ecological systems is one of the most basic questions of ecology (Finney *et al.* 2002; Kearney & Porter 2006; McGill *et al.* 2006; Buckley & Jetz 2007; Savage *et al.* 2007b; Buckley *et al.* 2008) – a question whose answer is pressing because of practical concerns about anthropogenic impacts such as climate change (Davis *et al.* 1998; Post *et al.* 1999; Sanford 1999; Parmesan & Yohe 2003; Root *et al.* 2003). Characterising the organisation of entire communities (necessary to understand mechanisms driving their organisation) is difficult because of their immense complexity and diversity. Correlations between community organisation and the physical environment have long been recognised, but an understanding of the mechanisms responsible for these patterns has been notoriously difficult to identify. Physical drivers strongly influence ecological processes at all levels of biological organisation, including species interactions, populations and communities (Denny 1990; Link 2002; McGill *et al.* 2006; Barton & Schmitz 2009). Even coarsely resolved empirical data reveals clear relationships between community type and environmental drivers, such as temperature and rainfall (e.g., vegetation changes with altitude or across a rainfall gradient).

Differences in the physical environment across the globe can be minor or very large, and individual organisms often do not possess traits that allow movement between two very distinct environments (e.g., aquatic and terrestrial habitats). Organisms living in similar habitats experience similar environmental conditions, and therefore by the process of natural selection often possess similar traits. This also means that possession of similar traits means that individuals respond to the physical environment in similar ways (Usseglio-Polatera *et al.* 2000; Green *et al.* 2008). Therefore, it is important to examine each physical driver and determine its effects on individuals, species interactions and, ultimately, the communities and ecosystems they comprise. In the presence of fluctuating abiotic conditions, interactions among species will be influenced if the species are affected differentially. For example, a shift in an abiotic factor might favour the mean physiological optimum of one species over another, thus translating into differential predation, competition, and parasitism outcomes (Anderson *et al.* 2001). While there is potentially an enormous array of physical drivers that influence ecological organisation, a small number of key drivers are known to have strong influences in communities around the globe.

1.3.1. Temperature

Temperature affects rates of biochemical reactions and thus metabolic rate (Johnson *et al.* 1974; Cossins & Bowler 1987; Gillooly *et al.* 2001; Gillooly *et al.* 2002; Savage *et al.* 2004). Since metabolic rate influences a wide range of biological processes, temperature is a key environmental driver of biology at all levels of organisation (Cossins & Bowler 1987; Sanford 1999; Gillooly *et al.* 2001; Gillooly *et al.* 2002; Allen *et al.* 2006). Substantial theory exists for quantifying the effects of temperature and has been incorporated into scaling theory for a huge diversity of physiological and ecological processes (Gillooly *et al.* 2001; Allen *et al.* 2002; Ernest *et al.* 2003; Brown *et al.* 2004; Savage *et al.* 2004).

Thermal effects are almost certainly most direct (and therefore best understood) at the molecular level, but identifying the effects of temperature on the performance of individuals and on species interactions is vital for understanding thermal effects at higher levels of ecological organisation like populations and communities. The effects of temperature on an individual depend strongly on its basic physical and physiological traits. Communities are composed of individuals that differ in their responses to temperature, depending on their traits, and these differences can create asymmetries in the interactions of species, such as between predators and prey. For example, differential responses of traits such as the speed and agility of a predator and prey can clearly alter the outcome of the interactions they affect. This means that changing the ambient temperature in which a community functions will not only alter the types of organisms that can persist (as different organisms have different basic affinities for temperature), but can also profoundly alter ecological interactions. Indeed, even slight changes in environmental temperature can fundamentally alter the nature of interactions and their strength (Sanford 1999). A trait-based approach to understanding thermal effects on ecological systems, which is both general and mechanistic, should provide a predictive framework for making predictions about how life will respond to earth’s currently shifting temperature regimes. Similarly, if temperature effects are important in structuring ecological organisation, they probably have a major role in latitudinal gradients in species diversity, predation intensity, niche breadth, defence and foraging behaviours, and population size and variability (Jeanne 1979; East 1980; Hansson & Henttonen 1985; Vermeij 1987; Allen *et al.* 2002; Vazquez & Stevens 2004).

1.3.2. Habitat Dimensionality

Consumers and resources interact in a wide array of habitats ranging from the desert substrate to pelagic and abyssal zones in oceans and lakes. One of the most important differences among these habitats is dimensionality (habitat surfaces like grasslands and benthic substrates are approximately 2-dimensional (2*D*), while pelagic, forest and aerial habitats are approximately 3-dimensional (3*D*)[2]. Due to its potential effects on encounter rates, dimensionality has previously been proposed as a major factor for differences in food web structure between 2*D* and 3*D* habitats (Briand & Cohen 1987; Whitehead & Walde 1992; Cohen 1994; McGill & Mittelbach 2006). Dimensionality of interaction between predator and prey may strongly influence the probability of detection (McGill & Mittelbach 2006) and the metabolic cost of locomotion (Schmidt-Nielsen 1984). It is possible that substantial variation in consumption rates arise because in a homogenous environment consumers generally encounter resources more frequently in three dimensions (3*D*) (e.g., arboreal and pelagic zones) than two dimensions (2*D*) (e.g., terrestrial and benthic zones). Nevertheless, this idea remains largely unexplored almost three decades after it was first proposed (Briand & Cohen 1987).

1.4. Thesis Aims and Outline

The aim of this thesis is to improve understanding of how local-scale interactions unite to drive and stabilise patterns at higher levels of ecological organisation, and to determine the role of the physical environment. I use an approach that combines meta-analysis of published data, eco-informatics, and mechanistic theory. Each chapter builds upon previous chapters, which ultimately combine to significantly advance our understanding of how the physical environment drives universality and variation in ecological systems.

Temperature is a key driver of biology at all levels of organisation, so in Chapter 2, Chapter 3, and Chapter 4 I explore its effects on ecological systems in more detail. In Chapter 2 I present a dataset on how diverse biological rates and times respond to temperature, comprising 2,352 thermal responses for 220 traits for microbes, plants, and animals compiled from 270 published sources. This database represents the most diverse and comprehensive thermal response dataset ever compiled. In Chapter 3 I analyse the high-quality thermal response curves in this database (representing 1,072 thermal responses for microbes, plants, and animals) to understand the effects of temperature on physiological and ecological systems. In Chapter 4 I combine the empirical thermal scaling’s of ecological traits (Chapter 2 and Chapter 3) with consumer-resource allometric theory to present a mechanistic model for the thermal response of consumer-resource interactions. Another key environmental driver is habitat dimensionality. Therefore, in Chapter 5 I extend the temperature database to

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[2] More complex measures of dimensionality, such as the fractal dimensionality of resource dispersion, have also been studied within ecological systems, and are further discussed in Chapter 5.

explore the influence of dimensionality on ecological organisation, specifically the strength of consumer-resource interactions and their likely effects on population and community organisation (i.e., coexistence, stability). In Chapter 5 I also extend the consumer-resource theory presented in Chapter 4 to explain empirical patterns in the effect of habitat dimensionality on consumption rate. Combined, Chapter 2 – Chapter 5 show how the physical environment can alter the ways in which species interact, which can have significant impacts on the organisation of more complex levels of ecological organisation. Finally, in the general discussion (Chapter 6) I discuss the general conclusions that can be drawn from the other chapters and highlight important current and future research directions.

Chapter 2. A Database for the Thermal Dependence of Biological Traits[3]

2.1. Introduction

Because environmental temperature has pervasive effects across cells, individuals, populations, and ecosystems, elucidating mechanisms by which biological systems respond to temperature is essential for understanding how these systems operate in nature. Given rapid changes to Earth's thermal environment (IPCC 2007), understanding species' thermal responses and their consequences for biodiversity and ecosystem functioning is especially critical (Petchey *et al.* 2010; Rall *et al.* 2010b).

Body temperature, a major driver of individual physiology from cellular respiration to whole organismal respiration, is strongly affected by environmental temperature in ectotherms (Johnson *et al.* 1974; Cossins & Bowler 1987; Huey & Kingsolver 1989; Somero 1997; Gillooly *et al.* 2001; Brown *et al.* 2004; Angilletta 2009). These individual-level effects cascade up to affect populations, species interactions, and ecosystems. An understanding of how these effects translate across levels of biological organisation requires analysis of a broad suite of functional traits spanning from cells to communities (Angilletta 2009). For nearly a century, intraspecific studies, which measure a trait within a single species' population across a range of temperatures, have been conducted on a variety of biological traits (e.g., Bennett 1980; Hertz *et al.* 1982; Cossins & Bowler 1987; Gillooly *et al.* 2002; Savage *et al.* 2004; Ratkowsky *et al.* 2005; Frazier *et al.* 2006; Angilletta 2009; Irlich *et al.* 2009a). However, comparative studies of these intraspecific data have tended to focus on small subsets of available data (e.g., Huey & Bennett 1987; Huey & Kingsolver 1989; Bauwens *et al.* 1995; Huey & Berrigan 2001; Irlich *et al.* 2009a), probably for two central reasons. First, there is clearly a general lack of empirical data on the thermal response of ecological traits required to address particular ecological and evolutionary questions. This

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[3] A modified version of this chapter is published as: Dell A.I., S. Pawar, & V.M. Savage. The thermal dependence of biological traits. *Ecology* 94(5): 1205.

issue must be addressed by a renewed effort by empirical biologists to collect more thermal response data on traits relevant to species interactions. Second, there is a lack of a comprehensive database that compiles existing data, which is required to compare methodologically and taxonomically diverse thermal response data.

In this chapter I address the second issue by constructing from published sources a dataset that contains 2,352 intraspecific temperature responses. This dataset is the most comprehensive ever compiled for the thermal responses of physiological and ecological traits. This database focuses mainly on “ecological traits”, which I define here to mean any organismal trait that directly determines or measures interactions between individuals within or between species. This effort was motivated by the fact that understanding effects of global warming on species interactions is one of the major challenges in contemporary ecology (Harrington *et al.* 1999; Walther *et al.* 2002; Helmuth *et al.* 2005; Vasseur & McCann 2005; Woodward *et al.* 2010). The resulting global database contains intraspecific thermal responses for 220 traits and 411 species of plants, microbes, and animals that span 16 orders of magnitude in body size. This is also the first compilation of organismal thermal responses wherein all traits have been converted to consistent units and standardized trait definitions.

Analysis of this dataset should reveal how biological systems respond to temperature (Irlich *et al.* 2009b; Englund *et al.* 2011a; Nilsson-Örtman *et al.* 2012). These intraspecific data can also be used to investigate interspecific thermal response curves, which are constructed from trait measurements for multiple species at their optimal temperature and plotted together to construct a single curve (Brown *et al.* 2004; Angilletta 2009). Patterns of interspecific thermal response curves are important because they represent underlying constraints on thermal adaptation (Gillooly *et al.* 2001; Gillooly *et al.* 2002; Izem 2005; Frazier *et al.* 2006; Knies *et al.* 2009; Angilletta *et al.* 2010; Corkrey *et al.* 2012). This dataset should also be useful in testing assumptions and predictions of mechanistic models, such as the metabolic theory of ecology (Gillooly *et al.* 2001; Gillooly *et al.* 2002; Brown *et al.* 2004). Ultimately, I expect analysis of this comprehensive dataset to illuminate previously unrecognized generalities and deviations in how biological systems respond to temperature, and help elucidate the mechanisms by which life responds to Earth’s complex and rapidly changing thermal landscape.

2.2. Dataset descriptors

2.2.1. Summary

The dataset has 19,921 records from 2,352 intraspecific temperature response curves that measure the thermal dependence of physiological and ecological traits from 411 taxa and various marine, terrestrial and freshwater habitats. Each record (row) has 65 fields that detail the trait, taxa, and experimental conditions of each thermal response (see Table 2.1).

2.2.2. Objectives

The objective of this chapter was to construct a comprehensive and consistent dataset of measurements of the thermal dependence of a wide range of physiological and ecological traits from diverse taxa and habitats. Such a single, extensive dataset for multiple traits with consistent measurement units and trait definitions should facilitate novel comparative analyses and hypothesis testing, yielding new insights into generalities and important deviations in thermal responses of biological systems. Eventually, these data should help reveal general mechanisms by which life responds to changing thermal landscapes worldwide.

2.2.3. Data Acquisition

I searched for intraspecific thermal response curves of diverse biological traits, with a primary focus on traits central to species interactions. The temperature response of traits can be strongly influenced by organismal behaviour (e.g., Schieffelin & Dequeiroz 1991; Cooper 2000; Shine *et al.* 2000; Herrel *et al.* 2007). Therefore, I focused on rates and times of the execution of biological processes (e.g., attack body velocity, handling rate) and not on decisions about whether to execute them (e.g., attack probability, defence behaviour probability).

Potential data sources were identified using three methods. First, I used literature search engines (e.g., Web of Science, JSTOR) to find published literature using keyword combinations that included: ‘ecological’, ‘ecology’, ‘interaction’, ‘physiological’, ‘physiology’, ‘response’, ‘temperature’, ‘thermal’, and ‘trait’. In many cases, the authors of these studies were contacted directly to obtain raw data. Second, I contacted known researchers in the field of thermal biology and directly requested data. Third, I looked through citations in the publications found by the first and second method. Once identified, data were obtained by from the authors directly, otherwise from the main text and tables of published literature, and from figures using DataThief (Tummers 2006) that allows digitisation of data points from a graph. Use of DataThief made it impossible to know the true precision of the original data. Also, because I sometimes obtained raw data from the authors, in some cases the dataset does not exactly match that described within the original publication (e.g., replicate thermal responses are not combined in my database, as they often are in the published literature).

In total, I found 270 data sources that described intraspecific thermal responses, including journal articles, published reports, and books. These sources yielded 2,352 intraspecific temperature responses and 19,921 data points. I primarily selected studies where environmental conditions, such as precipitation, light, and prey density were either controlled or standardized. Consequently, most responses (97%) were measured in the laboratory, where ectotherm body temperatures were known to be close to ambient (based on direct measurements and extended acclimation times at test temperatures). The 270 sources from which data were described and analysed in this paper are listed in the `Citations` field of the data file (see below for availability). Because the number of studies on thermal responses of ecological traits is increasing rapidly, I am regularly adding to the dataset, which is being updated periodically at www.biotraits.ucla.edu (see below).

2.2.4. Trait Ontology

An ontology was constructed that allowed me to classify biological traits in a way that permits subsets of data to be easily isolated and analysed, and that defined categories of data that were closely tied to biological mechanisms and measurements. Two main components of the ontology are level of biological organisation and trait motivation.

Levels of biological organisation that are defined are *internal* (processes internal to the organism), *individual* (processes at the level of individual organisms that include mechanical interactions with the external environment), *population* (processes for a group of conspecific individuals), and *species interaction* (processes involving interaction between two or more species).

Trait response can be strongly influenced by the motivation of an organism. For example, how fast an organism moves through the landscape depends not only on its morphological capacity and how this capacity interacts with the environment, but also on its motivation (Irschick & Losos 1998; Husak 2006; Scales *et al.* 2009). I therefore also categorise trait motivation: *autonomic* traits as those that act largely involuntarily, such as basal metabolic rate, whereas *somatic* traits are largely under voluntary control (Dorland 2007). Somatic traits are further classified as *negative* (defence or movement away from a stimulus), *positive* (consumption or movement toward a stimulus), and the remainder as *voluntary*. Body velocity, for example, can be negative (e.g., escape body velocity), positive (i.e., attack body velocity), or voluntary (i.e., voluntary body velocity). Appendix 3.1 and Appendix 3.2 detail the classification of each data series into this ontology.

2.2.5. Unit Conversions

Definitions and measures of many traits are inconsistent throughout the literature, so equivalent traits were converted to comparable definitions and units. All times were converted to rates to ensure a single currency. For consistency, and because of the counterintuitive nature of many mass-specific traits (e.g., detection distance), mass-specific units were converted to per number of individuals (i.e., per capita).

2.2.6. Taxonomy and Systematics

Taxonomic designations were used as stated in the source publication, unless there was clear evidence of a name change in which case the new name was used. Each species' taxonomic hierarchy (Kingdom, Phylum, Class, Order, Family, Genus) was determined by using Species 2000 (http://www.sp2000.org), the Encyclopaedia of Life (http://eol.org), and Animal Diversity Web (http://animaldiversity.ummz.umich.edu).

2.2.7. Body Size

When available, wet mass of each organism was obtained from the original data source. For studies in which body mass was not provided, I developed an algorithm that assigned a wet mass estimate to species in each data row. This algorithm was based on taxonomic relatedness to published size estimates and length-mass regressions, and allowed me to rapidly obtain estimates of wet body mass that well matched published measurements. The algorithm involved three steps:

Step 1: For trait responses where no size estimate was given in the original source, body size was assigned from a reference data table of measurements compiled from the literature.

Step 2: Body length was converted to body mass (wet, dry or ash-free-dry) using 364 published size-mass regressions. I did not extrapolate outside the length range of individuals used to construct the regressions.

Step 3: All dry masses (dry or ash-fee-dry) were converted to wet mass using ten published taxon-specific conversion ratios.

2.2.8. Data Verification

I entered records directly from original sources into MS Access. All values were at minimum triple checked at various stages of data complication and analysis. Plots of each thermal response were automatically produced in MS Access and compared to figures in the original source. In addition, outliers in numeric variables were sorted to examine extreme values. For body size estimates I constructed box plots by taxonomy (Family and Order) and observed outliers for errors.

2.2.9. Storage Location and Medium

The dataset is available from the Ecological Society of America's data archives (see below). A digital version of the dataset in MS Excel format is held by A.I. Dell, and a beta mySQL version (searchable by trait, taxa and citation) is available online at www.biotraits.ucla.edu.

2.3. Data structural descriptors

2.3.1. Size

The dataset comprises 19,921 records (including header) and 65 fields. Total file size is 17.8 mb.

2.3.2. Format and Storage Media

Uncompressed UTF-16 text, tab delimited.

2.3.3. Header and Row Information

The first row of the file contains variable names (see below). Each additional row represents trait performance at a single ambient or body temperature for a single species, or combination of two species when the trait involves interactions between species (e.g., encounter or consumption rate).

2.3.4. Alphanumeric Attributes

Mixed. Note that degree of precision (i.e., number of decimal places) in number fields does not always match the original source for two reasons. First, my data is often more detailed than in the original source because where possible I obtained raw data from the authors (e.g., replicate thermal responses are not combined). Second, my use of DataThief (see above) made it impossible to know the true precision of the original data. For consistency all SI number fields were converted to scientific notation floating point (Table 2.1).

2.3.5. Special Characters and Fields

Missing data denoted as `NA`.

2.3.6. Authentication Procedures

Mostly, data from published literature were obtained, although in a few cases I included other associated data offered by authors whom I contacted about their published data. Field sums for all numeric fields are listed in the `Authen` field and should be used to authenticate the accuracy of the data.

2.3.7. Variable Information

Variables and their details are provided in Table 2.1.

Table 2.1. Summary of variable information.

Variable	Variable definition	Type	Variable codes
DataSeriesID	Unique identifier code for each intraspecific thermal response curve	Integer	NA
Trait	Trait name	Character	NA
TraitDef	Trait definition	Character	NA

Variable	**Variable definition**	**Type**	**Variable codes**
TraitOrg	Level of biological organisation of the trait	Character	internal = processes internal to the organism; individual = processes at the level of individual organisms that include mechanical interactions with the external environment; population = processes for a group of conspecific individuals; interaction = processes involving interaction between two or more species
AmbientTemp	Temperature (℃) of ambient environment (i.e., field or experimental arena).	Floating point	If null (NA) then see ConTemp or ResTemp
TraitValueSI	Value of trait performance in SI units	Floating point	NA
TraitUnitSI	Units for trait performance in SI units	Character	NA
ErrorPosSI	Positive value of error in SI units (see ErrorUnitSI)	Floating point	NA
ErrorNegSI	Negative value of error in SI units (see ErrorUnitSI)	Floating point	NA
ErrorUnitSI	Unit of error	Character	SD = standard deviation; SE = standard error; 95% CI = 95% confidence interval; interquartile range; range
Replicates	Number of replicates for each record	Integer	NA
Habitat	Habitat where trait performance was measured	Character	terrestrial; freshwater; marine
LabField	Whether trait performance was measured in the laboratory or field	Character	laboratory; field
ArenaValueSI	SI value of size of arena where trait performance was measured	Floating point	NA
ArenaUnitSI	SI unit of size of arena where trait performance was measured	Character	cubic meter; square meter; meter = when only length of arena was stated
ObsTimeValueSI	SI value of total observation time (i.e., time over which experiment was run for measurement of trait performance)	Floating point	NA
ObsTimeUnitSI	SI unit of total observation time (i.e., time over which experiment was run for measurement of trait performance)	Character	second; prey caught = time taken for ObsTimeValueSI number of prey caught
ObsTimeNotes	Notes for total observation time (i.e., time over which experiment was run for measurement of trait performance)	Character	NA
ResRepValueSI	SI value for how often resources were replaced over observation time	Floating point	NA
ResRepUnitSI	SI value for how often resources were replaced over observation time	Character	not replaced; second; to satiation = resources replaced sufficiently frequently so that consumer always had access to resources

Variable	**Variable definition**	**Type**	**Variable codes**
Location	Location (generally town, state, country) of where organisms were collected, or when measurements were taken at a different location then both are listed	Character	NA
Latitude	Approximate latitude of middle of location where animals were collected (e.g., filed station, town, state, country), or when not available then where measurements were taken.	Numeric (3 decimal places)	NA
Longitude	Approximate longitude of middle of location where animals were collected (e.g., filed station, town, state, country), or when not available then where measurements were taken.	Numeric (3 decimal places)	NA
TaxaPresent	Whether one or two taxa are part of the trait measurement and definition. If only a single organism is involved (e.g., metabolic rate, heart rate), it is always listed as a trait for a consumer.	Character	consumer = trait involves a single organism; consumer-resource = trait involves two organisms
ConType	Type of consumer	Character	alive = organism alive when trait performance measured; dead = organism dead when trait performance measured; artificial = ‘organism’ simulated by a physical stimulus (e.g., predator model, prodding, gravity)
Con	Binomial name of consumer or lowest taxonomic identity, or other appropriate name for artificial taxa (see ConType)	Character	NA
ConCommon	Common name of consumer	Character	NA
ConStage	Life stage of consumer, and sex in parenthesis when available	Character	NA
ConIDLevel	Taxonomic level to which the consumer was identified	Character	kingdom, phylum, class, order, family, genus, species
ConKingdom	Taxonomic name of Kingdom of consumer	Character	NA
ConPhylum	Taxonomic name of Phylum of consumer	Character	NA
ConClass	Taxonomic name of Class of consumer	Character	NA
ConOrder	Taxonomic name of Order of consumer	Character	NA
ConFamily	Taxonomic name of Kingdom of consumer	Character	NA
ConTrophic	Broad trophic group of consumer, as determined by published literature and expert opinion	Character	carnivore; detritivore; herbivore; omnivore, producer, artificial (see ConType); self = energy self-supplied (e.g., pupae, egg); dead (see ConType)
ConThermy	Thermy of consumer	Character	ectotherm; endotherm

Variable	**Variable definition**	**Type**	**Variable codes**
ConTemp	Body temperature (℃) of consumer	Floating point	NA
ConTempMethod	Method of determining body temperature of consumer	Character	direct = measured directly from within or on the organism; inferred (ambient) = estimated from known ambient temperature and generally within arena where organism not able to thermoregulate; inferred (endotherm) = body temperature relatively constant and estimated from published literature; inferred (consumer) = estimated from known consumer body temperature (relevant for ResTempMethod, see below)
ConMassValueSI	Mass of consumer as obtained from original source or estimated from other published literature (see Dell *et al.* (2011) for further details)	Floating point	NA
ConMassUnitSI	SI unit of consumer mass	Character	kilogram (wet body mass) = wet mass of entire body of consumer; kilogram (wet tissue mass) = wet mass of tissue of consumer (e.g., excluding shell for gastropods)
ConDenValueSI	Value of consumer density standardized to SI units	Floating point	NA
ConDenTypeSI	Type of units of consumer density	Character	individual; kilogram (dry body mass); kilogram (wet body mass); liter; to satiation = resource density above what consumer could fully consume (relevant for ResDenTypeSI, see below)
ConDenUnitSI	SI units of consumer density	Character	arena; square meter; cubic meter
ResType	*Same as for ConType (see above), but for resource*		
Res	*Same as for Con (see above), but for resource*		
ResCommon	*Same as for ConCommon (see above), but for resource*		
ResStage	*Same as for ConStage (see above), but for resource*		
ResIDLevel	*Same as for ConIDLevel (see above), but for resource*		
ResKingdom	*Same as for ConKingdom (see above), but for resource*		
ResPhylum	*Same as for ConPhylum (see above), but for resource*		
ResClass	*Same as for ConClass (see above), but for resource*		
ResOrder	*Same as for ConOrder (see above), but for resource*		
ResFamily	*Same as for ConFamily (see above), but for resource*		
ResTrophic	*Same as for ConTrophic (see above), but for resource*		
ResThermy	*Same as for ConThermy (see above), but for resource*		
ResTemp	*Same as for ConTemp (see above), but for resource*		
ResTempMethod	*Same as for ConTempMethod (see above), but for resource*		
ResMassValueSI	*Same as for ConMassValueSI (see above), but for resource*		
ResMassUnitSI	*Same as for ConMassUnitSI (see above), but for resource*		
ResDenValueSI	*Same as for ConDenValueSI (see above), but for resource*		
ResDenTypeSI	*Same as for ConDenTypeSI (see above), but for resource*		
ResDenUnitSI	*Same as for ConDenUnitSI (see above), but for resource*		
CitationID	Unique identification number for citation	Integer	NA
Citation	Citation from which data was obtained	Character	NA

Variable	Variable definition	Type	Variable codes
FigureTable	Figure or table from which data was obtained within original citation	Character	NA

Chapter 3. The Effects of Temperature on Physiological and Ecological Traits[4]

3.1. Introduction

Investigation of the thermal response of diverse biological processes should reveal general mechanisms by which life responds to Earth's complex and rapidly changing thermal landscape (IPCC 2007; Huber & Knutti 2011). General patterns of how temperature affects biological systems can be deduced in at least two ways. First, physiological and ecological traits (e.g., metabolic or encounter rate) can be measured for each species at its optimal temperature and plotted together to construct a single curve across species (Brown *et al.* 2004; Angilletta 2009). This interspecific approach has been used extensively (Bennett 1980; Cossins & Bowler 1987; Gillooly *et al.* 2001; Brown *et al.* 2004; Savage *et al.* 2004; Ratkowsky *et al.* 2005; Angilletta 2009), including studies of how climate affects biological systems (Allen *et al.* 2002; Savage *et al.* 2004; Vasseur & McCann 2005; Asbury & Angilletta 2010). Second, a curve can be constructed by measuring trait values across a range of temperatures for a single species (intraspecific) (Huey & Stevenson 1979; Schoolfield *et al.* 1981). In both intra- and inter-specific cases, each curve can be characterised by its Q_{10} value or activation energy (Bennett 1980; Gillooly *et al.* 2001). These parameters, along with peak temperature and response breadth for intraspecific responses, can be contrasted to explore effects of taxa, traits, and habitats. For nearly a century, intraspecific studies have been conducted on numerous physiological and ecological traits that span diverse taxa and habitats (Shapley 1920; Chadwick & Rahn 1954; Huey & Stevenson 1979; Bennett 1980; Huey & Kingsolver 1989; Angilletta *et al.* 2002; Angilletta 2009). Comparative studies of these intraspecific data are rare but valuable and have tended to focus on a subset of the available data (Huey & Bennett 1987; Huey & Kingsolver 1989; Bauwens *et al.* 1995; Huey

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[4] A modified version of this chapter is published as: Dell A.I., S. Pawar, & V.M. Savage. Systematic variation in the temperature dependence of physiological and ecological traits. *Proceedings of the National Academy of Science* 108(26): 10591-10596.

& Berrigan 2001; Irlich *et al.* 2009b). Analysis of intraspecific data that span a broad range of biological traits, taxa, and habitats has not been performed previously due to a lack of a comprehensive database.

In this chapter I use a broad-scale, comparative approach to gain a deeper understanding of the general features of intraspecific thermal responses not accessible with interspecific studies. Specifically, I analyse the database described Chapter 2, which comprises 2,445 intraspecific temperature responses. I use an ecoinformatics approach that allows me to: i) combine these data into a single database with consistent measurement units and trait definitions and ii) discover mechanisms that drive generalities and deviations in the thermal dependence of biological traits. Even though the vast majority of studies only record measurements for a restricted temperature range over which responses typically rise or fall monotonically (Gillooly *et al.* 2001; Savage *et al.* 2004; Angilletta 2009), over the full temperature range thermal responses are typically unimodal (Figure 3.1). Consequently, I analyse three components of the thermal response: the initial increase in the trait value with temperature (rise), its ultimate decrease at higher temperatures (fall), and the transition between the rise and fall components (unimodal) (Figure 3.1). Results of this analysis identify generalities and deviations in the thermal response of biological traits and improve predictions of how biological systems, from cells to communities, might respond to temperature change.

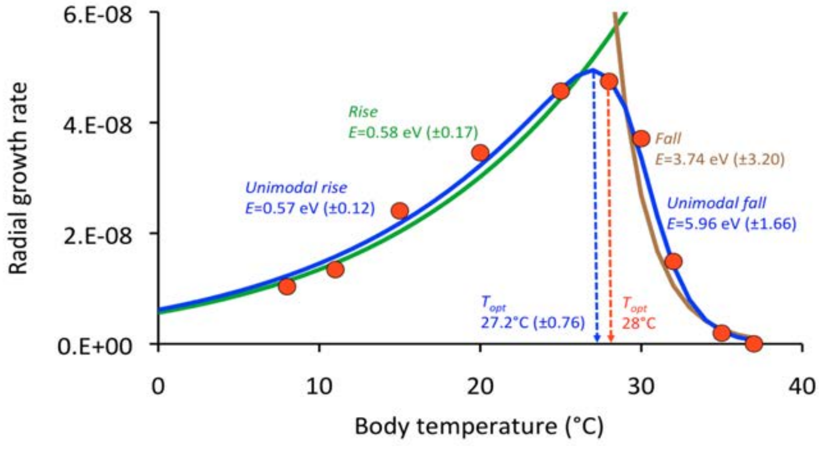

Figure 3.1. The thermal response of radial growth rate of sac fungi (m /(colony*s)). Green and brown lines are OLS regressions to the Boltzmann-Arrhenius model (Eqn. 3.1) for the subset of data that are the rise and fall components, respectively. These components were extracted as the algorithm described in Section 3.2.2. For this particular response, the rise was obtained by the algorithm through removal of the measurements at the four highest temperatures and the fall through removal of measurements at the five lowest temperatures. The blue curve is the best fit to the Johnson & Lewin (1946) model (Eqn. 3.2). Values shown are estimated activation energies with 95% confidence intervals for the respective response components. Dotted vertical arrows are estimated temperatures for T_{pk}–the temperature at which the trait value peaks–calculated from the direct method (red) and Johnson & Lewin model (blue) (see Section 3.2.4). Data are from Fargues et al. (1997).

3.2. Materials and Methods

3.2.1. Data Acquisition

Methods for data acquisition and standardisation of units are described in Chapter 2.

3.2.2. Data Quality and Classification

To be included in the analysis for this chapter, trait responses must have had: i) non-zero measurements at four or more distinct temperatures (thermal response models require a minimum of two free parameters), and ii) a temperature range spanning at least 5°C (it is difficult to statistically differentiate between linear and Boltzmann-Arrhenius model fits over smaller temperature ranges). For responses that satisfied these two criteria, ordinary least squares (OLS) regression was used to fit quadratic functions and then classified responses based on statistically significant coefficients as being rising, falling, or unimodal. For responses not well fit by a quadratic function, correlation coefficients were calculated to categorise them as either rise or fall, or if the criterion for biological significance ($R^2 \geq 0.5$ and P-value<0.05) was not met, it was excluded (8.3% of responses). Because unimodal responses include both rise and fall components, the minimum temperature range for inclusion as a unimodal was doubled to 10°C. Unimodal responses were further subdivided into rise (fall) components by iteratively removing trait measurements at upper or lower terminal temperatures until monotonicity was observed in a contiguous subset of the responses (Figure 3.1). After each data point removal, I reassessed whether a quadratic or cubic model fit better than a linear model. The model selection was done using the small-sample Akaike Information Criterion (AIC) value (Burnham & Anderson 2002). In cases where only four points remained after removal of terminal points, an *F*-test was used instead. The original unimodal responses were retained after their monotonic portions were extracted. Thus, three separate categories of temperature responses were obtained: rise (802), fall (239), and unimodal (536). These numbers include pseudoreplicates (see Section 3.2.7), and rise and fall categories include responses that were extracted from the unimodal set.

The 192 sources from which data are analysed in this chapter are listed in Appendix 3.3 and the raw data in Appendix 3.2.

3.2.3. Data Analysis of Monotonic Rise and Fall Temperature Responses

The Metabolic Theory of Ecology (MTE) suggests that the Boltzmann-Arrhenius model from chemical reaction kinetics can be used to understand the rise (and fall) of many biological rates and times, including systematic effects on metabolic rate (Johnson *et al.* 1974; Cossins & Bowler 1987; Somero 1997; Gillooly *et al.* 2001; Brown *et al.* 2004; Savage *et al.* 2004; Allen *et al.* 2006; Angilletta 2009). According to MTE, the scaling of a biological rate (R) with body temperature (T) is

$$R = R_0 e^{-E/kT} \tag{3.1}$$

where E is activation energy, k is Boltzmann's constant, and R_o is an organism- and state-dependent scaling coefficient. Interspecific studies have found that the activation energy (E) generally falls between 0.2 – 1.2 eV (Johnson *et al.* 1974; Gillooly *et al.* 2001; Irlich *et al.* 2009b), with 0.65 eV being near the middle of this range and some variation around this value therefore being expected.

Fits and calculated E's of both trait rises and falls for the Boltzmann-Arrhenius model were assessed in the same way. The fit of each response to the Boltzmann-Arrhenius model (Eqn. 3.1) was assessed by OLS regression of log-transformed trait values on the reciprocal of temperature (in Kelvin). OLS regression was appropriate because temperatures are typically measured with much less error than trait values. The Boltzmann-Arrhenius model predicts that the transformed data would be best fit by a straight line. The Boltzmann-Arrhenius model was considered to fit a response if $R^2 \geq 0.5$ and the F-test P-value < 0.05. These relatively liberal criteria allowed use of a larger set of responses to analyse deviations from the Boltzmann-Arrhenius model. I assessed how many responses showed concave upward or downward deviations by analysing the residuals of the above fits. Using OLS regression the residuals were fit with a quadratic model using the same R^2 and P-values as above to determine significance. The direction and magnitude of the curvature of residuals was recorded (values of the coefficient of the quadratic term). The small-sample AIC could not be used here to differentiate between a quadratic and a linear fit to the residuals because most of the data consist of four points, for which the small-sample AIC cannot be calculated. To estimate the activation energies of trait rises, both ordinary and weighted averages of measured activation energies (E) were calculated. Weights were calculated as the ratio of the total number of data points in each response to the total number of data points in all responses within a category (e.g., trait, taxon, habitat, level of organisation, or motivation). Weighted and unweighted 95% confidence intervals were calculated for the respective means. Medians, skewness, and quartiles of the E's in each category were also calculated.

I used ANOVA to detect differences in mean E between categories of rise responses (Table 3.1), but not for falls because of inadequate sample size. A fixed-effects model using Habitat and Organisation as grouping variables was used. Motivation was not included because of the strong overlap in some categories between motivation and organisation, for example all responses that are autonomic (motivation) are also internal (organisation). The effect of taxonomy is examined separately because most traits above the internal and individual organisation level consist of multiple taxa. A similar problem arises with trophic level categorisation. Because activation energies in most categories are right skewed (Figure 3.3b), E's were log-transformed to render them approximately normal (two-tailed, one-sample Kolmogorov-Smirnov test, $p<0.05$) across category combinations. To mitigate imbalances in sample sizes across categories, data from freshwater and marine habitats were combined into a single aquatic category and Type III sums of squares was used. The merging of data from marine and freshwater habitats is reasonable because there is no significant difference in mean activation energy between them, and because marine and freshwater environments share many physical properties (Denny 1990). Figure 3.3 shows that the significant effect of organisation partially arises from the fact that E's of population traits tend to have higher values than those in other categories. This pattern may also be weakly determined by habitat, as seen by the significant Organisation × Habitat interaction.

I also tested whether the distribution of intercept coefficients (Eqn. 3.1) was normal (see Section 3.2.6).

Table 3.1. Results of ANOVA to test effects on mean activation energy, *E*, of rise responses.

Source	Sum Sq.	d.f.	Mean Sq.	F	P-value
Organisation	11.238	3	3.746	11.91	0
Habitat	0.025	1	0.02506	0.08	0.7779
Organisation × Habitat	2.631	3	0.87692	2.79	0.0408
Error	98.446	313	0.31452		
Total	116	320			

3.2.4. Data Analysis of Peak Temperature (T_{pk})

For unimodal responses T_{pk} was estimated as the temperature at which the maximum trait value was recorded. For responses with multiple maximal values (within 5% of each other), their average temperature was calculated. Direct estimates of T_{pk} values (estimated as the temperature at which maximum trait value occurs) were compared with those obtained by fitting a unimodal function. Because of its simplicity and mechanistic basis, the Johnson and Lewin (1946) model was used, which is a unimodal extension of the Boltzmann-Arrhenius function (Eqn. 3.1) for trait rises (Johnson *et al.* 1974; Johnson *et al.* 1977; Sharpe & DeMichele 1977; Farquhar *et al.* 1980; Schoolfield *et al.* 1981; Ratkowsky *et al.* 2005):

$$h(T) = ce^{-\frac{E}{kT}} \Big/ 1 + e^{-\frac{1}{kT}\left(E_D - \left(\frac{E_D}{T_{pk}} + k\ln\left(\frac{E}{E_D - E}\right)\right)T\right)} \qquad 3.2$$

Here, the additional thermodynamic parameter E_D determines the steepness of decline of the trait values at temperatures higher than T_{pk}, while c is a constant (other parameters defined in Eqn. 3.1). All responses classified as being unimodal were fitted to this model using nonlinear least-squares regression (Seber & Wild 2003). The Levenberg-Marquardt algorithm was used with a maximum of 2000 iterations and an error tolerance of 1×10^{-30}. This involved allocating reasonable response-specific initial values for the parameters, to improve algorithm convergence and parameter estimation. I found that the overall mean T_{pk} value obtained from the unimodal model fits (26.0°C) was comparable with that from the direct method described above (25.3°C). Therefore, I use the direct method for T_{pk} estimation because 38% of the fits to the Johnson & Lewin model have very large confidence intervals (bounds > 25% away from the mean).

As described above for activation energies of rise and fall responses, values of T_{pk} across trait categories were compared using ANOVA (Table 3.2). Methods for this analysis largely follow those for activation energies (Section, 3.2.3, Table 3.1), except that transformation is unnecessary because distributions are approximately normal (two-tailed one-sample Kolmogorov-Smirnov test, $p<0.05$) across category combinations. Results show a significant effect of Habitat and Organisation, as well as significant interactions between them.

Table 3.2. Results of ANOVA to test effects on mean peak temperature (T_{pk}).

Source	Sum Sq.	d.f.	Mean Sq.	F	P-value
Organisation	614.8	3	204.94	5.75	0.0008
Habitat	1780.5	1	1780.48	49.92	0.0001
Organisation × Habitat	324.5	3	108.16	3.03	0.0301
Error	8239.8	231	35.67		
Total	14652.7	238			

3.2.5. Body Size Estimation

Wet body mass was estimated using the procedure described in Chapter 2 (Section 2.2.7), which resulted in all thermal responses having wet body mass estimates for all species and life stages.

3.2.6. Analysis of Intercept Coefficients for Monotonic Rise and Fall Responses

Typically, random error in fitted regression parameters will result in a normal distribution. The intercept coefficients calculated here (Eqn. 3.1) are indeed distributed approximately normally. Thus, the right-skewness observed in activation energies (Section 3.3.2, Figure 3.3, Figure 3.4) is most likely biologically significant. For analysis of effect of motivation on body velocity (Section 3.3.2) intercept coefficients were calculated at 20°C across all traits (standardised intercept). The exponentials of the resulting intercepts were the predicted trait values at 20°C. These standardised values were corrected for the effect of body mass by multiplying each value by $m^{-1/4}$, where m is the mass of the consumer species (resource mass was used for traits that had negative motivation). Choosing any other standardisation temperature between 0 – 50°C, or an allometric scaling exponent of 1/3, does not qualitatively affect these results.

3.2.7. Treatment of Pseudoreplicates

Pseudoreplicates were defined as responses that share taxa (or combinations of taxa for species interaction traits) and experimental conditions (i.e., from each pseudoreplicate group). I obtained a single value of the parameters E, T_{pk} and scaling coefficient by taking the weighted average of their estimates across the individual responses in each pseudoreplicate group. The weights were a linear function of the mean number of data points across responses within each group.

3.3. Results and Discussion

Requiring each response to have non-zero measurements at a minimum of four distinct temperatures (covering a range of at least 5°C) yielded 1,072 thermal responses (Figure 3.2). These responses represent 112 distinct traits that span levels of biological organisation from internal physiology to species interactions (Appendix 3.1). Traits were measured in marine, freshwater, and terrestrial habitats for 309 species of plants, microbes, and animals (Appendix 3.2).

3.3.1. Mean Activation Energy of Trait Rises

A general pattern in the rise component was observed, which covers the temperature ranges over which organisms commonly operate under natural conditions (Martin & Huey 2008; Angilletta 2009). Of the 374 intraspecific rises analysed, 87% were consistent ($R^2 \geq 0.5$ and $P<0.05$) with the Boltzmann-Arrhenius model. The mean activation energy E of these responses was 0.66±0.05 eV (mean±95% confidence intervals (CI) used throughout this chapter) (Figure 3.3a). The 95% CI includes the value of 0.65 eV reported across species for MTE. The generality of this result across traits, taxa, trophic groups, levels of organisation, and habitats (Figure 3.2) is probably due to the influence of metabolism on a wide range of biological processes (Peters 1983; Brown *et al.* 2004). Indeed, for rises that are significant, the majority (88%) of activation energies are between 0.2-1.2 eV, corresponding to the range observed for metabolic reactions (Gillooly *et al.* 2001). Even at the population level, where variance is largest, 80% of activation energies fall between 0.2-1.2 eV (Figure 3.3a). Of the rises well fit by the Boltzmann-Arrhenius model, about a quarter have residuals with curvature, the vast majority of which are concave (downward). Such deviations from the Boltzmann-Arrhenius model have been observed previously in growth rate data (Ratkowsky *et al.* 1982; Knies & Kingsolver 2010).

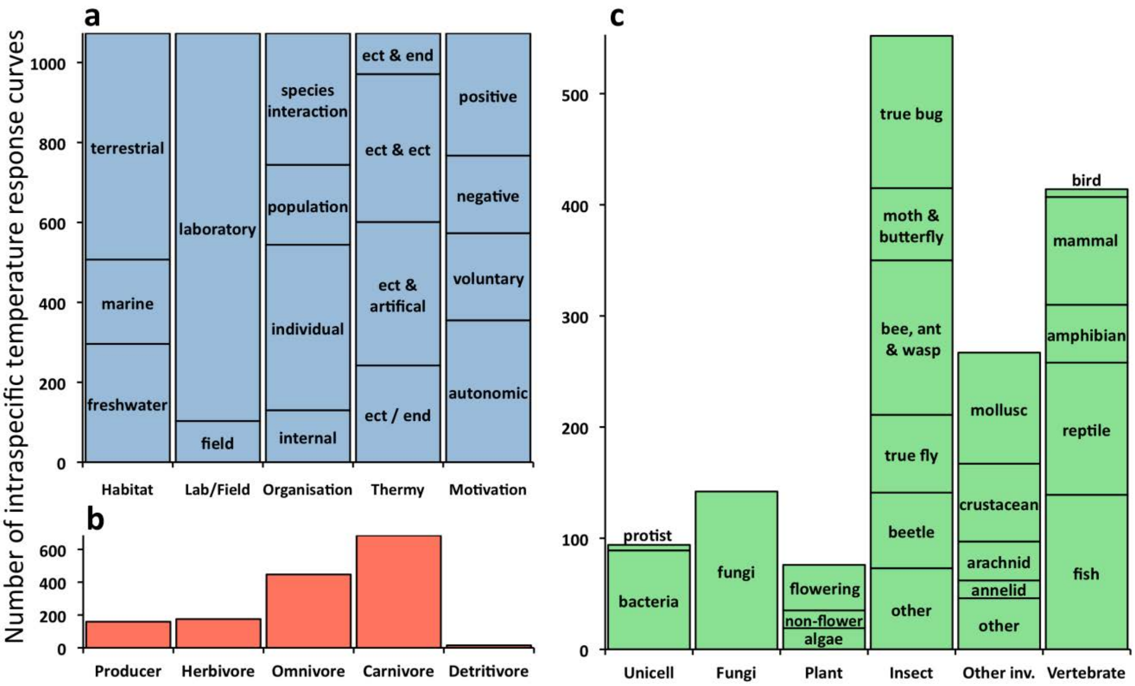

Figure 3.2. Diversity of intraspecific temperature responses analysed in this study. Total number of thermal response data for a) habitat, laboratory/field, level of biological organisation, thermy (ectotherm – 'ect', endotherm – 'end'), and motivation (see Section 2.2.4), b) trophic group, and c) taxonomic group. Panels b) and c) sum to more than 1,072 (the total number of responses) because species interactions include multiple species.

3.3.2. Distribution of Activation Energy for Trait Rises

Systematic deviations around the mean activation energy of 0.66 eV for rise responses were evident. The most noticeable deviation was strong right skewness, which was consistent across levels of organisation, taxa, habitats, and trophic groups (Figure 3.3a-b & Figure 3.4). This right skewness indicates deviations from normality and random error (see Section 3.2.6) and thus represents a real and unexplained biological signal. This skewness means that the majority of trait responses have activation energies below 0.66 eV (median of 0.55 eV) (Figure 3.3b & Figure 3.4). MTE does not predict and cannot currently explain why the distribution of activation energies is right skewed, and thus, why the majority of rise responses have activation energies lower than 0.65 eV. Therefore, MTE needs to be assessed to determine whether or not it can be extended to explain the full form of the distribution of activation energies and its biological consequences. Careful examination of these types of deviations can help elucidate biological mechanisms.

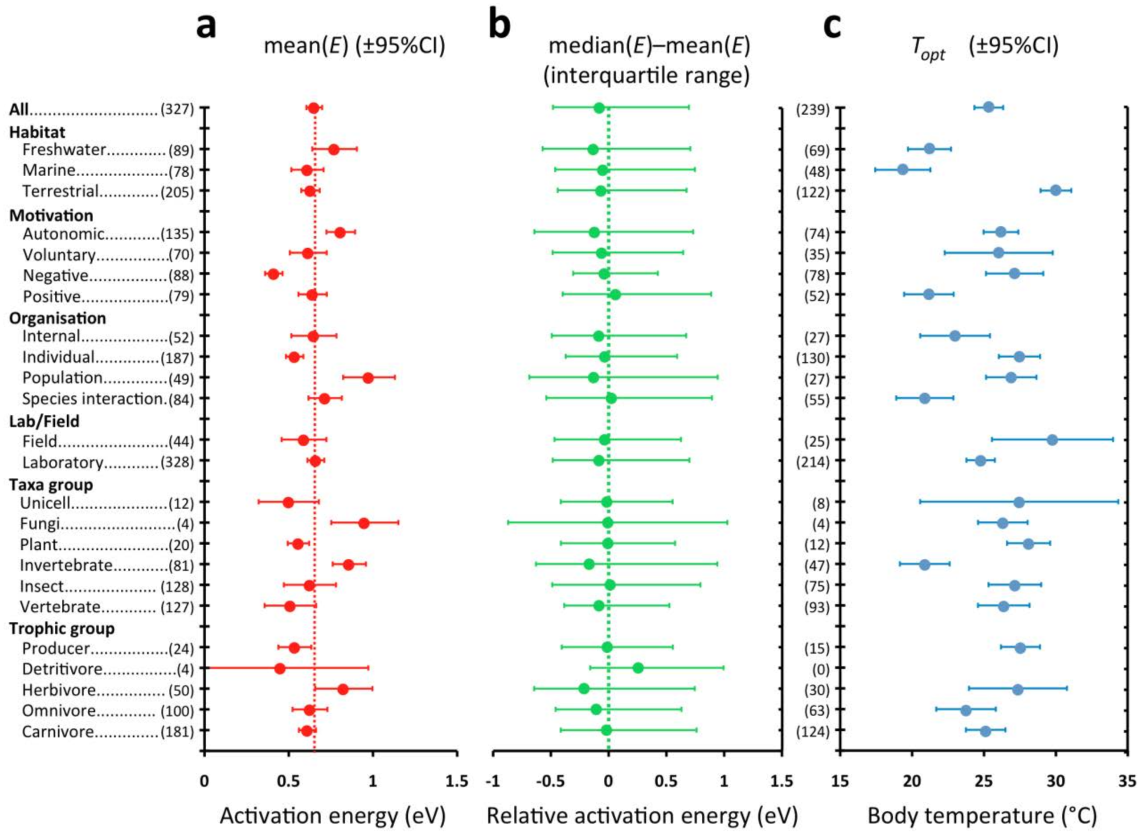

Figure 3.3. Activation energies, *E*, for rise responses and temperatures for peak trait values (T_{pt}). a) Mean *E* (±95%CI) of intraspecific rise responses calculated from the Boltzmann-Arrhenius model. Responses are grouped by habitat, motivation, level of biological organisation, laboratory or field measurements, taxa, and trophic group. Red dotted line marks 0.65 eV, as reported for interspecific studies within the metabolic theory of ecology (MTE). b) Relative activation energy (median(*E*)-mean(*E*)) of intraspecific rise responses bounded by the inter-quartile range. Symmetric distributions have equal mean and median, and thus a relative activation energy of zero (green dotted line). Most medians lie below zero, indicating right-skew. c) Mean T_{pk} (±95%CI) of intraspecific unimodal responses. All values in parentheses are sample sizes with pseudoreplicates combined.

One possible mechanism driving skewness in rise activation energies is trait motivation (Section 2.2.4). Analysis of trait rises reveal that negative motivation traits have significantly lower mean activation energies (0.40±0.05 eV) than do positive (0.69±0.09 eV), voluntary (0.64±0.12 eV), or autonomic (0.76±0.08 eV) traits (Figure 3.3a & Figure 3.4). Because negative motivation traits make up 23.4% of all rises and typically have lower activation energies, they contribute substantially to the right-skewness observed across taxa and habitats (Figure 3.4).

This difference in activation energies means that traits with negative motivation are less sensitive to temperature than traits that are positive or voluntary, and thus supports the hypothesis of stronger selection pressure on prey to escape capture and death by maintaining nearly optimal performance across a range of temperatures (the life-dinner principle)

(Dawkins & Krebs 1979; Brodie III & Brodie Jr 1999; Scales *et al.* 2009). That is, although it may be energetically costly to maximise effort at low temperature, individuals under attack may do so for survival. Prey presumably increase their performance at lower temperatures rather than decrease their performance at higher temperatures, which would more likely result in being captured by a predator. This differential performance is consistent with physiological limitations (Hochachka & Somero 1984) or shifts in motivation at low versus high temperatures (Schieffelin & Dequeiroz 1991; Cooper 2000; Shine *et al.* 2000; Herrel *et al.* 2007). Moreover, diurnal and seasonal variation in temperature could allow the evolution of differences in, for example, the thermal response of attack and escape velocities needed for an individual to alternate between being both a predator and a prey.

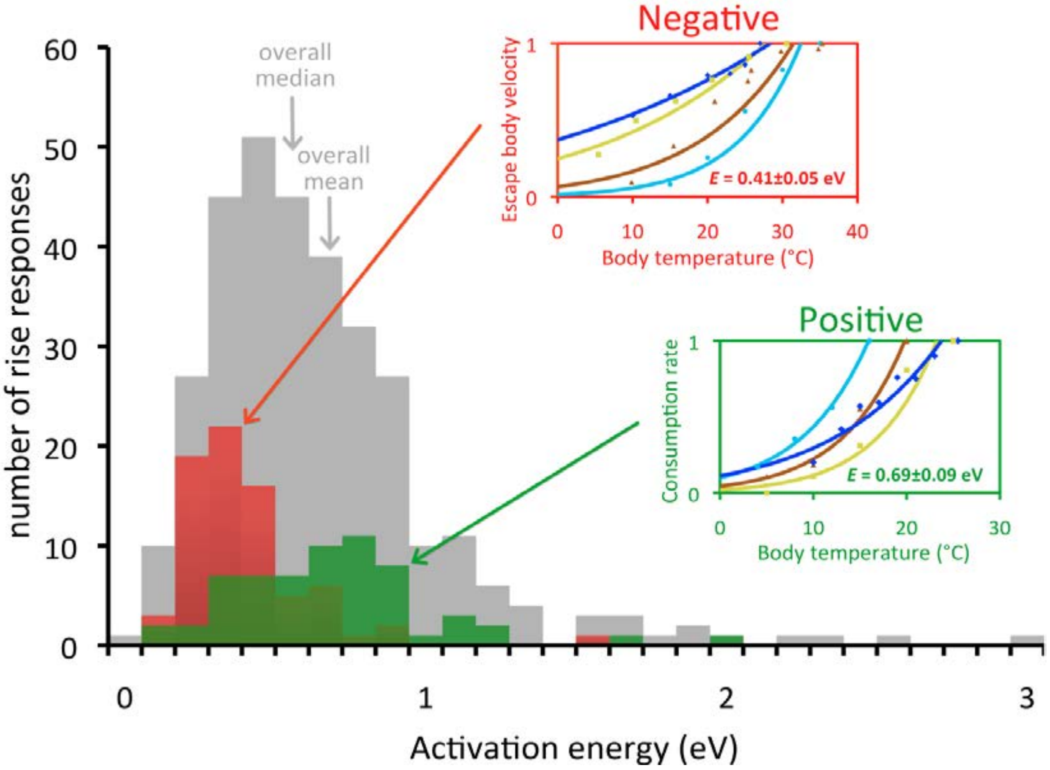

Figure 3.4. Activation energies of the rise thermal responses. Grey columns in main panel are total number of rise responses, red columns are the subset of these responses that correspond to negative motivation, and green columns are the subset that corresponds to positive motivation. Inset panels show example responses of traits corresponding to positive (green panel) and negative (red panel) motivations, respectively. OLS regressions based on the Boltzmann-Arrhenius model (Eq. 1) were fitted to the rise component of each response. Trait values are normalised relative to the maximum trait value in each data series in order to present multiple responses on the same scale. Values of E in insets are mean values for negative and positive motivation. Escape body velocity (m / s) (negative motivation) of the northern desert iguana (●, *E*=0.96±0.52 eV); western fence lizard (▲, *E*=0.63±0.28 eV); african clawed frog (◆, *E*=0.25±0.06 eV); and wandering garter snake (■, *E*=0.36±0.14 eV). Consumption rate (consumed prey / (predator * s)) (positive motivation) of river perch preying on phantom midge larvae (●, *E*=0.99±0.25 eV); back-swimmer preying on *Culex* mosquito larvae (▲, *E*=1.09±0.46 eV); dampwood termite feeding on eucalyptus tree (◆, *E*=0.65±0.40 eV); and atlantic oyster drill preying on eastern oysters (■, *E*=1.18±0.83 eV). Data sources shown in Appendix 3.2.

Focus only on body velocities allows direct testing of the life-dinner principle. Consistent with the principle, rises for escape body velocity (0.39±0.05 eV) had lower activation energies than did voluntary velocities (0.52±0.09 eV). I also measured how much faster the mass-corrected coefficient (R_o in Eqn. 3.1) at 20°C for escape body velocity (2.61 m/s) was than for voluntary body velocity (0.31 m/s). These values represent averages across diverse taxa and are qualitatively similar to previous results for lizards that did not examine thermal effects (Irschick & Losos 1998; Husak 2006). For this analysis, I only included responses for which the individual organism was working at or near maximum capacity, thus precluding other effects and explanations related to behaviour and shifts in motivation or strategy (see Section 2.2.4). Because escape or attack velocity is largely anaerobic and is governed by different biochemical reactions than voluntary velocity (Bennett 1989, 1991), it may experience different selection pressures, contributing to differences in activation energies for thermal responses.

Analysis of variance of all rises shows that level of organisation is also a strong predictor of mean rise activation energies (Table 3.1), with internal (0.65±0.13 eV) and individual (0.54±0.05 eV) having much lower mean E values than population (0.98±0.15 eV) (Figure 3.3). For terrestrial insects, fish, and lizards taxa, mean rise activation energies averaged across all traits were again very close to 0.65 eV (Figure 3.5). Activation energies of specific trait rises were more variable and tended to increase across levels of biological organisation (Table 3.1).

3.3.3. Trait Falls

Few data or theories exist for the decline of trait performance at higher temperatures. Protein degradation is considered a likely mechanism for falls of some traits (Johnson & Lewin 1946; Hochachka & Somero 1984; Ratkowsky *et al.* 2005), and in those cases activation energy can be interpreted as the energy of degradation processes. The mean E of the 31 significant fall responses was 1.15±0.39 eV, and the median was 0.65 eV, indicating strong right-skewness as found for trait rises. Falls had much higher activation energies than rises, consistent with the left-skew typically observed in temperature responses (Cossins & Bowler 1987; Ratkowsky *et al.* 2005; Martin & Huey 2008; Angilletta 2009). Several trait falls were conversion efficiencies (Appendix 3.2), contradicting the common tacit assumption of their temperature invariance (Peters 1983; Brown *et al.* 2004; Allen *et al.* 2005; Vasseur & McCann 2005).

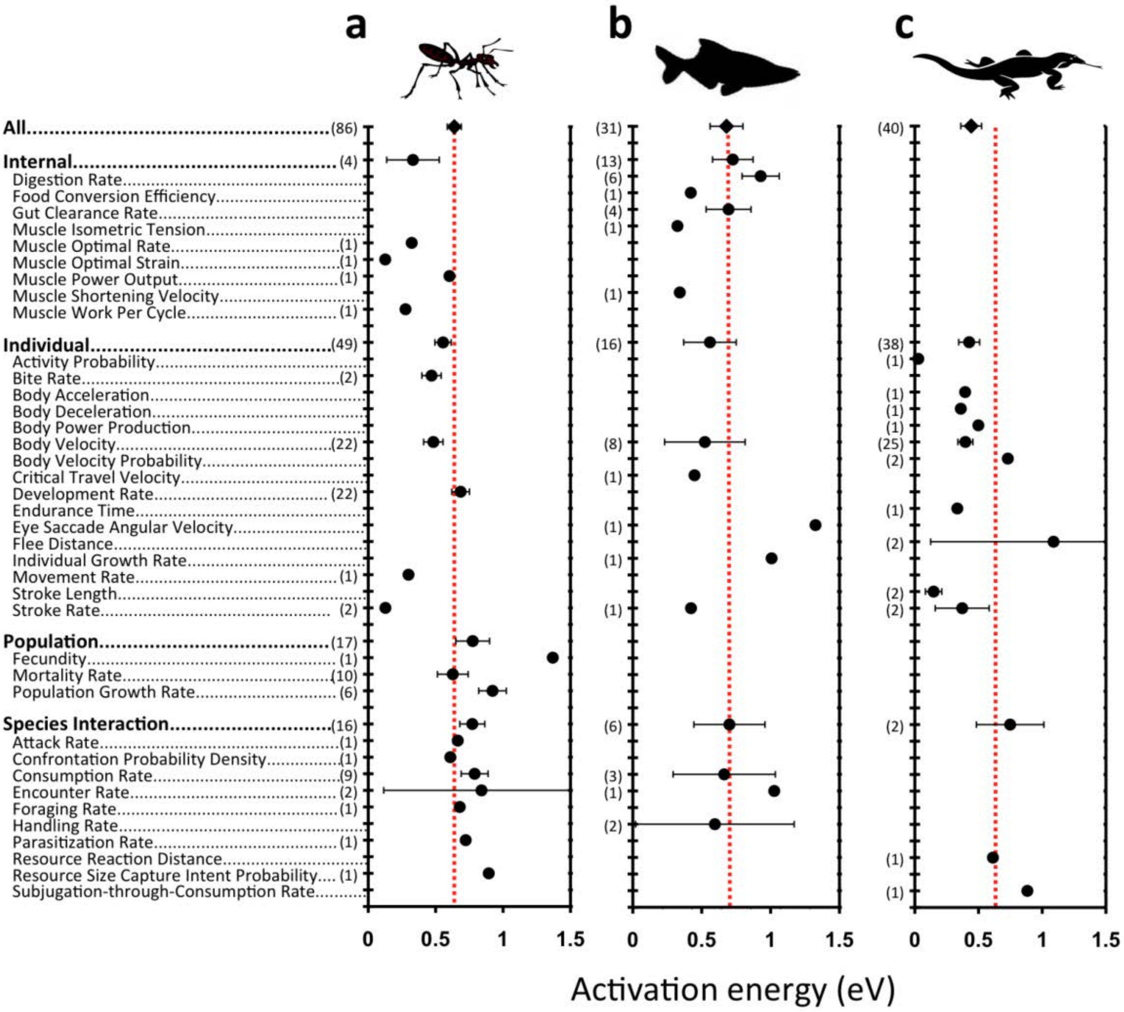

Figure 3.5. Mean activation energies, E, (±95%CI) of intraspecific rise responses calculated using the Boltzmann-Arrhenius model. Categorised by different levels of organisation for a) terrestrial insects, b) marine and freshwater fish, and c) terrestrial lizards. Red dotted line marks 0.65 eV reported for interspecific studies (Gillooly *et al.* 2001; Brown *et al.* 2004; Irlich *et al.* 2009b). Values in parentheses are sample sizes with pseudoreplicates combined.

3.3.4. Peak Temperature and Unimodal Responses

For the 240 unimodal responses, the mean temperature at which peak trait values occur (T_{pk}), was 25.3±1°C. Although temperature fluctuates more in terrestrial habitats than freshwater or marine, no evidence was found that T_{pk} was more variable for terrestrial taxa (Figure 3.6). These results cannot be attributed to factors such as the more homogeneous thermal landscape of aquatic habitats (Huey 1974; Huey *et al.* 1977; Tracy *et al.* 1993; Wilson & Franklin 2000; McConnachie *et al.* 2011) because most data were measured in experimental arenas with constant temperatures. Therefore, organisms were not able to behaviourally thermoregulate, effectively eliminating differences between body and ambient temperature (see Section 3.2.1). Habitat was by far the strongest determinant of mean T_{pk} (Figure 3.3, Figure 3.6, Table 3.2). Traits for terrestrial organisms had a higher mean T_{pk} (30°C) than those in freshwater (21°C) or marine (19°C) environments. These differences corresponded to environmental temperatures (Vasseur & Yodzis 2004), indicating a matching between environmental temperatures and those for near optimal performance (Deutsch *et al.* 2008; Angilletta 2009).

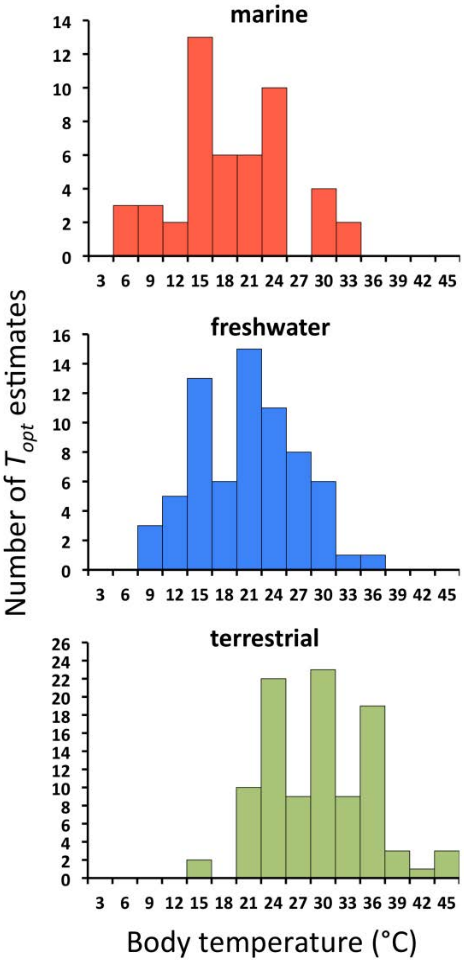

Figure 3.6. T_{pk} categorised by habitat. The peaks at ~15, 20, 25, 30 and 35°C likely represent over-representation of these temperatures in experimental studies.

3.3.5. Conclusion

The ecoinformatic analysis I present in this Chapter illuminates previously unrecognised generalities and deviations in how biological systems respond to temperature. I show that almost 90% of intraspecific rise responses are well fit by the Boltzmann-Arrhenius model. Across all traits the mean activation energy is 0.66 eV, close to the value of 0.65 eV reported for interspecific responses and indicating that metabolism potentially affects a wide range of biological processes (Peters 1983; Gillooly *et al.* 2001; Brown *et al.* 2004; Savage *et al.* 2004; Allen *et al.* 2006). Nonetheless, systematic and substantial patterns exist in the variation of activation energies around this canonical value, including persistent right skewness in their distribution. Notably, the median value of activation energies is 0.55 eV, indicating that most activation energies are lower than 0.65 eV. These results, therefore, indicate limitations in the precision, power, and utility of MTE as it currently stands. Clearly, the MTE requires re-assessment and modification to discover whether it can explain these novel features of the temperature responses of biological traits.

The persistent right-skewness in the distribution of activation energies raises important questions about whether to interpret the mean or median value as the most biologically relevant measure. Processes involving individuals or single species may be more affected by the median because most individuals and species will have activation energies close to this value. In contrast, ecosystem processes may be determined more by the mean value because they represent an average over many individuals, species, and processes.

Folding the Boltzmann-Arrhenius model into a more realistic unimodal model (Johnson *et al.* 1977; Schoolfield *et al.* 1981; Ratkowsky *et al.* 2005) should prove insightful in this regard and may help explain recently observed deviations of growth rate data fit to the model, including effects of the values and range of chosen experimental temperatures (Knies & Kingsolver 2010). Further elucidation of these effects requires more high quality experimental data. Detailing the response of traits over the entire temperature range has been central to understanding and making predictions about the effects of climate change (Huey *et al.* 2009b). It would therefore be useful to measure the response of a greater diversity of traits over the full temperature range, allowing characterisation of the entire unimodal response.

The right-skewness in distribution of activation energies persists across nearly all trait categories. Detailed analyses of these and similar patterns indicate dominant selection pressures and novel biological mechanisms. Differences between negative and positive motivation can be explained by a thermal version of the life-dinner principle (Dawkins & Krebs 1979; Brodie III & Brodie Jr 1999; Scales *et al.* 2009), which predicts systematic differences in the thermal responses of organisms when they are acting as either a predator or a prey. Collecting high-quality data for the thermal dependence of attack velocity is a high priority for more sensitive tests of the life-dinner principle.

Activation energies for rises are generally more variable and tend to increase across levels of biological organisation, from internal to species interactions. This increase represents enhanced thermal sensitivity of populations and species interactions, potentially reflecting density or frequency dependence. These patterns probably have important consequences for species interactions and community stability, and their identification suggests that scaling constraints can be shifted or relaxed by evolutionary or behavioural processes. Data on multiple traits within single species will also help resolve an understanding of how temperature influences the interaction and integration of traits across different levels of biological organisation (Huey 1982).

This trait ontology is a first categorisation of thermal response curves and allows me to identify novel patterns and mechanisms, such as right skewness and the life-dinner principle. Alternative categorisation of the traits in the database will likely reveal other biological mechanisms. Because life evolves and operates across a complex thermal landscape, it is essential to synthesise empirical knowledge and to deduce general mechanisms for shifts in the thermal responses of biological traits. This work is an important step along this path and should aid research on how species, communities, and ecosystems respond to changes in temperature.

Chapter 4. The Temperature Dependence of Consumer-Resource Interactions[5]

4.1. Introduction

Earth's thermal landscape is rapidly changing, and there is growing recognition of associated changes in the geographic distribution, phenology, and behaviour of species (Parmesan *et al.* 1999; Hughes 2000; Walther *et al.* 2002; Parmesan & Yohe 2003; Burrows *et al.* 2011). Virtually all organisms have a physiological response to temperature, and these responses have important consequences for higher levels of ecological organisation, such as populations, communities, and ecosystems (Kingsolver & Woods 1997; Brown *et al.* 2004; Helmuth *et al.* 2005; Angilletta 2009; Woodward *et al.* 2010; Dell *et al.* 2011; Buckley & Kingsolver 2012). Thermal response curves describe how biological rates and times (e.g., metabolic rate, growth, reproduction, mortality, and activity) vary with temperature. These responses can vary systematically between life stages, populations, and species (Angilletta 2009; Dell *et al.* 2011; Kingsolver *et al.* 2011). The strength and dynamics of the temperature response of ecological interactions results from integration of the thermal dependence of the relevant traits of individuals involved in the interaction. For example, changes in temperature can alter encounter rate between a consumer and resource, and therefore consumption rate, in a manner that may not be predictable by studying either species in isolation (Vasseur & McCann 2005; Dell *et al.* 2011; O'Connor *et al.* 2011; Vucic-Pestic *et al.* 2011). Understanding how temperature alters the dynamics of ecological interactions is therefore necessary for predicting effects on populations, communities, and ecosystems (Harrington *et al.* 1999; Walther *et al.* 2002; Helmuth *et al.* 2005; Vasseur & McCann 2005; Abrahams *et al.* 2007; Woodward *et al.* 2010; Stevnbak *et al.* 2012).

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[5] A modified version of this chapter is published as 'Dell A.I., S. Pawar, & V.M. Savage. Temperature dependence of trophic interactions driven by asymmetry of species responses and foraging strategy. Journal of Animal Ecology (In print).

Consumer-resource interactions are a particularly important class of ecological interactions because they determine most of the flux of nutrients and materials among individuals and through communities and ecosystems. Even small changes in temperature can have major effects on the strength of consumer-resource interactions (Davis *et al.* 1998; Post *et al.* 1999; Sanford 1999). Because of their central role to communities and ecosystems, a general framework for predicting how temperature influences consumer-resource dynamics is of great importance (Vasseur & McCann 2005; Petchey *et al.* 2010; Rall *et al.* 2010a; O'Connor *et al.* 2011; Stegen *et al.* 2012).

If a consumer and resource possess traits, such as metabolic rate and body velocity, that all respond identically to temperature, then the consumer-resource dynamics should unfold in exactly the same qualitative manner but at an overall accelerated or decelerated pace (depending on whether temperature was increased or decreased). As long as temperatures are not so extreme that they cause populations to go extinct (due to death or inability to reproduce), static properties like equilibrium densities and coexistence should not change with temperature. This is because static properties are merely outcomes of the dynamics, whether sped up or slowed down. However, when the temperature responses of two interacting species are different (i.e., asymmetric; Figure 4.1), changes in interaction dynamics are likely to arise that have important consequences for populations and communities (Davis *et al.* 1998; Post *et al.* 1999; Sanford 1999; Izem & Kingsolver 2005; Takasuka *et al.* 2007; Pörtner & Farrell 2008; Barton & Schmitz 2009; Kingsolver 2009; O'Connor 2009; Rall *et al.* 2010a; Kordas *et al.* 2011). For example, differential effects of temperature on the average consumer and resource body velocity would likely alter the rate at which the two species encounter each other, which can drive differences in consumption rate and ultimately their population dynamics. In this Chapter I use theory and data to show that consumption rates do vary with temperature, and identify specific asymmetries between consumers and resources.

Because most biological rates have a unimodal response to temperature (Chapter 3), there are three general scenarios for how the thermal response of traits may differ between species (Figure 4.1). First, the absolute magnitude of temperature responses could differ between consumer and resource (Figure 4.1a). Second, consumer and resource traits may respond to temperature at different rates (Figure 4.1b) (Kordas *et al.* 2011). This could be a difference in the rate of increase (rise), the rate of decrease (fall), or both, and is likely to be important in nature because differences in reaction and/or denaturation rates are known to exist across taxa and traits (Chapter 3). For example, at low temperatures, resources tend to achieve higher escape velocities than consumers, which I previously hypothesised (Chapter 3) arises because avoiding predation is more critical to survival for an individual resource than each attempt by an individual consumer to obtain food. An extreme version of this scenario occurs when one species is an endotherm, where many traits are effectively invariant to temperature (horizontal blue line in Figure 4.1b). Third, both consumer and resource respond to temperature at the same rate, but each has a different temperature for peak performance (T_{pk}), resulting in response curves being offset (Figure 4.1c) (Pörtner & Farrell 2008; Kordas *et al.* 2011). These offsets will be particularly critical when the T_{pk}'s are sufficiently asymmetric that one species is responding positively to temperature (i.e., in the rise region for temperatures lower than T_{pk}) while the other is responding negatively (i.e., in the fall region beyond T_{pk}). Such scenarios may become increasingly common as species shift geographic ranges and come into contact with new species.

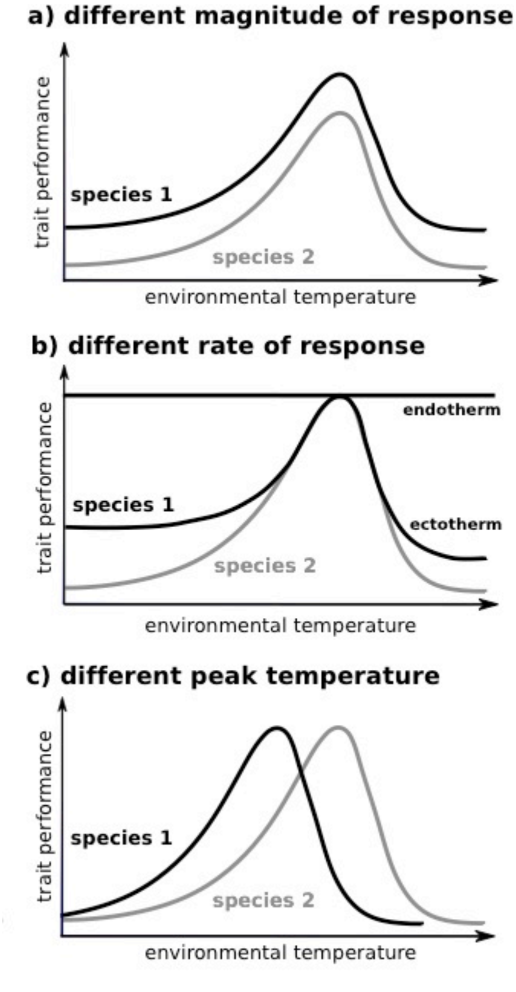

Figure 4.1. Three general scenarios for how differences might arise in the thermal responses of individual- or population-level traits (e.g., metabolic rate, body velocity, and endurance) of interacting consumer-resource pairs (black and grey lines). These differences can affect consumption rate via effects on encounter rate. **a)** Differences in the magnitude of response, **b)** differences in rates of response (either the rise or fall; unimodal black curve), with an extreme case being when one species responds to environmental temperature and the other does not (i.e., endotherm) (horizontal black line), and **c)** differences in temperature for peak performance (T_{pk}).

In this chapter I use a trait-based approach (McGill *et al.* 2006; Weitz & Levin 2006; Savage *et al.* 2007b; O'Connor *et al.* 2011; Pawar *et al.* 2012) to develop a general framework that applies to a wide diversity of consumer-resource interactions. This work builds on earlier studies of the thermal responses of consumption rates that have yielded crucial insights (Vasseur & McCann 2005; O'Connor *et al.* 2011; Vucic-Pestic *et al.* 2011). This approach differs from most previous work because it explicitly considers the thermal dependence of component traits underlying consumption rate. Despite the extraordinarily diverse ways in which consumers and resources interact, it is possible to focus on a few key traits because virtually all consumer-resource interactions involve some combination of search, detection, and handling (Figure 4.2).

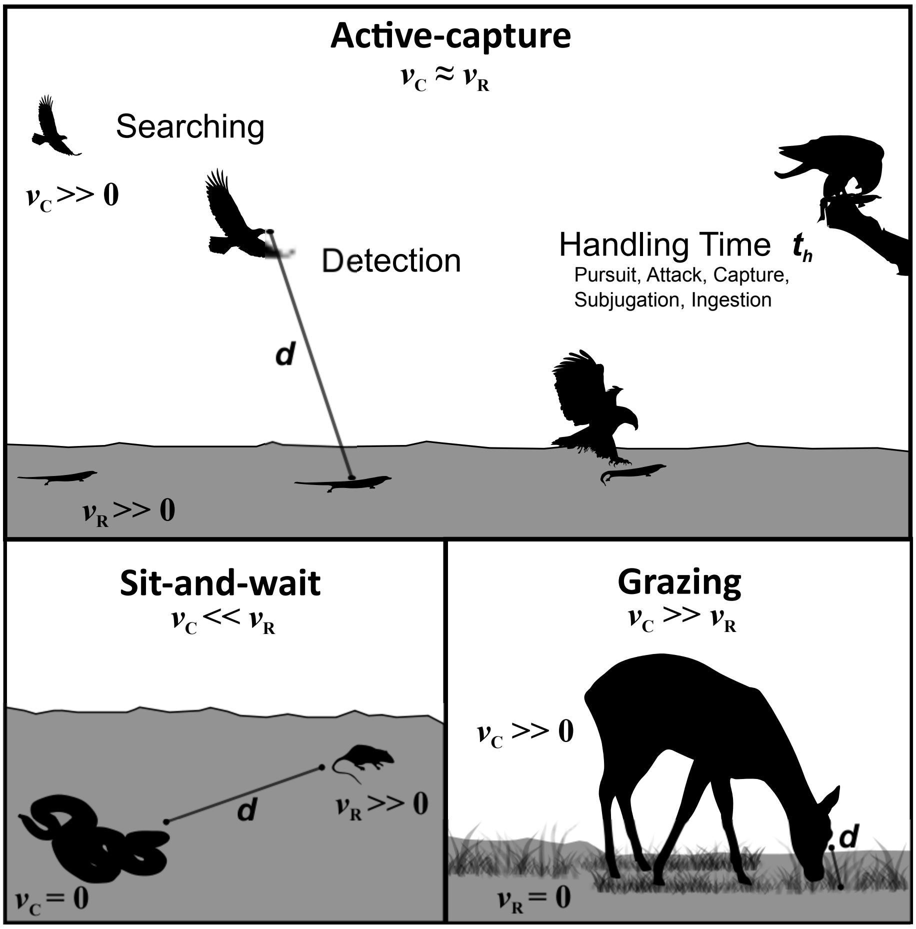

Figure 4.2. The three general foraging strategies shown categorised by consumer-resource pairs, determined by the relative body velocities of the consumer (v_c) and/or resource (v_R). When both species move throughout the landscape, the interaction is active-capture (top panel), when only the resource moves but the consumer is sessile or stationary the interaction is sit-and-wait (bottom left panel), and when the consumer is active but the resource is sessile or stationary, the interaction is grazing (bottom right panel). The components of a typical trophic interaction are detailed in the top panel, and include searching, detection, and handling time (see main text). Body velocity varies with temperature whenever $v >> 0$, and detection distance (d) is independent of temperature in this model.

Predictions are derived for how these component traits integrate to determine the thermal responses of search and consumption rates, with particular focus on asymmetries. I test the assumptions and predictions using a comprehensive database of thermal responses that I described in Chapter 2 and analysed in Chapter 3. Finally, I examine how thermal responses and their asymmetries could affect equilibrium population densities, a critical feature of populations and communities, via its effects on consumption rate and its component traits.

4.2. Modelling Framework

4.2.1. Thermal Dependence of Biological Traits

As detailed in Chapter 3, biological rates are typically unimodal over the full temperature range, with the fall usually occurring faster than the initial rise. This faster decline may be due to denaturation of proteins (Johnson & Lewin 1946; Hochachka & Somero 1984; Ratkowsky *et al.* 2005; Corkrey *et al.* 2012), or for aquatic environments, also due to the substantial decrease in oxygen solubility at higher temperatures (Pörtner & Knust 2007). Within the range of temperatures for which the thermal response is rising, except at temperatures near the critical thermal minimum or close to the peak, the dependence of most rates can be modelled as a Boltzmann-Arrhenius equation (Gillooly *et al*. 2001; Brown *et al*. 2004; Angilletta 2009; Dell *et al*. 2011; Price *et al*. 2012; but see Clarke 2006; Irlich *et al*. 2009; Englund *et al*. 2011)

$$P = P_0 e^{\frac{-E}{kT}} \tag{4.1}$$

where P is a trait performance in terms of a rate, E is the average activation energy for the underlying biochemical processes, k is Boltzmann's constant, T is body temperature in Kelvin, and P_0 is a taxon-, activity-, and mass-dependent scaling coefficient (Gillooly *et al.* 2001) that also includes effects of interaction dimensionality (see Chapter 5) in the case of search or consumption rate.

The full unimodal response can be described either by extending the Boltzmann-Arrhenius model using thermodynamic principles or by adding a phenomenological decline at higher temperatures (Johnson & Lewin 1946; Ratkowsky *et al.* 2005; Martin & Huey 2008; Angilletta 2009; Amarasekare & Savage 2012). A unimodal model based on the Boltzmann-Arrhenius model should have the general form

$$P = P_0 e^{\frac{-E}{kT}} f\left(T_{pk}, E_D\right) \tag{4.2}$$

where T_{pk} is the temperature at which trait performance reaches its peak value and E_D is a parameter that partly controls the steepness of decline beyond T_{pk}. In the case of a fully thermodynamic model, E_D can be interpreted as the average energy constant at which proteins denature (Corkrey *et al.* 2012).

In this chapter I focus theory on the rise component of thermal responses (Eqn. 4.1). This allows me to more easily connect to previous theoretical and empirical work (Savage *et al.* 2004; Deutsch *et al.* 2008; Martin & Huey 2008; Angilletta 2009; Dell *et al.* 2011). Also, organisms often live at temperatures below T_{pk} (Deutsch *et al.* 2008; Martin & Huey 2008; Angilletta 2009; Huey *et al.* 2009a), so concentrating on rises should help understand initial physiological and ecological responses to temperature change. Finally, by focusing on the rise response, it is possible to show that even for the simplest version of the model, asymmetric responses can lead to large effects. Including a full unimodal model (see Discussion) may amplify and possibly exacerbate the effects of temperature based purely on the rise response, because of large asymmetries created by differences in peak temperatures and the differential rates of falls compared with rises. Below, I discuss the potential effects of incorporating full unimodal responses, especially from the perspective of the asymmetries introduced in Figure 4.1.

4.2.2. Search Rate

For a consumer-resource interaction to occur, both the consumer and resource must first encounter each other. The search rate of a consumer throughout the landscape (α) governs the number of potential attacks that a consumer can make, and is measured in units of area or volume per time. Search rate can be expressed as

$$\alpha = d^{(D-1)} v_r \tag{4.3}$$

where *d* is the distance at which the consumer and/or resource can detect one another, *D* is the dimensionality of the consumer search space, and v_r is relative velocity of the consumer and resource. For random movement (Gerritsen & Strickler 1977; Okubo 1980; Barrett & Lowen 1998) relative velocity can be shown to be proportional to the root-mean-square of average velocities of the consumer (v_C) and resource (v_R) (i.e., $v_r = \sqrt{v_C^2 + v_R^2}$). When the consumer moves with a velocity much faster than the resource, or if the resource is sessile (grazing; Figure 4.2, bottom right panel), relative velocity is well approximated by the velocity of the consumer ($v_r \sim v_C$). In contrast, when the resource moves much faster than the consumer, or the consumer is sessile (sit-and-wait foraging; Figure 4.2, bottom left panel), relative velocity is well approximated by resource velocity ($v_r \sim v_R$).

The consumer must invest time and effort in pursuing, subduing, and ingesting each individual resource. These components can be combined with search rate using a Type II functional response to yield a saturating per-capita consumption rate (c) (Holling 1959b):

$$c = \alpha g(R) \tag{4.4}$$

Here, R is resource density (individuals × area^{-1} or volume^{-1}), and the function $g(R)$ is the risk function that determines the shape of the functional response (Murdoch & Oaten 1975), which in principle can be any form. This choice of notation allows treatment of different functional responses simultaneously, and facilitates direct comparison of different functional responses for thermal effects. Here, I restrict focus to Type I and Type II functional responses with the associated risk functions

$$g_{\mathrm{I}}(R) = R \tag{4.5}$$

$$g_{\mathrm{II}}(R) = \frac{R}{1+\alpha t_h R} \tag{4.6}$$

When handling time is instantaneous, Eqn. 4.6 reduces to Eqn. 4.5. Equation 4.4 implicitly includes the probability of a successful attack by the consumer, which I assume is largely invariant with temperature. If attack success probability is temperature dependent, it will need to be incorporated, most likely through an extra factor multiplying the search rate or possibly through handling time.

4.2.3. Thermal Dependence of Component Traits

I now derive the thermal dependence of search rate (Eqn. 4.3). For consumers that search for prey visually, detection distance (d in 4.3) is expected to depend on properties of the eye, height of the eye above the foraging surface (Kirschfeld 1976; Kiltie 2000; Pawar *et al.* 2012), and the size of the prey. Because none of these are known to depend on temperature directly, detection distance is also not expected to vary with temperature. Consequently, changes in temperature will not differ according to the dimensionality (D in Eqn. 4.3) of the system (Chapter 5), as it does with body size. For sensory modalities such as hearing, smell, or touch, the temperature dependence is also expected to be weak. For example, hearing and smell may vary as a square root due to how temperature influences diffusion (for smell) and the density of the environmental medium through which sound waves travel (for hearing). Because of the mathematical form of this dependence, these effects are expected to be much weaker than the exponential thermal dependencies of many other traits and rates (see below).

Relative velocity (v_r in Eqn. 4.3), on the other hand, should depend strongly on temperature. Metabolic rate is the power produced by an organism to be used for maintenance, growth, and reproduction. By definition, power equals the product of force and velocity. The force or strength available for movement (e.g., jumping, swimming, flying, running, etc.) scales with the cross sectional area of muscle and appears to be independent of temperature (Schmidt-Nielsen 1984; Savage *et al.* 2007a). Consequently, individual body velocity should depend on temperature only according to how the power (metabolic rate) given to locomotion changes with temperature. Using the well-established relationship (Eqn. 4.1) between temperature and metabolic rate (described in detail in Chapter 3), I predict that within the rise part of the response, individual body velocity (v) should scale as

$$v \propto \frac{B}{F} \propto e^{\frac{-E}{kT}} \qquad 4.7$$

where F is force and B is metabolic rate. Substituting the scaling of velocity into search rate (Eqn. 4.3) yields a set of predictions for search rate that depends upon foraging strategy (Figure 4.2; Table 4.1).

Finally, I consider the thermal dependence of handling time, which is important for Type II functional responses (Eqn. 4.6). Once a consumer has attacked and killed a resource, the resource becomes inactive, so its thermy will no longer contribute to handling time. Therefore, for an ectothermic consumer, when the dominant time spent handling a resource involves ingestion (following subjugation) (Figure 4.2, top panel), handling rate ($1/t_h$) will scale as e^{-E/kT_C} over the increasing (rise) part of the response (Table 4.1). Throughout the remainder of the chapter, subscripts C and R on traits, such as body temperature (T), refer to those traits for the consumer or resource respectively. Handling rate should be temperature invariant for an endothermic consumer.

Combining all the components together provides a set of foraging-strategy- and thermy-specific predictions for search rate. For ectotherm consumer-resource pairs, the temperature dependence for search rate for active-capture strategies is based on both the consumer and resource. For sit-and-wait strategies it is based on the resource, and for grazers the thermal dependence of search rate is based only on the consumer (Table 4.1). Endothermic consumer-resource pairs should be largely unaffected by shifts in environmental temperature. For interactions between species with a thermy mismatch (i.e., endotherm and ectotherm), the thermal dependence will depend on whether the endotherm is sessile (endothermic resource in a grazing strategy, or endothermic consumer in a sit-and-wait strategy) or is moving around the landscape (endothermic consumer in an active or grazing strategy, or endothermic resource in an active or sit-and-wait strategy) (Table 4.1). As I explain below, the thermal dependence of consumption rate can be derived from that of search rate, handing time (for Type II responses), and resource density (Table 4.1).

Table 4.1. Theoretical predictions for temperature dependence of trophic interactions for an ectothermic consumer and an ectothermic resource. Differences in the foraging strategies of each consumer-resource pair (Figure 4.2) determine whether effects of temperature on relative body velocity (v_r) are driven primarily by the consumer and/or the resource. Differences in interaction thermy (ectotherm or endotherm) also affect temperature scaling's (see main text). Asymmetries in the temperature response of the consumer and resource (Δ in Eqn. 4.8; Figure 4.1) for any of these traits are likely to have significant effects on search rate, consumption rate, and equilibrium population densities. The constant *a* depends on type of locomotion, taxonomy, and other factors. Per-capita consumption rate (c_{I} and c_{II}) are for temperature-independent resource population density (i.e., $R \propto T^0$; see main text).

		Foraging strategy	
Temperature scaling	grazer	sit-and-wait	active-capture
Detection distance (d) Interaction dimensionality (D)	T^0	T^0	T^0
Relative velocity (v_r) Search rate (α) Consumption rate – Type I (c_{I})	e^{-E_C/kT_C}	e^{-E_R/kT_R}	$e^{-E_C/kT_C}\sqrt{1+a\Delta^2}$
Handling rate $(1/t_{\mathrm{h}})$	e^{-E_C/kT_C}	e^{-E_C/kT_C}	e^{-E_C/kT_C}
Consumption rate – Type II (c_{II})	e^{-E_C/kT_C}	$\dfrac{e^{-E_R/kT_R}}{1+R\Delta}$	$\dfrac{e^{-E_C/kT_C}\sqrt{1+a\Delta^2}}{1+R\sqrt{1+a\Delta^2}}$
Risk function $(g(R))$ Resource equilibrium density $(\hat{R})$	T^0	Δ^{-1}	$\dfrac{1}{\sqrt{1+a\Delta^2}}$
Consumer equilibrium density $(\hat{C})$	Δ	T^0	$\dfrac{\Delta}{\sqrt{1+a\Delta^2}}$

4.2.4. Thermal Dependence of Consumption Rate

I now derive the thermal dependence of per-capita consumption rate (Eqn. 4.4). Because most of the data are from the laboratory, resource density (*R*) does not depend on temperature, but instead is determined by choices of the experimentalist (see Discussion). For Type I responses (Eqn. 4.5), this implies the thermal dependence of consumption rate is directly proportional to search rate (Table 4.1). For Type II responses, the risk function (Eqn. 4.6) has an additional term that depends on the product of search rate and handling time. For grazers, this product is temperature independent $(\alpha t_h \propto e^{-E_C/kT_C} e^{E_C/kT_C} \propto T^0)$, so the prediction for grazers for a Type II response is exactly the same as for Type I (Table 4.1). For sit-and-wait foraging strategy, the product is equal to a factor that explicitly depends on asymmetries between the consumer and resource (Table 4.1). That is,

$$\alpha t_h \propto e^{-E_R/kT_R} e^{E_C/kT_C} = e^{-\frac{1}{k}\left(\frac{E_R}{T_R}-\frac{E_C}{T_C}\right)} \equiv \Delta \qquad 4.8$$

This reveals the critical importance of the asymmetry of temperature responses because it affects the dynamics of consumer-resource interactions. Asymmetries could arise either due to differences in activation energies (e.g., life-dinner-principle, Chapter 3), thermy (e.g., ectotherm vs. endotherm), or thermoregulation (e.g., two ectotherms with different body temperatures) (Figure 4.1b). Finally, for active-capture foraging strategies, the product is more complicated but can still be expressed in terms of the asymmetry factor Δ and a Boltzmann-Arrhenius dependence for the consumer. Substituting Eqn. 4.7 for both the consumer and resource into the equation for relative velocity under random movement (see above; Table 4.1), I obtain $\alpha t_h \propto e^{-E_C/kT_C}\sqrt{1+a\Delta^2}\,e^{E_C/kT_C} = \sqrt{1+a\Delta^2}$ for active-capture, where a is a constant that depends on the temperature coefficients for the body velocity of the consumer and the resource. This constant depends on body size, type of locomotion, taxonomy, and other factors.

When the consumer and resource have the same body temperature and the same activation energies, the asymmetry factor is one (i.e., $\Delta = 1$), and the predictions for Type I and II responses are exactly the same for all foraging strategies. However, when asymmetries exist (i.e., $\Delta \neq 1$), differences between Type I and II responses are expected.

4.2.5. Thermal Dependence of Equilibrium Population Densities

To predict the thermal dependence of equilibrium population density, I begin with a general model for changes in resource (*R*) and consumer (*C*) population densities

$$\frac{dR}{dT} = rR\left(1-\frac{R}{K}\right) - \alpha g(R)C \qquad 4.9$$

$$\frac{dC}{dT} = \varepsilon\alpha g(R)C - zC \qquad 4.10$$

where *r* is resource intrinsic population growth rate (time^{-1}), *K* is resource carrying capacity (individuals × area^{-1} or volume^{-1}), *z* is the consumer's mortality rate (time^{-1}), and *ε* is the consumer's conversion efficiency, or the efficiency of converting ingested resource biomass to biomass of consumers.

Solving Eqns. 4.9 and 4.10 at equilibrium yields

$$g(\hat{R}) = \frac{z}{\varepsilon\alpha} \qquad 4.11$$

$$\hat{C} = \frac{r\hat{R}\left(1 - \hat{R}/K\right)}{\alpha g(\hat{R})} = \frac{r\varepsilon\hat{R}\left(1 - \hat{R}/K\right)}{z} \qquad 4.12$$

In Eqn. 4.11, the term $z/\varepsilon\alpha$ is the ratio of consumer mortality rate to the conversion rate of resources to consumers, and can be interpreted as the inverse proficiency of consumer production. Similarly, the term r/α in Eqn. 4.12 is the ratio of resource production rate to consumer search rate, and can be interpreted as the proficiency of finding prey per area. The term $r\varepsilon/z$ in the last expression in Eqn. 4.12 represents the maximum rate of converting resources to consumers relative to the consumer mortality rate, and can be interpreted as the maximal proficiency of consumer production. Each of these three quantities is the ratio of rates that are temperature dependent. Thus, differences in equilibrium densities will only occur when there are asymmetries in these relative rates. This mathematically captures earlier comments about asymmetries in thermal responses being necessary for changes in static properties of consumer-resource dynamics with temperature (see above). For Type II functional responses (Eqn. 4.6), the equilibrium (Eqn. 4.12) may be unstable (Vasseur & McCann 2005; Pawar *et al.* 2012). Because Δ arises from the product αt_h (Eqn. 4.8), I can further infer that asymmetries will also influence population stability, and thus decrease the coexistence probabilities of consumer-resource pairs with greater Δ.

I now explicitly introduce and substitute the thermal dependence of each variable in Eqns. 4.11 and 4.12 to quantify these effects.

The temperature dependence of many of these variables have been described previously (Savage *et al.* 2004).

$$\begin{aligned} z &\propto e^{-E_C/kT_C} \\ r &\propto e^{-E_R/kT_R} \\ K &\propto e^{E_R/kT_R} \\ \varepsilon &\propto T^0 \end{aligned} \qquad 4.13$$

For conversion efficiency I assume temperature independence (Peters 1983), similar to the mass independence assumed by Weitz and Levin (2006). Temperature invariance is likely because lower gut passage times at higher temperatures probably cancel any increases in energy uptake within the gut due to increased diffusion at higher temperatures, although it would be straightforward to introduce thermal dependence of conversion efficiency into the model if required (Chapter 3). The temperature dependence of search rate depends on foraging strategy of the interaction (Table 4.1), and the thermy of both consumer and resource, which I discuss below.

Substituting the temperature dependencies yields predictions for the thermal dependence of the risk function (Eqns. 4.5 and 4.6) and resource equilibrium density (Eqn. 4.11) categorised by foraging strategy (Table 4.1). It is straightforward to show that the thermal response of resource equilibrium density exactly matches the risk function for both Type I and Type II functions (Table 4.1). For grazing foraging strategies, the temperature dependence of consumer mortality rate cancels the increased consumer search and consumption rate. That is, consumers will be able to eat and grow faster, but this effect is exactly balanced by the increased mortality rate at higher temperatures. In contrast, asymmetries arise for both sit-and-wait and active-capture foraging strategies. For sit-and-wait strategy, any asymmetry between the consumer mortality rate and resource velocity will increases encounter rate with the consumer at higher temperatures, and thus result in changes in the risk function and the resource equilibrium density. For active-capture strategies, there is an additional dependence on consumer velocity, and although the resulting prediction is slightly more complicated (Table 4.1), it is still driven by the same asymmetry factor (Δ). Indeed, when $\Delta >> 1$, corresponding to resource velocity being much greater than consumer velocity (Figure 4.2, lower left panel), the prediction for active-capture reduces to that for sit-and-wait (Δ^{-1}). Similarly, when $\Delta << 1$, corresponding to consumer velocity being much greater than resource velocity, the prediction for active-capture reduces to that for grazing (T^0). If either the resource or consumer (or both) is an endotherm, then there is the potential for extreme asymmetries to be created or thermal dependencies to be eliminated.

In the field, resource density may be temperature dependent, which will alter the temperature dependence of the risk function. Per-capita consumption rate depends on this risk function (Eqn. 4.4). In the lab, resource density is typically independent of temperature, as discussed above. At resource equilibrium density, I substitute Eqn. 4.11 into Eqn. 4.4 to obtain the per-capita consumption rate

$$c = \frac{z}{\varepsilon} \propto e^{-E_C/kT_C} \qquad 4.14$$

Intriguingly, this result holds across all foraging strategies, is driven completely by consumer mortality, and indicates that per-capita consumption rate will increase with temperature for systems at equilibrium.

To obtain the thermal dependence of consumer equilibrium density, it is assumed that resource equilibrium density and carrying capacity scale identically with temperature, or at least that their difference is weaker than the exponential dependencies in the Boltzmann-Arrhenius model. Given this, thermal dependences are substituted into Eqn. 4.12 to obtain predictions for the thermal response of consumer equilibrium density (Table 4.1). These predictions show that for grazing strategies, consumer equilibrium density is thermally dependent (whereas both the risk function and resource equilibrium density are temperature invariant, see above). In contrast, for sit-and-wait strategies these dependencies are reversed, and the consumer equilibrium density is temperature invariant, whereas the risk function and resource equilibrium density do depend on temperature. Together, these represent thermal trade-offs between the consumer and resource populations that are driven by asymmetries in their temperature responses.

4.3. Empirical Analyses

I test the model assumptions and predictions by analysing the data collected in Chapter 2, which represents the most comprehensive existing database on thermal response curves of ecological traits. This database contains 2445 intraspecific (i.e., within species) thermal response curves for an ecologically and taxonomically diverse set of species from freshwater, terrestrial, and marine habitats.

4.3.1. Data Compilation and Analysis

The methods used to obtain, standardise, and analyse these data are described in Chapter 2. Briefly, only directly measured thermal response data were used (e.g., estimates of handling time and attack rate derived from fitting functional responses were excluded). All times were converted to rates and all mass-specific units were converted to per-individual (i.e., per-capita) units. Thermal responses for identical taxa (or combinations of taxa for species interaction traits) and experimental conditions were combined before calculating parameters of the response curve by averaging the trait value at each unique temperature. Statistical methods to estimate E, T_{pk}, and E_D (Eqn. 4.1 and 4.2) are described in Chapter 3.

Ideally, tests of the predictions for consumption rate and its components would involve data with information about the foraging strategy of each consumer-resource interaction (Table 4.1). However, these data are rarely reported. Therefore, consumers were categorised by trophic group (herbivore, omnivore, carnivore), which to a first approximation likely correlates with foraging strategy (Figure 4.2) (Lang 2012). Specifically, herbivores feed on sessile resources (plants) and are thus grazers. Most carnivores more closely match an active-capture strategy than sit-and-wait or grazing (see Chapter 5). Omnivores feed at multiple trophic levels and probably eat both active and sessile resources by employing a mixture of foraging strategies.

The traits I extract from the Chapter 2 database are: *body velocity* (v_R or v_C; units of m × s^{-1}) (includes avoidance, escape, foraging, attack, strike, and voluntary velocities), *reaction* *distance* (d; units of m) (includes resource-reaction-to-consumer and strike distances), *search rate* (α; units of individual or event or area × s^{-1}) (includes grazing rate, line encounter rate, point encounter rate, resource-habitat encounter rate, and voluntary movement rate), *attack rate* (includes attack rate, bite rate), and *handling rate* ($1/t_h$; in units of events × s^{-1}) (includes inverse handling time and inverse subjugation-through-consumption time), *consumption rate* (c; units of resources × (consumer × s) $^{-1}$) (includes consumption rate and filtration rate), and *conversion efficiency* (ε; a proportion that is introduced in Eqn. 4.10) (includes energy assimilation and mass conversion efficiencies).

4.3.2. Results

I calculated the activation energy (E; Eqn. 4.1) from the Boltzmann-Arrhenius model for the rise portion of each thermal response in the dataset. In addition, whenever possible I calculated T_{pk} for responses that included a sufficient temperature range (Figure 4.1 and Eqn. 4.2). Although I focus on the rise part of the response in the model, analysis of peak temperatures (T_{pk}) provides additional insights into the effects of asymmetries on consumer-resource trait responses (Figure 4.1; see Discussion). No single trait had sufficient data for fall rates (E_D) to draw robust conclusions about variation among trophic groups.

4.3.3. Components of Consumption Rate

The theoretical predictions for the temperature independence of detection distance (d in Eqn. 4.3) appear to be validated by the limited available empirical data. I found data on the reaction distance of a snake preying on mice and of seven species of terrestrial lizards reacting to an approaching human. Of these, only a single response was thermally dependent and well-fit (R2 ≥ 0.5 and the F test P value <0.05; Dell *et al.* 2011) by the Boltzmann-Arrhenius model: a carnivorous lizard with an E of 0.61 eV.

The mean activation energy, E, for the 70 body velocity responses I analyse is 0.46 eV ± 0.03 (± standard error, used throughout this chapter). The median is 0.43 eV, indicating a weak right skew. These 70 responses cover 62 species, including frogs, fish, snakes, lizards, crustaceans and insects (Dell *et al.* 2011). Carnivores (0.45 eV ± 0.04), herbivores (0.50 eV ± 0.07), and omnivores (0.44 eV ± 0.05) all have mean activation energies that are statistically indistinguishable from one another (Figure 4.3). The mean for the 45 body velocity T_{pk} estimates is 30.4°C ± 1.30, and the median was 34°C. Categorising the responses by trophic group reveals that carnivores (28.8°C ± 1.68) have a slightly lower mean T_{pk} than omnivores (30.0°C ± 2.28) and much lower than herbivores, with a mean T_{pk} of 39.2°C ± 2.30 (Figure 4.3). Habitat strongly influences T_{pk} (Chapter 3), so it is not surprising that herbivores have a much higher T_{pk} because all data were collected in terrestrial habitats, while many carnivore (37%) and omnivore (33%) responses were aquatic (i.e., marine or freshwater).

Lastly, the entire database contains only six estimates of food mass conversion efficiency following consumption (ε in Eqn. 4.10). Of these, only two had estimates of rise activation energies: a carnivorous aquatic protist and a carnivorous fish, and their mean activation energy is 0.31 eV ± 0.08. Three estimate of T_{pk} were obtained: a crustacean (omnivore), a fish (carnivore), and a protist (carnivore). The mean T_{pk} for the two carnivores was 18.45°C ± 3.45, and the omnivore was 20°C. Additional empirical data are clearly required, but the few data available are consistent with the assumption of temperature invariance of conversion efficiency.

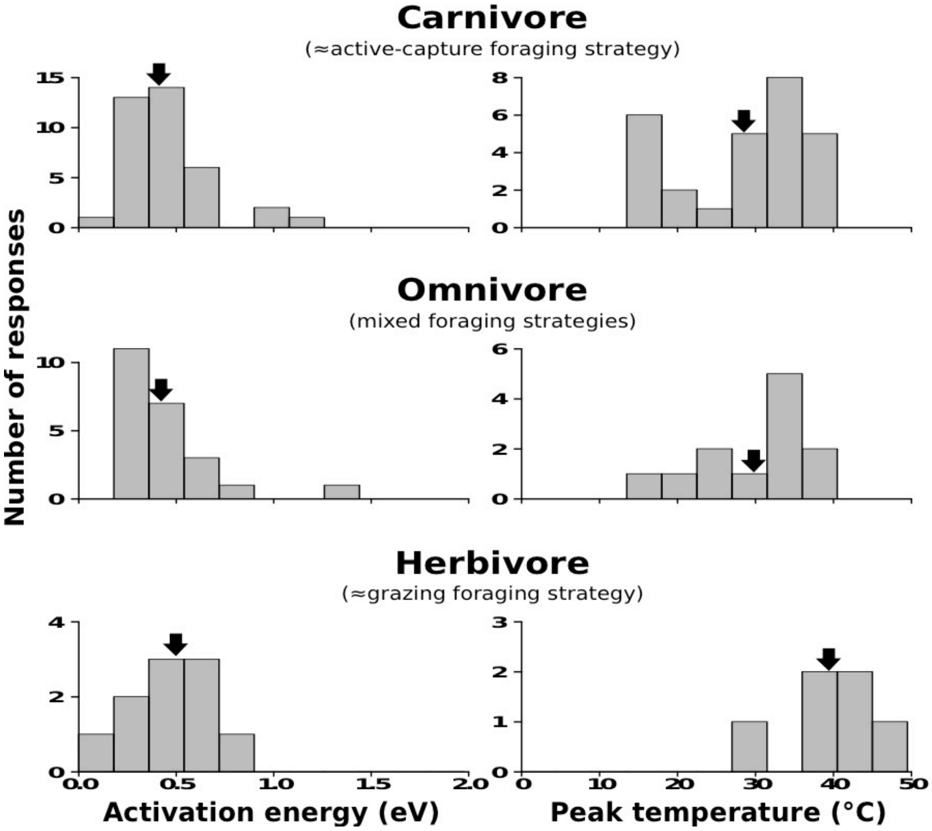

Figure 4.3. Variation in the rise activation energy (E) (left column) and peak temperature (T_{pk}) (right column) of the thermal dependence of body velocity (m × (individual × s)$^{-1}$). Responses are categorised by trophic group, which approximate foraging strategy: carnivore (active-capture), omnivore (mixed), and herbivore (grazing). Asymmetries in the thermal response of body velocity of consumer-resource pairs are predicted to lead to differences in equilibrium population densities, and will thus likely have important consequences at the population and community levels (see main text; Figure 4.1). Arrows denote mean values. See Chapter 2 and Chapter 3 for further details, including trait definitions and data sources.

4.3.4. Consumption Rate

Mean rise activation energy from 48 encounter and consumption rate responses is 0.73 eV ± 0.04. This value is the same for the median, indicating a symmetric distribution. Categorising responses by trophic group (Figure 4.4) reveals that carnivores (0.78 eV ± 0.05), herbivores (0.84 eV ± 0.13), and omnivores (0.65 eV ± 0.08) all have mean activation energies that are statistically indistinguishable. These data include 44 species of worms, arachnids, crustaceans, and insects (Appendix 3.2). The mean for the 43 T_{pk} estimates for encounter and consumption rates is 19.42 °C ± 1.02. Categorising responses by trophic group (Figure 4.4)

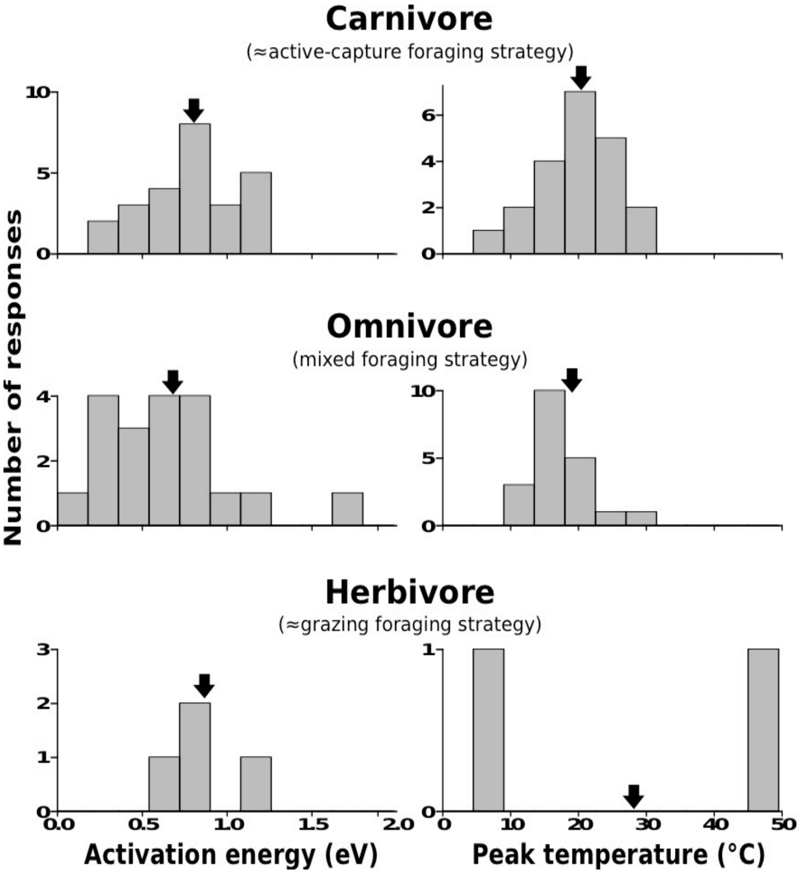

Figure 4.4. Variation in the activation energy (E) (left column) and peak temperature (T_{pk}) (right column) of combined data for the thermal response of encounter (events / (individual × s) $^{-1}$) and consumption (resources / (consumer × s) $^{-1}$) rates. Responses are categorised by trophic group: carnivore (active-capture), omnivore (mixed), and herbivore (grazing). Encounter and consumption rate data can be straightforwardly combined when probability of attack and probability of success are temperature invariant, as assumed in the model (main text). Asymmetries in the thermal response of encounter and consumption rates of consumer-resource pairs are predicted to lead to differences in equilibrium population densities, and will thus likely have important consequences at the population and community levels (see main text; Figure 4.1). Arrows denote mean values. See Chapter 3 for further details, including trait definitions and data sources.

reveals that carnivores (20.03 °C ± 1.22) have a statistically indistinguishable mean T_{pk} from omnivores (18.01 °C ± 1.06). There were only two T_{pk} estimates for herbivores (Figure 4.4). Very few data are available on the thermal responses of attack rates. In fact, I only found a single attack rate estimate from a carnivorous tiger beetle, with an activation energy of 0.66 eV. I did find data on bite rate, which is the number of bites or analogue (e.g., radular scrape) per consumer per time. The four herbivores—two caterpillars and two molluscs—for which E estimates are available, show that bite rate rises have a mean activation energy of 0.46 eV ± 0.03. Only two T_{pk} estimates for attack rate were found: 34.72°C for a carnivorous tiger beetle and 12.5°C for an omnivorous fish. Only four data series for how handling rate $(1/t_h)$ varies with temperature were well fit ($R^2 \geq 0.5$ and the F test P value <0.05) to the Boltzmann-Arrhenius model found (Chapter 3). These were all for trait rises. Handling rate included subjugation-through-consumption rate (N=2), which I assume is a constant fraction of handling rate. The mean E for these four responses is 0.68 eV ± 0.14. Three of these four responses were for carnivores, including a fish, a lizard, and an aquatic true bug (Appendix 3.2), with a mean E of 0.63 eV ± 0.18.

4.4. Discussion

Temperature systematically affects the physiology of individuals, and these physiological effects integrate to drive species interactions and the dynamics and stability of populations and communities. By combining models of the temperature dependence of physiological rates with existing theory for the dependence of search and consumption rate on body size, I construct a general framework for predicting effects of temperature on consumer-resource interactions. Using this framework it is possible to make specific predictions about how temperature change, such as climate change or seasonal variation, might alter the dynamics of interacting species. In the theory, the effects of temperature on consumer-resource interactions arise primarily through effects on body velocity. Therefore, when one species is sessile, such as the consumer in a sit-and-wait interaction and the resource in a grazing interaction, temperature effects on encounter rate arise only through the species that is moving (Table 4.1; Figure 4.2) (Vucic-Pestic *et al.* 2011). When both species are moving, such as in active-capture interactions, temperature dependence arises by influencing the body velocity of both species. This mechanism has been proposed previously (Vucic-Pestic *et al.* 2011), but not in a generalised way that applies to all consumer-resource interactions. Temperature effects also depend on the thermy of the interacting species. Endothermic body temperature remains relatively constant despite changes in environmental temperature, so body velocity is largely invariant to temperature change. In contrast, the body temperature of ectotherms varies with environmental temperature, and thus, their body velocity does too. The thermal predictions for consumer-resource interactions therefore depend on both the foraging strategy (Table 4.1) and the thermy of the interacting species.

I test the predictions and assumptions of the theory with data from a diverse range of taxa and habitats (Chapter 2 and Chapter 3). I use trophic group as a proxy for foraging strategy, but future analysis should use data for which the foraging strategy of the consumer-resource pair is explicitly known. Similarly, future analyses should use thermal response data from directly interacting species, which will require a new generation of empirical data. In experiments currently underway, I am using video and automated tracking software to better characterise temperature effects on the mechanics (e.g., foraging strategy, attack and escape body velocity, encounter rates, attack success probabilities, consumption rates) of specific consumer-resource pairs. New empirical data on how temperature influences the population dynamics of consumer-resource pairs are also required and experiments at the mesocosm and microcosm level should be useful here (e.g., Yoshida *et al.* 2003).

A key insight of this chapter is how asymmetries in the thermal response of interacting species (Figure 4.1) can qualitatively and quantitatively affect their population dynamics. These asymmetries are captured by the newly defined asymmetry factor, Δ (Eqn. 4.8). When consumer and resource have the equivalent body temperature and activation energies, the asymmetry factor (Δ) equals one, and changes to temperature should not quantitatively affect consumer-resource population dynamics. However, asymmetries will exist when $\Delta \neq 1$ (Figure 4.1; Table 4.1), and thus changes in consumer-resource dynamics and their outcomes, such as equilibrium population densities (Table 4.1), are expected. Asymmetries could arise due to differences in activation energies (e.g., life-dinner-principle, Chapter 3), thermy (e.g., ectotherm vs. endotherm), or thermoregulation (e.g., two ectotherms with different body temperatures) (Figure 4.1b). For example, I predict that across most temperatures ectotherms will likely be relatively slower and weaker at low temperatures, and endothermic consumers feeding on these ectothermic resources will therefore have higher success rates for capture and attack at these lower temperatures (Christian & Tracy 1981). When both consumer and resource are ectothermic, escapes and failed attacks may be more common at low temperatures because escape body velocity typically remains close to peak levels and is thus higher than attack body velocity (Figure 4.1b) (Chapter 3). For ectothermic pairs, consumers should also be much better at attacking resources when temperatures exceed the peak temperature (T_{pk}) for the resource but not for the consumer (Figure 4.1c). For interactions involving two endotherms, there should be little or no temperature dependence. An additional key prediction of the theory is how resource equilibrium densities can respond to temperature (Table 4.1). If this holds in real systems, it suggests susceptibility to extinction due to overexploitation. That is, extinction rates may increase as the temperature increases and consumers increase their ability to find resources. Future studies will further elucidate coexistence conditions.

Conditions promoting asymmetries in the response of traits relevant to trophic interactions will exist in virtually all ecosystems. Moreover, each of the scenarios in Figure 4.1 should become more likely as species change their geographic and temporal niches in response to climate change. It is now well established that warm-adapted species are moving into regions that were previously too cold, and that climate change is altering the phenology of many plants and animals (Walther *et al.* 2002; Parmesan & Yohe 2003; Logan *et al.* 2006; Logan 2008; Pörtner & Farrell 2008; Burrows *et al.* 2011; Chen *et al.* 2011; Urban *et al.* 2012). Climate change could elicit such shifts when warming cues occur earlier in the year, while other cues, such as seasonal light conditions, remain constant. These differences in environmental drivers could potentially cause matched species interactions to become uncoordinated (Pörtner & Farrell 2008), and new combinations of interacting species to arise.

Importantly, the theory can be easily modified to account for additional factors that may be important in natural systems. First, although the theory explicitly deals with the rise part of the thermal response (to provide a simpler foundation upon which more complexity can be added and to allow more direct connection to previous theory and data), other models of thermal dependence could easily be substituted. For example, a full unimodal model (Eqn. 4.2) could easily be substituted to replace the equation for the rise response (Eqn. 4.1). Doing so may amplify and possibly exacerbate effects of temperature because of the new asymmetries introduced by differences in peak temperatures and rates of fall among species (Figure 4.1) (Deutsch *et al.* 2008; Farrell *et al.* 2008; Pörtner & Farrell 2008; Tewksbury *et al.* 2008; Huey *et al.* 2009b; Englund *et al.* 2011b). Second, although the predictions based on the assumption of random movement, many of these results will likely still hold for a wide variety of search and movement patterns (Cantrell *et al.* 2006; Chen *et al.* 2008; Humphries *et al.* 2010; Smouse *et al.* 2010). Provided that the directional movement of the consumer relative to the resource is independent of body temperature, other non-random patterns of movement could be substituted straightforwardly into the framework presented here. Indeed, non-random movement may explain why the average activation energy of consumption rate (0.73 eV ± 0.04) is almost double that for body velocity (0.46 eV ± 0.03). Consumption rate should scale similarly with relative velocity, but in cases of non-random movement, the individual body velocities may combine non-additively (e.g., multiplicatively) to determine relative velocity. Third, I assume that consumer search space dimensionality (*D* in Eqn. 4.3) is independent of temperature, but it is possible that a correlative (but not causal) dependence between dimensionality and temperature exists because aquatic environments are likely to be dominated by 3*D* interactions (see Chapter 5) and also have a lower variance in temperature. Fourth, I assume that resource equilibrium population density and carrying capacity scale identically with temperature, but differences in these dependencies can be incorporated. At carrying capacity, the resource population is utilising all nutrients coming into the system, so the number of resource individuals is equal to the rate of nutrient supply divided by individual metabolic rate (Damuth 1981; Savage *et al.* 2004). When nutrient supply rate varies according to the Boltzmann-Arrhenius model, this will cancel with the temperature dependence of individual metabolic rate such that carrying capacity should be temperature independent (Allen *et al.* 2002; O'Connor *et al.* 2011). However, when nutrient supply rates themselves are temperature independent, carrying capacity will have an inverse Boltzmann-Arrhenius dependence (Savage *et al.* 2004). For Type II responses, the temperature dependence of resource density is the same as for Type I because the temperature dependence of handling time cancels that of the equilibrium density (Table 4.1).

The theory I present provides a framework that should prove useful for studying temperature effects on consumer-resource interactions, extinctions, and invasions that has the potential to apply to diverse taxa and habitats. Predicting trophic interactions strength is key to understanding effects in complex food webs, such as indirect interactions and polyphagy (Laska & Wootton 1998; Rip & McCann 2011). This framework can be used to make predictions about how food-web organisation differs between tropical and temperate regions, potentially explaining distributions of foraging strategies between habitats and across latitudes. Integration of the theory for thermal dependence with theory for other environmental drivers (e.g., light, moisture, habitat dimensionality) should account for even more variation in the dynamics of consumer-resource interactions. Understanding how temperature controls each component trait of a consumer-resource interaction would be a major step forward in predicting how seasonal variation and climate change affect the strength of species interactions, and specifically consumption rate and associated effects on population dynamics.

Chapter 5. The Effects of Habitat Dimensionality on Consumer-Resource Interactions[6]

5.1. Introduction

Consumers and resources interact in a wide array of habitats, ranging from deserts to pelagic zones. Understanding how physical differences between habitats, such as precipitation, temperature, and spatial dimensionality, affect trophic interactions is key to understanding variation in ecological systems (Briand & Cohen 1987; Cohen 1994; Ritchie 2009; Rip & McCann 2011). Because consumption rate (energy acquisition) is closely tied to metabolic rate (energy use), current models assume that per-capita consumption rates scale with consumer body mass (m) to the canonical exponent of ¾ (= 0.75), irrespective of taxon and environment (Yodzis & Innes 1992; Brown *et al.* 2004; Brose 2010). Biomass flow rate and interaction strength of each trophic link are typically defined in food-web research as mass-specific quantities and are thus posited to scale as $m^{-0.25}$ (Yodzis & Innes 1992; Brose *et al.* 2006a; Berlow *et al.* 2009; Brose 2010).

Although quarter-power scaling is a key component of models for ecosystem dynamics (Brose *et al.* 2006a; Berlow *et al.* 2009; Brose 2010), deviations can arise for at least two reasons. First, non-metabolic constraints of consumer size (e.g., limb length) are important when foraging and do not necessarily scale according to metabolic rate (Peters 1983). Second, species interactions in the field do not occur under the idealised conditions at which metabolic rates are often measured, when individuals are not typically foraging, growing, or reproducing (Peters 1983; Schmidt-Nielsen 1984). Therefore, consumption rate scaling should be governed by field or maximal metabolic rate (exponent >0.85), rather than by the more frequently measured resting metabolic rate (exponent ≈0.75) (Peters 1983; Weibel *et al.* 2004).

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Both non-metabolic and metabolic constraints on consumption rate may depend on spatial dimensionality because it strongly influences cost of locomotion (Schmidt-Nielsen 1984) and probability of detection (McGill & Mittelbach 2006). Indeed, dimensionality was first proposed as a mechanism driving food web and ecosystem dynamics over two decades ago (Briand & Cohen 1987; Holling 1992; Cohen 1994). Subsequent studies have sought to elucidate the effects of habitat dimensionality (Whitehead & Walde 1992; Wilson *et al.* 1995; Witting 1995; Cyr *et al.* 1997b; Ritchie & Olff 1999; Ritchie 2009). Of particular significance, Witting (1995) and Ritchie (Ritchie & Olff 1999; Ritchie 2009) developed insightful models for how grazers (a specific type of consumer) are constrained by spatial distribution of resources. These studies are foundational, but cannot account for differences in detectability based on resource body size and do not apply to the wide range of consumer strategies within real communities (Figure 5.1).

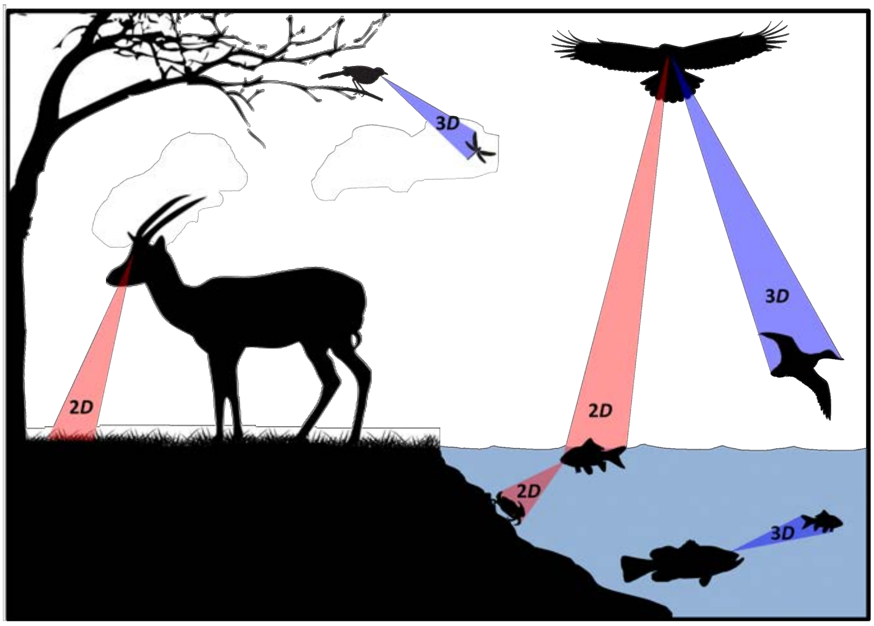


Figure 5.1. Illustration of how consumer-resource interactions can be classified by their dimensionality. In 2D interactions (red), consumers search for resources on habitat surfaces (e.g., water surface, benthos, grassland), while in 3D interactions (blue) consumers search throughout the habitat volume by flying, swimming, or sitting-and-waiting. Dimensionality is defined by each consumer-resource pair, so the same consumer or resource may be involved in both 2D and 3D interactions corresponding to different pairings. See Appendix 5.6 for criteria used to determining interaction dimensionality.

Currently, no mechanistic theory predicts the full effects of dimensionality on interaction strengths in food webs (Yodzis & Innes 1992; Brose *et al.* 2006b; Berlow *et al.* 2009; Brose 2010). In this chapter I show that shifting focus from dimensionality of the habitat (Briand & Cohen 1987; Whitehead & Walde 1992; Wilson *et al.* 1995; Witting 1995; Cyr *et al.* 1997a; Ritchie 2009) to dimensionality of each trophic interaction (potentially allowing both 2*D* and 3*D* interactions in the same habitat; Figure 5.1) yields a novel, predictive theory for trophic interaction strengths. This theory is tested with a dataset on per-capita consumption rate for 255 consumer-resource interactions that cover 230 species, 12 orders of magnitude in body size, and a variety of aquatic (189 interactions) and terrestrial (66 interactions) habitats. Interaction dimensionality is assigned based on the consumer's search space as either 2*D* (area) or 3*D* (volume) (Figure 5.1; Appendix 5.6).

5.2. Data Methods

5.2.1. Data Compilation

Functional Response

Data on consumption rates were obtained as described in Chapter 2, with some additional data obtained from the literature detailing consumption rates at different resource densities for a single temperature. Consumer and resource body masses for this additional data were obtained from the original study when reported or were estimated (see Section 3.2.5). Studies where consumer density or resource choice (simultaneous consumption of multiple resources) was manipulated were excluded. In total, data were extracted from 118 studies, which yielded 309 functional responses from interactions among 262 consumers and resource (including species and life stages) from all major habitats (176 freshwater, 63 marine, and 70 terrestrial) (Appendix 5.1). These data represent 230 species (96 orders) spanning 18 orders of magnitude in body size (5.24×10^{-16} – 800 kg). The majority (96%) of these data were measured under controlled laboratory or field enclosure conditions, the remainder being estimated from predation data in the field. Functional responses were classified as being nonlinear, linear, or concave upwards by OLS regression fits to a quadratic polynomial model. Of the 309 functional responses in the database, 86% show a nonlinear functional response.

Reaction Distance

Data on reaction distance and corresponding body mass estimates were obtained using the same methods as for functional responses (see above). Studies were excluded that used inanimate objects (e.g., animal models) as either consumer or resource. The majority (89%) of these data were measured in the laboratory. All distances were converted to meters. The resulting dataset (Appendix 5.2) consists of 39 unique interactions (from 35 studies, 22 aquatic and 17 terrestrial) between 56 taxa spanning 11 orders of magnitude in body size (1.8×10^{-9} – 200 kg).

Handling Time

Data on handling time were obtained using the same methods as for functional responses (see above). Only studies that directly measured handling time were included. This excluded most studies that estimated handling time by fitting Type II or III functional response models. All handling times were converted to seconds. The resulting dataset (Appendix 5.3) consists of 78 interactions (from 89 studies, 45 aquatic and 33 terrestrial) between 93 taxa spanning ten orders of magnitude in body size (3×10^{-10} – 4 kg).

Consumer-Resource Pairs from Real Communities

Data on seven food webs were compiled from the literature for communities across a wide range of terrestrial and aquatic habitats (Appendix 5.5). When body mass data were missing, estimates were obtained using methods described below (Section 3.2.5). These seven communities comprise a total of 2,930 interactions between 854 species. Each interaction was assigned a dimensionality using the methods described below (Section 5.2.2).

5.2.2. Classification of Interaction Dimensionality

Each unique consumer-resource pair was assigned an interaction dimensionality based on search space and foraging strategy using the criteria shown in Figure 5.1 and Appendix 5.6. Most (97%) terrestrial interactions in the database were 2*D,* while most (73%) aquatic interactions were 3*D*. These differences arise partly because it is difficult to measure consumption rates in flying consumers-resource pairs in terrestrial habitats and because of other biases in the choice of study taxa. The foraging strategy of interacting consumer-resource pairs was determined from the literature. The final interaction dimensionality designations for the consumption rate, detection distance, handling time, and consumer-resource interactions are shown in Appendix 5.1 –Appendix 5.5.

5.2.3. Body Size Estimation

Wet body mass was estimated using the procedure described in Chapter 2 (Section 2.2.7).

5.2.4. Temperature Corrections

Consumption rates and handling times are often measured at different temperatures, often by the same researchers using the exact same protocol and organisms. Because temperature strongly affects biological rates and times (Chapter 3), comparisons of consumption rate and its components require corrections for body temperature, especially for ectotherms whose body temperature varies with ambient temperature (Deutsch *et al.* 2008; Angilletta 2009). Ectotherm body temperature was assumed to match ambient temperature, unless actual body temperature was measured and reported directly. This assumption is reasonable because most (96%) of the traits in the database were measured under temperature controlled laboratory conditions where individuals had sufficient acclimation time such that body temperature equalled experimental temperature (directly validated in most studies). For endotherms, estimates of mean body temperature were obtained from the literature. Thus, each consumption rate and handling time measure was associated with a body temperature. Reaction distance is not expected to exhibit temperature dependence (Chapter 3, Chapter 4). Measures of consumption rate and handling time were standardised to 15°C using the Boltzmann-Arrhenius model

$$C_{15} = C_{T_{obs}} e^{-\frac{E}{k}} \left(\frac{1}{288.15} - \frac{1}{273.15 + T_{obs}} \right) \tag{5.1}$$

where c is measured consumption rate, T is temperature in Kelvin, E is activation energy, k is Boltzmann’s constant, and T_{obs} the observed body temperature (°C) of the consumer. The Boltzmann-Arrhenius model has been shown to be suitable for modelling thermal responses of a wide array of biological rates, at least up to an optimal temperature range (Chapter 3, Chapter 4). 15°C was chosen because many traits, especially in aquatic habitats, peak at or below 20°C (Chapter 3). An activation energy (E) of 0.65 eV was used, which is the mean value observed across a wide range of biological rates (Chapter 3). For handling time, the appropriate correction is the inverse Boltzmann-Arrhenius model

$$t_{h,15} = t_{h,T_{obs}} e^{\frac{E}{k}} \left(\frac{1}{288.15} - \frac{1}{273.15 + T_{obs}} \right) \tag{5.2}$$

Note that unless one of the consumer or resource is an endotherm, the activation energy (E) in eqns 5.1 and 5.2 will be a combination (e.g., average and/or difference) of their activation energies (which I explored in detail in Chapter 4).

5.2.5. Data Conversions

All data were converted to SI units. Consumption rate is measured and expressed in a variety of ways in the literature, so estimates were all converted to consumer per-capita resource biomass consumption rate, i.e., kg resource/(consumer×s×m^2 (in 2D) or ×m^3 (in 3D)). Resource densities were converted to kg/m^2 (2D) or kg/m^3 (3D) by multiplying number density with average resource mass.

5.2.6. Pseudoreplicates

Data series having the same consumer and resource taxa, life stage, habitat, and consumer body mass were identified as belonging to the same pseudoreplicate group. From each of these groups, only the trial with the maximum consumption rate (c), with abundant resources was retained. This minimised the confounding effects of size-ratio variation within species pairs, and instead allowed focus on the scaling of consumption rate with consumer size across pairs. After removal of pseudoreplicates, the original set of 309 responses reduced to 255.

5.2.7. Statistical Analysis

Scaling relationships

Ordinary least squares (OLS) regression of log-transformed x and y data was used to determine scaling relationships of consumption rate and its components. Major axis (MA) regression was not used because the objective was to obtain the most accurate (not necessarily the least biased) prediction of the scaling of consumption rate components with respect to body mass (Sokal & Rohlf 1995; Warton *et al.* 2006). Using MA regression yields steeper exponents than those reported here, but this choice did not alter the main result about differences between 2D and 3D interactions. An F test was used to test whether an observed exponent matched predictions, and the 95% CI's around the observed exponent was examined to see whether it included the predicted value. The significance of difference between two observed exponents (e.g., between 2D and 3D interactions) was tested using a likelihood ratio test of common slope with unknown error variance (Warton *et al.* 2006).

To determine if foraging strategy influences the scaling of search and consumption rates, I examined whether subsets of 2D and 3D interactions classified as active-capture, sit-and-wait, and grazing, had significantly different scaling slopes and intercepts.

Functional responses

To identify the type of each functional response in the database, a generalised model was used (Eqn. 5.28. This model was fitted to each functional response using non-linear least squares (NLS) (Appendix 5.1). The NLS can yield $t_h < 0$, $q < 0$, or both. Negative t_h is biologically impossible, but indicates an upward curving response. Negative q is biologically unlikely as it indicates a decline in search rate with resource density (Vucic-Pestic *et al.* 2010), but is useful as a measure of deviation away from a Type III response. Neither t_h or q were restricted to be ≥ 0 in the NLS fitting algorithm iterations to ensure the best possible NLS fit and thus the best characterisation of functional response shape. Nevertheless, none of the negative t_h values returned by the NLS regression were significantly different from zero (Supplementary Table 5). To determine whether the shape of the functional response was systematically different between 2D and 3D interactions, all fitted responses with $R^2 < 0.5$ were dropped, and tested for differences in means of the q value distribution (one-tailed t-test with unequal variance). The mean value of q in 2D (0.41±1.14 SD) is higher than in 3D (0.31±0.74), but not significantly so ($t = 0.79$, p=0.21).

5.3. Consumption Rate Scaling Model

Here I extend the theory described in Chapter 4 that details the temperature and body size dependence of consumer-resource dynamics to derive a model for how per-capita biomass consumption rate scales with body size and is influence by the dimensionality of consumer search space. The model explicitly predicts the influence of the dimensionality of the search space of consumers for resources by considering size constraints on the components of consumption rate (Section 5.3.1 – 5.3.4. Figure 5.2 illustrates the model, and Table 5.1 summarises it). Throughout model development, key assumptions were empirically validated and empirical estimates of scaling exponents obtained. For these empirical tests, ordinary least squares (OLS) was used rather than major axis (MA) regression because the objective was to obtain the most accurate (not necessarily the least biased) prediction of the scaling of consumption rate components with respect to body mass (Sokal & Rohlf 1995; Warton *et al.* 2006). Using MA regression yielded steeper exponents than those reported here, but does not alter the main result about differences between 2*D* and 3*D* interactions.

5.3.1. Relative Velocity

Encounter rate between consumers and resources is partly determined by their relative velocity, v_r (units of distance/time), which is the population average for how fast a consumer and resource move across the physical landscape relative to each other (Figure 5.2). Assuming random movement (see below), relative velocity is the root mean square (Okubo 1980) of the average velocity of the consumer (v_C) and resource (v_R)

$$v_r = \sqrt{v_R^2 + v_C^2} \qquad 5.3$$

If either the resource (i.e., grazing interaction) or the consumer (i.e., sit-and-wait interaction) is sessile, v_r reduces to the velocity of whichever of the two is moving (Figure 5.2). Beginning with the simplest case of random movement, a simple functional form for search and encounter rate can be obtained that resembles real systems. Indeed, for most animals foraging seems to follow diffusion-like movement (distance scaling with square root of time) more than directional (distance scaling linearly with time) (Werner & Anholt 1993; Crowley & Hopper 1994; Aljetlawi *et al.* 2004). When foraging is directed, more complicated models for v_r can be easily substituted.

To derive the scaling of v_r, I begin with the size dependence of individual metabolic rate (B), which scales with body mass (m) as

$$B = B_0 m^{\beta} \qquad 5.4$$

B_0 is a coefficient that depends upon taxon, metabolic state, and body temperature. The exponent β typically varies between two thirds and one for multicellular eukaryotes (Peters

1983; DeLong *et al.* 2010), with smaller exponents normally associated with resting and larger exponents with active (field, maximal) metabolic states (Peters 1983; Johnston *et al.* 1991; Clarke & Johnston 1999; Weibel *et al.* 2004; Nagy 2005; DeLong *et al.* 2010). If the scaling of metabolic rate devoted to locomotion is a constant proportion of B, then one can use the fact that power expended for movement is the product of body velocity (v) and force (F) applied by the locomotory appendage (leg, wing, tail, etc.) onto the environmental medium, to derive

$$v = \frac{B_0 m^{\beta}}{F} \tag{5.5}$$

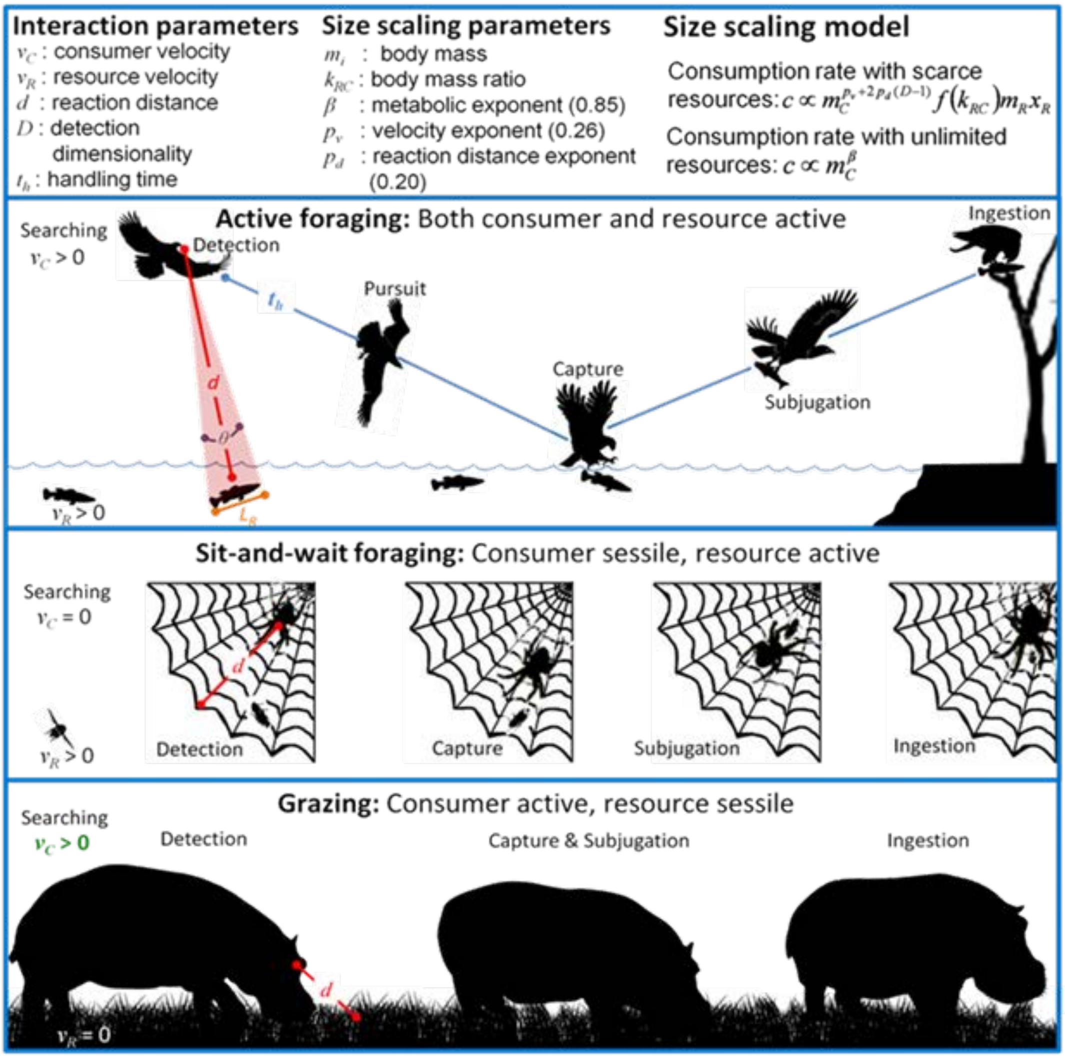


Figure 5.2. Schematic for classification of foraging strategies and components of consumption rate**.** The active foraging and grazing interactions shown are 2*D* because consumers search for resources in two dimensions (water surface and grassland, respectively). The sit-and-wait interaction is 3*D* because the spider web can trap ("search") resource individuals that are flying in three dimensions. The reaction distance model is illustrated in the active foraging interaction (top panel).

Table 5.1. Consumption rate scaling model and its components for different foraging strategies**.** See Figure 5.2 for definitions of mathematical symbols. The scaling of resource size (m_R) and resource density (x_R) (Figure 5.3G–J) are not shown here because they are not a part of consumption rate scaling model *per se*, but are required to empirically test the model (see Section 5.3.5).

Model parameter	Size scaling model by foraging strategy		
	Active foraging	Sit-and-wait	Grazing
Relative velocity (v_r)	$v_0\sqrt{m_R^{2P_v}m_C^{2P_v}}$	$v_{R.0}m_R^{P_v}$	$v_{c.0}m_C^{P_v}$
Reaction distance (d)	$d_0(m_R m_C)^{Pd}$		
Handling time (t_h)	$t_{h,0}^{-1}m_C^{-\beta}$		
Search rate (α)	$\alpha_0 m_C^{P_v+2P_d}f(k_{RC})$ in 2D $\alpha_0 m_C^{P_v+4P_d}f(k_{RC})$ in 3D		
Consumption rate $(c\lim xR\rightarrow 0)$	$\alpha_0 m_C^{P_v+2P_d}f(k_{RC})m_R x_R$ in 2D $\alpha_0 m_C^{P_v+4P_d}f(k_{RC})m_R x_R$ in 3D		
Consumption rate $(c\lim xR\rightarrow \infty)$	$t_{h,0}^{-1}m_C^{\beta}$		
Scaling coefficient (α_0)	$2v_0 d_0$ in 2D $\pi v_0 d_0^2$ in 3D	$2v_{R,0}d_0$ in 2D $\pi v_{R,0}d_0^2$ in 3D	$2v_{C,0}d_0$ in 2D $\pi v_{C,0}d_0^2$ in 3D
Size ratio scaling $(f(k_{RC}))$	$\sqrt{1+k_{RC}^{2P_v}k_{RC}^{P_d}}$ in 2D $\sqrt{1+k_{RC}^{2P_v}k_{RC}^{2P_d}}$ in 3D	$k_{RC}^{P_v+P_d}$ in 2D $k_{RC}^{P_v+2P_d}$ in 3D	$k_{RC}^{P_d}$ in 2D $k_{RC}^{2P_d}$ in 3D

Force is proportional to the cross-sectional area of body and appendage muscles, which scales with body mass to an exponent, β_F, that typically varies between 0.5 – 0.67 (Peters 1983; Schmidt-Nielsen 1984; Savage *et al.* 2007b). Thus, Eqn. 5.5 becomes,

$$v = v_0 m^{\beta-\beta_F} \tag{5.6}$$

Here, v_0 is a constant that depends on locomotory mode (Peters 1983; Bejan & Marden 2006) and the metabolic scaling constant B_0 (Eqn. 5.4). Using the scaling of field to maximal metabolic rate (0.8–0.9; see text following Eqn. 5.4), v should scale with mass to an exponent between 0.13 (β = 0.8, β_F = 0.67) and 0.4 (β = 0.9, β_F = 0.5). Henceforth, $p_v \equiv \beta - \beta_F$. Substituting Eqn. 5.6 into Eqn. 5.3 gives the scaling of v_r for an active consumer capturing active resources (“active” strategy) (Figure 5.2)

$$v_r = \sqrt{v_{0,R}^2 m_R^{2p_v} + v_{0,C}^2 m_C^{2p_v}} \tag{5.7}$$

Within the same habitat and for similar locomotory modes $v_{0,R} \cong v_{0,C} \cong v_0$, so Eqn. 5.7 simplifies to

$$v_r = v_0 \sqrt{m_R^{2p_v} + m_C^{2p_v}} \qquad 5.8$$

Analogous equations for sit-and-wait and grazing strategies are provided in Table 5.1. These equations predict that larger sized consumer-resource pairs will converge in space faster than smaller ones, and that v_r will approximately equal the body velocity of the faster of the two individuals (often the larger) for active strategy interactions in which consumer and resource have significantly different velocities.

Empirical Validation of Body Velocity

The empirical scaling of body velocity has been extensively studied for various running, swimming, and flying animals (Peters 1983; Schmidt-Nielsen 1984). The exponent ranges between 0.10–0.38 (see Appendix VIb of Peters 1983; Bejan & Marden 2006). This is in excellent agreement with the range 0.13–0.4 predicted above (Eqn. 5.6). For ease of calculation and comparison, I use the average of the values reported by Peters (1983), which gives $p_v = 0.26 \pm 0.04$ (±95% confidence intervals (CI), $n = 25$). As show in Sections 5.3.3 – 5.3.5 and Table 5.2, using either extreme value of p_v (0.13 or 0.4) does not qualitatively affect the results.

Table 5.2. Effect of variation in the scaling of body velocity on the scaling of search and consumption rate.

Velocity scaling exponent (p_v)	Search rate		Consumption rate	
	2*D*	3*D*	2*D*	3*D*
0.13	0.50	0.90	0.65	1.03
0.26	0.63	1.03	0.78	1.16
0.40	0.77	1.17	0.92	1.30

5.3.2. Reaction Distance

An encounter occurs when the consumer detects the resource or vice versa (Figure 5.2). Therefore, encounters are constrained by the maximum distance (reaction distance, d) at which the consumer and resource can sense and react to each other, as well as the shape of their detection region. For a homogeneous habitat, consumers will search a D-dimensional sphere, independent of detection modality. Therefore, from the formula for the surface area of a D-dimensional sphere, the detection region $S_D = (\pi^{(D-1)/2}/\Gamma((D+1)/2))d^{\,D-1}$ where $\Gamma(.)$ is the gamma function. Substituting the different dimensions therefore gives,

$$\begin{gathered} S_D = 1 \text{ in 1D} \\ S_D = 2d \text{ in } 2D \\ S_D = \pi d^2 \text{ in } 3D \end{gathered} \quad 5.9$$

The detection region is classified as 2*D* when both consumer and resource move in 2*D* (e.g., both are benthic) or if a consumer moves in 3*D* and a resource in 2*D* (e.g., pelagic consumer on benthic resource). The detection region is classified as 3*D* when both consumer and resource move in 3*D* (e.g., both pelagic) or if the consumer moves in 2*D* and resource in 3*D* (e.g., benthic consumer, pelagic resource). Equation 5.9 also predicts that 1*D* consumers will encounter resources independent of reaction distance as long as $v_r>0$ (Eqn. 5.8; Table 5.1). Because a 1*D* search space is rare in nature, I henceforth focus on 2*D* and 3*D* cases. Nonetheless, Eqn. 5.9 can be easily used to make scaling predictions for search rate in 1*D* interactions, as is done for 2*D* and 3*D* in Section 5.3.3 below.

For the scaling of *d*, I use a simplified version of a model previously developed by McGill & Mittelbach (2006):

$$d = d_0 (m_R m_C)^{Pd} \quad 5.10$$

where the exponent p_d is expected to be close to 1/3 and d_0 is a constant depending on sensory properties of the consumer and the shape of the resource. This model (illustrated in Figure 5.2, top panel) is based upon the intuition that *d* should increase with both consumer and resource size because larger individuals have a higher vantage point, longer line of sight, and are easier to resolve at greater distances. The constant d_0 is expected to be lower for organisms with compound eyes (e.g., most arthropods) because of their lower visual acuity (Autrum 1981). In reality, reaction distance may actually scale differently from detection distance with an exponent smaller than 1/3 because larger organisms have poorer manoeuvrability, and increasing size often leads to relatively smaller attack distances (Blake & Domenici 2000; Alexander 2003; Dial *et al.* 2008). These effects will result in a decrease in p_d relative to that expected from visual constraints alone.

Empirical Validation of Reaction Distance

Taking the logarithm of both sides of Eqn. 5.10 allows it to be expressed as a multiple linear regression model with independent variables $\log(m_C)$ and $\log(m_R)$. However, these two variables are strongly correlated because m_R typically scales with m_C as

$$m_R = m_{R,0} m_{\boldsymbol{C}}^{Pm} \quad 5.11$$

The constant $m_{R,0}$ and exponent p_m have been observed to vary with interaction and environment type (Peters 1983; Cohen *et al.* 2005; Brose *et al.* 2006a). This scaling arises because certain size-ratios are energetically optimal or promote consumer-resource coexistence stability, or even both (Peters 1983; Cohen *et al.* 2005; Brose *et al.* 2006a). Substituting Eqn. 5.11 into Eqn. 5.10 gives,

$$d = d_0 m_{R,0}^{p_d} m_C^{p_d(1+p_m)} \tag{5.12}$$

Hence, I first use OLS regression of log(d) on log(m_C) to obtain the value of the exponent $p_d(1+p_m)$: 0.36±0.14 (±95% CI) in 2*D* and 0.49±0.11 in 3D (Figure 5.3A&B). I then estimate p_m separately in 2*D* and 3*D* interactions using the same reaction distance dataset. The reaction distance scaling model (Eqn. 5.10) is supported by data, with the exponent p_m = 0.67±0.17 in 2*D* and 1.46±0.12 in 3*D* (Figure 5.3C&D), which means that p_d = 0.36/(1+0.67) = 0.21 in 2*D*, and 0.49/(1+1.46) = 0.20 in 3*D*. It is to be expected that these exponents are lower than the 0.33 predicted from visual constraints, as discussed after Eqn. 5.10. Similar scaling models should apply to olfactory and auditory detection modes that are also common in nature, because these senses also tend to increase with consumer size as do the corresponding stimuli (signals) with resource size (e.g., Dusenbery & Snell 1995). Indeed, the test of the reaction distance model includes data on consumers that use olfactory (many insects, some mammals) and auditory (bats) cues (see Appendix 5.2), none of which show any notable deviations from the overall regression.

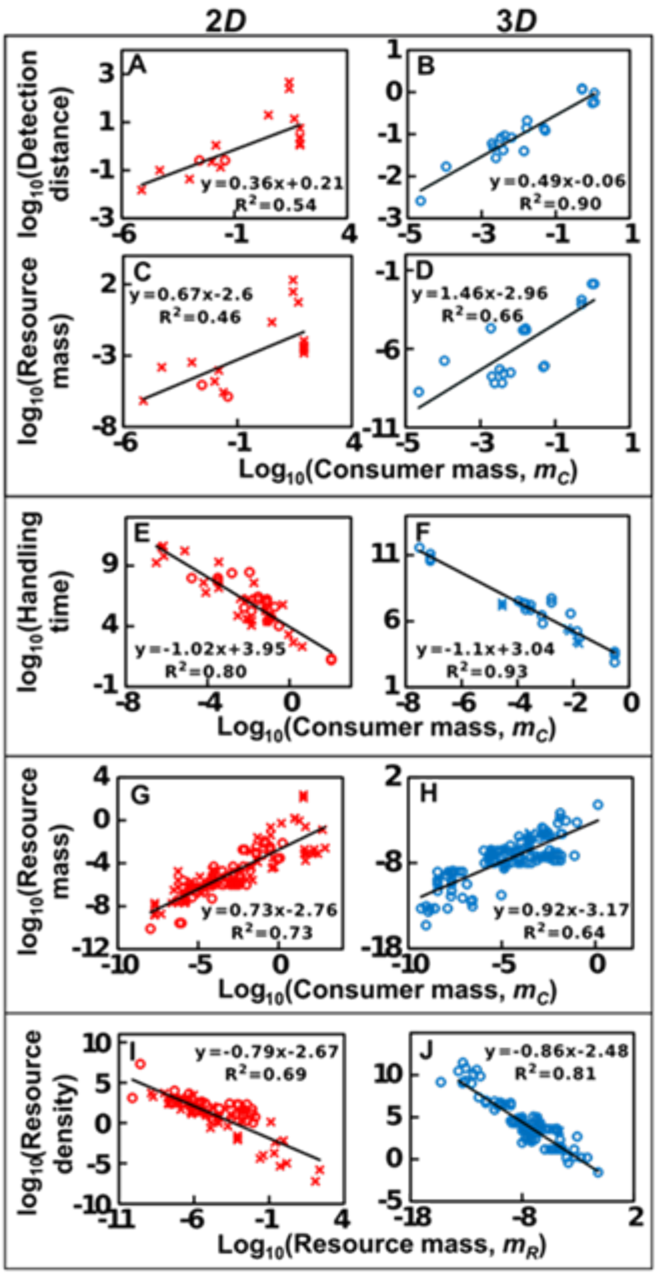
5.3.3. Search, Encounter, and Capture Rate

Multiplying S_D by v_r gives search rate, which is the potential rate at which the consumer clears the habitat of resource individuals (units of distance^D/time):

$$\alpha = v_r S_D \tag{5.13}$$

From Eqn. 5.9, $\alpha = 2v_r d$ (units of area/time) when the consumer searches for resources in 2*D*, and $=\pi v_r d^2$ (units of volume/time) in 3*D*. That is, in 2*D* (3*D*) interactions, over a period of time T the consumer will have “swept” a transect (tube) of habitat of area $2v_r dT$ (volume $\pi v_r d^2 T$) for resources. Thus, dimensionality of the search region, *D*, is equivalent to “interaction dimensionality” used throughout this paper. For 2*D* grazing, $v_r = 0$, and $\alpha = 2v_C d$, so α is a generalisation of Holling’s (Holling 1959a) “attack coefficient” to interactions with arbitrary foraging strategies and interaction dimensionalities. Multiplying search rate (α) by resource density gives encounter rate. Following an encounter, the consumer will succeed in capturing the resource with a probability (A) conditional on attack.

For each consumer-resource pair, I assume that consumers typically select resource sizes that maximise attack success, and therefore that A is approximately constant across pairs (or at least does not vary by orders of magnitude, as does body mass and search and consumption rate). For grazing, this assumption is expected to be particularly accurate because resources are either sessile (e.g., deer eating grass) or passive (e.g., zooplankton grazing) and capture success is practically guaranteed upon “attack” (Shipley *et al.* 1994).



A–D: Reaction distance, *d*, (m) exponent (Eqn. 5.12) is 0.36±0.14 (±95% CI) in 2*D* (**A**) and 0.49±0.11 in 3*D* (**B**). Within these data, the exponent p_m for scaling of resource mass (kg) with consumer mass (Eqn. 5.11) is 0.67±0.17 in 2*D* and 1.4±0.12 in 3*D* (panels **C**&**D**).

E–F: The resource mass-specific handling time, t_h, (s/kg) exponent is -1.02±0.08 in 2*D* (**E**) & -1.1±0.07 in 3*D* (**F**).

G–H: In the consumption rate dataset, resource mass scales with consumer mass with exponent p_m = 0.73±0.07 in 2*D* (**G**) and 0.92±0.08 in 3*D* (**H**).

I–J: Minimum resource density, x_R, (individuals/m^2 in 2*D* and individuals/m^3 in 3*D*) scales with resource mass (Eqn. 5.21) with exponent p_x = -0.79±0.09 in 2*D* (**I**) and -0.86±0.06 in 3*D* (**J**).

Figure 5.3. Scaling of the components of consumption rate**.** Left panels detail 2*D* (red) and right panels 3*D* (blue) interactions across aquatic (circles) and terrestrial (crosses) habitats. See Section 5.2 for description of regression fitting and discussion of these results. I combine these scaling relationships to obtain predictions for consumption rate scaling shown in Table 5.3.

In order to isolate the dependence of the parameters on consumer mass, I introduce the consumer-resource-size ratio, $k_{RC}=m_R/m_C$, which becomes another parameter that itself is well studied in relation to its distribution and dependence on consumer mass. Substituting Eqn. 5.10 into 5.9, combining this with Eqns. 5.8 and 5.13, and algebraically manipulating the right side of the resulting equation to separate the m_C and k_{RC} components, means that the scaling of search rate for active-capture interactions is,

$$\begin{aligned} \alpha &= \alpha_0 m_C^{p_v+2p_d}\sqrt{1+k_{RC}^{2p_v}}\,k_{RC}^{p_d} \quad \text{in 2D} \\ \alpha &= \alpha_0 m_C^{p_v+4p_d}\sqrt{1+k_{RC}^{2p_v}}\,k_{RC}^{2p_d} \quad \text{in 3D} \end{aligned} \qquad 5.14$$

$$\text{where } k_{RC} = m_R / m_C \qquad 5.15$$

and the constant $\alpha_0 = 2c_vc_d$ in $2D$ and πc_vc_d in $3D$. Analogous equations for grazing and sit-and-wait strategies are provided in Table 5.1. For all three foraging strategies, the first scaling term quantifies the locomotory (p_v) and detection ($2p_d$ in $2D$, $4p_d$ in $3D$) constraints on search rate (and hence consumption rate) imposed by consumer size, m_C. The second scaling term quantifies constraints due to consumer-resource size ratio (k_{RC}). The value of the exponent of scaling of α with k_{RC} depends upon foraging strategy and interaction dimensionality, being lowest for $2D$ grazing and highest for $3D$ sit-and-wait interactions (Table 5.1). Importantly though, differences in size-k_{RC} scaling exponents between foraging strategies (i.e., while keeping dimensionality fixed) are minor compared to differences between dimensionality (Table 5.1). Hence, foraging strategy has a much smaller effect on the scaling exponent and intercept of α than dimensionality. Also, if m_R scales almost linearly with m_C, k_{RC} will be almost constant, and α will scale primarily with m_C rather than k_{RC}. To quantify and control for the effect of k_{RC} on the scaling of α, Eqn. 5.11 is combined with Eqn. 5.15 to get

$$k_{RC} = m_{R,0} / m_C^{p_m - 1} \qquad 5.16$$

Then, as in the evaluation of the reaction distance time scaling model (Section 5.3.2), I estimate p_m separately for each dimension with OLS regression of resource mass on consumer mass using the functional response dataset (Section 5.2.1; Figure 5.3G&H). I find that $p_m = 0.73 \pm 0.07$ in $2D$ and 0.92 ± 0.08 in $3D$. Substituting these values for p_m together with empirically validated values for p_v (0.26; Section 5.3.1) and p_d (0.21 in $2D$, 0.20 in $3D$; Section 5.3.2) into Eqn. 5.14, gives the scaling of search rate shown in Eqn. 5.31 (see below):

$$\begin{aligned} \alpha &\sim \alpha_{2D} m_C^{0.63} \quad \text{in 2D} \\ \alpha &\sim \alpha_{3D} m_C^{1.03} \quad \text{in 3D} \end{aligned} \qquad 5.17$$

where c_{2D} and c_{3D} are constants that include α_0 and $m_{R,0}$ (Table 5.1). Table 5.2 shows how much the predicted scaling of α is expected to vary with scaling exponent for velocity (p_v) (Section 5.3.1). Clearly, the highest possible value in $2D$ (0.77 at $p_v = 0.4$) is much lower than the lowest possible value in 3*D* (0.9 at $p_v = 0.13$). Thus, results about the effect of dimensionality on search rate remain qualitatively unchanged irrespective of variation in p_v.

Empirical Validation of Search, Encounter, and Capture Rate

To empirically evaluate the predicted scaling in Eqn. 5.17, I first calculated the observed coefficients from OLS regression of log-search rates (α) from the functional response data (see Section 5.2) on log(m_C). These exponents were then compared with predicted ones using *F* tests and 95% CI's. I also tested whether 2*D* and 3*D* exponents differed significantly using a likelihood ratio test of common slope with unknown error variance (Warton *et al.* 2006). Results of this analysis are shown in Section 5.5. The empirical values of α were obtained as follows. For each functional response in the database, consumption rate (units of kg/s) at minimum measured resource density (kg/m^2 or kg/m^3) were extracted and divided by that minimal density. This methods was chosen instead of estimating α from fitted Type I, II, or III functional response functions because the theory is only relevant to the scaling of consumption under scarce vs. abundant resource densities, not the shape of the functional response (see Section 5.3.4).

5.3.4. Handling Time

Handling time is the time required by a consumer to pursue, subdue, and ingest individual resources, and this delay between encounter and consumption typically prevents consumers from exploiting resources in direct proportion to their availability (Holling 1959a; Jeschke *et al.* 2004). Long handling times result in the commonly observed Type II functional response (Holling 1959b; Jeschke *et al.* 2004)

$$c = \frac{\alpha m_R x_R}{1 + t_h \alpha m_R x_R} \qquad 5.18$$

Here, t_h is resource-mass-specific handling time. When resources become unlimited ($x_R \rightarrow \infty$), $c \rightarrow 1/t_h$, as the consumer should achieve maximal population growth rate, $r_{\max} = 1/(m_C t_h)$. The quantity $1/m_C$ converts consumed resource biomass ($m_R x_R$) into consumer individuals. Thus, $t_h = 1/(m_C r_{\max})$, and because $r_{\max} \propto m_C^{\beta-1}$, where β is the scaling exponent of the consumer's whole body metabolic rate, I obtain

$$t_h \propto t_{h,0} m_C^{-\beta} \qquad 5.19$$

where $t_{h,0}$ is a body temperature and metabolic state dependent constant. Thus, resource mass-specific handling time is predicted to decline with consumer mass to the exponent of resting metabolic rate scaling (0.75).

Empirical Validation of Handling Time

To test the handling time scaling model (Eqn. 5.19), I first divided each temperature-corrected handling time measurement by the resource mass to obtain resource-mass specific handling time (t_h). OLS regression of log(t_h) on log(m_C) (Figure 5.3E&F) allowed assessment of the fit of the data to the scaling model and obtainment of an estimate of the scaling exponent β. 2*D* and 3*D* data were analysed separately because different dimensionalities impose different physical constraints on consumers (Schmidt-Nielsen 1984; Bejan & Marden 2006; Dial *et al.* 2008). I found that $\beta = 1.02 \pm 0.08$ in 2*D* and 1.1±0.07 in 3*D* (Figure 5.3E&F). These exponents are significantly higher than the 0.75 expected from the scaling of resting metabolic rate (one sample *F* test) and are consistent with the fact that handling time should depend upon active or maximal rather than resting metabolic rate (i.e., exponent >0.85) (Peters 1983; Weibel *et al.* 2004; DeLong *et al.* 2010).

5.3.5. Consumption Rate

Scarce Resources

When resources are very scarce, much more energy is invested by the consumer in searching for resources than in handling them. In Eqn. 5.18, this is equivalent to saying that as $x_R \rightarrow 0$, $c \rightarrow \alpha x_R m_R$. Substituting Eqn. 5.14 into this expression gives

$$\begin{aligned} c &\sim \alpha_0 m_C^{p_v+2p_d} \sqrt{1+k_{RC}^{2p_v}}\, k_{RC}^{p_d} m_R x_R \quad \text{in 2D} \\ c &\sim \alpha_0 m_C^{p_v+4p_d} \sqrt{1+k_{RC}^{2p_v}}\, k_{RC}^{2p_d} m_R x_R \quad \text{in 3D} \end{aligned} \qquad 5.20$$

Analogous equations for the other foraging strategies are shown in Table 5.1. Equations 5.11 & 5.16 permit accounting for the scaling contributions of m_R and k_{RC}. In nature, resource density (x_R) also scales with resource mass m_R, where population densities typically decline as power-law of size (“Damuth’s rule”) such that,

$$x_R = x_0 m_R^{-p_x} \qquad 5.21$$

where x_0 includes the effects of temperature (Savage *et al.* 2004). This scaling in the dataset was evaluated by OLS regression of log(x_R) on log(m_R) and found that the estimated exponent p_x ranged from -0.79±0.09 in 2*D* to -0.86±0.06 in 3*D* (Figure 5.3I&J). These densities are artificially controlled because 96% of functional responses in the dataset are from laboratory or field-enclosure studies. Thus, even in laboratory studies experimentalists inadvertently impose a scaling on x_R by tending to keep the minimum resource number relatively constant (one to few individuals per arena) and by increasing arena size in proportion to consumer size. Substituting Eqn. 5.11 into Eqn. 5.21 gives $x_R = x_0 m_{R,0}^{-p_x} m_C^{-p_m}$ which, when substituted along with Eqn. 5.11 and Eqn. 5.16 into Eqn. 5.20, and the values of p_v (0.26; Section 5.3.1),

p_d (0.21 in 2*D*, 0.20 in 3*D*; section 5.3.2), and p_m (0.73 in 2*D* and 0.92 in 3*D*; Section 5.3.3) and p_x, gives the scaling of consumption rate with scarce resources:

$$\begin{aligned} c &\sim c_{2D} m_C^{0.78} \text{ in 2D} \\ c &\sim c_{3D} m_C^{1.16} \text{ in 3D} \end{aligned} \qquad 5.22$$

where the constants c_{2D} and c_{3D} include the constants of scaling of search rate, m_R and x_R. As discussed above, this scaling of consumption rate is only weakly dependent on foraging strategy (Section 5.3.3). Table 5.2 show how much the predicted scaling of c is expected to vary with scaling exponent for velocity (p_v) (Section 5.3.1). The highest possible value in 2*D* (0.92 at $p_v = 0.4$) is much lower than the lowest value in 3*D* (1.03 at $p_v = 0.13$). Thus, this result about the effect of dimensionality on consumption rate remains qualitatively the same irrespective of the variation in p_v.

Abundant Resources

When resources are sufficiently abundant, $c \sim 1/t_h$ (see Section 5.3.4), so from Eqn. 5.19 the scaling of consumption rate is expected to be

$$c \sim t_h^{-1} m_C^{\beta} \qquad 5.23$$

irrespective of interaction dimensionality. However, as discussed below, even when resources are not scarce, resource densities may not ultimately reach the theoretically expected levels for Eqn. 5.23 to hold.

Empirical Validation of Consumption Rate

Data for resource abundance were identified using the functional response database described above (Section 5.3.3). The minimum measured resource density was classified as scarce, while resource densities at which consumption rate was maximal were classified as abundant. This categorisation was necessary because functional responses frequently decline at very high resource densities (Jeschke *et al.* 2004). For data for scarce resources (Eqn. 5.22), OLS regressions of log-transformed consumption rates were performed on log(m_C) with interactions classified by dimensionality. The same procedure was used to test the predicted scaling of c with abundant resources (Eqn. 5.23). The predicted and observed exponents were compared using statistical methods described above (Section 5.3.3).

5.4. Modelling Population Dynamics

The Rosenzweig-MacArthur (RM) model for changes in resource and consumer biomass densities (R and C respectively) (Rosenzweig & Macarthur 1963; Yodzis & Innes 1992;

Weitz & Levin 2006) was used to explore the population and community consequences of interaction dimensionality:

$$\begin{aligned} \frac{dR}{dt} &= rR\left(1-\frac{R}{K}\right)-\frac{\alpha' RC}{1+t'_h\alpha' R} \\ \frac{dC}{dt} &= -zC+e\frac{\alpha' RC}{1+t'_h\alpha' R} \end{aligned} \tag{5.24}$$

Here, r is the resource's intrinsic biomass production rate (1/time), K its carrying capacity (biomass/area), z the consumer's biomass loss rate, α' its mass-specific search rate (i.e., $\alpha' \equiv \alpha/m_C$ (cf. Eqn. 5.13), e its conversion efficiency of resource biomass into consumer biomass, and t'_h the product of consumer mass and resource mass-specific handling time, $t'_h = t_h m_C$ (cf. Eqn. 5.19). I use the following size-scaling of the parameters of Eqn. 5.24:

$$\begin{aligned} r &= r_0 m_R^{\beta-1} \\ z &= z_0 m_C^{\beta-1} \\ K &= K_0 m_R^{1-\beta} \\ \alpha &= \alpha' / m_C = c_\alpha m_C^{p_v+2p_d(D-1)-1} f(k_{RC}) \\ t'_h &= t_h m_C = t_{h,0} m_C^{1-\beta} \end{aligned} \tag{5.25}$$

The scaling models for r, z, and K are based upon previous work (Peters 1983; Brown *et al.* 2004; Savage *et al.* 2004). Note that K should scale as $m^{3/4}$ in 2D as well as 3D because it represents the abundance of primary producers, who are not subject to constraints of search rate and, therefore, dimensionality. The scaling models for α' and t'_h are completely new results from this consumption rate model, and are derived from Eqn. 5.14 and Eqn. 5.19. This allows, for the first time, full parameterisation of the Rosenzweig-MacArthur equations in terms consumer-resource body sizes. The parameterisations of all scaling exponents and constants are shown in Appendix 5.7. The values for K_0 10^6 in 2D and 10^9 in 3D are based upon empirical data on abundance scaling (Peters 1983). I set $t_{h,0} = 0.1$ because the results show that consumption rate scaling when resources are abundant is similar to when resources are scarce (Table 5.3) and are only slightly constrained by handling time. Varying this value between zero and ten does not qualitatively affect the results.

Although different mass scaling's are derived for α' (Table 5.1), the RM model yields similar results for all three foraging strategies because differences in the scaling exponents are small within either 2D or 3D. The results presented in Figure 5.6 are for active-capture, as this is the most common strategy seen in the community data (Appendix 5.5). Also note that in 2D the scaling of α' is similar to that assumed by previous studies ($m_C^{-0.25}$) (Peters 1983; Yodzis & Innes 1992; Vasseur & McCann 2005; Brose *et al.* 2006b; Otto *et al.* 2007; Lewis *et al.* 2008), while in 3D it deviates substantially, lying between 0–0.25. This difference is a novel and crucial contribution of this work and leads to fundamentally different conclusions about population dynamics, equilibrium abundances, and boom and bust cycles in 3*D* systems like pelagic and aerial zones.

5.4.1. Coexistence Domains

Solving Eqn. 5.24 for equilibrium biomass densities gives

$$\hat{R}=\frac{z}{\alpha'(e-t'_h z)} \qquad \hat{C}=\frac{er(z+Ke\alpha'-Kt'_h z\alpha')}{K\alpha'^2(e-t'_h z)^2} \tag{5.26}$$

And as $t_h \rightarrow 0$ (linear functional response), the equilibrium densities become,

$$\hat{R}=\frac{z}{\alpha' e} \qquad \hat{C}=\frac{er(z+Ke\alpha')}{K\alpha'^2 e^2} \tag{5.27}$$

Substitution of the body size scaling of each parameter (Eqn. 5.25) allowed mapping of the consumer-resource size-abundance space (Figure 5.6) where both populations achieve non-zero biomass abundance (coexistence domains). Note that the scaling of resource abundance depends largely on consumer size (through the scaling of z, α', and t'_h), while the scaling of consumer abundance depends upon a more complex function of both consumer and resource sizes (z, α', and t'_h depend mainly on m_C, while r and K depend on m_R). As a result, resource abundances will show little variation around the scaling line compared to consumer abundances (Figure 5.6C). To compare the predicted coexistence regions with real world interactions, I overlaid 2,930 consumer-resource pairs from seven food-webs (Brose *et al.* 2005; Brose *et al.* 2006a) (Appendix 5.5). Each interaction was assigned a dimensionality using the criteria previously outlined (Section 5.2.2; Appendix 5.6).

5.4.2. Population Cycling

To compare the population dynamical properties of 2*D* and 3*D* consumer-resource pairs, I performed a standard local stability (perturbation) analysis (May 1974; Murdoch *et al.* 2003) and plotted stability (eigenvalue) domains in the consumer-resource size space (Figure 5.4). To illustrate differences in the dynamics of small and large species pairs in 2*D* and 3*D*, I chose two 2*D* and two 3*D* consumer-resource pairs selected from the food-web data overlaid in Figure 5.6A. These species pairs had similar body size ratios to minimise the confounding effects of k_{RC} scaling (Table 5.1; Section 5.3.3). Equation 5.25 was numerically integrated for each species pair for 10,000 generations to ensure that all population pairs reached dynamical equilibrium.

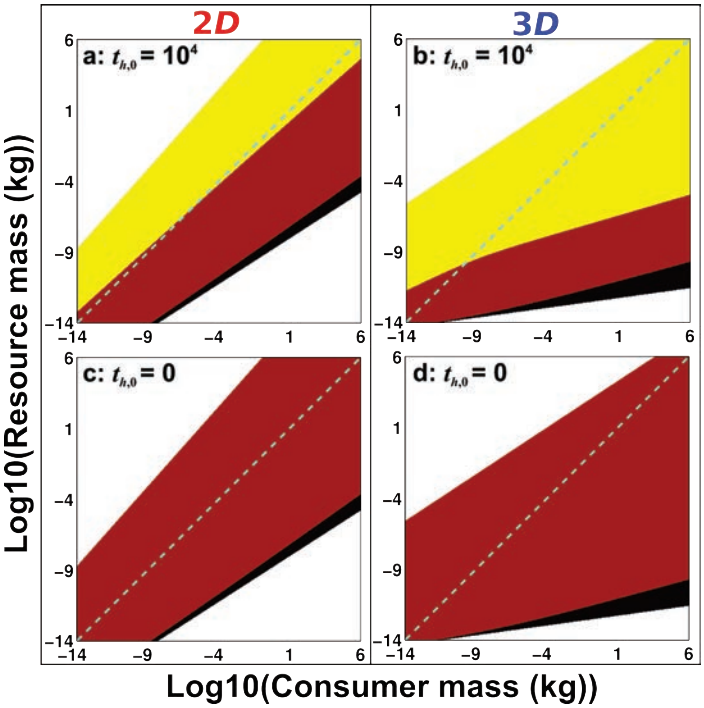


Figure 5.4. Stability regions predicted by the size-constrained population dynamics model**.** The size parameterisations are shown in Eqn. 5.24 and Eqn. 5.25. Dashed line is the line for which consumer and resource have the same mass, i.e., a ratio of one-to-one.

5.4.3. Abundance Scaling

The scaling of species abundance with body mass can be calculated by substituting parameter values into Eqn. 5.26 or Eqn. 5.27 to obtain biomass abundance, which must then be divided by species mass to obtain number abundance. To calculate the size-abundance density scaling within empirically realistic size-ratio combinations I model abundances for the 2,930 consumer-resource pairs mapped on the coexistence domains using Eqn. 5.27. Scaling exponents were calculated by performing OLS regression of log-transformed abundance against log-transformed consumer mass.

5.4.4. Model Robustness

I tested the robustness of the results for coexistence regions, population dynamics, and abundance scaling by varying $t_{h,0}$ between 0 (classical Lotka-Volterra (LV) model) and 10^4 (Rosenzweig-MacArthur (RM) model with Type II functional response). This variation in model structure did not qualitatively affect the results shown below in Figure 5.7 (cf. Figure 5.4). For the LV model (Figure 5.4c & d), regions of stable limit cycles are replaced by transient cycles, but feasible coexistence regions remain the same as those obtained from the RM model.

The effect of a Type III functional response on population dynamics was examined by recalculating coexistence regions and abundances using the generalised model (Vucic-Pestic *et al.* 2010)

$$\hat{R} = \frac{z}{\alpha' e} \qquad \hat{C} = \frac{er(z + Ke\alpha')}{K\alpha'^2 e^2} \tag{5.28}$$

instead of Type II response (5.18) in Eqn. 5.24. The results are shown in Figure 5.5. To determine feasible values of q, I fitted Eqn. 5.28 to the functional responses in the database (Section 5.2.1 & 5.2.7). Note that feasible coexistence regions with Type III responses (Figure 5.5) are shifted up along the resource mass axis relative to those with Type II response (cf. Figure 5.7a), but the relative difference between 2D and 3D coexistence regions remains qualitatively the same.

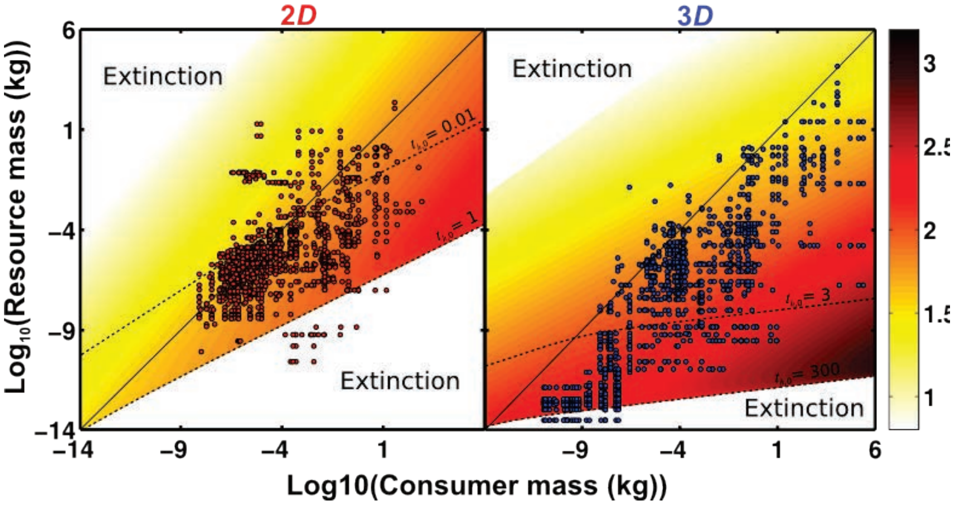


Figure 5.5. Effect of type III functional responses on 2D versus 3D population dynamics. Coexistence regions were calculated in the same way as in Figure 5.7 (Eqns. 5.24 and 5.25; Appendix 5.7), but with a Type III functional response (Eqn. 5.28 with q = 0.5). The value of q = 0.5 is approximately the mean of values obtained from the data analyses (Section 5.2.7) and previous work (Vucic-Pestic *et al.* 2010). As in main text Fig. 4, $t_{h,0} = 10^4$.

5.5. Results and Discussion

Strong differences exist in the scaling of consumption rate between 2D and 3D interactions (Figure 5.6). When resources are scarce, which more closely resembles field conditions, the observed exponent of 3D interactions (1.06 ± 0.06 (95% confidence intervals, CI)) is significantly higher than in 2D (0.85 ± 0.05) (likelihood ratio test $p < 0.001$) (Figure

5.6A&C). Both are significantly higher than the currently used exponent of 0.75 (one sample *F*-test $p < 0.01$). Furthermore, apart from organisms much smaller than a cricket ($<3\times10^{-4}$ kg, where 2*D* and 3*D* scaling lines intersect; Figure 5.6A&B), 3*D* consumption rates are higher than 2*D*. For example, for a one kg organism, 3*D* consumption rate is an order of magnitude higher than in 2*D* (5.00±3.01 vs. 0.50±0.24 mg/s) (Figure 5.6).

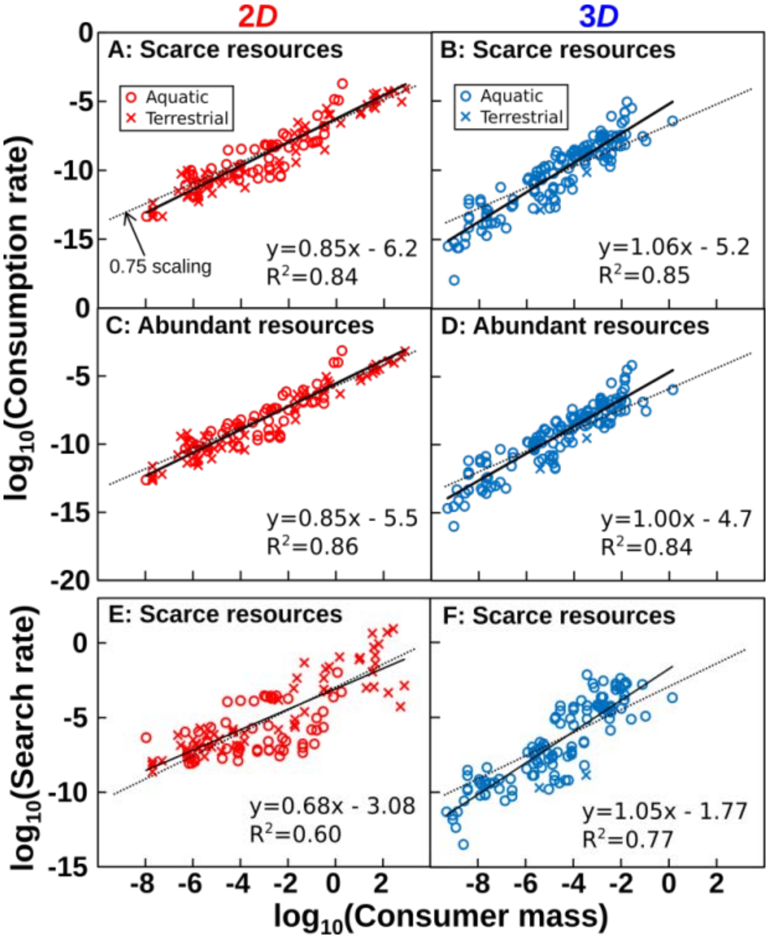


Figure 5.6. Effect of interaction dimensionality on scaling of search and consumption rate. Scaling of per-capita consumption rate (kg/s) with consumer body mass (kg) are shown separately for scarce (A–B) and abundant (C–D) resources. Scaling of search rate (m^2/s in 2*D* and m^3/s in 3*D*) is shown for scarce resources (E&F). The solid black lines were fitted using OLS regression (Section 5.2.1). Estimated scaling exponents (±95% CI) are A: 0.85±0.05, B: 1.06±0.06, C: 0.85±0.05, D: 1.00±0.06, E: 0.68±0.12, F: 1.05±0.08 (see Table 5.3). All exponents (except panel E) are significantly different from the canonical 0.75 value (black dotted lines). Consumption rate scaling shows less variance than search rate scaling because consumers typically choose resources of sizes that maximise biomass consumption rate (product of search rate, resource density, and resource mass; Eqn. 5.30, thus minimising scatter around the scaling constraint.

When resources are abundant, typical of laboratory conditions, consumption rates still scale more steeply (1.00 ± 0.06 vs. 0.85 ± 0.05) and show higher baseline values in 3*D* than

2*D* (19.00±11.00 vs. 3.20±1.30 mg/s for a one kg organism) (Figure 5.6C&D). Consequently, even at high resource densities, where finding resources is expected to be least constraining, interaction dimensionality remains important. The canonical 0.75 scaling (Brown *et al.* 2004) exponent is again excluded by 95% CI under all conditions (Figure 5.6).

These differences in consumption rate scaling are primarily driven by search rate (area/time or volume/time), which has a scaling exponent of 1.05±0.08 in 3*D* and 0.68±0.12 in 2*D* (Figure 5.6E&F). For active-capture and grazing foragers, search rate is the speed at which a consumer moves throughout the landscape seeking food, while for sit-and-wait foragers it is the speed at which resources move through the consumer's attack space (Figure 5.1; Figure 5.2). Together, these results reveal for the first time that search and consumption rates scale significantly differently with interaction dimensionality.

The consumption rate model described earlier (Section 5.3) predicts these empirical patterns. The model focuses on three key components of consumption rate: relative velocity of the consumer and resource, consumer's reaction distance, and handling time (Yodzis & Innes 1992; McGill & Mittelbach 2006; Weitz & Levin 2006). Relative velocity (v_r) is the rate at which consumer-resource pairs converge across the landscape and is the root-mean-square of their body velocities. A potential encounter occurs when either the resource or consumer comes within the reaction distance (d) at which one can detect and react to the other. Because of the geometry of search spaces, search rate (α) increases with dimensionality (D) as

$$\alpha = s_D v_r d^{D-1} \tag{5.29}$$

The constant s_D includes a geometric factor and roughly constant attack success probability (Section 5.3). Multiplying α with resource density (x_R) (individuals per area or volume) yields encounter rate. Consumption rate is constrained by this encounter rate and by handling time—the time taken to pursue, subdue, and ingest each resource. Combined, these components give a saturating per-capita biomass consumption rate (c) (Type II functional response of Holling (1959b)) in D dimensions,

$$c = \frac{\alpha x_R m_R}{1 + t_h \alpha x_R m_R} = \frac{s_D v_r d^{D-1} x_R m_R}{1 + t_h s_D v_r d^{D-1} x_R m_R} \tag{5.30}$$

Here, m_R is the average mass of the resource, $x_R m_R$ is resource biomass density, and t_h the handling time per unit resource mass. I predict and verify the scaling of all components (Table 5.3) of Eqns. 5.29 and 5.30. Substituting the scaling of components of α (Eqn. 5.29) shows that irrespective of foraging strategy (grazing, sit-and-wait, or active-capture; Figure 5.1; Figure 5.2)

$$\alpha \sim \alpha_{2D} m_C^{0.63} \text{ in } 2D \tag{5.31}$$

$$\alpha \sim \alpha_{3D} m_C^{1.03} \text{ in } 3D$$

where α_{2D} and α_{3D} are constants depending on dimensionality and foraging strategy. These exponents match data extremely well (Figure 5.6E&F; Table 5.3).

With scarce resources ($x_R \rightarrow x_{R,\mathrm{min}}$) the second term in the denominator of Eqn. 5.30 becomes much smaller than 1, and $c \sim \alpha x_R m_R = s_D v_r d^{D-1} x_R m_R$. Substituting $c \sim c_{2D} m_C^{0.78}$ in 2D the scaling of components gives

$$\begin{aligned} c &\sim c_{2D} m_C^{0.78} \text{ in } 2D \\ c &\sim c_{3D} m_C^{1.16} \text{ in } 3D \end{aligned} \qquad 5.32$$

where c_{2D} and c_{3D} are constants. This equation predicts the steeper 3D scaling of consumption rate in the empirical data (Figure 5.6A&B; Table 5.3). Comparison of Eqn. 5.31 and 5.32 verifies the empirical observation that consumption rate scaling (Eqn. 5.32) is driven mainly by search rate (Eqn. 5.31). The small differences between scaling exponents in Eqn. 5.31 and 5.32 arise because resource density (x_R) and body size (m_R), which are multiplied by search rate (α) to obtain consumption rate (c) (Eqn. 5.30), scale with consumer size in data (Table 5.3; Figure 5.3).

Table 5.3. Variation with interaction dimensionality **(*D*)** in the scaling exponents of consumption rate and its components**.** * denotes exponent statistically indistinguishable from its predicted value (in parentheses). For search and consumption rate, if the 3*D* exponent is significantly larger than 2*D* (likelihood ratio test) as predicted, both are shown in bold face. For all significance tests, *p*=0.05. There are no predicted exponents for resource density and resource mass scaling because they depend upon choices by experimentalists (Section 5.3.5). Steeper than predicted exponents of handling time arise because pursuit and subjugation depend on scaling of maximal rather than resting metabolic rate (Peters 1983; Weibel *et al.* 2004).

	Search and consumption rate			**Consumption rate components**				
		Consumption rate						
	Search rate (scarce resources) (*n* = 255)	Scarce resources (*n* = 255)	Abundant resources (*n* = 255)	Relative velocity (*n* = 21)	Reaction distance (*n* = 39)	Handling time (*n* = 78)	Resource mass (*n* = 255)	Resource density (*n* = 255)
2*D*	**0.68**±0.12* (0.63)	**0.85**±0.05 (0.78)	**0.85**±0.05 (0.78)	0.26±0.04* (0.27)	0.21±0.08 (0.33)	-1.02±0.08 (-0.75)	0.73±0.10	-0.79±0.08
3*D*	**1.05**±0.08* (1.03)	**1.06**±0.06 (1.16)	**1.00**±0.06 (1.16)	0.26±0.04* (0.27)	0.20±0.06 (0.33)	-1.1±0.07 (-0.75)	0.92±0.08	-0.86±0.07

As resources become unlimited ($x_R \rightarrow \infty$), the term $s_D v_r d^{D-1} x_R m_R$ dominates the numerator and denominator of Eqn. 5.30 and cancels. Thus, search and detection become instantaneous and c depends only on handling rate ($1/t_h$), which is independent of dimensionality and scales as 1.1±0.07 in 3D and 1.02±0.08 in 2D (Table 5.3; Figure 5.3).

When resources are abundant, observed consumption rate scaling in 2*D* (0.85 ± 0.05) and 3*D* (1.00 ± 0.06) is consistent with the prediction for scarce rather than unlimited resources (Table 5.3). Hence, even when functional responses appear to saturate and resources are considered abundant, consumption rate is constrained by search dimensionality and pursuit biomechanics. These results cannot be explained as differences between aquatic and terrestrial habitats because 2*D* aquatic and 2*D* terrestrial interactions scale similarly (Figure 5.6A–C).

Deriving the scaling of search rate (α) from first principles provides a mechanistic basis for linking habitat dimensionality to trophic interaction strength ($\alpha x_R m_R/m_C$), a fundamental parameter in consumer-resource and food-web models (Peters 1983; Yodzis & Innes 1992; Brose *et al.* 2006b; Brose 2010). In contrast to current theories (Yodzis & Innes 1992; Brose *et al.* 2006b; Berlow *et al.* 2009; Brose 2010), these results imply that interaction strength scaling can deviate substantially from $m_C^{-0.25}$. In particular, if resource size (m_R) and density (x_R) are decoupled from consumer size, consumption rate scales like search rate (Eqn. 5.31; Figure 5.6; Table 5.3) and interaction strength as $\alpha x_R m_R / m_C = m_C^{-0.32}$ in 2*D* and $m_C^{0.05}$ in 3*D*. Even when m_R and x_R scale with size (Table 5.3; Figure 5.3), interaction strengths scale as $m_C^{-0.15}$ (2*D*) or $m_C^{0.06}$ (3*D*) when resources are scarce (Figure 5.6A-B) and $m_C^{-0.15}$ (2*D*) or m_C^{0} (3*D*) when resources are abundant (Figure 5.6C-D). Thus, consumer-resource dynamics in the field are likely to be strongly constrained by interaction dimensionality.

By incorporating the dimension-specific equations (Eqn. 5.31) into a population dynamics model (Section 5.3), I explore how dimensionality affects consumer-resource dynamics, leading to three key results. First, 3*D* interactions allow a larger range of viable consumer-resource body size combinations, mainly because in 3*D* larger consumers have higher consumption rates than small consumers. The vast majority (99%) of 2,930 species pairs from seven communities fall within the predicted coexistence domains (Figure 5.7A), with the upper and lower limits of observed size ratios closely matching predicted extinction boundaries. Thus, interaction dimensionality may account for differences in viable consumer-resource size ratios in pelagic versus benthic or terrestrial environments (Peters 1983; Cohen 1994; Brose *et al.* 2006a). For example, these results explain why filter and suspension feeding strategies (i.e., consumers feeding on relatively small resources) are viable in 3*D* but largely missing from 2*D* (Figure 5.7A). Zones in the coexistence regions that lack observed species pairs likely represent interactions for small consumers (microorganism, parasite, and parasitoids) that are under-sampled (Brose *et al.* 2006a).

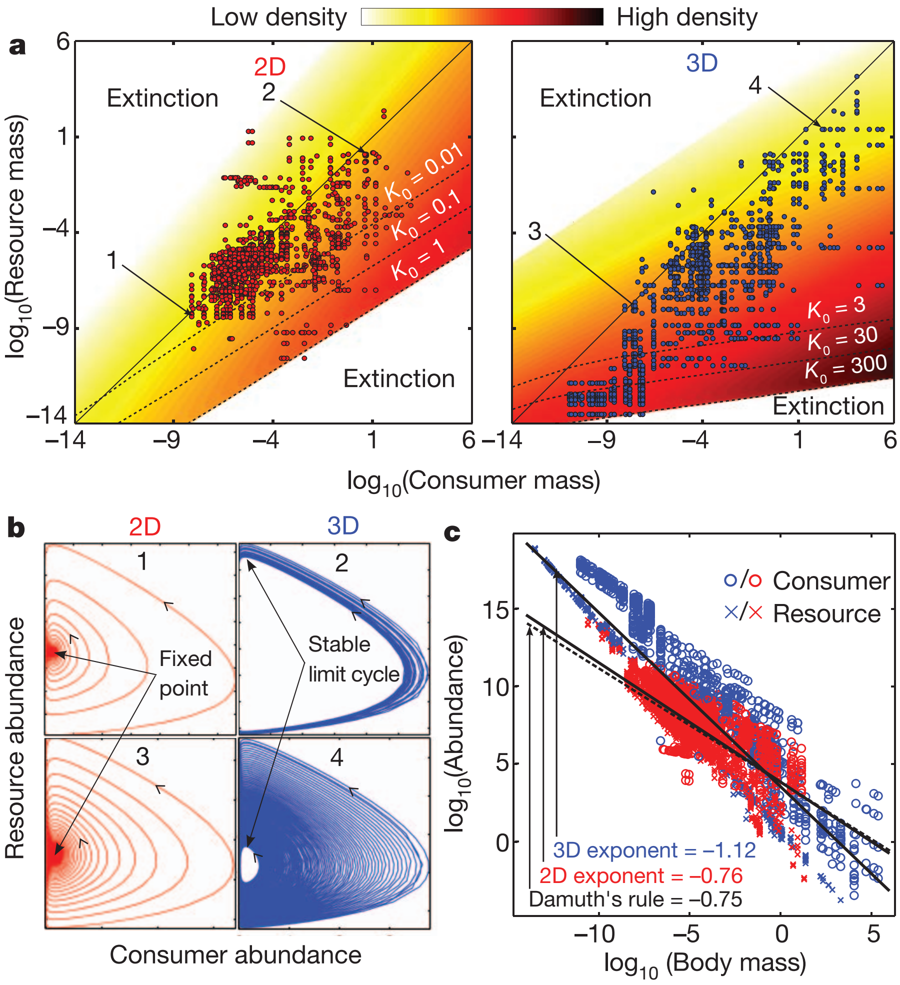


Figure 5.7. Effects of interaction dimensionality on consumer-resource dynamics. **a**, Intensity map of logarithm of total consumer–resource equilibrium densities, ranging from coexistence at high (dark) to low (yellow) densities, or extinction (white). Black dots are real 2*D* (n=1,627) and 3*D* (n=1,302) consumer–resource pairs (Appendix 5.5). Consumer and resource sizes are equal along the diagonal line. Lower extinction boundaries (dashed lines) correspond to different baseline carrying capacities (K_0); the outermost boundary corresponds to empirical estimates. Predicted 2*D* coexistence regions that lack observed species pairs probably represent under-sampling of interactions for the smallest consumers (for example, micro predators) and largest consumers (for example, large mammalian herbivores) (Brose *et al.* 2006a). **b**, Comparison of population dynamics of two 2D (1 and 2 in a) and two 3D (3 and 4 in a) species pairs. **c**, Scaling of equilibrium abundance across all 3D (blue) and 2D (red) consumer–resource pairs plotted in a. The variation and discrete appearance of the data arises mainly because a consumer may feed on multiple resource species of different sizes and vice versa.

Second, because strong trophic interactions may destabilise communities (Brose *et al.* 2006b; Brose 2010), the higher consumption rates by larger consumers in 3*D* suggest that communities dominated by 3*D* interactions (i.e., pelagic or aerial habitats) may be inherently unstable. By modelling the dynamics of four representative consumer-resource pairs from the dataset (Figure 5.7A), I find that persistent boom-bust dynamics are more common in 3*D* than 2*D* (Figure 5.7B). These destabilising effects may be partially offset by larger regions of coexistence that are possible in *3D* (Figure 5.7A) or by negative consumer density dependence (Witting 1995; Ritchie 2009). Few empirical studies exist for how population stability differs with habitat dimensionality (Rip & McCann 2011).

Third, population densities across consumer-resource pairs scale with body size more steeply in 3*D* (–1.13) than 2*D* (–0.78) (Figure 5.7C). Only 2*D* scaling matches Damuth's –¾ rule, which was derived from data on terrestrial mammals (2*D* consumers) (Savage *et al.* 2004; Schmitz & Price 2011). Results of this chapter help explain deviations from energetic equivalence (Damuth 1981; Leaper & Raffaelli 1999; Savage *et al.* 2004; Reuman *et al.* 2009) and also predict more frequent deviations in 3*D* with scarce resources.

The results presented here are for consumer-resource pairs, but community dynamics may also depend on indirect interactions and on consumers choosing from multiple resource species (Laska & Wootton 1998). Nevertheless, predicting the strength of direct consumer-resource interactions is a first, important step and empirical hurdle in understanding higher-order effects (Laska & Wootton 1998; Rip & McCann 2011). Thus, predicting how interaction dimensionality affects direct interactions lays the foundation for studying how similar effects propagate through complex food webs. Studying communities with mixtures of 2*D* and 3*D* interactions will be especially revealing in this context.

In addition, previous studies suggest that trophic interactions for grazers are constrained by the fractal dimensionality of spatial resource dispersion (Ritchie & Olff 1999; Ritchie 2009). Synthesising approaches should predict when 3*D* habitats fail to provide an advantage to 3*D* consumers due to lack of sufficient resources or appropriate geometry of resource dispersion.

This study complements the recent interest in effects of body size on consumer-resource interactions (Brose *et al.* 2006a; Berlow *et al.* 2009; Brose 2010), and offers new insights for incorporating foraging strategy and habitat structure into food-web dynamics. The results help explain why aquatic environments generally show higher energy fluxes and lower stability than terrestrial ones (Rip & McCann 2011) and why larger consumers appear to have a relative advantage in pelagic (3*D*) versus terrestrial (2*D*) environments (Cohen 1994; Cyr *et al.* 1997b). I conclude that interaction dimensionality is a critical factor driving consumer-resource dynamics, and better understanding and incorporating effects of dimensionality will lead to more accurate predictions for food web and ecosystem dynamics.

Chapter 6. Discussion

The aim of this thesis was to improve understanding how local-scale interactions unite to drive and stabilise patterns at higher levels of ecological organisation, and to determine what role the physical environment plays. Ecologists have made significant progress toward this goal, but there is still much to be determined. Using an approach that combines field literature analysis, and mechanistic theory, I show that the physical environment interacts with traits of organisms (i.e., body size, thermy, foraging strategy) to alter the strength and outcome of species interactions. I also show that these mechanisms are likely to have strong effects on the population dynamics of the interacting species, and ultimately are likely responsible for differences that are observed in the functional organisation of communities across different habitats, such as body size distributions and stability. I specifically focus on the effect of temperature and habitat dimensionality but this same approach should be useful for studying other physical drivers and other types of species interactions.

To understand how different patterns in community organisation can arise within different habitats, in subsequent chapters I explore how the physical environment affects the ecological interactions between organisms. A focus on local-scale processes is necessary because they are ultimately responsible for community-scale properties (see Chapter 1). To do this, I focus on specific mechanisms for how the physical environment might affect species interactions, but in a generalized way. For example, despite extraordinarily diverse ways in which consumers and resources interact, it is possible to focus on a few key traits because virtually all consumer-resource interactions involve some combination of search, detection, and handling. I then investigate how influences of the physical environment, such as temperature and habitat dimensionality, might affect these traits, and how these effects would integrate to influence populations and communities. As a basis for this understanding, I focus on metabolism, because metabolism is the biological processing of energy and materials, and all ecological interactions involve exchanges of energy and materials. In other words, the metabolic rate is the pace of living and interacting with the environment. My work builds upon significant advances on this research front in recent years, primarily the metabolic theory of ecology (Brown *et al.* 2004). I extend this work to the study of species interactions.

I begin by investigating the role of temperature on the organisation of ecological systems. Temperature is a key environmental driver that often differs markedly across habitats in both magnitude and variability, and understanding its effect on ecological systems is critical given current global change. However, in order to understand temperature effects on species interactions it is first necessary to determine how temperature affects the traits relevant to species interactions, such as body velocity, encounter rate, and consumption rate. Therefore, in Chapter 2 and Chapter 3 I compile a comprehensive database on the thermal responses for microbes, plants, and animals to understand the effects of temperature on physiological and ecological traits. My analysis identified generalities and deviations in the thermal response of biological traits. A general pattern in the rise component was observed, which covers the temperature ranges over which organisms commonly operate under natural conditions. Eighty-seven percent of thermal response curves analysed were consistent with the Boltzmann-Arrhenius model, suggesting a strong influence of metabolism on a wide range of biological processes. Systematic deviations around the mean activation energy of 0.66 eV for rise responses were evident. This included strong right skewness, possibly due to stronger selection pressure on prey to escape capture and death by maintaining nearly optimal performance across a range of temperatures (the life-dinner principle). Focus only on body velocities confirmed the existence of the thermal dependence of the life-dinner principle. Detailed analyses of these and similar patterns indicate dominant selection pressures and novel biological mechanisms. These patterns probably have important consequences for species interactions and community stability, and their identification suggests that scaling constraints can be shifted or relaxed by evolutionary or behavioural processes.

In Chapter 4 I constructed a general framework for predicting effects of temperature on consumer-resource interactions by combining models of the temperature dependence of physiological rates determined in Chapter 3 with allometric theory for consumer-resource interactions. The framework makes it possible to make specific predictions about how temperature change, such as climate change or seasonal variation, might alter the dynamics of interacting species. In the theory, the effects of temperature on consumer-resource interactions arise primarily through effects on body velocity, and therefore foraging strategy. A key insight of this chapter is how asymmetries in the thermal response of interacting species can qualitatively and quantitatively affect their population dynamics. Asymmetries could arise due to differences in activation energies (e.g., life-dinner-principle, Chapter 3), thermy (e.g., ectotherm vs. endotherm), or thermoregulation (e.g., two ectotherms with different body temperatures). Moreover, these asymmetries should become more likely as species change their geographic and temporal niches in response to climate change. The theory I present provides a framework that should prove useful for studying temperature effects on consumer-resource interactions, extinctions, and invasions, and that could apply to diverse taxa and habitats. To test the predictions and assumption of the theory I use the data detailed in Chapter 2 and Chapter 3. However, foraging strategy had not been determined for species in that dataset so I use trophic group as a proxy for foraging strategy. Future analysis should use data for which the foraging strategy of the consumer-resource pair is explicitly known. Predicting trophic interaction strength is key to understanding effects in complex food webs. Understanding how temperature controls each component trait of a consumer-resource interaction would be a major step forward in predicting how seasonal variation and climate change affect the strength of species interactions, and specifically consumption rate and associated effects on population dynamics.

One of the main physical differences between aquatic and terrestrial habitats is spatial dimensionality. In Chapter 5 I extend the mechanistic theory of Chapter 4 with extensive empirical data to show how dimensionality of a habitat can strongly affect the strength and outcome of consumer-resource interactions. I show how substantial variation in consumption rate data, and thus trophic interaction strengths, arises because consumers generally encounter resources more frequently in three dimensions (3D) (e.g., arboreal and pelagic zones) than two dimensions (2D) (e.g., terrestrial and benthic zones). I show that consumption rates scale sub-linearly with consumer body mass (exponent~0.85) for 2D interactions, but super-linearly (~1.06) in 3D, contrasting with the current usage of a single exponent (~0.75) in food web research. A further analysis shows that interaction dimensionality is potentially a major driver of species coexistences, population stability, and abundances in local communities. The results presented here are for consumer-resource pairs, but community dynamics may also depend on indirect interactions and on consumers choosing from multiple resource species. Nevertheless, predicting the strength of direct consumer-resource interactions is a first, important step and empirical hurdle in understanding higher-order effects (Laska & Wootton 1998; Rip & McCann 2011). Thus, predicting how interaction dimensionality affects direct interactions lays the foundation for studying how similar effects propagate through complex food webs. Studying communities with mixtures of 2*D* and 3*D* interactions will be especially revealing in this context. Future work in this area involves using this theory to explain differences caused by dimensionality in the size ratio of consumer-resource body size ratios of communities.

The results I present in this thesis suggests how major future research directions might be prioritised.. The dependence of interactions on temperature and habitat dimensionality is based on real mechanism (i.e., physiology and encounter rate), but there are other environmental drivers that should be included in the theory. For example, light is clearly an important and variable driver across habitats, and so mechanistic theory to explain effects of light on species interactions would be revealing. What is also required is more accurate and comprehensive empirical data on how the mechanics of species interactions are altered by the environment. For example, in experiments currently under way I am using video and automated tracking software to better characterise temperature, light, and dimensionality effects on the mechanics (e.g., foraging strategy, attack and escape body velocity, encounter rates, attack success probabilities, consumption rates) of specific consumer-resource pairs. Another priority would be to develop the theory to include environmental dependence of biomechanics of interactions between species after an encounter. The current version of the theory assumes that a successful attack will occur after encounter, but clearly this is not true in real systems and surely the environment plays a role in this variability.

Combined, the results and discussion I present in this thesis significantly advance understanding of how local-scale interactions unite to drive and stabilise patterns at higher levels of ecological organisation, and the role of the physical environment. Ecological communities are extraordinarily complex and diverse, so a mechanistic understanding of how they operate is not easily obtained. This thesis advances our understanding about how ecological systems are affected by the physical environment. It provides clear evidence of physical drivers of community organisation and offers new insights into understanding mechanisms responsible for the organisation of ecological communities.

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Appendices

Quick Guide

Appendix 3.1

Trait names and definitions for the effects of temperature on biological systems (Chapter 3). Traits are listed alphabetically within level of organisation. Unless stated otherwise, traits are measured per capita (i.e., per individual). All measurements are listed in SI units. $\boldsymbol{C_n}$ ($\boldsymbol{R_n}$) is the number of individual consumers (resources). When the trait involves a single species, C_n is used as the default. Times are denoted as 'organism * s' so that rates are interpreted as per individual, because rate is the focal unit. *A* (arena size) is measured as area or volume depending on the dimensionality of the habitat, as determined by the original authors. I standardise by resource and consumer density whenever possible, and this is the default unit of all traits listed below. Weights are wet mass unless otherwise stated. Original trait definitions and units are given in the original sources (see Appendix 3.2; Appendix 3.3).

Trait name	Trait unit	Motivation	Trait definition
Internal			
Ammonia Excretion Rate	kg / (C_n * s)	autonomic	Rate of ammonia (NH_3) mass excretion per consumer.
Digestion Rate	R_n / (C_n * s)	autonomic	Rate at which resources are digested per consumer.
Faecal Excretion Rate	kg / (C_n * s)	autonomic	Rate of faecal mass excretion per consumer.
Feeding Heart Beat Rate	event / (C_n * s)	positive	Rate of heartbeats per consumer while filter feeding.
Filtration Metabolic Efficiency	m^3 / (m^3 * C_n)	autonomic	Metabolic efficiency of the filtration process expressed as water volume per oxygen volume per consumer.
Food Energy Assimilation Efficiency	proportion / C_n	autonomic	Efficiency of digesting ingested energy per consumer expressed as the amount of energy that is digested in proportion to that which is ingested.
Food Mass Conversion Efficiency	proportion / C_n	autonomic	Efficiency of converting food mass to body mass per consumer expressed as growth in tissue mass in proportion to total mass of resource consumed.
Gut Clearance Rate	event / (C_n * s)	autonomic	Rate food moves through a consumer from initial ingestion to evacuation (i.e., faeces).
Gut Loading Rate	event / (C_n * s)	autonomic	Rate at which the gut physically fills with food.
In Vitro Heart Beat Rate	event / s	autonomic	Rate of heartbeats measured in a heart removed from a living organism.
In Vitro Muscle Isometric Tension	N / m^2	autonomic	Isometric tension of muscle measured in muscle removed from a living organism.
In Vitro Muscle Optimal Phase	proportion	autonomic	Phase at which the power output of the muscle is maximum in muscle removed from a living organism.
In Vitro Muscle Optimal Rate	event / s	autonomic	Optimal frequency corresponding to the maximum power output of the muscle removed from a living organism.
In Vitro Muscle Optimal Strain	proportion	autonomic	Strain at which the power output of the muscle is maximum in muscle removed from a living organism.
In Vitro Muscle Power Output	W	autonomic	Power output of muscle measured in muscle removed from a living organism.
In Vitro Muscle Shortening Velocity	m / s	autonomic	Velocity of muscle shortening measured in muscle removed from a living organism.
In Vitro Muscle Work Per Cycle	J / event	autonomic	Muscle work per cycle at optimal frequency measured in muscle removed from a living organism.
Log-Linear Gut Clearance Rate	event / (C_n * s)	autonomic	The slope of the regression of log gut content mass per consumer individual per time.
Oxygen Mass Scope For Activity	kg / (C_n * s)	voluntary	Amount of oxygen available for use for activity measured as rate of oxygen mass production per consumer.
Photosynthetic Oxygen Production Rate	kg / (C_n * s)	autonomic	Organic oxygen mass production rate per consumer through photosynthesis.

Trait name	Trait unit	Motivation	Trait definition
POC Photosynthetic Oxygen Production Rate	kg / (kg * s)	autonomic	Carbon-specific (POC) oxygen mass production rate through photosynthesis.
Respiration Rate	kg / (C_n * s)	autonomic	Organic oxygen mass consumption rate per consumer during respiration.
Square Root-Linear Gut Clearance Rate	event / (C_n * s)	autonomic	The slope of the regression of square root gut content mass versus time.
Surface Area-Specific Dark Respiration Rate	kg / (m^2 * s)	autonomic	Surface area-specific CO2 production during dark respiration.
Surface Area-Specific Maximum Photosynthesis Rate	kg / (m^2 * s)	positive	Surface area-specific maximum photosynthesis rate.
Surface Area-Specific Mitochondrial Respiration Rate	kg / (m^2 * s)	autonomic	Surface-area specific respiration rate in leaf mitochondria during photosynthesis.
Surface Area-Specific Photosynthetic Oxygen Production Rate	kg / (m^2 * s)	autonomic	Surface area-specific oxygen production rate during photosynthesis.
Voluntary Heart Beat Rate	event / (C_n * s)	voluntary	Rate of heartbeats measured in an organism that is voluntarily stationary.
Individual			
48-hr Hatching Probability	proportion / C_n	autonomic	Probability of an egg having hatched at 48 hrs.
Avoidance Body Velocity	m / (R_n * s)	voluntary	Velocity of the body during movement in avoidance of a weak stimulus (differs from Escape Body Velocity because the stimulus is not an immediate threat).
Bite Rate	event / (C_n * s)	positive	Rate of bites or analogue (e.g., radular scrape) per consumer.
Critical Holding Velocity	m / (R_n * s)	negative	Velocity at which animal failed to hold position on the substrate when placed in a multi-speed flow chamber for a set time at sequentially increasing speeds.
Critical Travel Velocity	m / (R_n * s)	negative	Velocity at which an individual fails to maintain when placed in a multi-speed flow chamber for a set time at sequentially increasing speeds.
Critical Upright Time	R_n * s	negative	Time taken for animal to become completely exhausted from repeated up-righting of body.
Development Rate	1 / (C_n * s)	autonomic	Rate at which individuals complete development of one or more life stages.
Endurance Time	R_n * s	negative	Time maintained on a single-speed treadmill or flow chamber until exhaustion during escape locomotion.
Escape Angle of Body Turning	rad / R_n	negative	The sum of the absolute angles of turning of the head relative to the body during escape burst locomotion.
Escape Angular Rate of Body Turning	rad / (R_n * s)	negative	Velocity of the turning of the front of the resource relative to the mid-point throughout movement during escape burst locomotion.
Escape Body Acceleration	m / (R_n * s^2)	negative	Acceleration of the whole body during escape burst locomotion.
Escape Body Deceleration	m / (R_n * s^2)	negative	Deceleration of the whole body during escape burst locomotion.
Escape Body Power Production	W / R_n	negative	Power production of the whole body during escape burst locomotion.
Escape Body Response Rate	event / (R_n * s)	negative	Rate of response of a resource to an attacking consumer or otherwise negative stimulus.
Escape Body Velocity	m / (R_n * s)	negative	Velocity of the whole body during escape burst locomotion.
Escape Body Velocity Probability	proportion / R_n	negative	Velocity of the whole body during escape burst locomotion expressed as the ratio of sprint velocity of an individual to the maximum velocity of that individual in all trials at all temperatures.
Escape Gait Change Velocity	m / (R_n * s)	negative	Velocity at which resource changes gait during escape burst locomotion.
Escape Jump Contact Rate	event / (R_n * s)	negative	Rate of time the resource exerts force on substrate during an escape jump.
Escape Jump Distance	m / R_n	negative	Distance animal travels in a single escape jump.
Escape Jump Force	N / R_n	negative	Force exerted on the substrate by a resource during an escape jump.
Escape Jump Rate	event / (R_n * s)	negative	Jump rate of a resource during escape locomotion.
Escape Stroke Length	m / R_n	negative	Distance covered by a resource in a single locomotory stroke during escape.

Trait name	Trait unit	Motivation	Trait definition
Escape Stroke Peak Force	N / R_n	negative	Force attained on the substrate by the resource during a locomotory stroke during escape.
Escape Stroke Peak Force Rate	N / (R_n * s)	negative	Rate of force attained on the substrate by the resource during a locomotory stroke during escape.
Escape Stroke Rate	event / (R_n * s)	negative	Rate of locomotory strokes of a resource during escape.
Escape Tail Beat Rate	event / (R_n * s)	negative	Rate of tail beats of a resource during escape burst locomotion.
Flee Distance	m / R_n	negative	Distance moved by a resource when fleeing a predator before stopping (includes escape burst component and other slower movement, if present).
Foraging Body Undulation Rate	event / (C_n * s)	positive	Rate of undulating body strokes used for feeding.
Foraging Gill Beat Rate	event / (C_n * s)	positive	Rate of beating cilia on gill of living consumer measured by direct examination of cilia.
Foraging Submersion Rate	event / (C_n * s)	voluntary	Rate consumer swims underwater while foraging.
Foraging Velocity	m / (C_n * s)	voluntary	Velocity of the whole consumer when foraging for food.
In Vitro Gill Beat Rate	event / s	autonomic	Rate of cilia beating on gill fragments removed from a living organism measured by direct examination of cilia.
In Vitro Gill Particle Transport Velocity	m / s	autonomic	Velocity of particles in grooves of gill fragments removed from a living organism.
Individual Length Growth Rate	m / (C_n* s)	autonomic	Rate of increase in length of an individual.
Individual Mass Growth Rate	kg / (C_n * s)	autonomic	Rate of increase in mass of an individual.
Population Voluntary Activity Probability	proportion	voluntary	Proportion of individuals in a population that are active (i.e., awake, not sleeping) at time of observation.
Population Voluntary Movement Probability	proportion	voluntary	Proportion of individuals in a population that are physically moving through space at time of observation.
Rattle Rate	event / (R_n * s)	negative	Rate of a rattlesnake's rattle.
Strike Acceleration	m / (C_n * s^2)	positive	Acceleration of a consumer's head during a strike at a resource.
Strike Completion Rate	event / (C_n * s)	positive	Rate a consumer completes a strike.
Strike Distance	m / C_n	positive	Distance between a consumer and resource when consumer initiates a strike per consumer.
Strike Velocity	m / (C_n * s)	positive	Velocity of a consumers strike per consumer (averaged over strike distance).
Subjugation-Consumption Body Contraction Rate	event / (C_n * s)	positive	Rate of body contractions for locomotion of a consumer during subjugation and consumption of resources.
Surface Area-Specific Foraging Gill Filtration Rate	m^3 / (m^2 * s)	positive	Area-specific volumetric flow rate of water across the surface-area of a gill of a filter feeding organism (flow rate measured directly, or by the clearance method where flow rate is estimated by the volume of water cleared of material per time).
Voluntary Activity Probability	proportion / C_n	voluntary	Probability that an organism is active at time of observation.
Voluntary Body Contraction Rate	event / (C_n * s)	voluntary	Rate of body contractions for locomotion in an organism with no apparent stimulus.
Voluntary Body Velocity	m / (C_n * s)	voluntary	Velocity of the whole organism during voluntary locomotion.
Voluntary Eye Saccade Angular Velocity	rad / (C_n * s)	voluntary	Angular velocity of fast eye movements, or saccade velocity, of an organism during voluntary activity.
Voluntary Movement Rate	event / (C_n * s)	voluntary	Rate organism physically moves through space.
Voluntary Stroke Rate	event / (C_n * s)	voluntary	Stroke rate of an organism during voluntary locomotion.
Voluntary Tail Beat Rate	event / (C_n * s)	voluntary	Rate of tail-beat cycles of an organism during voluntary locomotion.
Voluntary Tongue Flick Cycle Number	event / C_n	voluntary	Number of up-and-down motions or cycles of the tongue per flick in an organism with no obvious stimulus.
Voluntary Tongue Flick Cycle Rate	event / (C_n * s)	voluntary	Rate of up-and-down motions or cycles of the tongue per flick in an organism with no obvious stimulus.

Trait name	Trait unit	Motivation	Trait definition
Voluntary Tongue Flick Non-Cycle Rate	event / (C_n * s)	voluntary	Rate tongue is outside mouth and not moving in an organism with no obvious stimulus.
Voluntary Wing Beat Rate	event / (C_n * s)	voluntary	Rate of wing beating in a flying organism with no apparent stimulus.
Population			
Chlorophyll-a-Specific Carbon Production Rate	kg / (kg * s)	autonomic	Production rate of carbon by a primary producer, measured as mass of carbon produced per mass of chlorophyll-a.
Fecundity	1 / (C_n * s)	autonomic	Number of offspring produced by a female per time.
Mortality Rate	1 / (C_n * s)	autonomic	Number of deaths scaled by population size per time.
Population Density	C_n / A	autonomic	Number of individuals in the population per arena size.
Population Growth Rate	1 / (C_n * s)	autonomic	Intrinsic rate of population growth measured as individuals per individuals per time.
Radial Growth Rate	m / (C_n * s)	autonomic	Rate of increase in size (length, mass, or volume) of a population over time.
Interaction			
Attack Density Rate	event / ((R_n * C_n * s) / A)	positive	Rate of the completion of one attack to the start of the next attack per consumer standardized by arena size.
Attack Rate	event / (C_n * s)	positive	Rate of the completion of one attack to the start of the next attack per consumer.
Consumption Probability	proportion / C_n	positive	Probability that an active consumer will consume food offered to it.
Consumption Rate	event / (R_n * C_n * s)	positive	Rate of resources consumed per consumer.
Filtration Rate	m^3 / (C_n * s)	positive	Volumetric flow rate of water through a filter feeding consumer (flow rate measured directly, or by the clearance method as the volume of water cleared of material per time).
Foraging Behavior Probability	proportion / C_n	voluntary	Proportion of foraging time a consumer spends undertaking a particular foraging behavior within a subset of a single foraging bout.
Foraging Rate	event / (C_n * s)	voluntary	Length of a single foraging bout of a consumer.
Grazing Rate	m^2 / (C_n * s)	voluntary	The area grazed per consumer per time.
Handling Rate	R_n / (C_n * s)	positive	Rate at which consumer pursues, subjugates, and ingests resources (differs from attack rate because includes ingestion).
Host-Per-Parasitoid Parasitisation Rate	event / ((R_n * C_n * s) / A)	positive	Rate of host parasitisation per parasitoid standardized by arena size.
Intraspecific Confrontation Probability Density	proportion / (C_n / A)	voluntary	Proportion of time organism spends in intraspecific confrontations out of total observation time standardized by arena size.
Line Encounter Rate	event / s	voluntary	Encounter rate of individuals in a population moving past a fixed line.
Nest Provisioning Rate	R_n / (C_n * s)	positive	Rate resources bought back to the nest for consumption, by itself or its young, per consumer.
Point Encounter Density Rate	event / ((C_n * s) / A)	voluntary	Encounter rate of individuals in a population with an arbitrary point or line per consumer standardized by arena size.
Point Encounter Number Rate	event / (C_n * s)	voluntary	Encounter rate per consumer of individuals in a population with a fixed point or line.
Population Catchability	C_n / (R_n * s)	voluntary	Rate of resources caught in baited fishing traps per number of traps set.
Population Foraging Probability	proportion	voluntary	Proportion of consumer population that are foraging at time of observation.
Refuge Distance	m / R_n	negative	Distance to refuge for resource when initially spotted by a consumer (e.g., bush, rock, clump of grass).
Resource Habitat Encounter Density Rate	event / ((C_n * s) / A)	voluntary	Rate consumer encounters its resource habitat within the larger landscape per consumer standardized by arena size.

Trait name	Trait unit	Motivation	Trait definition
Resource Reaction Distance	m / R_n	negative	Distance from resource to consumer when resource apparently first reacts to approaching consumer (i.e., stops and/or moves away).
Resource Size Capture Intent Acceptance Probability	proportion / C_n	positive	Proportion of times that a 6 mg resource item was accepted when presented to a consumer after a captured 32 mg resource was taken.
Sediment Mass Processing Rate	kg / (C_n * s)	positive	Rate sediment mass is ingested and processed for food by a deposit feeder (most of what is ingested in non-digestible inorganic sediment).
Subjugation-through-Consumption Rate	event / (C_n * s)	positive	Rate resources are subdued and consumed per consumer.

Appendix 3.2

Summary of intraspecific thermal responses used in the analysis (Chapter 3). Data are listed in alphabetical order by traits and then taxa. Trait names correspond to those in Appendix 3.1. Taxa names represent the lowest level of taxonomy given in the original source (typically species), followed by life stage and sex when present (in square parenthesis), and trophic designation (P, producer; H, herbivore; O, omnivore; C, carnivore; D, detritivore; S, non-feeding organisms, such as eggs, pupae etc). For interaction traits, consumer and resource are separated by an arrow (consumer is on the left). Artificial “taxa”, such as light as a resource for photosynthesis or pressure waves as a consumer for escape body velocity, are appropriately designated and are not assigned a trophic group. **Ref** is citation code (Appendix 3.3); **H** is habitat (M, marine; F, freshwater; T, terrestrial); **LF** is whether the setting was laboratory (L) or field (F); **Temp** is minimum and maximum temperatures over which the response was measured; **N** is the number of distinct temperature points. $\mathbf{E_R}$ and $\mathbf{E_F}$ are estimated activation energies of the rise and fall components of the temperature responses, calculated from fits to the Boltzmann-Arrhenius model. $\mathbf{Q_{10\ R}}$ and $\mathbf{Q_{10\ F}}$ are estimated $\mathbf{Q_{10}}$ values of the rise and fall components of the temperature responses. NS are non-significant fits; $\mathbf{T_{pk}}$ are estimates of peak temperatures. See Section 3.2 for details on how these values were calculated.

Trait / Consumer [stage] trophic group –> Resource [stage] trophic group	Ref	H	LF	Temp	N	E_R	$Q_{10\ R}$	E_F	$Q_{10\ F}$	T_{pk}
48-hr Hatching Probability (individual)										
Acartia sinjiensis [adult] O –> microalgae P	125	M	L	10–38	8	0.66	2.42			34
Ammonia Excretion Rate (internal)										
Dreissena polymorpha [adult] O	2	F	L	20–32	4	1.1	4.17			
Attack Density Rate (species interaction)										
Perca flavescens [juvenile] O –> Coregonus clupeaformis [juvenile] C	190	F	L	5–18	4					10
	190	F	L	5–18	4					15
Perca fluviatilis [adult] O –> Chaoborus obscuripes [juvenile] C	140	F	L	12–21	4			NS	NS	
Rutilus rutilus [adult] O –> Chaoborus obscuripes [juvenile] C	140	F	L	12–21	4			NS	NS	
Attack Rate (species interaction)										
Cicindela hybrida [adult] C –> cursorial insects	42	T	F	23–40.3	8	0.66	2.33			34.7
Avoidance Body Velocity (individual)										
gravity –> Aphidius ervi [adult] C	60	T	L	12–36	7	0.9	3.37			28
	60	T	L	12–36	7	0.92	3.47			28
light –> Homarus americanus [adult] C	120	M	L	10–28	5	NS	NS			25
	120	M	L	2–15	4					5
	120	M	L	2–20	5					10
	120	M	L	2–25	6					12.5
	120	M	L	2–25	6	NS	NS			20
	120	M	L	5–25	5					20
Bite Rate (individual)										
Cellana ornata [adult] H –> microalgae P	21	M	F	7.3–17.3	12	0.52	2.08			
Hyles lineata [juvenile] H –> desert plants P	27	T	F	13.7–34	5	0.43	1.77			
Littorina littorea [adult] H –> epiphytic micro-organisms O	133	M	L	5–25	5	0.4	1.76			
Manduca sexta [juvenile] H –> Datura inoxia P	27	T	F	13.1–31.8	7	0.51	1.96			

Trait / Consumer [stage] trophic group –> Resource [stage] trophic group	Ref	H	LF	Temp	N	E_R	$Q_{10\,R}$	E_F	$Q_{10\,F}$	T_{pk}
Chlorophyll-a-Specific Carbon Production Rate (population)										
Periphyton P	93	F	L	3–21	7	0.49	1.99			
Consumption Probability (species interaction)										
Pituophis catenifer affinis [adult] C –> Mus musculus [adult] O	65	T	L	18–33	4	NS	NS			
Consumption Probability (species interaction)										
Uta stansburiana [adult] C –> Acheta sp. A [adult] O	178	T	L	20–36	6	NS	NS			32
	178	T	L	20–36	6	NS	NS			32
Consumption Rate (species interaction)										
Acroneuria californica [juvenile] O –> Hydropsyche spp. [juvenile] O	75	F	L	14–28	8	0.33	1.57			26
	75	F	L	16–28	7	0.42	1.74			
	75	F	L	6–20	7	0.62	2.42			18
Acroneuria californica [juvenile] O –> Simulium spp. [juvenile] O	75	F	L	10–24	8			0.12	0.85	12
	75	F	L	10–24	8	0.15	1.22			
	75	F	L	18–30	6	NS	NS	NS	NS	
Agonum dorsale [adult] C –> Sitobion avenae [juvenile] H	162	T	L	12.3–23.6	4	1.15	4.79			
Bembidion lampros [adult] C –> Rhopalosiphum padi [adult] H	31	T	L	10–25	4	0.72	2.7			
Bembidion lampros [adult] C –> Rhopalosiphum padi [juvenile] H	31	T	L	10–25	4					25
Bembidion lampros [adult] C –> Sitobion avenae [juvenile] H	162	T	L	12.3–23.6	4					20.6
Bembidion obtusum [adult] C –> Sitobion avenae [juvenile] H	162	T	L	12.3–23.6	4	NS	NS			
Carcinops pumilio [adult] C –> Musca domestica [juvenile] D	59	T	L	15–33	4	0.8	2.87			
Carcinus maenas [adult] O –> Mytilus edulis [adult] O	179	M	L	3.8–17.7	4	0.77	3.05			
	179	M	L	6.9–18.4	6	NS	NS			16.3
Celithemis fasciata [juvenile] C –> Chironomus tentans [juvenile] O	66	F	L	10–25	4					15
	66	F	L	10–25	4					20
	66	F	L	10–25	4	0.85	3.2			
	66	F	L	10–25	4	NS	NS			
	66	F	L	10–25	4	NS	NS			
Chaoborus americanus [juvenile] C –> Diaptomus kenai [adult] O	50	F	L	5–20	4	0.68	2.63			
	50	F	L	5–20	4	NS	NS			
Chaoborus americanus [juvenile] C –> Diaptomus tyrelli [adult] O	50	F	L	5–20	4	NS	NS			
Chaoborus trivittatus [juvenile] C –> Diaptomus kenai [adult] O	50	F	L	5–20	4					15
	50	F	L	5–20	4	NS	NS			
	50	F	L	5–20	4	NS	NS			
Chaoborus trivittatus [juvenile] C –> Diaptomus tyrelli [adult] O	50	F	L	5–20	4	0.69	2.66			
Cicindela hybrida [adult] C –> cursorial insect	42	T	F	19.9–39.9	5					29.9
Dreissena polymorpha [adult] O –> Chlorella spp. P	2	F	L	20–32	4					24
Gymnocephalus cernuus [adult] C –> Chaoborus obscuripes [juvenile] C	18	F	L	4–20	5	0.16	1.25			
	18	F	L	4–20	5	0.4	1.76			
	18	F	L	4–20	5	NS	NS			
	18	F	L	4–20	5	NS	NS			
Harpalus rufipes [adult] C –> Sitobion avenae [juvenile] H	162	T	L	12.3–23.6	4	0.89	3.38			
Ischnura elegans elegans [juvenile] C –> Daphnia magna [adult] O	171	F	L	5–27.5	6			NS	NS	12
	171	F	L	5–27.5	6	0.59	2.33			16
	171	F	L	5–27.5	6	NS	NS			16
	171	F	L	5–27.5	6	NS	NS			16
	171	F	L	5–27.5	6	NS	NS			16

Trait / Consumer [stage] trophic group –> Resource [stage] trophic group	Ref	H	LF	Temp	N	E_R	$Q_{10 R}$	E_F	$Q_{10 F}$	T_{pk}
	171	F	L	5–27.5	6	NS	NS			16
	171	F	L	5–27.5	6	NS	NS			16
	171	F	L	5–27.5	7	0.97	4			16
	171	F	L	5–27.5	8	NS	NS			
Macrocheles muscaedomesticae [adult] C –> Musca domestica [juvenile] D	59	T	L	15–33	4	0.85	3.06			
Naucoris congrex [adult] C –> Culicidae spp. [juvenile] O	118	F	L	5–25	4					20
	118	F	L	5–25	4	0.52	2.07			
	118	F	L	5–25	4	0.53	2.1			
	118	F	L	5–25	4	0.57	2.23			
	118	F	L	5–25	4	0.58	2.24			
	118	F	L	5–25	4	0.6	NS			
	118	F	L	5–25	4	NS	NS			
Notonecta glauca [adult] C –> Asellus aquaticus [adult] O	34	F	L	5–20	4					10
	34	F	L	5–25	5					15
Notonecta glauca [adult] C –> Culex pipiens [juvenile] O	34	F	L	5–25	5	0.76	2.86			
	34	F	L	5–25	5	1.1	4.76			20
Notonecta hoffmani [adult] C –> Culex pipiens [juvenile] O	129	F	L	10–25	4	1.1	4.54			
Nucella lapillus [adult] C –> Mytilus edulis [adult] O	99	M	L	3–25	8	0.91	3.65			
Orius insidiosus [adult] C –> Panonychus ulmi [adult] H	117	T	L	18.3–35	4					29.4
	117	T	L	18.3–35	4					29.4
	117	T	L	18.3–35	4	0.72	2.55			
	117	T	L	18.3–35	4	NS	NS			
	117	T	L	18.3–35	4	NS	NS			
Parus major [adult] O –> Zygiella x-notata [adult] C	7	T	L	2.9–12.7	6	NS	NS			
Perca flavescens [juvenile] O –> Coregonus clupeaformis [juvenile] C	190	F	L	5–18	4					15
	190	F	L	5–18	4					18
Perca fluviatilis [adult] O –> Chaoborus obscuripes [juvenile] C	18	F	L	4–20	5					16
	18	F	L	4–20	5	0.8	3.11			
	18	F	L	4–20	5	0.99	4.21			16
	18	F	L	4–20	5	NS	NS			16
	18	F	L	4–20	5	NS	NS			16
	18	F	L	4–20	5	NS	NS			16
	140	F	L	12–21	4	0.46	1.88			
	140	F	L	12–21	4	0.53	NS			
	140	F	L	12–21	4	NS	NS			
	140	F	L	12–21	4	NS	NS			
	140	F	L	12–21	4	NS	NS			
	140	F	L	12–21	4	NS	NS			
Phytoseiulus persimilis [adult] C –> Tetranychus urticae [adult] H	48	T	L	15–30	4					25
	48	T	L	15–30	4	0.46	1.83			
	48	T	L	15–30	4	0.63	2.31			
	48	T	L	15–30	4	0.65	2.37			
	48	T	L	15–30	4	0.74	2.67			
	48	T	L	15–30	4	0.85	3.07			
Polinices duplicatus [adult] C –> Mya arenaria [adult] O	45	M	F	9.5–23	4	1.14	5.26			22.8
Porotermes adamsoni [adult] D –> Eucalyptus regnans [adult] P	105	T	L	11.5–24	4	0.74	2.75			
Porotermes adamsoni [adult] D –> Eucalyptus viminalis [adult] P	105	T	L	11.5–24	4	0.65	2.42			

Trait / Consumer [stage] trophic group –> Resource [stage] trophic group	Ref	H	LF	Temp	N	E_R	$Q_{10\,R}$	E_F	$Q_{10\,F}$	T_{pk}
Porotermes adamsoni [adult] D –> Pinus radiata [adult] P	105	T	L	9–26	5	0.77	2.86			
Ranatra dispar [adult] C –> Anisops deanei [adult] C	10	F	L	15–30	4	0.51	1.97			
	10	F	L	15–30	4	0.56	NS			
	10	F	L	15–30	4	NS	NS			
	10	F	L	15–30	4	NS	NS			
Rutilus rutilus [adult] O –> Chaoborus obscuripes [juvenile] C	140	F	L	12–21	4	0.77	2.89			
	140	F	L	12–21	4	0.86	3.28			
	140	F	L	12–21	4	0.86	3.27			
	140	F	L	12–21	4	0.92	3.55			
	140	F	L	12–21	4	0.93	3.62			
	140	F	L	12–21	4	NS	NS			
Salvelinus malma [juvenile] C –> dead Euphausia superba [adult]	93	F	L	3–21	7	NS	NS	2.4	0.04	12
Stethorus punctum [adult] O –> Panonychus ulmi [adult] H	82	T	L	21–32.5	5	0.53	1.99			
	82	T	L	21–32.5	5	0.58	2.13			
	82	T	L	21–32.5	5	0.61	2.21			31
	82	T	L	21–32.5	5	0.93	3.36			31
	82	T	L	21–32.5	5	NS	NS			31
Tachyporus hypnorum [adult] C –> Sitobion avenae [juvenile] H	162	T	L	12.3–23.6	4					20.6
Thais haemastoma [adult] C –> Crassostrea virginica [juvenile] O	58	M	L	10–30	6	NS	NS			
Urosalpinx cinerea [adult] C –> Crassostrea virginica [juvenile] O	70	M	L	8.3–30	5	1.18	5.1			25
Urosalpinx cinerea [adult] C –> Mytilus edulis [juvenile] O	70	M	L	10–30	5	NS	NS			25
Critical Holding Velocity (individual)										
electric shock –> Salmo salar [juvenile] C	63	F	L	3.1–14.6	7	0.31	1.6			9.6
	63	F	L	3.1–14.6	7	0.56	2.29			9.6
Critical Travel Velocity (individual)										
electric shock –> Barbus barbus [adult] O	135	F	L	7–25	4					19
	135	F	L	7–25	4	NS	NS			
electric shock –> Cyprinella spiloptera [juvenile] O	78	F	L	15–35	5	0.53	2.01			30
electric shock –> Exodon paradoxus [adult] C	15	F	L	20–35	4					30
electric shock –> Leporinus fasciatus [adult] O	15	F	L	25–37	4					35
electric shock –> Micropterus salmoides [juvenile] C	78	F	L	15–35	5	0.24	1.37			30
electric shock –> Oncorhynchus nerka [juvenile] C	22	F	L	5–27.5	7			NS	NS	20
electric shock –> Puntius schwanenfeldii [adult] O	135	F	L	17–30	4					25
	135	F	L	20–33	4					30
light –> Micropterus dolomieu [juvenile] C	100	F	L	10–30	5	0.31	1.52			
	100	F	L	10–30	5	0.43	1.77			
	100	F	L	10–30	5	0.56	2.16			25
	100	F	L	5–20	4	0.53	2.13			
	100	F	L	5–25	5	0.53	2.12			20
retaining screen –> Ictalurus punctatus [juvenile] O	78	F	L	15–35	5	NS	NS			30
Critical Upright Time (individual)										
Homo sapiens [adult] O –> Natrix maura [adult] C	68	T	L	10–35	6	0.48	1.91			30
Development Rate (individual)										
Aphis gossypii H –> Cucumis sativus P	191	T	L	10–30	5	0.6	2.26			
Bactrocera correcta [egg] S	112	T	L	18–36	5	0.48	1.88			33
Bactrocera correcta [pupae] S	112	T	L	18–36	5	0.45	1.78			

Trait / Consumer [stage] trophic group –> Resource [stage] trophic group	Ref	H	LF	Temp	N	E_R	$Q_{10\ R}$	E_F	$Q_{10\ F}$	T_{pk}
	112	T	L	18–36	5	0.44	1.78			33
Cherax quadricarinatus [juvenile] O –> crayfish ration	121	F	L	16–32	9	0.8	2.89			28
Chinemys reevesii [egg] S	43	F	L	24–34	6	0.29	1.44			
Cydia pomonella [egg] S	1	T	L	14–33	6	0.76	2.74			30
Cydia pomonella [juvenile] H –> artificial diet	1	T	L	14–33	6	0.76	2.8			27
Cydia pomonella [pupae] S	1	T	L	14–33	6	0.77	2.77			30
Euplectrus ronnai [juvenile] C –> Pseudaletia sequax [juvenile] H	189	T	L	15–29	5	0.79	2.88			
Euplectrus ronnai [pupae] S –> Pseudaletia sequax [juvenile] H	189	T	L	15–29	5	0.91	3.34			
Glyptapanteles muesebecki [juvenile] C –> Pseudaletia sequax [juvenile] H	54	T	L	14–29	6	0.72	2.64			26
Glyptapanteles muesebecki [pupae] S –> Pseudaletia sequax [juvenile] H	54	T	L	14–29	6	0.82	2.98			
Macrocentrus iridescens [juvenile] C –> Choristoneura rosaceana [juvenile] H	97	T	L	13.9–31	6	0.74	2.72			25.8
Planococcus citri [egg] S –> Solenostemon scutellarioides P	61	T	L	15–32	8	0.72	2.59	NS	NS	25
	61	T	L	18–32	7	1.2	4.96	NS	NS	25
Planococcus citri [juvenile] H –> Solenostemon scutellarioides P	61	T	L	15–32	8	0.93	3.51	0.49	0.53	25
	61	T	L	18–32	7	0.46	1.83			
Planococcus citri [pupae] H –> Solenostemon scutellarioides P	61	T	L	18–32	7	0.84	3.02	NS	NS	25
	61	T	L	18–32	7	1.03	3.86	NS	NS	25
Procambarus clarkii [adult] O –> uncooked mixed vegetables	30	F	L	15–30	6	0.65	2.38			
Procambarus clarkii [juvenile] O –> uncooked mixed vegetables	30	F	L	15–30	6	0.54	2.05			
Sitona discoideus [egg] S	5	T	L	8.5–30	8	0.67	2.48			28
Telenomus chrysopae [juvenile] C –> Chrysoperla rufilabris [egg] S	155	T	L	15.6–26.7	5	0.85	3.14			
	155	T	L	15.6–26.7	5	0.91	3.36			
Telenomus isis [juvenile] C –> Busseola fusca [egg] S	25	T	L	18–32	6	0.61	2.21			30
	25	T	L	18–32	6	0.64	2.31			30
Telenomus isis [juvenile] C –> Sesamia calamistis [egg] S	25	T	L	18–32	6	0.57	2.13			30
	25	T	L	18–32	6	0.59	2.18			30
Telenomus isis [juvenile] C –> Sesamia nonagrioides [egg] S	25	T	L	18–32	6	0.59	2.16			30
	25	T	L	18–32	6	0.64	2.32			30
Telenomus lobatus [juvenile] C –> Chrysoperla rufilabris [egg] S	155	T	L	15.6–26.7	5	0.89	3.31			
Tetraneura nigri abdominalis [juvenile] H –> Oryza sativa P	98	T	L	10–35	6	0.64	2.39			30
Theocolax elegans [juvenile] C –> Sitophilus zea-mais [egg] S	84	T	L	20–35	6	0.79	2.79			32
	84	T	L	20–35	6	0.81	2.86			32
Trichogramma bruni [juvenile] C –> Corcyra cephalonica [egg] S	90	T	L	15–32	6	0.6	2.23			30
	90	T	L	20–32	5	NS	NS			30
Trichogramma sp. nr. lutea [juvenile] C –> Corcyra cephalonica [egg] S	90	T	L	15–32	6	0.47	1.84			
	90	T	L	15–32	6	0.56	2.09			30
	90	T	L	15–32	6	0.57	2.13			30
	90	T	L	15–32	6	0.65	2.38			28
	90	T	L	15–35	7	0.41	1.71			
	90	T	L	15–35	7	0.43	1.75			
Trichogramma sp. nr. mwanzai [juvenile] C –> Corcyra cephalonica [egg] S	90	T	L	15–32	6	0.59	2.17			30
	90	T	L	15–32	6	0.64	2.34			30
	90	T	L	15–35	7	0.42	1.73			
	90	T	L	15–35	7	0.48	1.86			
Digestion Rate (internal)										
Perca fluviatilis [adult] O –> Gammarus pulex [adult] O	139	F	L	4–21.7	7	1.07	4.64			
Ptychocheilus oregonensis [adult] C –> Oncorhynchus mykiss [juvenile] C	163	F	L	6–24	5	0.88	3.4			

Trait / Consumer [stage] trophic group –> Resource [stage] trophic group	Ref	H	LF	Temp	N	E_R	$Q_{10\,R}$	E_F	$Q_{10\,F}$	T_{pk}
	163	F	L	6–24	5	1.05	4.33			
	163	F	L	6–24	5	1.26	5.8			
Salmo trutta [adult] C –> dead Hydropsyche spp. [juvenile]	47	F	L	5.2–15	4	0.77	3.06			
	47	F	L	5.2–15	4	0.77	3.06			
	47	F	L	5.2–15	4	0.77	3.05			
	47	F	L	5.2–15	4	0.78	3.07			
Salmo trutta [adult] C –>dead invertebrate	47	F	L	5.2–15	5	0.77	3.06			
	47	F	L	5.2–15	5	0.77	3.07			
	47	F	L	5.2–15	5	0.78	3.07			
	47	F	L	5.2–15	5	0.78	3.1			
Salmo trutta [adult] C –> dead Protonemura meyeri [juvenile]	47	F	L	5.2–15	5	0.73	2.88			
	47	F	L	5.2–15	5	0.74	2.91			
	47	F	L	5.2–15	5	0.74	2.9			
	47	F	L	5.2–15	5	0.74	2.91			
Salmo trutta [adult] C –> Tenebrio molitor [juvenile] H	47	F	L	5.2–15	5	0.77	3.06			
	47	F	L	5.2–15	5	0.77	3.06			
	47	F	L	5.2–15	5	0.77	3.06			
	47	F	L	5.2–15	5	0.78	3.07			
Thamnophis elegans vagrans [adult] C –> Mus musculus [adult] O	167	T	L	9.8–35	10	1.06	4.19	NS	NS	24.8
Endurance Time (individual)										
Homo sapiens [adult] O –> Sceloporus undulatus [adult] O	4	T	L	11.4–40.6	9	0.33	1.54			33
Escape Angle of Body Turning (individual)										
prodding with a probe –> Myoxocephalus scorpius [adult] C	170	M	L	0.8–20	4					5
	170	M	L	0.8–20	4			NS	NS	
	170	M	L	0.8–20	4			NS	NS	
prodding with a probe –> Taurulus bubalis [adult] C	170	M	L	0.8–20	4					5
Escape Angular Rate of Body Turning (individual)										
pressure waves –> Carassius auratus [adult] O	87	F	L	10–40	5					40
	87	F	L	5–30	5					25
pressure waves –> Fundulus heteroclitus [adult] O	87	F	L	5–30	5					25
prodding with a probe –> Myoxocephalus scorpius [adult] C	170	M	L	0.8–20	4	NS	NS			
prodding with a probe –> Taurulus bubalis [adult] C	170	M	L	0.8–20	4					5
	170	M	L	0.8–20	4					5
Escape Body Acceleration (individual)										
electric shock –> Danio rerio [juvenile] O	56	F	L	21.1–30	7	NS	NS			
Homo sapiens [adult] O –> Phelsuma dubia [adult] O	19	T	L	15–35	5	0.39	1.69			30
prodding with a probe –> Myoxocephalus scorpius [adult] C	170	M	L	0.8–20	4					15
	170	M	L	0.8–20	4					15
prodding with a probe –> Taurulus bubalis [adult] C	170	M	L	0.8–20	4					15
	170	M	L	0.8–20	4	NS	NS			
Escape Body Deceleration (individual)										
Homo sapiens [adult] O –> Phelsuma dubia [adult] O	19	T	L	15–35	5	0.36	1.61			30
Escape Body Power Production (individual)										
electric shock –> Rana pipiens [adult] C	77	T	L	14–30	4					25
Homo sapiens [adult] O –> Phelsuma dubia [adult] O	19	T	L	15–35	5	0.5	1.91			

Trait / Consumer [stage] trophic group –> Resource [stage] trophic group	Ref	H	LF	Temp	N	E_R	$Q_{10\ R}$	E_F	$Q_{10\ F}$	T_{pk}
Escape Body Response Rate (individual)										
pressure waves –> Calanus finmarchicus [adult] O	106	M	L	3.7–15.4	11	0.33	1.62			14.5
Escape Body Velocity (individual)										
electric shock –> Danio rerio [juvenile] O	56	F	L	21–30	4	0.18	1.26			
	56	F	L	21–30	4	0.25	1.38			
electric shock –> Necturus maculosus [adult] C	126	F	L	5–25	5					15
electric shock –> Xenopus laevis [adult] C	126	F	L	10–30	7	0.25	1.4			27
Homo sapiens [adult] O –> Acanthodactylus erythrurus [adult] C	14	T	L	25.4–40.4	6	0.21	1.3			
Homo sapiens [adult] O –> Agama savignyi [adult] C	76	T	L	18–42	7	0.5	1.92			34
Homo sapiens [adult] O –> Bufo boreas [adult] C	143	T	L	3.8–27.9	5	0.61	2.33			
Homo sapiens [adult] O –> Bufo woodhousii woodhousii [adult] C	113	T	L	15–30	4					30
	113	T	L	15–30	4					30
Homo sapiens [adult] O –> Coleonyx brevis [adult] C	81	T	L	20–40	6	0.24	1.35			37.5
Homo sapiens [adult] O –> Coleonyx variegatus [adult] C	81	T	L	15–40	7	0.28	1.43			
Homo sapiens [adult] O –> Hemidactylus frenatus [adult] C	81	T	L	15–39.5	7	0.46	1.83			34
Homo sapiens [adult] O –> Hemidactylus turcicus [adult] C	81	T	L	20–40	6	0.25	1.37			38.8
Homo sapiens [adult] O –> Iberolacerta monticola [adult] C	14	T	L	26.6–40	6	NS	NS			34.9
Homo sapiens [adult] O –> Lacerta agilis [adult] C	14	T	L	25.9–39.5	6	0.38	1.61			37.7
Homo sapiens [adult] O –> Lacerta schreiberi [adult] C	14	T	L	24.8–40.4	6	0.3	1.47			35.9
Homo sapiens [adult] O –> Lepidodactylus lugubris [adult] O	81	T	L	15–36.5	6	0.33	1.53			
Homo sapiens [adult] O –> Natrix maura [adult] C	68	T	L	4.2–34.1	7	0.63	2.35			
	68	T	L	5.7–35.6	7	0.62	2.28			
Homo sapiens [adult] O –> Phelsuma dubia [adult] O	19	T	L	15–35	5	0.33	1.53			
Homo sapiens [adult] O –> Podarcis bocagei [adult] O	14	T	L	26.2–39.7	6	0.42	1.7			35
Homo sapiens [adult] O –> Podarcis hispanica [adult] O	14	T	L	26.1–40.2	6	0.5	1.88			37.5
	14	T	L	26–39.5	6	0.47	1.8			37.3
Homo sapiens [adult] O –> Podarcis lilfordi [adult] O	14	T	L	26.1–39.9	6	0.32	1.48			37.3
Homo sapiens [adult] O –> Podarcis muralis [adult] O	14	T	L	25.1–39.6	6	0.3	1.45			35.2
Homo sapiens [adult] O –> Podarcis tiliguerta [adult] O	175	T	L	20–37.5	7	0.3	1.46			
	175	T	L	20–37.5	7	0.31	1.49			
Homo sapiens [adult] O –> Psammodromus algirus [adult] C	14	T	L	24.5–39.8	6	0.36	1.57			34.7
Homo sapiens [adult] O –> Psammodromus hispanicus [adult] C	14	T	L	25.8–39.5	6	0.48	1.83			34.5
Homo sapiens [adult] O –> Rana pipiens [adult] C	143	T	L	4.4–29.1	5	0.33	1.57			
Homo sapiens [adult] O –> Sceloporus occidentalis [adult] O	116	T	L	9.9–39.5	9	0.63	2.27			35.3
Homo sapiens [adult] O –> Sceloporus undulatus [adult] O	4	T	L	11.3–40.5	9	0.44	1.76			36
Homo sapiens [adult] O –> Scincella lateralis [adult] C	159	T	L	19.5–38	5	0.29	1.45			33.5
Homo sapiens [adult] O –> Thamnophis elegans vagrans [adult] C	167	F	L	5.4–35.6	7	0.36	1.63			30.5
	167	F	L	5.6–35.7	7	0.38	1.68			30.7
	167	T	L	3.9–34	7	0.71	2.61			
	167	T	L	3.9–34.1	7	0.55	2.1			
Homo sapiens [adult] O –> Thamnophis sirtalis [adult] C	73	T	L	15.5–30.6	5	0.57	2.12			
	73	T	L	16.2–32.4	11	0.51	1.94			
	73	T	L	16.8–30.6	5	0.6	2.23			26.3
	73	T	L	16.8–31.5	5	0.57	2.11			
	73	T	L	16.9–31.2	5	NS	NS			
	73	T	L	17.1–31.2	5	0.68	2.48			31.2
pressure waves –> Barbus barbus [adult] O	135	F	L	7–25	4					25

Trait / Consumer [stage] trophic group –> Resource [stage] trophic group	Ref	H	LF	Temp	N	E_R	$Q_{10\,R}$	E_F	$Q_{10\,F}$	T_{pk}
	135	F	L	7–25	4	0.19	1.31			
pressure waves –> Carassius auratus [adult] O	87	F	L	10–40	5					35
	87	F	L	10–40	5	NS	NS			35
	87	F	L	5–30	5					15
	87	F	L	5–30	5	0.2	NS			25
pressure waves –> Fundulus heteroclitus [adult] O	87	F	L	5–30	5					20
	87	F	L	5–30	5					20
prodding with a probe –> Clupea harengus [juvenile] H	12	M	L	4.7–17.5	22	0.2	1.34			
	12	M	L	4.9–17.2	13	0.29	1.52			
prodding with a probe –> Cnemidophorus murinus [adult] C	17	T	L	20–43.5	6	NS	NS			40
	17	T	L	20–44	6	0.51	NS			40
	17	T	L	20–44	6	NS	NS			40
prodding with a probe –> Dipsosaurus dorsalis [adult] H	17	T	L	15–43.5	7	0.89	3.1			40
	17	T	L	15–44	7	0.85	3			35
	17	T	L	15–44	7	0.96	3.48			35
prodding with a probe –> Elgaria multicarinata [adult] C	17	T	L	10–37.5	7	0.44	1.82			30
	17	T	L	10–37.5	7	0.5	1.92			
	17	T	L	10–37.5	7	0.52	2.02			30
prodding with a probe –> Myoxocephalus scorpius [adult] C	170	M	L	0.8–20	4					15
	170	M	L	0.8–20	4					15
prodding with a probe –> Sceloporus occidentalis [adult] O	17	T	L	10–40	5	0.54	2.03			
	17	T	L	10–40	7	0.38	1.64			35
	17	T	L	10–40	7	0.46	1.84			35
	17	T	L	10–40	7	0.51	1.92			
prodding with a probe –> Taurulus bubalis [adult] C	170	M	L	0.8–20	4					15
	170	M	L	0.8–20	4	NS	NS			
prodding with a probe –> Uma inornata [adult] C	17	T	L	20–43.5	7	0.24	1.35			40
Escape Body Velocity Probability (individual)										
prodding with a probe –> Conolophus pallidus [juvenile] O	32	T	F	15–39.3	5	NS	NS			33.5
	32	T	F	17–39.5	10	0.72	2.53			34.4
	32	T	F	20.4–39.8	4					39.8
prodding with a probe –> Uta stansburiana [adult] C	177	T	L	15–38.5	4					33.5
	177	T	L	15–41.9	9	0.39	1.65			37.9
	177	T	L	19.9–39.9	6	1.27	5			38
Escape Gait Change Velocity (individual)										
electric shock –> Uromastyx aegyptia [adult] H	41	T	L	35.1–44	7			4.28	0.01	
Escape Jump Contact Rate (individual)										
electric shock –> Rana pipiens [adult] C	77	T	L	14–30	4	0.29	1.47			
Escape Jump Distance (individual)										
electric shock –> Rana pipiens [adult] C	77	T	L	14–30	4					18
	77	T	L	14–30	4					25
	77	T	L	14–30	4					25
	77	T	L	14–30	4	0.35	1.61			
	77	T	L	14–30	4	NS	NS			
	77	T	L	14–30	4	NS	NS			
Homo sapiens [adult] O –> Bufo woodhousii woodhousii [adult] C	113	T	L	15–30	4					30

Trait / Consumer [stage] trophic group –> Resource [stage] trophic group	Ref	H	LF	Temp	N	E_R	$Q_{10\ R}$	E_F	$Q_{10\ F}$	T_{pk}
	113	T	L	15–30	4	0.24	1.38			
Homo sapiens [adult] O –> Rana clamitans [adult] C	80	T	L	5–30	7	0.25	1.43			20
prodding with a probe –> Acris crepitans [adult] C	96	T	L	5–30	6	0.2	1.31			
prodding with a probe –> Bufo americanus [adult] C	146	T	L	5–25	5	0.13	1.2			
	146	T	L	5–25	5	NS	NS			
prodding with a probe –> Bufo woodhousii woodhousii [adult] C	113	T	L	15–30	4					25
	113	T	L	15–30	4	0.21	1.31			
prodding with a probe –> Hyla femoralis [adult] C	96	T	L	5–30	6	0.2	1.32			
prodding with a probe –> Limnodynastes tasmaniensis [adult] C	184	T	L	4.4–33.2	6	NS	NS			29.5
	184	T	L	4.4–35.7	7	0.33	1.58			29.5
prodding with a probe –> Pseudacris triseriata [adult] C	96	T	L	5–30	6	0.13	1.29			
	96	T	L	5–30	6	0.15	1.23			
prodding with a probe –> Rana clamitans [adult] C	96	T	L	5–30	6	0.33	1.59			25
prodding with a probe –> Rana pipiens [adult] C	146	T	L	5–25	5	0.38	1.71			
	146	T	L	5–25	5	NS	NS			
prodding with a probe –> Rana sylvatica [adult] C	96	T	L	5–30	6	0.26	1.43			
	96	T	L	5–30	6	0.29	1.49			
Escape Jump Force (individual)										
electric shock –> Rana pipiens [adult] C	77	T	L	14–30	4					25
Escape Jump Rate (individual)										
Homo sapiens [adult] O –> Bufo woodhousii woodhousii [adult] C	113	T	L	15–30	4					20
	113	T	L	15–30	4					25
Escape Stroke Length (individual)										
Homo sapiens [adult] O –> Phelsuma dubia [adult] O	19	T	L	15–35	5	0.18	1.27			
Homo sapiens [adult] O –> Sceloporus occidentalis [adult] O	116	T	L	9.9–39.6	9	0.11	1.16			
Escape Stroke Peak Force (individual)										
pressure waves –> Calanus finmarchicus [adult] O	106	M	L	3.8–15.4	11	0.23	1.41			
Escape Stroke Peak Force Rate (individual)										
	106	M	L	4.5–14.6	8	0.44	1.89			
Escape Stroke Rate (individual)										
Homo sapiens [adult] O –> Atelopus muisca [adult] C	130	F	F	5–25	5					10
Homo sapiens [adult] O –> Atelopus sp. nov. [adult] C	130	F	F	5–25	5					15
Homo sapiens [adult] O –> Atelopus varius [adult] C	130	F	F	5–30	6	0.37	1.68			27.5
Homo sapiens [adult] O –> Colostethus flotator [adult] C	130	F	F	14.6–30	4					20
Homo sapiens [adult] O –> Colostethus subpunctatus [adult] C	130	F	F	5–25	5					15
Homo sapiens [adult] O –> Colostethus talamancae [adult] C	130	F	F	10–30	5					25
Homo sapiens [adult] O –> Eleutherodactylus bogotensis [adult] C	130	F	F	5–25	5					15
Homo sapiens [adult] O –> Eleutherodactylus diastema [adult] C	130	F	F	10–30	5					25
Homo sapiens [adult] O –> Hyla ebraccata [adult] C	130	F	F	5–30	6	NS	NS			25
Homo sapiens [adult] O –> Hyla labialis [adult] C	130	F	F	5–25	5	NS	NS			
Homo sapiens [adult] O –> Hyla microcephala [adult] C	130	F	F	9.7–30	5	NS	NS			25
Homo sapiens [adult] O –> Phelsuma dubia [adult] O	19	T	L	15–35	5	0.26	1.41			
Homo sapiens [adult] O –> Sceloporus occidentalis [adult] O	116	T	L	10.3–39.7	9	0.48	1.87			35.4
pressure waves –> Calanus finmarchicus [adult] O	106	M	L	3.6–15.3	11	0.23	1.4			
	106	M	L	4.9–14.8	13	0.38	1.75			
Escape Tail Beat Rate (individual)										

Trait / Consumer [stage] trophic group –> Resource [stage] trophic group	Ref	H	LF	Temp	N	E_R	$Q_{10\,R}$	E_F	$Q_{10\,F}$	T_{pk}
prodding with a probe –> Clupea harengus [juvenile] H	12	M	L	4.6–17.4	22	0.4	1.78			
	12	M	L	5–17.1	11	0.38	1.72			17
Faecal Excretion Rate (internal)										
Hexagenia limbata [juvenile] H –> sediment 'a'	192	F	L	5–25	5	0.31	1.55			
	192	F	L	5–25	5	0.37	1.69			
	192	F	L	5–25	5	0.43	1.84			
Fecundity (population)										
Tetraneura nigri abdominalis [adult] H –> Oryza sativa P	98	T	L	10–35	6	1.37	6.27			30
Feeding Heart Beat Rate (internal)										
Crassostrea virginica [adult] O	51	M	L	10–21.9	4	0.75	2.84			
	51	M	L	10–21.9	4	0.89	3.6			
	51	M	L	10–22	4					17.9
	51	M	L	10–22	4					17.9
	51	M	L	10–22	4	0.92	3.58			
	51	M	L	10–22	4	1.26	5.73			
	51	M	L	4.8–39.5	6	0.5	1.97			34.7
	51	M	L	4.8–40.1	6	NS	NS			29.8
	51	M	L	4.9–39.7	6	NS	NS			29.5
	51	M	L	4.9–40.1	6	0.56	2.14			29.8
	51	M	L	5.1–39.9	6	NS	NS			30
	51	M	L	5.2–39.9	6	0.24	1.38			35
	51	M	L	5.2–39.9	6	0.6	2.2			
	51	M	L	5.3–40	6	0.79	NS			30
	51	M	L	5.3–40.1	6	0.66	NS			29.9
	51	M	L	9.8–22	4	0.67	2.54			
	51	M	L	9.9–21.9	4	0.88	3.4			
	51	M	L	9.9–22	4	0.85	3.24			
	51	M	L	9.9–22	4	0.92	3.57			
Mytilus edulis [adult] O	185	M	L	10–25	4	0.45	1.85			
	185	M	L	10–25	4	0.45	1.87			
	185	M	L	10–25	4	0.46	1.87			
	185	M	L	5–25	5	0.44	1.84			
	185	M	L	5–25	5	0.71	2.7			
	185	M	L	5–30	6	0.65	2.47			25
Filtration Metabolic Efficiency (internal)										
Cardium lamarcki [adult] O –> yeast & sediment	23	M	L	4–20	5			NS	NS	
	23	M	L	4–20	5			NS	NS	
	23	M	L	4–20	5			NS	NS	
	23	M	L	4–28	7			0.32	0.64	
	23	M	L	4–28	7			NS	NS	
	23	M	L	4–28	7	NS	NS			
Cerastoderma edule [adult] O –> yeast & sediment	23	M	L	4–20	5			0.15	0.81	
	23	M	L	4–20	5			0.25	0.7	
	23	M	L	4–28	7			0.57	0.45	8
	23	M	L	4–28	7			0.76	0.35	
	23	M	L	4–28	7			1.04	0.24	

Trait / Consumer [stage] trophic group –> Resource [stage] trophic group	Ref	H	LF	Temp	N	E_R	$Q_{10\,R}$	E_F	$Q_{10\,F}$	T_{pk}
Ostrea edulis [adult] O –> Phaeodactylum tricornutum P	132	M	L	10–30	6			0.71	0.38	
	132	M	L	10–30	6			0.79	0.34	
	132	M	L	10–30	6			NS	NS	
	132	M	L	10–30	6			NS	NS	
	132	M	L	10–30	6			NS	NS	
Filtration Rate (species interaction)										
Cardium lamarcki [adult] O –> yeast & sediment	23	M	L	4–20	5	0.71	2.78			
	23	M	L	4–20	5	NS	NS			
	23	M	L	4–20	5	NS	NS			
	23	M	L	4–28	7	0.57	2.23			24
	23	M	L	4–28	7	1.09	4.74			20
Cerastoderma edule [adult] O –> yeast & sediment	23	M	L	4–20	5	0.42	1.83			
	23	M	L	4–20	5	0.56	2.23			
	23	M	L	4–20	5	NS	NS			
	23	M	L	4–28	7			0.65	0.42	12
	23	M	L	4–28	7	NS	NS			
Ciona intestinalis [adult] O –> Rhodomonas spp. P	141	M	L	4.3–21.6	5	0.59	2.33			18.1
	141	M	L	5.3–20.7	4	0.65	2.52			
	141	M	L	5–22	5	NS	NS			19.5
	141	M	L	6.3–21.5	5	0.79	3.09			18.1
	141	M	L	6.3–21.6	5	0.64	2.46			
Conopeum reticulum [adult] O –> Cryptomonas spp. P	123	M	L	6–22	4					18
	123	M	L	6–22	4					18
	123	M	L	6–22	4					18
	123	M	L	6–22	4					18
	123	M	L	6–22	4					18
	123	M	L	6–22	4					18
	123	M	L	6–22	4					18
	123	M	L	6–22	4					18
	123	M	L	6–22	4	0.35	1.65			
	123	M	L	6–22	4	0.42	1.81			
	123	M	L	6–22	4	0.44	1.86			
	123	M	L	6–22	4	0.55	2.16			
Daphnia magna [adult] O –> Scenedesmus acutus P	119	F	L	10–25	4					20
	119	F	L	5–25	5			0.29	0.67	10
	119	F	L	5–25	5	0.67	2.57			
	119	F	L	5–25	5	0.84	3.31			20
	119	F	L	5–25	5	NS	NS			
Daphnia rosea [adult] O –> Chlamydomonas spp. P	91	M	L	5–25.2	9	0.29	1.52	0.16	0.81	14.1
Electra crustulenta [adult] O –> Rhodomonas spp. P	111	M	L	6–24	6	0.6	2.32			22
Electra pilosa [adult] O –> Cryptomonas spp. P	123	M	L	6–22	4					18
	123	M	L	6–22	4					18
	123	M	L	6–22	4					18
	123	M	L	6–22	4					18
	123	M	L	6–22	4	0.55	2.18			
	123	M	L	6–22	4	0.45	1.89			
	123	M	L	6–22	4	0.26	1.43			

Trait / Consumer [stage] trophic group –> Resource [stage] trophic group	Ref	H	LF	Temp	N	E_R	$Q_{10\,R}$	E_F	$Q_{10\,F}$	T_{pk}
	123	M	L	6–22	4	0.4	1.76			
	123	M	L	6–22	4	0.49	1.99			
Halichondria panicea [adult] O –> Rhodomonas spp. P	151	M	L	6.1–14.9	10	1.54	9.19			
	151	M	L	6.1–15	10	0.72	2.84			
	151	M	L	6–14.9	9	1.04	4.45			
	151	M	L	7–13.9	4	NS	NS			
Hiatella arctica [adult] O –> Phaeodactylum tricornutum P	3	M	L	1.6–24.9	8	0.97	4.16	3.42	0.01	15.4
	3	M	L	3.3–22.4	4					16.3
Mya arenaria [adult] O –> Rhodomonas spp. P	149	M	L	4–22.3	6	0.32	1.58			18
	149	M	L	5.6–22	5	0.35	1.63			
Mytilus californianus [adult] O –> colloidal graphite	145	M	L	5–20	4	NS	NS			
Mytilus edulis [adult] O –> Phaeodactylum tricornutum P	186	M	L	5–25	5			NS	NS	10
Mytilus edulis [adult] O –> Rhodomonas spp. P	89	M	L	2.7–15	6	0.41	1.81			
	89	M	L	4.9–14.8	4	0.29	1.51			
	89	M	L	5.6–21.4	7	0.33	1.59			
	94	M	L	4.8–19.6	7	0.3	1.54			
	94	M	L	8.6–19.4	6	0.33	1.6			17.3
Nereis diversicolor [adult] C –> phytoplankton P	152	M	L	11–24	6			NS	NS	
Nereis diversicolor [adult] C –> Rhodomonas spp. P	152	M	L	5.1–25	6	0.36	1.67			16
	152	M	L	7.9–26.7	4					14.9
	152	M	L	8.1–26.3	11	0.39	1.7			23.4
	152	M	L	8.4–21.6	4					18.9
Ostrea edulis [adult] O –> Phaeodactylum tricornutum P	132	M	L	10–30	6			NS	NS	
	132	M	L	5–30	7	1.15	NS			
	132	M	L	5–30	7	1.56	9.25			20
	132	M	L	5–30	7	2.42	31.24	NS	NS	
	132	M	L	5–30	7	NS	NS	NS	NS	
Paraphysomonas imperforata C –> Phaeodactylum tricornutum P	26	M	L	14–26	4	NS	NS			
Rutilus penicillus [adult] O –> Rhodomonas spp. P	150	M	L	13.7–21.8	6	0.18	1.28			
	150	M	L	6.2–21.6	8	0.31	1.56			
Flee Distance (individual)										
Homo sapiens [adult] O –> Holbrookia propinqua [adult] C	35	T	F	26.6–49.3	12	0.6	2.03			
	35	T	F	29.3–49.6	7	NS	NS			
Homo sapiens [adult] O –> Sceloporus mucronatus [adult] O	160	T	F	26.1–34.1	8	1.58	7.48			
Homo sapiens [adult] O –> Urosaurus bicarinatus [adult] C	160	T	F	35.2–40.6	4			NS	NS	
Food Energy Assimilation Efficiency (internal)										
Acroneuria californica [juvenile] O –> Hydropsyche spp. [juvenile] O	75	F	L	10–26	5			0.58	0.45	
	75	F	L	8–20	4			0.58	0.44	
Acroneuria californica [juvenile] O –> Simulium spp. [juvenile] O	75	F	L	10–24	7			NS	NS	
	75	F	L	11–23	4			NS	NS	
	75	F	L	13–27	4					17
Food Mass Conversion Efficiency (internal)										
Cherax quadricarinatus [juvenile] O –> crayfish ration	121	F	L	16–32	9			0.22	0.75	20
Dicentrarchus labrax [juvenile] C –> commercial extruded dry pellet	138	M	L	13.4–28.8	6	0.39	1.71			21.9
Paraphysomonas imperforata C –> Halomonas marina D	154	M	L	0–20	5	0.23	1.4			15
Foraging Behaviour Probability (species interaction)										

Trait / Consumer [stage] trophic group –> Resource [stage] trophic group	Ref	H	LF	Temp	N	E_R	$Q_{10\,R}$	E_F	$Q_{10\,F}$	T_{pk}
Calidris mauri [adult] C –> mudflat invertebrate	131	T	F	25–35	8			NS	NS	
	131	T	F	25–35	8	NS	NS			
Foraging Body Undulation Rate (individual)										
Nereis diversicolor [adult] C –> Rhodomonas spp. P	152	M	L	6.1–16.9	7	0.48	1.98			
	152	M	L	7.6–27.8	8	0.41	1.75			
	152	M	L	7.9–26.7	4	0.42	1.77			
Foraging Gill Beat Rate (individual)										
Ciona intestinalis [adult] O –> Rhodomonas spp. P	137	M	L	7.4–20.1	4	NS	NS			
Foraging Rate (species interaction)										
Bembidion lampros [adult] C	31	T	L	10–30	4					20
	31	T	L	5–30	5	NS	NS			
	31	T	L	5–30	5	NS	NS			
Cicindela hybrida [adult] C	42	T	F	22.4–43.5	8	0.68	2.35			37.4
Nereis diversicolor [adult] C –> Rhodomonas spp. P	152	M	L	5.5–28	11	0.45	1.85			
Pterostichus cupreus [adult] C	31	T	L	5–30	5					15
	31	T	L	5–30	5			NS	NS	
	31	T	L	5–30	5	NS	NS			
	31	T	L	5–30	5	NS	NS			
Foraging Submersion Rate (individual)										
Notonecta glauca [adult] C	34	F	L	5–25	5	1.09	4.65			
	34	F	L	5–25	5	1.45	7.72			
	34	F	L	5–25	5	1.69	10.75			
	34	F	L	5–25	5	1.93	14.91			
Foraging Velocity (individual)										
Acromyrmex versicolor [adult] H	83	T	F	17.2–32.4	8	0.53	2			30.3
Aphaenogaster senilis [adult] H	102	T	F	6–40	14	0.7	2.5			
Cicindela hybrida [adult] C	42	T	F	17.5–42.6	15	0.27	1.42	NS	NS	33
Dorymyrmex goetschi [adult] O	172	T	F	18.9–37.4	5	0.2	1.29			
Formica rufa [adult] C	79	T	F	9.1–20.8	5	0.52	2.05			
	79	T	F	9.8–17.5	6	0.6	2.32			
Gymnocephalus cernuus [adult] C	18	F	L	4–20	5	0.18	1.3			
Kinixys spekii [adult] H	67	T	F	21.5–38.5	8			0.97	0.29	
Leptogenys intermedia [adult] C	44	T	L	20–35	4	0.54	1.99			
Leptogenys schwabi [adult] C	44	T	L	20–35	4	0.41	1.7			
Linepithema humile [adult] C	33	T	F	5.9–35.6	10	0.7	2.54			
	33	T	F	8.4–35.3	7	0.4	1.71			
	158	T	F	25.5–33.8	6	0.46	1.8			
Liometopum apiculatum [adult] O	157	T	F	9.7–38.3	10	0.61	2.23			
Messor pergandei [adult] H	83	T	F	21.5–36.3	5	0.72	2.51			34.1
	108	T	F	21.4–43.2	11	0.4	1.71			40
	153	T	F	17–37.4	6	0.44	1.77			34.5
Ocymyrmex barbiger [adult] C	115	T	F	28.6–61.2	12	0.44	1.65			
Perca fluviatilis [adult] O	18	F	L	4–20	5	0.72	2.79			
Pogonomyrmex barbatus [adult] H	128	T	F	25–51.7	10	0.32	1.48			
Pogonomyrmex desertorum [adult] H	128	T	F	27.2–48.4	8	0.42	1.65			45.9
Pogonomyrmex maricopa [adult] H	182	T	F	26.1–45.8	10	0.69	2.32			43.8

Trait / Consumer [stage] trophic group –> Resource [stage] trophic group	Ref	H	LF	Temp	N	E_R	$Q_{10\,R}$	E_F	$Q_{10\,F}$	T_{pk}
Pogonomyrmex occidentalis [adult] H	128	T	F	34.1–50	15	NS	NS			
Pogonomyrmex rugosus [adult] H	182	T	F	24.5–44	11	0.55	1.99			41.1
Rutilus rutilus [adult] O –> Chaoborus obscuripes [juvenile] C	140	F	L	12–21	4	NS	NS			
Solenopsis invicta [adult] O	148	T	F	10.5–32.3	10	0.54	2.05			
Tapinoma sessile [adult] O	158	T	F	20.4–36.9	10	0.49	1.87			
Grazing Rate (species interaction)										
Glossosoma spp. [juvenile] H –> periphyton P	93	F	L	3–21	7			0.57	0.45	9
Gut Clearance Rate (internal)										
Aurelia aurita [juvenile] C –> Clupea harengus [juvenile] H	74	M	L	5–22	4	0.66	2.55			
Centropages hamatus [adult] O –> Ditylum brightwellii P	92	M	L	1–15	4	0.92	3.84			
Conopeum reticulum [adult] O –> Cryptomonas spp. P	123	M	L	6–22	4	0.36	1.67			
Electra pilosa [adult] O –> Cryptomonas spp. P	123	M	L	6–22	4	0.5	2.03			
Gadus morhua [juvenile] C –> dead Pandalus montagui [adult]	174	M	L	2–19	5	0.73	2.92			15
	174	M	L	2–19	5	0.75	2.99			15
Hexagenia limbata [juvenile] H –> sediment 'a'	192	F	L	5–25	5	0.43	1.86			20
	192	F	L	5–25	5	0.44	1.88			20
Pleuronectes platessa [adult] C –> Arenicola marina [adult] O	46	M	L	1–20	5	0.48	1.99			
	46	M	L	1–20	5	1.15	5.25			
Pleuronectes platessa [juvenile] C –> fish-paste	85	M	L	5–21	5	0.49	2			
Uta stansburiana [adult] C –> Acheta sp. A [adult] O	178	T	L	22–32	5	NS	NS			
	178	T	L	22–32	5	NS	NS			
Gut Loading Rate (internal)										
Hexagenia limbata [juvenile] H –> sediment 'a'	192	F	L	5–25	5	0.51	2.09			20
Handling Rate (species interaction)										
Gymnocephalus cernuus [adult] C –> Chaoborus obscuripes [juvenile] C	18	F	L	4–20	5	0.28	1.49			
Perca fluviatilis [adult] O –> Chaoborus obscuripes [juvenile] C	18	F	L	4–20	5	0.83	3.24			
Host-Per-Parasitoid Parasitisation Rate (species interaction)										
Anisopteromalus calandrae [adult] C –> Rhyzopertha dominica [juvenile] H	122	T	L	20–35	4					30
	122	T	L	20–35	4					35
	122	T	L	20–35	4					35
	122	T	L	20–35	4	NS	NS			
	122	T	L	20–35	4	NS	NS			
Anisopteromalus calandrae [adult] C –> Sitophilus zea-mais [juvenile] H	161	T	L	20.2–35.3	4	NS	NS			
Cardiochiles philippinensis [adult] C –> Cnaphalocrocis medinalis [juvenile] H	156	T	L	25–35	5			0.55	0.5	
	156	T	L	25–35	5			0.74	0.39	
	156	T	L	25–35	5			0.84	0.35	28
	156	T	L	25–35	5			1.08	0.26	28
	156	T	L	25–35	5			NS	NS	
	156	T	L	25–35	5			NS	NS	28
Cephalonomia waterstoni [adult] C –> Cryptolestes ferrugineus [juvenile] H	53	T	L	20–38	5					25
	53	T	L	20–38	5					30
	53	T	L	20–38	5					30
	53	T	L	20–38	5			NS	NS	25
	53	T	L	20–38	5	NS	NS			35
Praon exsoletum [adult] C –> Therioaphis trifolii [adult] H	124	T	L	10–23.9	5					23.9
	124	T	L	10–23.9	5	NS	NS			

Trait / Consumer [stage] trophic group –> Resource [stage] trophic group	Ref	H	LF	Temp	N	E_R	$Q_{10\,R}$	E_F	$Q_{10\,F}$	T_{pk}
	124	T	L	10–26.7	4					12.8
	124	T	L	10–26.7	4					23.9
	124	T	L	10–26.7	6					15.6
	124	T	L	10–26.7	6	NS	NS			21.1
	124	T	L	10–26.7	6	NS	NS			23.9
	124	T	L	10–26.7	6	NS	NS	NS	NS	23.9
	124	T	L	10–26.7	7	0.72	2.7			23.9
	124	T	L	10–26.7	7	NS	NS			23.9
	124	T	L	11.4–25.8	4					21.1
	124	T	L	11.4–25.8	4	NS	NS			
Theocolax elegans [adult] C –> Rhyzopertha dominica [juvenile] H	52	T	L	20–32.5	4					30
	52	T	L	20–32.5	4					30
In Vitro Gill Beat Rate (individual)										
Dreissena polymorpha [adult] O	103	F	L	8–22	4	0.5	2.01			
	103	F	L	8–22	4	0.5	2			
In Vitro Gill Particle Transport Velocity (individual)										
Mytilus edulis [adult] O –> yeast D	88	M	L	5–20	4	0.36	1.67			
	88	M	L	5–20	4	0.45	1.91			
	88	M	L	5–20	4	0.47	1.96			
	88	M	L	5–20	4	0.49	2.01			
Mytilus sp. A [adult] O	64	M	L	0–35	10	0.61	2.34			32.5
In Vitro Heart Beat Rate (internal)										
Oceanites oceanicus [egg] S	187	T	L	10.1–40.4	15	0.86	3.05			
Oceanodroma leucorhoa [egg] S	187	T	L	12–41	14	1.15	4.4			
In Vitro Muscle Isometric Tension (internal)										
Myoxocephalus scorpius [adult] C	11	M	L	0–20	5			NS	NS	15
	11	M	L	0–20	5	0.3	1.56			15
In Vitro Muscle Optimal Phase (internal)										
Manduca sexta [adult] H	166	T	L	20.2–40.3	5			NS	NS	
In Vitro Muscle Optimal Rate (internal)										
Manduca sexta [adult] H	166	T	L	20–39.9	5	0.32	1.5			
In Vitro Muscle Optimal Strain (internal)										
Manduca sexta [adult] H	166	T	L	19.9–39.9	5	0.13	1.17			
In Vitro Muscle Power Output (internal)										
Manduca sexta [adult] H	166	T	L	20–40	5	0.6	2.14			
In Vitro Muscle Shortening Velocity (internal)										
Myoxocephalus scorpius [adult] C	11	M	L	0–20	5	0.23	1.39			
	11	M	L	0–20	5	0.41	1.81			
In Vitro Muscle Work Per Cycle (internal)										
Manduca sexta [adult] H	166	T	L	20–40	5	0.28	1.42			
Individual Length Growth Rate (individual)										
Moina macrocopa [adult] O –> Chlorella sorokiniana P	16	F	L	15–30	5	0.99	3.7			
Moina macrocopa [juvenile] O –> Chlorella sorokiniana P	16	F	L	15–30	5	0.86	3.14			
Individual Mass Growth Rate (individual)										

Trait / Consumer [stage] trophic group –> Resource [stage] trophic group	Ref	H	LF	Temp	N	E_R	$Q_{10\,R}$	E_F	$Q_{10\,F}$	T_{pk}
Caulerpa serrulata [adult] P –> light	107	M	L	5–40	8	0.6	2.27			30
Cherax quadricarinatus [juvenile] O –> crayfish ration	121	F	L	16–32	9	2.57	30.3			28
Dicentrarchus labrax [juvenile] C –> commercial extruded dry pellet	138	M	L	13.4–28.8	6	0.94	3.58			24.9
Intraspecific Confrontation Probability Density (species interaction)										
Bembidion lampros [adult] C	31	T	L	5–30	5					20
	31	T	L	5–30	5					20
Pterostichus cupreus [adult] C	31	T	L	5–30	5	0.61	2.31			
	31	T	L	5–30	5	0.61	2.34			
	31	T	L	5–30	5	NS	NS			
	31	T	L	5–30	5	NS	NS			
Line Encounter Rate (species interaction)										
Pogonomyrmex occidentalis [adult] H	36	T	F	23.5–52.2	5					41.6
	36	T	F	23.7–57.3	11	1.16	4.13	NS	NS	
	36	T	F	24.3–51.4	9	1.35	5.15			47.1
	36	T	F	25.7–55.8	7	0.83	2.74			46.3
	36	T	F	26.5–51.4	9	1.02	3.34			
	36	T	F	26.6–57.9	13	1.52	6.41	1.95	0.11	42.9
	36	T	F	26.9–58.3	10	1.27	4.5	NS	NS	51.8
	36	T	F	27.3–51.1	11	0.59	2.01			48.3
	36	T	F	27.7–57.1	11	1.12	3.75	0.87	0.38	42.6
	36	T	F	27.9–57.9	8	1.88	9.86	NS	NS	42.1
	36	T	F	28.2–50.5	9	NS	NS	NS	NS	42.7
	36	T	F	28.6–56.7	9	1.13	3.71	NS	NS	
	36	T	F	28.9–58.1	11	1.52	6.31	2.37	0.07	43.6
	36	T	F	29.5–55.3	10	1.21	4.19	NS	NS	47.2
	36	T	F	30.7–59	11	1.1	3.71	1.38	0.22	47.9
	36	T	F	32.3–53.6	6	NS	NS			44.6
	36	T	F	32.9–51.4	5			NS	NS	39
	36	T	F	32.9–52.8	6	NS	NS			49.7
	36	T	F	33.5–53.2	6	NS	NS			45
	36	T	F	36.1–55	7	NS	NS			
	36	T	F	37–56.4	9	NS	NS			
	36	T	F	45.7–56.5	4					49.8
Log-Linear Gut Clearance Rate (internal)										
Temora longicornis [adult] O –> Thalassiosira weissflogii [adult] P	37	M	L	1–17	10	0.88	3.65			13
Mortality Rate (population)										
Aphis gossypii [adult] H –> Cucumis sativus P	191	T	L	10–30	5	0.54	2.08			
	191	T	L	10–30	5	NS	NS			
Aphis gossypii [juvenile] H –> Cucumis sativus P	191	T	L	10–30	5	NS	NS			
Euplectrus ronnai [juvenile] C –> Pseudaletia sequax [juvenile] H	189	T	L	15–29	5	NS	NS			
Moina macrocopa [adult] O –> Chlorella sorokiniana P	16	F	L	15–30	5	0.43	1.78			
Planococcus citri [adult] H –> Solenostemon scutellarioides P	61	T	L	18–32	7	0.32	1.52			
	61	T	L	18–32	7	0.47	1.86			30
	61	T	L	18–32	7	NS	NS	0.32	0.66	25
Procambarus clarkii [adult] O –> uncooked mixed vegetables	30	F	L	15–30	6	0.68	2.45			
Procambarus clarkii [juvenile] O –> uncooked mixed vegetables	30	F	L	15–30	6	0.66	2.4			

Trait / Consumer [stage] trophic group –> Resource [stage] trophic group	Ref	H	LF	Temp	N	E_R	$Q_{10\,R}$	E_F	$Q_{10\,F}$	T_{pk}
Telenomus chrysopae [juvenile] C –> Chrysoperla rufilabris [egg] S	155	T	L	15.6–26.7	5	NS	NS			
Telenomus isis [adult] C –> Busseola fusca [egg] S	25	T	L	18–32	6	0.6	2.19			
	25	T	L	18–32	6	0.8	2.87			
Telenomus isis [adult] C –> Sesamia calamistis [egg] S	25	T	L	18–32	6	0.94	3.44			
	25	T	L	18–32	6	1.03	3.86			
Telenomus isis [adult] C –> Sesamia nonagrioides [egg] S	25	T	L	18–32	6	0.54	2.03			30
	25	T	L	18–32	6	1.12	4.33			
Telenomus isis [juvenile] C –> Busseola fusca [egg] S	25	T	L	18–32	6	0.55	2.06			30
	25	T	L	18–32	6	0.74	2.65			
Telenomus isis [juvenile] C –> Sesamia calamistis [egg] S	25	T	L	18–32	6	0.54	2.04			
	25	T	L	18–32	6	NS	NS			
Telenomus isis [juvenile] C –> Sesamia nonagrioides [egg] S	25	T	L	18–32	6	0.47	1.87			
	25	T	L	18–32	6	0.57	2.12			
Tetraneura nigri abdominalis [adult] H –> Oryza sativa P	98	T	L	10–30	5	0.56	2.13			
	98	T	L	10–35	6	0.24	1.38			
Theocolax elegans [adult] C	84	T	L	20–35	6	0.58	2.12			
	84	T	L	20–35	6	0.86	3.04			
Nest Provisioning Rate (species interaction)										
Buteo jamaicensis [adult] C –> Serpentes spp. [adult] C	168	T	F	15.3–30.2	12			0.43	0.57	
Oxygen Mass Scope For Activity (internal)										
Oncorhynchus mykiss [adult] C	39	F	L	5–25	5					15
	39	F	L	5–25	5					20
Photosynthetic Oxygen Production Rate (internal)										
Caulerpa serrulata [adult] P –> light	107	M	L	5–40	8	0.66	2.48			30
Lithophyllum margaritae P –> light	164	M	L	10–30	5	NS	NS			25
POC Photosynthetic Oxygen Production Rate (internal)										
Phaeodactylum tricornutum P –> light	69	M	L	0–30	7	0.38	1.71			25
Prorocentrum minimum P –> light	69	M	L	0–30	7	0.51	2.07			25
Prymnesium patelliferum O –> light	69	M	L	0–30	7	0.4	1.75			25
Point Encounter Density Rate (species interaction)										
Phytoseiulus persimilis [adult] C	48	T	L	15–30	4					25
Tetranychus urticae [adult] H	48	T	L	15–30	4	NS	NS			
Point Encounter Number Rate (species interaction)										
Homarus americanus [adult] C	147	M	L	11–28.5	9	0.76	2.81			
Salmo salar [juvenile] C	142	F	L	6–21	6	1.2	5.36			
	142	F	L	6–27	8	0.78	2.95			
Population Catchability (species interaction)										
Homarus americanus [adult] C	120	M	F	2.8–11.5	6	2.28	29.18			
Population Density (population)										
Acartia sinjiensis [adult] O –> microalgae P	125	M	L	10–38	8	1.68	9.45			30
Acarus siro [adult] H –> wheat germs, oat flakes and baker’s yeast	6	F	L	5–35	12	1.71	10.5	2.19	0.06	27.5
Aleuroglyphus ovatus [adult] H –> wheat germs, oat flakes and baker’s yeast	6	T	L	5–35	12	2.23	21.15	NS	NS	27.5
Tyrophagus putrescentiae [adult] H –> wheat germs, oat flakes and baker’s yeast	6	T	L	10–35	11	1.33	6.26			20
Population Foraging Probability (species interaction)										
Brachycentrus americanus [juvenile] H –> dead Artemia spp. [adult]	57	F	F	8.6–30	5	NS	NS			24.6

Trait / Consumer [stage] trophic group –> Resource [stage] trophic group	Ref	H	LF	Temp	N	E_R	$Q_{10\ R}$	E_F	$Q_{10\ F}$	T_{pk}
	57	F	F	8.8–30.9	6					13.1
	57	F	F	15.4–26.3	7			0.24	0.73	
	57	F	F	15.4–26.3	7			0.26	0.7	
	57	F	F	15.4–26.3	7			0.39	0.59	15.4
	57	F	F	4–16	4	NS	NS			
	57	F	F	4–16	4	NS	NS			
Hyles lineata [juvenile] H –> desert plant P	27	T	F	14.8–36.1	6					27.5
Manduca sexta [juvenile] H –> Datura inoxia P	27	T	F	18.9–35.8	6			0.36	0.63	22.6
Population Growth Rate (population)										
Acarus siro [adult] H –> wheat germs, oat flakes and baker’s yeast	6	T	L	5–35	12	1.93	13.86	0.76	0.38	26.3
Aleuroglyphus ovatus [adult] H –> wheat germs, oat flakes and baker’s yeast	6	T	L	5–35	12	1.74	10.73	NS	NS	26.3
Aphis gossypii [adult] H –> Cucumis sativus P	191	T	L	10–30	5	0.91	3.47			25
Chlorella vulgaris P –> light + mineral medium	38	F	L	10–35	6	0.39	1.69			30
Coelastrum microporum P –> light	20	F	L	15–35	5	0.5	1.92			
Cosmarium subprotumidum P –> light	20	F	L	15–35	5	NS	NS			
Escherichia coli O –> luria broth	24	T	L	10–45	11	0.45	1.81	NS	NS	37
Fragilaria crotonensis P –> light + mineral medium	38	F	L	10–35	6	0.47	1.9			25
Lemna minor P –> aqueous growth medium	101	F	L	5–35	12	1.09	4.49	1.35	0.18	27
Moerisia lyonsi [adult] C –> Acartia tonsa O	114	M	L	10–29	5	1.56	8.24			
Paraphysomonas imperforata C –> Halomonas marina D	154	M	L	0–20	5	1.04	4.58			15
Paraphysomonas imperforata C –> Phaeodactylum tricornutum P	26	M	L	14–26	4	0.65	2.41			
Planococcus citri [adult] H –> Solenostemon scutellarioides P	61	T	L	18–32	7	1.18	4.84	NS	NS	25
Salmonella enterica C –> tetrathionate broth	24	T	L	10–43	10	0.56	2.09			36
Selenastrum minutum P –> light	20	F	L	15–35	5	0.34	1.56			
Staurastrum pingue P –> light + mineral medium	38	F	L	10–35	6	0.56	2.15			25
Synechocystis minima P –> light + mineral medium	38	F	L	10–35	6	0.36	1.61			
Telenomus isis [adult] C –> Busseola fusca [egg] S	25	T	L	18–32	6	0.74	2.64			30
	25	T	L	18–32	6	0.95	3.53			27
Telenomus isis [adult] C –> Sesamia calamistis [egg] S	25	T	L	18–32	6	0.75	2.67			30
	25	T	L	18–32	6	0.98	3.67			27
Telenomus isis [adult] C –> Sesamia nonagrioides [egg] S	25	T	L	18–32	6	0.87	3.15			27
	25	T	L	18–32	6	NS	NS			27
Tetraneura nigri abdominalis [adult] H –> Oryza sativa P	98	T	L	10–30	5	0.87	3.21			
Tyrophagus putrescentiae [adult] H –> wheat germs, oat flakes and baker’s yeast	6	T	L	10–35	11	1.37	6.63			25.6
Urotricha farcta H –> Cryptomonas spp. P	183	F	L	9–24	6	0.6	2.28			
Population Voluntary Activity Probability (individual)										
Crangonyx richmondensis [adult] O	180	F	L	3.9–22.1	8	0.97	4.02			20.2
Hyallela azteca [adult] O	180	F	L	8–23.3	6	1.34	6.53			20.4
Population Voluntary Movement Probability (individual)										
Crangonyx richmondensis [adult] O	180	F	L	5–20	5					12.5
Hyallela azteca [adult] O	180	F	L	8.9–20	4			NS	NS	
Pomacea paludosa [adult] H –> lettuce, spinach, bladderwort P	165	F	L	14.5–21.3	6	NS	NS			
	165	F	L	14.5–24	6	1.81	11.72			
	165	F	L	17–22	5	2.06	16.33			
Radial Growth Rate (population)										
Beauveria bassiana [adult] C –> agar medium	49	T	L	8–32	8	0.91	NS			20

Trait / Consumer [stage] trophic group –> Resource [stage] trophic group	Ref	H	LF	Temp	N	E_R	$Q_{10\,R}$	E_F	$Q_{10\,F}$	T_{pk}
	49	T	L	8–35	9	0.55	2.13	NS	NS	25
	49	T	L	8–35	9	0.63	2.42	NS		20
	49	T	L	8–35	9	0.65	2.46			28
	49	T	L	8–35	9	0.8	3.03			28
	49	T	L	8–35	9	0.83	3.1			28
	49	T	L	8–35	9	0.83	3.15	NS	NS	25
	49	T	L	8–35	9	0.86	3.21	NS	NS	25
	49	T	L	8–35	9	0.88	3.37	NS	NS	25
	49	T	L	8–35	9	0.94	3.67	NS	NS	25
	49	T	L	8–35	9	1	3.97			28
	49	T	L	8–35	9	1.12	4.79			20
	49	T	L	8–35	9	NS	NS	NS	NS	25
	49	T	L	8–37	10	0.49	1.96	4.08	0.01	28
	49	T	L	8–37	10	0.51	2.04	3.85	0.01	25
	49	T	L	8–37	10	0.56	2.16	3.32	0.02	25
	49	T	L	8–37	10	0.57	2.17	NS	NS	28
	49	T	L	8–37	10	0.58	2.2	3.74	0.01	28
	49	T	L	8–37	10	0.61	2.29	NS	NS	28
	49	T	L	8–37	10	0.62	2.35	NS	NS	25
	49	T	L	8–37	10	0.64	2.42	NS	NS	25
	49	T	L	8–37	10	0.65	2.43			25
	49	T	L	8–37	10	0.66	2.49	3.47	0.01	25
	49	T	L	8–37	10	0.66	2.47	5.14	0	28
	49	T	L	8–37	10	0.66	2.46			30
	49	T	L	8–37	10	0.68	2.49	NS	NS	28
	49	T	L	8–37	10	0.7	2.6	NS	NS	28
	49	T	L	8–37	10	0.73	2.73	2.83	0.03	25
	49	T	L	8–37	10	0.73	2.73	NS	NS	25
	49	T	L	8–37	10	0.75	2.82	NS	NS	25
	49	T	L	8–37	10	0.76	2.82	NS	NS	28
	49	T	L	8–37	10	0.77	2.9	2.89	0.03	25
	49	T	L	8–37	10	0.77	2.88	NS	NS	25
	49	T	L	8–37	10	0.78	2.95	NS	NS	25
	49	T	L	8–37	10	0.79	2.99	3.97	0.01	25
	49	T	L	8–37	10	0.8	3.03	NS	NS	25
	49	T	L	8–37	10	0.83	3.1	NS	NS	25
	49	T	L	8–37	10	0.83	3.12	NS	NS	25
	49	T	L	8–37	10	0.83	3.05	NS	NS	28
	49	T	L	8–37	10	0.85	3.2	2.15	0.07	25
	49	T	L	8–37	10	0.85	3.22	NS	NS	25
	49	T	L	8–37	10	0.85	3.2	NS	NS	28
	49	T	L	8–37	10	0.86	3.29	NS	NS	28
	49	T	L	8–37	10	0.88	3.37	NS	NS	25
	49	T	L	8–37	10	0.89	3.433.5	NS	NS	25
	49	T	L	8–37	10	0.91	2.4	4.28	0	25
	49	T	L	8–37	10	0.93	3.56	NS	NS	25

Trait / Consumer [stage] trophic group –> Resource [stage] trophic group	Ref	H	LF	Temp	N	E_R	$Q_{10\ R}$	E_F	$Q_{10\ F}$	T_{pk}
	49	T	L	8–37	10	0.93	3.55	NS	NS	28
	49	T	L	8–37	10	0.95	3.71	NS	NS	25
	49	T	L	8–37	10	0.96	3.78	NS	NS	28
	49	T	L	8–37	10	0.98	3.86	NS	NS	25
	49	T	L	8–37	10	1	3.93	0.83	0.35	25
	49	T	L	8–37	10	1	3.95	NS	NS	25
	49	T	L	8–37	10	1.01	4.03	NS	NS	25
	49	T	L	8–37	10	1.03	4.13	NS	NS	20
	49	T	L	8–37	10	1.03	4.1	NS	NS	25
	49	T	L	8–37	10	1.04	4.19	NS	NS	25
	49	T	L	8–37	10	1.05	4.19	NS	NS	25
	49	T	L	8–37	10	1.05	4.21	NS	NS	28
	49	T	L	8–37	10	1.07	4.34	NS	NS	25
	49	T	L	8–37	10	1.11	4.62	0.84	0.35	25
	49	T	L	8–37	10	1.31	6.1	NS	NS	25
	49	T	L	8–37	10	1.36	6.47	NS	NS	25
	49	T	L	8–37	10	1.54	8.26	NS	NS	25
	49	T	L	8–37	10	NS	NS	NS	NS	25
Metarhizium anisopliae [adult] C –> agar medium	136	T	L	11–37	9			NS	NS	25
	136	T	L	11–37	9			NS	NS	25
	136	T	L	11–37	9			NS	NS	25
	136	T	L	11–37	9	NS	NS			29
	136	T	L	8–35	9	0.69	NS	1.94	0.08	25
	136	T	L	8–35	9	1.08	4.44	NS	NS	25
	136	T	L	8–35	9	1.24	5.51	NS	NS	25
	136	T	L	8–35	9	1.62	9.26			25
	136	T	L	8–35	9	NS	NS	NS	NS	25
	136	T	L	8–37	10	0.76	2.82	NS	NS	25
	136	T	L	8–37	10	0.82	3.02	1.78	0.11	28
	136	T	L	8–37	10	0.88	3.25	2	0.08	28
	136	T	L	8–37	10	0.89	NS	1.59	0.13	25
	136	T	L	8–37	10	0.89	3.33	NS	NS	28
	136	T	L	8–37	10	1	3.92	2.47	0.05	26.5
	136	T	L	8–37	10	1.01	3.94	0.71	0.41	25
	136	T	L	8–37	10	1.02	4.01	NS	NS	28
	136	T	L	8–37	10	1.03	4.1	NS	NS	28
	136	T	L	8–37	10	1.07	4.34	1.89	0.09	25
	136	T	L	8–37	10	1.16	NS			30
	136	T	L	8–37	10	NS	NS	NS	NS	25
	136	T	L	8–37	10	NS	NS	NS	NS	25
Metarhizium flavoviride [adult] C –> agar medium	136	T	L	11–37	9	0.66	NS			30
	136	T	L	11–37	9	0.72	NS			30
	136	T	L	11–37	9	0.79	NS			30
	136	T	L	11–37	9	NS	NS	NS	NS	28
	136	T	L	11–37	9	NS	NS	NS	NS	28
	136	T	L	11–37	9	NS	NS	NS	NS	28
	136	T	L	8–37	10	0.78	2.92	NS	NS	25

Trait / Consumer [stage] trophic group –> Resource [stage] trophic group	Ref	H	LF	Temp	N	E_R	$Q_{10\,R}$	E_F	$Q_{10\,F}$	T_{pk}
	136	T	L	8–37	10	0.78	2.93	NS	NS	28
	136	T	L	8–37	10	1.08	4.3	NS	NS	28
	136	T	L	8–37	10	1.28	NS			30
	136	T	L	8–37	10	1.31	5.88	NS	NS	28
	136	T	L	8–37	10	1.38	6.55	NS	NS	28
	136	T	L	8–37	10	1.43	7.02	NS	NS	26.5
	136	T	L	8–37	10	1.75	11.14	NS	NS	25
Paecilomyces fumosoroseus C –> agar medium	176	T	L	8–30	7	0.83	3.14			25
	176	T	L	8–30	7	0.88	3.36			25
	176	T	L	8–32	8	0.54	NS			25
	176	T	L	8–32	8	0.56	NS			25
	176	T	L	8–32	8	0.63	2.41	NS	NS	20
	176	T	L	8–32	8	0.69	2.66	NS	NS	20
	176	T	L	8–32	8	0.74	NS			25
	176	T	L	8–32	8	0.78	2.99	NS	NS	20
	176	T	L	8–32	8	0.93	3.66	NS	NS	20
	176	T	L	8–35	9	0.55	NS			28
	176	T	L	8–35	9	0.61	2.29			30
	176	T	L	8–35	9	0.64	2.4	NS	NS	25
	176	T	L	8–35	9	0.72	NS			28
	176	T	L	8–35	9	0.76	2.89	NS	NS	20
	176	T	L	8–35	9	0.79	NS			28
	176	T	L	8–35	9	0.8	NS			28
	176	T	L	8–35	9	0.8	NS			28
	176	T	L	8–35	9	0.83	NS			28
	176	T	L	8–35	9	0.85	NS			28
	176	T	L	8–35	9	0.86	NS			28
	176	T	L	8–35	9	0.86	NS			28
	176	T	L	8–35	9	0.86	3.27	NS	NS	25
	176	T	L	8–35	9	0.9	NS			28
	176	T	L	8–35	9	0.9	NS			28
	176	T	L	8–35	9	0.91	NS			28
	176	T	L	8–35	9	0.91	3.49	NS	NS	25
	176	T	L	8–35	9	0.92	3.56	NS	NS	25
	176	T	L	8–35	9	0.95	3.64	NS	NS	25
	176	T	L	8–35	9	0.96	3.74	NS	NS	25
	176	T	L	8–35	9	0.96	3.76	NS	NS	25
	176	T	L	8–35	9	0.97	3.79	NS	NS	25
	176	T	L	8–35	9	0.98	3.86	NS	NS	25
	176	T	L	8–35	9	1.03	4.13	NS	NS	25
	176	T	L	8–35	9	1.04	4.21	1.97	0.08	25
	176	T	L	8–35	9	1.04	4.16	NS	NS	25
	176	T	L	8–35	9	1.05	4.23	NS	NS	25
	176	T	L	8–35	9	1.1	NS	NS		28
Rattle Rate (individual)										
Homo sapiens [adult] O –> Crotalus viridis viridis [adult] C	29	T	L	8–36	7	0.42	1.75			
Refuge Distance (species interaction)										

Trait / Consumer [stage] trophic group –> Resource [stage] trophic group	Ref	H	LF	Temp	N	E_R	$Q_{10\ R}$	E_F	$Q_{10\ F}$	T_{pk}
Homo sapiens [adult] O –> Holbrookia propinqua [adult] C	35	T	F	26.6–49.3	12	NS	NS			
	35	T	F	29.3–49.6	7	NS	NS			
Resource Habitat Encounter Density Rate (species interaction)										
Bembidion lampros [adult] C	31	T	L	9–30	4		NS			20
Pterostichus cupreus [adult] C	31	T	L	5–30	5	0.47	1.91			
Resource Reaction Distance (species interaction)										
Homo sapiens [adult] O –> Holbrookia propinqua [adult] C	35	T	F	26–42.5	13	NS	1.68			
	35	T	F	27.9–41.6	10	0.61	2.11			
Homo sapiens [adult] O –> Norops lineatopus [adult] O	144	T	F	24.4–31.1	6			NS	NS	
Homo sapiens [adult] O –> Sceloporus anahuacus [adult] O	160	T	F	23.1–32.8	4			NS	NS	
Homo sapiens [adult] O –> Sceloporus gadoviae [adult] O	160	T	F	27.6–36.9	4			1.2	0.23	
Homo sapiens [adult] O –> Sceloporus mucronatus [adult] O	160	T	F	26.1–34.1	8	NS	NS			
Homo sapiens [adult] O –> Scincella lateralis [adult] C	159	T	F	23.5–33.8	8			0.38	0.62	
Homo sapiens [adult] O –> Urosaurus bicarinatus [adult] C	160	T	F	35.2–40.6	4	NS	NS			
Resource Size Capture Intent Acceptance Probability (species interaction)										
Formica schaufussi [adult] C –> dead Nauphoeta cinerea [adult]	173	T	F	16.5–33.6	7	0.89	3.18			
Respiration Rate (internal)										
Cherax quadricarinatus [juvenile] O –> crayfish ration	121	F	L	16–32	9	3.05	57.99			28
Lithophyllum margaritae P –> light	164	M	L	10–30	5	0.57	2.15			
Sediment Mass Processing Rate (species interaction)										
Pectinaria gouldii [adult] O –> fine sediment	62	M	L	13–19	5	1.27	5.81			
	62	M	L	13–19	5	2.84	51.7			
	62	M	L	13–19	5	NS	NS			
Square Root-Linear Gut Clearance Rate (internal)										
Pleuronectes platessa [juvenile] C –> fish-paste	86	M	L	5–15.5	4	0.55	2.2			
Strike Acceleration (individual)										
Pituophis catenifer affinis [adult] C –> Mus musculus [adult] O	65	T	L	18–33	4					27
	65	T	L	18–33	4					27
Strike Completion Rate (individual)										
Pituophis catenifer affinis [adult] C –> Mus musculus [adult] O	65	T	L	18–33	4					27
Strike Distance (individual)										
Pituophis catenifer affinis [adult] C –> Mus musculus [adult] O	65	T	L	18–33	4			NS	NS	
Strike Velocity (individual)										
Pituophis catenifer affinis [adult] C –> Mus musculus [adult] O	65	T	L	18–33	4					22
	65	T	L	18–33	4					27
	65	T	L	18–33	4					27
	65	T	L	18–33	4					27
	65	T	L	18–33	4					27
	65	T	L	18–33	4					27
	65	T	L	18–33	4					27
	65	T	L	18–33	4			NS	NS	
	65	T	L	18–33	4	NS	NS			
Subjugation-Consumption Body Contraction Rate (individual)										
Aurelia aurita [juvenile] C –> Clupea harengus [juvenile] H	74	M	L	5–22	4	NS	NS			

Trait / Consumer [stage] trophic group –> Resource [stage] trophic group	Ref	H	LF	Temp	N	E_R	$Q_{10\ R}$	E_F	$Q_{10\ F}$	T_{pk}
Subjugation-through-Consumption Rate (species interaction)										
Cicindela hybrida [adult] C –> cursorial insect	42	T	F	25.3–40.3	6			NS	NS	
Notonecta hoffmani [adult] C –> Culex pipiens [juvenile] O	129	F	L	10.8–25	4	0.72	2.67			
Zootoca vivipara [adult] C –> Acheta domesticus [juvenile] O	8	T	L	11.2–32.2	7	0.76	2.77			
	8	T	L	11–32.1	9	0.61	2.26			
	8	T	L	14.6–32.1	7	0.83	3.01			
	8	T	L	14.6–32.2	6	0.88	3.21			
	8	T	L	8.2–32.2	10	1.18	4.88			
	8	T	L	8.3–32.1	9	0.96	3.62			
Surface Area-Specific Dark Respiration Rate (internal)										
Betula pendula [adult] P –> light	188	T	L	-5–40	7	0.58	2.23			
Fagus sylvatica [adult] P –> light	188	T	L	-5–40	8	0.41	1.77			
Surface Area-Specific Foraging Gill Filtration Rate (individual)										
Mytilus edulis [adult] O –> Rhodomonas spp. P	89	M	L	5.9–16.9	8	0.38	1.72			
Surface Area-Specific Maximum Photosynthesis Rate (internal)										
Betula pendula [adult] P –> light	188	T	L	-5–40	7	0.55	2.19			30
Eucalyptus regnans [juvenile] P –> light	181	T	L	10–35	6	0.14	1.21			
	181	T	L	10–35	6	0.16	1.24			30
Fagus sylvatica [adult] P –> light	188	T	L	-5–40	8	0.31	1.56			30
Surface Area-Specific Mitochondrial Respiration Rate (internal)										
Eucalyptus regnans [juvenile] P –> light	181	T	L	10–35	6	0.74	2.66			
Surface Area-Specific Photosynthetic Oxygen Production Rate (internal)										
Embothrium coccineum [adult] P –> light	28	T	L	5–40	8					
	28	T	L	5–40	8	0.52	2.02			30
Gevuina avellana P –> light	28	T	L	5–40	8	0.79	2.98			25
	28	T	L	5–40	8	NS	NS			
Lomatia ferruginea P –> light	28	T	L	5–40	8	0.27	1.45			25
	28	T	L	5–40	8	0.39	NS			25
Voluntary Activity Probability (individual)										
Uta stansburiana [adult] C –> Acheta sp. A [adult] O	178	T	L	20–36	6	0.03	1.04			
Voluntary Body Contraction Rate (individual)										
Aurelia aurita [juvenile] C	40	M	L	10–35	6					25
Voluntary Body Velocity (individual)										
Anisops deanei [adult] C	9	F	L	15–28	4					20
	9	F	L	15–28	4					20
	9	F	L	15–28	4					20
	9	F	L	15–28	4					20
	9	F	L	15–28	4					20
	9	F	L	15–28	4					20
	9	F	L	15–28	4					25
	9	F	L	15–28	4					25
	9	F	L	15–28	4					25
	9	F	L	15–28	4			0.84	0.33	
	9	F	L	15–28	4			0.9	NS	
	9	F	L	15–28	4			NS	NS	

Trait / Consumer [stage] trophic group –> Resource [stage] trophic group	Ref	H	LF	Temp	N	E_R	$Q_{10\,R}$	E_F	$Q_{10\,F}$	T_{pk}
	9	F	L	15–28	4			NS	NS	
	9	F	L	15–28	4	1.03	3.94			
	9	F	L	15–28	4	NS	NS			
	9	F	L	15–28	4	NS	NS			
	9	F	L	15–28	4	NS	NS			
	9	F	L	15–28	4	NS	NS			
	9	F	L	15–28	4	NS	NS			
	9	F	L	15–28	4	NS	NS			
	9	F	L	15–28	4	NS	NS			
	9	F	L	15–28	4	NS	NS			
	9	F	L	15–28	4	NS	NS			
Astacus astacus [adult] O	95	F	L	0.6–34.4	6	NS	NS	NS	NS	26.1
	95	F	L	-1.3–32	8	NS	NS			20.2
Barbus barbus [adult] O	135	F	L	7–25	4	0.74	2.81			
	135	F	L	7–25	4	NS	NS			
Bembidion lampros [adult] C	31	T	L	5–30	4	NS	NS			
Cataglyphis bicolor [adult] D	71	T	F	29.2–60.1	12	0.16	1.2			
Chionoecetes opilio [adult] C	55	M	L	0–18	7	0.39	1.76			
Culicoides variipennis [juvenile] C	109	F	L	6–36	6	0.52	2.01			
Diaptomus kenai [adult] O	169	F	L	4–22	4	0.19	1.31			
Diaptomus kenai [juvenile] O	169	F	L	4–22	4					14
Dorymyrmex goetschi [adult] O –> sugar microspheres	172	T	F	18.6–37.4	5	0.28	NS			
Gymnocephalus cernuus [adult] C	18	F	L	4–20	5	0.36	1.68			16
Homarus americanus [adult] C	147	M	L	10–25	4	NS	NS			
Micropterus salmoides [adult] C	104	F	L	3–17	8					15
Nucella lapillus [adult] C	99	M	L	5–25	5	0.53	2.12			20
Perca fluviatilis [adult] O	18	F	L	4–20	5	1.28	6.18			
Pterostichus cupreus [adult] C	31	T	L	5–30	5	0.43	1.8			
Solenopsis invicta [adult] O	148	T	F	10.5–32.3	10	0.54	2.05			
Thamnophis sirtalis [adult] C	73	T	L	15.3–33	4	0.07	1.1			
Zygiella x-notata [adult] C	7	T	L	2–20	5	1.15	5.15			
Voluntary Eye Saccade Angular Velocity (individual)										
Girella tricuspidata [adult] H	127	M	L	6.9–14	8	1.24	6			
Voluntary Heart Beat Rate (internal)										
Rana temporaria [adult] C	72	T	L	15.5–29.4	8	0.47	1.88			
	72	T	L	16–29.4	7	0.4	1.69			
	72	T	L	16–29.7	7	0.54	2.06			
	72	T	L	17.5–29.7	5	0.54	2.03			
Voluntary Movement Rate (individual)										
Anisops deanei [adult] C	9	F	L	15–28	4					15
	9	F	L	15–28	4					15
	9	F	L	15–28	4					20
	9	F	L	15–28	4					25
Bembidion lampros [adult] C	31	T	L	10–30	4					15
	31	T	L	5–30	5			NS	NS	
	31	T	L	5–30	5	NS	NS			

Trait / Consumer [stage] trophic group –> Resource [stage] trophic group	Ref	H	LF	Temp	N	E_R	$Q_{10\ R}$	E_F	$Q_{10\ F}$	T_{pk}
Chionoecetes opilio [adult] C	55	M	L	0–18	7	1.11	5.06	NS	NS	9
Pterostichus cupreus [adult] C	31	T	L	5–30	5			NS	NS	
	31	T	L	5–30	5	0.3	1.53			20
	31	T	L	5–30	5	NS	NS			
Voluntary Stroke Rate (individual)										
Anisops deanei [adult] C	9	F	L	15–28	4					25
	9	F	L	15–28	4					25
	9	F	L	15–28	4					25
	9	F	L	15–28	4					25
	9	F	L	15–28	4					25
	9	F	L	15–28	4					28
	9	F	L	15–28	4			NS	NS	
	9	F	L	15–28	4			NS	NS	
	9	F	L	15–28	4	0.62	2.29			
	9	F	L	15–28	4	NS	NS			
	9	F	L	15–28	4	NS	NS			
	9	F	L	15–28	4	NS	NS			
	9	F	L	15–28	4	NS	NS			
	9	F	L	15–28	4	NS	NS			
	9	F	L	15–28	4	NS	NS			
	9	F	L	15–28	4	NS	NS			
	9	F	L	15–28	4	NS	NS			
	9	F	L	15–28	4	NS	NS			
	9	F	L	15–28	4	NS	NS			
	9	F	L	15–28	4	NS	NS			
	9	F	L	15–28	4	NS	NS			
	9	F	L	15–28	4	NS	NS			
	9	F	L	15–28	4	NS	NS			
	9	F	L	15–28	4	NS	NS			
Voluntary Tail Beat Rate (individual)										
Culicoides variipennis [juvenile] C	109	F	L	6–36	6	0.42	1.74			
Dendrodoa grossularia [juvenile] O	13	M	L	9.5–18.1	4	0.64	2.47			
Voluntary Tongue Flick Cycle Number (individual)										
Thamnophis elegans vagrans [adult] C	167	T	L	4.9–35	7			0.21	0.76	
Voluntary Tongue Flick Cycle Rate (individual)										
Thamnophis elegans vagrans [adult] C	167	T	L	5.1–34.8	7	0.74	2.75			29.8
	167	T	L	5–34.9	7	0.42	1.76			
Voluntary Tongue Flick Non-Cycle Rate (individual)										
Thamnophis elegans vagrans [adult] C	167	T	L	5.6–35.7	7	0.5	1.98			30.5
Voluntary Wing Beat Rate (individual)										
Coleomegilla fuscilabris [adult] O	134	T	F	28.2–35.9	7	0.11	1.15			
Popillia japonica [adult] H	134	T	F	30.7–40.3	10	0.14	1.19			

Appendix 3.3

Data sources for temperature response data (Chapter 3). Number on left corresponds to citation codes (**Ref**) in Appendix 3.2.

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Appendix 5.1

The dataset used in the analysis of the scaling of search and consumption rate with dimensionality (Chapter 5). Data are listed by interaction dimensionality (***D***), and then alphabetically by habitat (**H**; F: freshwater, M: marine, T: terrestrial), and then by consumer-resource name (**Consumer→Resource**) (including life stage and sex when available). The habitat of an interaction defined to be the space where the resource was actually captured (e.g., a pelican catching a fish is an aquatic interaction even though the former is terrestrial). The dimensionality of each interaction was determined using the criteria shown in Appendix 5. **ConSize** is the fresh mass (kg) of the consumer; **ResSize** is fresh mass (kg) of the resource; **ConsRate (S)** is consumption rate with scarce resources; **ResDen (S)** is resource density with scarce resources; **ResDen (S)** is resource density with scarce resources; **SRate (S)** is search rate with scarce resources; **ConsRate (A)** is consumption rate with abundant resources; **ResDen (A)** is resource density with abundant resources; **FR** is the broad category of functional response from which the consumption rates were extracted (see Section 5.2.7); **Ref** is reference code for the original study (see Appendix 5.4). All rates are temperature corrected, as described in Section 5.2.3.

D	H	Consumer→Resource	ConSize	ResSize	ConsRate (S)	ResDen (S)	SRate (S)	ConsRate (A)	ResDen (A)	FR	Ref
3	F	Salvelinus alpinus (Linnaeus, 1758) [juvenile]→Daphnia longispina (O.F. Müller, 1776)	0.00065	7.01E-08	3.15E-08	1.75E-05	0.0018	9.2E-08	0.00028	II/III	[1]
3	F		0.0018	7.01E-08	3.84E-08	1.43E-05	0.00269	1.5E-07	0.000351	II/III	[1]
3	F		0.0059	7.01E-08	3.06E-08	1.75E-05	0.00174	1.4E-07	0.000281	II/III	[1]
3	F		0.0094	7.01E-08	3.51E-08	8.76E-06	0.004	1.7E-07	0.00021	II/III	[1]
3	F		0.015	7.01E-08	3.89E-08	1.75E-05	0.00222	1.5E-07	0.000421	II/III	[1]
3	F		0.00075	1.98E-08	4.82E-09	4.96E-06	0.00097	2.5E-08	7.93E-05	I	[1]
3	F		0.006	1.98E-08	5.97E-09	4.96E-06	0.0012	2.9E-08	5.95E-05	II/III	[1]
3	F		0.009	1.98E-08	5.55E-09	4.96E-06	0.00112	2.8E-08	2.98E-05	II/III	[1]
3	F		0.014	1.98E-08	6.88E-09	4.96E-06	0.00139	3.4E-08	5.95E-05	II/III	[1]
3	F	Notonecta maculata Fabricius 1794 [instar 1]→Daphnia magna Straus, 1820	1.098E-06	2.74E-07	2.03E-11	0.005473	3.7E-09	1.6E-10	0.065671	II/III	[2]
3	F	Notonecta maculata Fabricius 1794 [instar 2]→Daphnia magna Straus, 1820	2.702E-06	2.74E-07	8.11E-11	0.005473	1.5E-08	3.5E-10	0.065671	II/III	[2]
3	F	Notonecta maculata Fabricius 1794 [instar 3]→Daphnia magna Straus, 1820	8.821E-06	2.74E-07	2.08E-10	0.005473	3.8E-08	7.9E-10	0.065671	II/III	[2]
3	F	Notonecta maculata Fabricius 1794 [instar 4]→Daphnia magna Straus, 1820	2.162E-05	2.74E-07	2.53E-10	0.005473	4.6E-08	1.1E-09	0.087562	I	[2]
3	F	Notonecta maculata Fabricius 1794 [instar 5]→Daphnia magna Straus, 1820	5.845E-05	2.74E-07	1.37E-10	0.005473	2.5E-08	1.3E-09	0.087562	II/III	[2]
3	M	Oikopleura dioica Fol, 1872 [juvenile]→Tetraselmis suecica Kylin (Butch)	2.714E-07	4.49E-13	3.15E-13	0.005835	5.4E-11	2.5E-11	0.409917	II/III	[3]
3	F	Anomalagrion hastatum (Say) [instar final]→Simocephalus vetulus (O. F. Müller, 1776)	2.636E-06	3.37E-07	3.87E-11	0.001011	3.8E-08	1.4E-10	0.021227	I	[4]
3	F	Anomalagrion hastatum (Say) [instar final]→Daphnia magna Straus, 1820	2.636E-06	2.21E-07	4.15E-11	0.000662	6.3E-08	1.3E-10	0.013905	II/III	[4]
3	M	Paralabrax clathratus [adult]→Brachyistius frenatus [juvenile]	0.10506	5.46E-04	1.3E-08	0.001093	1.2E-05	2.9E-08	0.00437	II/III	[5]
3	F	Ranatra dispar [instar 5]→Anisops deanei Brooks, 1951 [instar 1-2]	0.0002766	5.35E-07	4.92E-10	0.002141	2.3E-07	5.4E-09	0.026768	I	[6]
3	F	Ranatra dispar [instar 5]→Anisops deanei Brooks, 1951 [instar 3]	0.0002766	1.12E-06	1.08E-09	0.004478	2.4E-07	1.2E-08	0.05598	I	[6]
3	F	Ranatra dispar [instar 5]→Anisops deanei Brooks, 1951 [instar 4]	0.0002766	1.72E-06	1.38E-09	0.006888	2E-07	9.1E-09	0.0861	II/III	[6]
3	F	Ranatra dispar [instar 5]→Anisops deanei Brooks, 1951 [instar 5]	0.0002766	2.72E-06	2.24E-09	0.010869	2.1E-07	1E-08	0.13586	II/III	[6]
3	F	Ranatra dispar [instar 5]→Anisops deanei Brooks, 1951 [adult]	0.0002766	6.71E-06	5.36E-09	0.026828	2E-07	1.5E-08	0.335345	II/III	[6]

D	H	Consumer→Resource	ConSize	ResSize	ConsRate (S)	ResDen (S)	SRate (S)	ConsRate (A)	ResDen (A)	FR	Ref
3	F	Ranatra dispar [adult]→Anisops deanei Brooks, 1951 [adult]	0.0002884	1.24E-05	3.06E-10	0.04972	6.1E-09	2.4E-09	0.6215	I	[7]
3	F	Gymnocephalus cernuus (Linnaeus, 1758) [adult]→Chaoborus obscuripes Wulp, 1859 [instar 4]	0.0138	2.45E-05	1.5E-06	0.004898	0.00031	8.7E-06	0.195912	II/III	[8]
3	F	Perca fluviatilis (Linnaeus, 1758) [adult]→Chaoborus obscuripes Wulp, 1859 [instar 4]	0.0169	2.45E-05	8.64E-06	0.004898	0.00176	3.2E-05	0.195912	II/III	[8]
3	M	Pomatomus saltatrix (Linnaeus, 1766) [subadult]→Morone saxatilis (Walbaum, 1792) [juvenile]	0.0017579	9.15E-05	3.27E-08	0.000147	0.00022	9.2E-08	0.000734	II/III	[9]
3	M	Pomatomus saltatrix (Linnaeus, 1766) [subadult]→Morone saxatilis (Walbaum, 1792) [juvenile]	0.013057	1.88E-03	4.12E-07	0.003012	0.00014	1.4E-06	0.009035	II/III	[9]
3	M	Pomatomus saltatrix (Linnaeus, 1766) [subadult]→Menidia menidia (Linnaeus, 1766) [juvenile]	0.0014532	1.35E-04	1.22E-08	5.43E-05	0.00023	1.1E-07	0.001085	II/III	[9]
3	M	Pomatomus saltatrix (Linnaeus, 1766) [subadult]→Menidia menidia (Linnaeus, 1766) [juvenile]	0.01352	6.60E-03	1.57E-06	0.010591	0.00015	5.5E-06	0.042364	I	[9]
3	M	Acartia hudsonica Pinhey, 1926 [adult]→Skeletonema costatum (Greville) Cleve	1.946E-08	1.29E-12	1.6E-14	2.9E-05	5.5E-10	1.4E-11	0.016031	I	[10]
3	F	Chaoborus trivittatus Loew, 1862 [instar 4-2nd year]→Diaptomus tyrelli Poppe [adult]	4.715E-06	1.93E-08	7.14E-13	0.000162	4.4E-09	8.9E-12	0.003737	II/III	[11]
3	F	Chaoborus americanus Johannsen, 1903 [instar 4]→Diaptomus tyrelli Poppe [adult]	3.325E-06	1.93E-08	1.25E-12	0.000137	9.1E-09	6E-12	0.003485	II/III	[11]
3	F	Brachionus calyciflorus Pallas, 1766 [adult]→Monoraphidium minutum (Nägeli) Komárková-legnerová, 1969	1.2E-09	2.00E-14	2.53E-16	0.000574	4.4E-13	4.9E-14	0.009975	II/III	[12]
3	F	Sander vitreus (Mitchill, 1818) [juvenile]→Daphnia spp.	2.848E-05	4.64E-08	6.35E-10	2.32E-05	2.7E-05	1.2E-09	0.002319	II/III	[13]
3	F		0.0001018	4.64E-08	1.09E-09	2.32E-05	4.7E-05	2.1E-09	0.004638	I	[13]
3	F		0.0003731	4.64E-08	1.42E-09	2.32E-05	6.1E-05	3.2E-09	0.000464	I	[13]
3	F		0.0010167	4.64E-08	1.61E-09	2.32E-05	6.9E-05	4E-09	0.000464	I	[13]
3	F		0.0020616	4.64E-08	1.4E-09	2.32E-05	6.1E-05	4.6E-09	0.002319	II/III	[13]
3	F		0.0032779	4.64E-08	1.85E-10	2.32E-05	8E-06	3.7E-09	0.002319	II/III	[13]
3	F		0.0012491	4.64E-08	1.15E-09	2.32E-05	5E-05	3.4E-09	0.000464	II/III	[13]
3	F		0.0018525	4.64E-08	4.62E-10	2.32E-05	2E-05	1.8E-09	0.002319	II/III	[13]
3	F		0.0026355	4.64E-08	7.16E-10	2.32E-05	3.1E-05	3.7E-09	0.004638	II/III	[13]
3	F	Sander vitreus (Mitchill, 1818) [juvenile]→Cyprinus carpio Linnaeus, 1758 [juvenile]	2.848E-05	1.09E-06	9.46E-10	1.64E-05	5.8E-05	2E-09	7.1E-05	II/III	[13]
3	F		0.0001018	3.00E-06	2.21E-09	4.49E-05	4.9E-05	9.1E-09	0.000279	I	[13]
3	F	Sander vitreus (Mitchill, 1818) [juvenile]→Lepomis macrochirus Rafinesque, 1819 [juvenile]	0.0003731	5.02E-06	2.14E-09	7.53E-05	2.8E-05	1.3E-08	0.000467	I	[13]
3	F		0.0010167	8.25E-06	7.24E-09	0.000124	5.9E-05	1.7E-08	0.000206	II/III	[13]
3	F		0.0020616	1.50E-05	7.96E-09	0.000225	3.5E-05	3.4E-08	0.000976	II/III	[13]
3	F		0.0032779	2.51E-05	1.69E-08	0.000376	4.5E-05	5.1E-08	0.002331	II/III	[13]
3	F		0.0012491	2.36E-05	2.45E-08	0.000355	6.9E-05	1.1E-07	0.002199	I	[13]
3	F		0.0018525	3.31E-05	2.75E-08	0.000496	5.6E-05	1E-07	0.002149	II/III	[13]
3	F		0.0026355	4.46E-05	1.76E-08	0.000669	2.6E-05	1E-07	0.00415	II/III	[13]
3	F		0.010236	4.47E-04	2.64E-07	0.00671	3.9E-05	7.2E-07	0.041604	I	[13]
3	M	Mercenaria mercenaria (Linnaeus, 1758) [juvenile]→Isochrysis galbana Parke	8.878E-10	8.71E-14	5.72E-16	0.000193	3E-12	2.8E-15	0.000809	II/III	[14]
3	M	Mediomastus fragile Rasmussen, 1973 [larva]→Isochrysis galbana Parke	2.5E-09	4.96E-14	4.77E-16	0.014563	3.3E-14	3.1E-15	1.062215	II/III	[15]

D	H	Consumer→Resource	ConSize	ResSize	ConsRate (S)	ResDen (S)	SRate (S)	ConsRate (A)	ResDen (A)	FR	Ref
3	M	Philine aperta (Linnaeus, 1767) [larva]→Isochrysis galbana Parke	4.894E-10	4.77E-14	3.25E-16	6.64E-05	4.9E-12	2.1E-15	0.002626	I	[16]
3	M		1.408E-09	4.77E-14	2.54E-16	5.07E-05	5E-12	7.7E-15	0.003059	II/III	[16]
3	M		2.666E-09	4.77E-14	1.62E-15	6.13E-05	2.6E-11	2.7E-14	0.006783	II/III	[16]
3	M		1.258E-08	4.77E-14	4.05E-15	6.64E-05	6.1E-11	5.8E-14	0.00431	II/III	[16]
3	F	Utricularia vulgaris Linnaeus 1753 [adult]→Polyphemus pediculus (Linnaeus, 1761) [adult]	1.608E-05	6.00E-09	6.35E-13	0.00048	1.3E-09	2.1E-12	0.007203	II/III	[17]
3	F	Utricularia vulgaris Linnaeus 1753 [adult]→Eucyclops serrulatus (Fischer, 1851) [adult]	1.608E-05	4.46E-09	2.2E-13	0.000357	6.2E-10	1.8E-12	0.005351	II/III	[17]
3	M	Chionoecetes bairdi M. J. Rathbun, 1924 [zoeae]→Protoceratium reticulatum (Claparède & Lachmann) Butschli [adult]	1.366E-07	3.35E-11	6.68E-15	0.000245	2.7E-11	6.2E-14	0.004021	II/III	[18]
3	F	Coenagrion resolutum (Hagen in Selys, 1876) [nymph]→Daphnia magna Straus, 1820	1.895E-06	3.35E-08	1.78E-13	0.000134	1.3E-09	1.1E-10	0.002546	II/III	[19]
3	F	Lestes disjunctus Selys, 1862 [nymph]→Daphnia magna Straus, 1820	1.895E-06	3.35E-08	1.38E-11	0.000134	1E-07	1.3E-10	0.001742	II/III	[19]
3	F	Coenagrion resolutum (Hagen in Selys, 1876) [nymph]→Daphnia magna Straus, 1820	3.861E-06	1.29E-07	3.83E-11	0.000518	7.4E-08	3.9E-10	0.012943	II/III	[19]
3	F	Lestes disjunctus Selys, 1862 [nymph]→Daphnia magna Straus, 1820	4.014E-06	1.29E-07	1.12E-10	0.000518	2.2E-07	5.7E-10	0.007766	II/III	[19]
3	F	Coenagrion resolutum (Hagen in Selys, 1876) [nymph]→Daphnia magna Straus, 1820	6.368E-06	2.73E-07	1.34E-10	0.001092	1.2E-07	1.2E-09	0.012012	II/III	[19]
3	F	Lestes disjunctus Selys, 1862 [nymph]→Daphnia magna Straus, 1820	5.598E-06	2.73E-07	1.89E-10	0.001092	1.7E-07	1.4E-09	0.01638	II/III	[19]
3	M	Perca fluviatilis L. [juvenile]→Neomysis integer [adult]	0.00131	2.60E-05	6.93E-08	0.000974	7.1E-05	2.7E-07	0.003895	II/III	[20]
3	M	Sander lucioperca (L.) [juvenile]→Neomysis integer [adult]	0.00147	2.60E-05	3.8E-08	0.000974	3.9E-05	2E-07	0.038946	II/III	[20]
3	F	Alosa pseudoharengus (Wilson, 1811) [juvenile]→Artemia spp. [adult]	1.221E-06	1.00E-08	2.81E-11	0.00059	4.8E-08	1.4E-10	0.006815	I	[21]
3	F	Coregonus hoyi (Milner, 1874) [juvenile]→Artemia spp. [adult]	4.429E-06	1.00E-08	2.13E-11	0.000215	9.9E-08	1.4E-10	0.007815	II/III	[21]
3	F	Perca flavescens DO [juvenile]→Artemia spp. [adult]	3.701E-06	1.00E-08	3.66E-11	0.000444	8.2E-08	2E-10	0.005355	II/III	[21]
3	F	Alosa pseudoharengus (Wilson, 1811) [juvenile]→Artemia spp. [adult]	1.678E-05	1.00E-08	1.15E-09	0.000149	7.7E-06	4.5E-09	0.009893	II/III	[21]
3	F	Coregonus hoyi (Milner, 1874) [juvenile]→Artemia spp. [adult]	1.83E-05	1.00E-08	2.17E-09	0.000209	1E-05	5.5E-09	0.002413	II/III	[21]
3	F	Perca flavescens DO [juvenile]→Artemia spp. [adult]	2.848E-05	1.00E-08	8.12E-10	0.000208	3.9E-06	2.4E-09	0.007025	I	[21]
3	F	Alosa pseudoharengus (Wilson, 1811) [juvenile]→Artemia spp. [adult]	7.491E-05	1.00E-08	1.57E-09	0.000194	8.1E-06	1.2E-08	0.007184	I	[21]
3	F	Coregonus hoyi (Milner, 1874) [juvenile]→Artemia spp. [adult]	0.0001018	1.00E-08	8.47E-10	2.63E-05	3.2E-05	1.1E-08	0.007871	II/III	[21]
3	F	Perca flavescens DO [juvenile]→Artemia spp. [adult]	0.0001018	1.00E-08	3E-09	0.000996	3E-06	8E-09	0.007743	I	[21]
3	F	Perca flavescens DO [juvenile]→Artemia spp. [adult]	0.0003731	1.00E-08	3.05E-09	0.00039	7.8E-06	2.4E-08	0.008742	II/III	[21]
3	F	Coregonus hoyi (Milner, 1874) [juvenile]→Artemia spp. [adult]	0.0003731	1.00E-08	6.57E-09	9.45E-07	0.00695	3.3E-08	0.004681	II/III	[21]
3	F	Alosa pseudoharengus (Wilson, 1811) [juvenile]→Artemia spp. [adult]	0.0002165	1.00E-08	3.31E-09	2.51E-05	0.00013	1.9E-08	0.00767	II/III	[21]
3	F	Eucyclops subterraneus scythicus Plesa 1989 [adult]→Panagrolaimus spp. [adult]	1.16E-08	3.27E-10	5E-13	0.00109	4.6E-10	5.2E-12	0.0218	II/III	[22]
3	F	Eucyclops subterraneus scythicus Plesa 1989 [adult]→Poikilolaimus spp. [adult]	1.141E-08	3.27E-10	7.63E-13	0.00109	7E-10	8.1E-12	0.01635	II/III	[22]
3	F	Hydaticus grammicus Germar, 1830 [adult]→Culex tritaeniorhynchus Giles, 1901 [instar 4]	2.61E-05	2.14E-07	4.46E-12	0.010711	4.2E-10	6.5E-11	0.171376	I	[23]
3	F	Eretes griseus (Fabricius, 1781) [adult]→Culex tritaeniorhynchus Giles, 1901 [instar 4]	6.203E-05	2.14E-07	1.35E-11	0.021422	6.3E-10	3.1E-10	0.685504	I	[23]
3	F	Rhantus suturalis (MacLeay, 1825) [adult]→Culex tritaeniorhynchus Giles, 1901 [instar 4]	4.612E-05	2.14E-07	1.35E-11	0.021422	6.3E-10	1.5E-10	0.342752	I	[23]
3	F	Coregonus albula (Linnaeus, 1758) [juvenile]→Daphnia magna Straus, 1820	0.0096075	1.56E-07	2.99E-08	3.89E-05	0.00077	3E-07	0.001245	II/III	[24]
3	F	Coregonus fontanae Schulz and Freyhof, 2003→Daphnia magna Straus, 1820	0.0059854	1.56E-07	2.78E-08	3.89E-05	0.00071	2.4E-07	0.001245	II/III	[24]
3	M	Nyctiphanes australis Sars, 1883 [adult]→Acartia spp. [adult]	9.38E-06	2.32E-08	1.85E-13	1.16E-05	1.6E-08	8E-12	0.000348	II/III	[25]

D	H	Consumer→Resource	ConSize	ResSize	ConsRate (S)	ResDen (S)	SRate (S)	ConsRate (A)	ResDen (A)	FR	Ref
3	F	Daphnia magna Straus, 1820→Chlamydomonas reinhardtii P.A.Dang	2.333E-07	3.00E-13	2.43E-13	0.000307	7.9E-10	2.7E-12	0.144474	II/III	[26]
3	M	Negaprion brevirostris (Poey) [juvenile]→Gerres cinereus (Walbaum) [adult]	1.4	6.24E-02	3.65E-07	0.001791	0.0002	1.1E-06	0.014324	I	[27]
3	F	Daphnia pulicaria Forbes, 1893→Scenedesmus acutus Meyen	7.984E-08	8.53E-13	5.93E-12	0.035207	1.7E-10	4.6E-11	0.737291	II/III	[28]
3	M	Centropages typicus Krøyer, 1849 [adult]→Calanus finmarchicus (Gunner, 1765) [egg]	2.398E-08	1.24E-09	1.18E-13	2.64E-05	4.5E-09	3.9E-13	0.000162	II/III	[29]
3	F	Ischnura elegans elegans (Vander Linden, 1820) [instar 11]→Daphnia magna Straus, 1820 [adult]	2.279E-06	1.01E-07	1.56E-11	0.011634	1.3E-09	6.2E-11	0.107415	II/III	[30]
3	M	Aurelia aurita [juvenile]→Gadus morhua [juvenile]	0.026464	8.27E-04	3.09E-06	0.413625	7.5E-06	6.7E-05	13.236	I	[31]
3	F	Abramis brama, Linneaus [juvenile]→Daphnia magna Straus, 1820	0.0035792	2.78E-07	4.87E-10	0.000357	1.4E-06	1E-08	0.009343	I	[32]
3	M	Tortanus forcipatus (Giesbrecht, 1889) [juvenile]→Oithona davisae Ferrari & Orsi, 1984 [juvenile]	1.403E-08	9.63E-10	1.24E-14	3.72E-05	3.3E-10	3.9E-14	0.00023	II/III	[33]
3	M	Tortanus forcipatus (Giesbrecht, 1889) [juvenile]→Oithona davisae Ferrari & Orsi, 1984 [juvenile]	3.198E-08	9.63E-10	1.45E-14	3.72E-05	3.9E-10	7.5E-14	0.000307	I	[33]
3	M	Tortanus forcipatus (Giesbrecht, 1889) [adult]→Oithona davisae Ferrari & Orsi, 1984 [juvenile]	5.019E-08	9.63E-10	1.65E-14	3.72E-05	4.4E-10	9.6E-14	0.000307	II/III	[33]
3	M	Tortanus forcipatus (Giesbrecht, 1889) [adult]→Oithona davisae Ferrari & Orsi, 1984 [juvenile]	7.94E-08	9.63E-10	2.8E-14	3.72E-05	7.5E-10	1.7E-13	0.000191	II/III	[33]
3	F	Parabroteas sarsi (Daday) [adult]→Bosmina longirostris (Müller, 1776) [adult]	1.329E-05	2.24E-09	9.37E-13	4.48E-05	2.1E-08	4.3E-12	0.000179	II/III	[34]
3	F	Parabroteas sarsi (Daday) [adult]→Ceriodaphnia dubia Richard, 1894 [adult]	1.329E-05	1.01E-08	5.93E-12	0.000201	2.9E-08	1.6E-11	0.000704	I	[34]
3	F	Parabroteas sarsi (Daday) [adult]→Daphnia ambigua Scourfield, 1947	1.329E-05	8.94E-09	4.23E-12	0.000179	2.4E-08	1.2E-11	0.000715	I	[34]
3	F	Parabroteas sarsi (Daday) [adult]→Daphnia middendorffiana	1.329E-05	4.13E-07	5.9E-11	0.008269	7.1E-09	1.3E-10	0.032248	I	[34]
3	M	Praunus flexuosus (Müller, 1776) [adult]→Acartia spp. [adult]	8.429E-05	2.32E-08	4.25E-12	9.96E-05	4.3E-08	1.5E-10	0.001411	II/III	[35]
3	M	Praunus flexuosus (Müller, 1776) [adult]→Eurytemora affinis (Poppe, 1880) [adult]	8.429E-05	1.21E-05	1.73E-09	0.052215	3.3E-08	4E-08	1.056441	I	[35]
3	M	Praunus flexuosus (Müller, 1776) [adult]→Pleopsis polyphemoides (Leuckart, 1859) [adult]	8.429E-05	3.00E-08	2.16E-11	0.00039	5.5E-08	1.4E-09	0.007827	I	[35]
3	M	Praunus flexuosus (Müller, 1776) [adult]→Bosmina longispina Leydig, 1860 [adult]	8.429E-05	3.00E-07	4.24E-10	0.003904	1.1E-07	7.2E-09	0.078075	I	[35]
3	F	Chaoborus americanus Johannsen, 1903 [instar 4]→Daphnia pulex Leydig, 1860	2.152E-06	7.69E-08	1.77E-11	0.000385	4.6E-08	8.5E-11	0.004616	II/III	[36]
3	F	Chaoborus americanus Johannsen, 1903 [instar 4]→Daphnia rosea Sars, 1862 [adult]	2.152E-06	9.67E-08	1.62E-11	0.000483	3.4E-08	1.8E-10	0.011602	II/III	[36]
3	F	Chaoborus americanus Johannsen, 1903 [instar 4]→Moina hutchinsoni Brehm, 1937 [adult]	2.152E-06	1.30E-08	3.08E-12	6.48E-05	4.8E-08	4E-11	0.001036	II/III	[36]
3	F	Chaoborus americanus Johannsen, 1903 [instar 4]→Holopedium gibberum Zaddach, 1885 [adult]	2.152E-06	1.07E-07	4.15E-12	0.000534	7.8E-09	1E-10	0.002136	II/III	[36]
3	F	Chaoborus americanus Johannsen, 1903 [instar 4]→Diaptomus birgei [adult]	2.152E-06	1.56E-08	2.75E-12	7.79E-05	3.5E-08	5.3E-11	0.001869	I	[36]
3	F	Chaoborus americanus Johannsen, 1903 [instar 4]→Cyclops vernalis Fischer, 1853	2.152E-06	2.11E-08	3.73E-12	0.000106	3.5E-08	6.1E-11	0.002532	I	[36]
3	F	Chaoborus americanus Johannsen, 1903 [instar 4]→Diaptomus leptopus Forbes 1882 [adult]	2.152E-06	1.02E-07	1.81E-11	0.000511	3.5E-08	1.3E-10	0.012275	II/III	[36]
3	F	Cyclops abyssorum Sars, 1863→Askenasia volvox (Claparède & Lachmann, 1859)	2.044E-08	3.35E-11	1.38E-14	2.63E-05	5.2E-10	3.4E-13	0.005904	I	[37]
3	F	Cyclops kolensis Lilljeborg, 1901→Askenasia volvox (Claparède & Lachmann, 1859)	3.701E-09	3.35E-11	3.36E-14	2.62E-05	1.3E-09	6.5E-13	0.005879	I	[37]
3	F	Cyclops abyssorum Sars, 1863→Halteria grandinella (Mull.)	2.044E-08	5.58E-12	1.89E-15	2.86E-05	6.6E-11	2.6E-14	0.000849	I	[37]
3	F	Cyclops kolensis Lilljeborg, 1901→Halteria grandinella (Mull.)	3.701E-09	5.58E-12	7.3E-15	5.41E-05	1.3E-10	4.9E-14	0.000839	I	[37]
3	F	Cyclops abyssorum Sars, 1863→Strobilidium velox Faure-Fremiet, 1924	2.044E-08	6.55E-11	6.98E-14	0.000206	3.4E-10	4.5E-12	0.013162	I	[37]

D	H	Consumer→Resource	ConSize	ResSize	ConsRate (S)	ResDen (S)	SRate (S)	ConsRate (A)	ResDen (A)	FR	Ref
3	F	Cyclops kolensis Lilljeborg, 1901→Strobilidium velox Faure-Fremiet, 1924	3.701E-09	6.55E-11	3.88E-13	0.000132	2.9E-09	9.2E-13	0.009838	I	[37]
3	F	Cyclops abyssorum Sars, 1863→Stokesia vernalis Wenrich, 1929	2.044E-08	9.05E-10	1.53E-13	0.002317	6.6E-11	4.8E-12	0.092185	II/III	[37]
3	F	Cyclops kolensis Lilljeborg, 1901→Stokesia vernalis Wenrich, 1929	3.701E-09	9.05E-10	7.57E-13	0.004352	1.7E-10	6.6E-12	0.113859	I	[37]
3	F	Cyclops abyssorum Sars, 1863→Coleps hirtus (Mull.)	2.044E-08	1.13E-10	4.67E-14	0.000615	7.6E-11	1.3E-13	0.022754	I	[37]
3	F	Cyclops kolensis Lilljeborg, 1901→Coleps hirtus (Mull.)	3.701E-09	1.13E-10	4.28E-14	0.000303	1.4E-10	4.6E-14	0.016836	I	[37]
3	F	Chalcalburnus chalcoides (Güldenstädt, 1772)→Cyclops spp.	0.0036962	3.37E-08	1.5E-09	6.73E-05	2.2E-05	1.2E-08	0.000841	I	[38]
3	F	Chalcalburnus chalcoides (Güldenstädt, 1772)→Daphnia hyalina Linnaeus	0.0036962	7.01E-08	7.99E-09	0.00014	5.7E-05	4.4E-08	0.001753	II/III	[38]
3	F	Chalcalburnus chalcoides (Güldenstädt, 1772)→Leptodora kindtii (Focke, 1844) [subadult]	0.0036962	1.48E-05	8.05E-07	0.02966	2.7E-05	3.4E-06	0.2966	II/III	[38]
3	F	Chalcalburnus chalcoides (Güldenstädt, 1772)→Bythotrephes longimanus (Leydig, 1860) [adult]	0.0036962	3.14E-07	3.17E-08	0.000628	5.1E-05	1.9E-07	0.006281	II/III	[38]
3	T	Nesticodes rufipes (Lucas, 1846) [adult]→Musca domestica Linnaeus, 1758 [adult]	0.0003419	2.20E-05	7.16E-11	0.050865	1.4E-09	3E-10	0.254325	II/III	[20]
3	T	Grammonota trivittata Banks, 1895 [adult]→Prokelisia spp. [instar 2]	3.737E-06	1.85E-07	1.38E-13	0.000696	2E-10	1.7E-12	0.00696	I	[20]
2	F	Celithemis fasciata Kirby, 1889 [instar final]→Chironomus tentans Fabricius, 1805 [instar 3]	2.635E-05	7.07E-07	4.59E-11	0.000561	8.2E-08	2.6E-10	0.001402	II/III	[39]
2	M	Crangon septemspinosa Say, 1818 [adult]→Pseudopleuronectes americanus (Walbaum, 1792) [juvenile]	0.0015122	1.36E-05	1.76E-10	6.09E-05	2.9E-06	1.1E-09	0.001217	I	[40]
2	T	Podisus maculiventris DO [adult]→Spodoptera exigua Hübner 1803/08 [instar 4]	0.0001	2.00E-05	1.78E-10	0.001299	1.4E-07	1.6E-09	0.041575	II/III	[41]
2	T	Podisus nigrispinus DO [adult]→Spodoptera exigua Hübner 1803/08 [instar 4]	0.00007	2.00E-05	1.78E-10	0.001299	1.4E-07	2.3E-09	0.041575	II/III	[41]
2	T	Stethorus punctum (LeConte, 1852) [adult]→Panonychus ulmi (Koch 1836) [adult]	2.332E-07	1.95E-08	3.12E-12	4.74E-06	6.6E-07	1.6E-11	3.55E-05	I	[42]
2	T	Orius insidiosus (Say, 1832) [adult]→Panonychus ulmi (Koch 1836) [adult]	5.637E-07	1.95E-08	1.16E-12	3.15E-05	3.7E-08	4.2E-12	0.000503	II/III	[43]
2	T	Phytoseiulus persimilis DO [adult]→Tetranychus urticae Koch, 1836 [adult]	1.985E-08	1.95E-08	9.13E-14	3.91E-05	2.3E-09	2.7E-13	0.001368	II/III	[44]
2	M	Callinectes sapidus Rathbun, 1896 [adult]→Crassostrea virginica (Gmelin, 1791) [juvenile]	0.16201	6.76E-03	9.6E-07	0.10247	9.4E-06	2.6E-06	1.024697	I	[45]
2	F	Rhyacophila dorsalis (Curtis, 1834) [instar 5]→Chironomus spp. [larva]	2.42E-05	2.40E-07	2.74E-10	5.98E-05	4.6E-06	1.5E-09	0.000601	I	[46]
2	F	Rhyacophila dorsalis (Curtis, 1834) [instar 4]→Chironomus spp. [larva]	5.631E-06	2.40E-07	1.33E-10	5.98E-05	2.2E-06	8.9E-10	0.000541	I	[46]
2	F	Rhyacophila dorsalis (Curtis, 1834) [instar 3]→Chironomus spp. [larva]	1.742E-06	3.23E-08	9.1E-12	8.04E-06	1.1E-06	7.3E-11	8.08E-05	I	[46]
2	F	Rhyacophila dorsalis (Curtis, 1834) [instar 2]→Chironomus spp. [larva]	4.69E-07	3.23E-08	8.69E-12	8.04E-06	1.1E-06	4.7E-11	8.08E-05	I	[46]
2	M	Saduria entomon (Linnaeus, 1758) [juvenile]→Monoporeia affinis Lindström, 1855 [juvenile]	0.00008	1.81E-06	2.06E-11	0.000499	4.1E-08	6.3E-11	0.004122	I	[47]
2	M	Saduria entomon (Linnaeus, 1758) [juvenile]→Monoporeia affinis Lindström, 1855 [juvenile]	0.000515	1.81E-06	2.65E-11	0.000496	5.4E-08	2E-10	0.004124	I	[47]
2	M	Saduria entomon (Linnaeus, 1758) [adult]→Monoporeia affinis Lindström, 1855 [juvenile]	0.001605	1.81E-06	3.06E-11	0.000488	6.3E-08	3.2E-10	0.004112	I	[47]
2	M	Saduria entomon (Linnaeus, 1758) [adult]→Monoporeia affinis Lindström, 1855 [juvenile]	0.00455	1.81E-06	3.58E-11	0.000486	7.4E-08	3.1E-10	0.003218	I	[47]
2	M	Saduria entomon (Linnaeus, 1758) [juvenile]→Monoporeia affinis Lindström, 1855 [adult]	0.00008	5.69E-06	1.97E-11	0.00157	1.3E-08	7.3E-11	0.012962	I	[47]
2	M	Saduria entomon (Linnaeus, 1758) [juvenile]→Monoporeia affinis Lindström, 1855 [adult]	0.000515	5.69E-06	1.12E-10	0.001576	7.1E-08	4.4E-10	0.010105	II/III	[47]

D	H	Consumer→Resource	ConSize	ResSize	ConsRate (S)	ResDen (S)	SRate (S)	ConsRate (A)	ResDen (A)	FR	Ref
2	M	Saduria entomon (Linnaeus, 1758) [adult]→Monoporeia affinis Lindström, 1855 [adult]	0.001605	5.69E-06	1.09E-10	0.001561	7E-08	4E-10	0.007258	II/III	[47]
2	M	Saduria entomon (Linnaeus, 1758) [adult]→Monoporeia affinis Lindström, 1855 [adult]	0.00455	5.69E-06	4.18E-11	0.001581	2.6E-08	4.2E-10	0.012894	I	[47]
2	T	Chrysomya albiceps (Wiedemann, 1819) [larva]→Chrysomya megacephala (Fabricius, 1794) [larva]	3.081E-06	9.33E-07	6.5E-11	0.002639	2.5E-08	4E-10	0.018471	II/III	[48]
2	T	Pardosa vancouveri Emerton [adult]→Drosophila melanogaster Meigen, 1830 [adult] (wingless)	7.612E-06	6.95E-07	1.87E-11	2.56E-05	7.3E-07	4.8E-11	0.000256	II/III	[49]
2	T	Pardosa T-insignita (Boesenberg et Strand) [instar 4]→Drosophila melanogaster Meigen, 1830 [adult] (wingless)	2.05E-06	6.95E-07	1.75E-11	8.93E-06	2E-06	5.8E-11	4.47E-05	II/III	[50]
2	T	Pardosa T-insignita (Boesenberg et Strand) [instar 4]→Drosophila melanogaster Meigen, 1830 [adult] (wingless)	4.25E-06	6.95E-07	1.54E-11	8.93E-06	1.7E-06	3.8E-11	7.15E-05	II/III	[50]
2	T	Paratenodera angustipennis de saussure [instar 7]→Musca domestica Linnaeus, 1758 [adult]	0.0040047	1.63E-05	2.23E-10	0.000143	1.6E-06	1.4E-09	0.00186	I	[51]
2	F	Plectrocnemia conspersa (Curtis, 1834) [larva]→Leuctra nigra (Olivier, 1811) [larva]	4.177E-06	6.71E-08	9.66E-12	4.14E-05	2.3E-07	3E-11	0.000331	II/III	[52]
2	F	Plectrocnemia conspersa (Curtis, 1834) [larva]→Nemurella picteti Klapalek [larva]	4.177E-06	3.96E-07	4.7E-11	0.000244	1.9E-07	4.3E-10	0.001956	I	[52]
2	T	Peromyscus maniculatus (Wagner, 1845) [adult]→Neodiprion sertifer (Geoffroy, 1785) [cocoon]	0.02	5.35E-05	2.45E-09	0.000324	7.6E-06	2.6E-08	0.005379	II/III	[53]
2	T	Peromyscus maniculatus (Wagner, 1845) [adult]→Triticum spp. [seed]	0.02	4.00E-05	3.8E-10	0.000161	2.4E-06	6.4E-09	0.00129	II/III	[54]
2	T	Pergamasus crassipes (Linnaeus, 1758) [adult]→Onychiurus armatus (Tullberg) [adult]	3.064E-07	3.14E-07	5.54E-11	0.0004	1.4E-07	3.8E-10	0.010002	II/III	[55]
2	T	Lemmus sibiricus (Kerr, 1792) [adult]→sedges & grasses [tiller]	0.05	1.24E-04	1.69E-07	0.006902	2.4E-05	8.7E-07	0.223718	I	[56]
2	T	Phytoseiulus persimilis DO [adult]→Tetranychus pacificus McGregor, 1919 [juvenile]	1.985E-08	1.89E-09	4.01E-14	3.55E-06	1.1E-08	2.2E-13	0.000142	II/III	[57]
2	T	Amblyseius degenerans [adult]→Tetranychus pacificus McGregor, 1919 [juvenile]	4.971E-08	1.89E-09	4.55E-14	3.55E-06	1.3E-08	6.3E-13	0.000142	II/III	[57]
2	T	Odocoileus hemionus (Rafinesque, 1817) [juvenile (1 yr)]→sedges & grasses [tiller]	42	0.00195	3.29E-06	0.00289	0.00114	2.7E-05	0.150941	II/III	[58]
2	T	Cervus canadensis (Erxleben, 1777) [subadult]→sedges & grasses [tiller]	168.5	0.00195	3.68E-05	0.079824	0.00046	0.00013	1.886097	II/III	[58]
2	T	Cyrtorhinus lividipennis Reuter, 1885 [adult]→Nilaparvata lugens (Stål, 1854) [egg]	1.037E-06	8.40E-08	1.7E-11	5.27E-05	3.2E-07	1E-10	0.000421	I	[59]
2	T	Haematopus ostralegus Linnaeus, 1758 [adult]→Scrobicularia plana Da Costa, 1778 [adult]	0.46	0.00034	1.1E-06	0.002077	0.00053	4.3E-06	0.119661	I	[60]
2	T	Tenodera sinensis [instar 1]→Drosophila melanogaster Meigen, 1830 [adult]	6.079E-06	7.67E-07	2.19E-12	2.04E-05	1.1E-07	8.6E-12	0.00309	II/III	[61]
2	T	Bison bison (Linnaeus, 1758)→sedges & grasses [tiller]	800	0.00262	8.1E-05	0.05847	0.00139	0.00069	0.529979	II/III	[62]
2	T	Nabis kinbergii Reuter [adult]→Sidnia kinbergi Stal, 1859 [instar 4-5]	4.862E-05	2.00E-06	5.4E-11	5.26E-05	1E-06	1.7E-10	0.000632	I	[63]
2	T	Nabis kinbergii Reuter [instar 5]→Sidnia kinbergi Stal, 1859 [instar 4-5]	3.76E-06	2.00E-06	5.59E-12	5.26E-05	1.1E-07	7.4E-11	0.000632	II/III	[63]
2	T	Nabis kinbergii Reuter [adult]→Acyrthosiphon pisum (Harris) [instar final]	4.862E-05	6.00E-07	2.57E-11	1.58E-05	1.6E-06	5.1E-11	0.000189	I	[63]
2	T	Nabis kinbergii Reuter [instar 5]→Acyrthosiphon pisum (Harris) [instar final]	3.76E-06	6.00E-07	1.12E-11	1.58E-05	7.1E-07	3.5E-11	0.000189	I	[63]
2	T	Myodes glareolus (Schreber, 1780) [adult]→Salix myrsinifolia Salisb. [long shoot]	0.0185	1.28E-03	8.95E-09	0.00256	3.5E-06	4.7E-08	0.04608	I	[64]
2	T	Odocoileus hemionus sitkensis Merriam, 1898 [adult]→Rubus pedatus Sm. [adult]	48	0.00018	1.11E-05	7.47E-05	0.14912	2.7E-05	0.001228	II/III	[65]
2	T	Odocoileus hemionus sitkensis Merriam, 1898 [adult]→Tsuga heterophylla (Raf.) Sarg. [shoot]	48	2.50E-01	3.95E-05	0.000984	0.04013	7.2E-05	0.012634	II/III	[65]
2	T	Macrolophus caliginosus (Wagner) [adult]→Myzus persicae (Sulzer, 1776) [instar 4]	1.39E-06	1.35E-07	1.3E-12	6.76E-06	1.9E-07	1.4E-11	0.000203	II/III	[66]
2	T	Macrolophus caliginosus (Wagner) [adult]→Tetranychus urticae Koch, 1836 [adult]	1.39E-06	2.01E-08	9.53E-13	6.03E-06	1.6E-07	6E-12	5.02E-05	II/III	[66]
2	F	Phagocata vitta (Duges) [adult]→Tubifex tubifex (Johannes Muller, 1774)	1.19E-06	2.38E-06	9.38E-12	0.000539	1.7E-08	3.5E-11	0.008622	II/III	[67]
2	F	Phagocata vitta (Duges) [adult]→Chironomus spp. [larva]	1.19E-06	4.82E-07	1.24E-12	0.000109	1.1E-08	5.4E-12	0.001744	II/III	[67]

D	H	Consumer→Resource	ConSize	ResSize	ConsRate (S)	ResDen (S)	SRate (S)	ConsRate (A)	ResDen (A)	FR	Ref
2	T	Alces alces Gray, 1821 [adult]→Betula pubescens Ehrh. (twig)	550	0.132	9.42E-06	0.173669	5.4E-05	0.00025	7.038301	I	[68]
2	M	Calliopius laeviusculus (Krøyer, 1838) [adult]→Mallotus villosus Müller, 1776 [egg]	1.735E-05	4.78E-07	3.86E-11	0.002103	1.8E-08	5.9E-10	0.177576	II/III	[69]
2	T	Pardosa pseudoannulata (Boesenberg et Strand) [adult]→Nilaparvata lugens (Stål, 1854) [adult]	0.0001462	9.07E-07	5.5E-12	2.08E-05	2.6E-07	3.8E-11	8.34E-05	II/III	[70]
2	T	Pardosa pseudoannulata (Boesenberg et Strand) [adult]→Cyrtorhinus lividipennis Reuter, 1885 [adult]	0.0001462	3.39E-06	7.08E-11	7.79E-05	9.1E-07	4.7E-10	0.000935	II/III	[70]
2	T	kestrels and owls [adult]→Microtus spp. [adult]	0.049	0.025	4.75E-08	0.000001	0.04749	2.8E-07	0.000045	II/III	[71]
2	F	Baetis tricaudatus (Banks) [late instar]→Navicula spp.	6.9E-07	2.68E-10	4.68E-11	0.0055	8.5E-09	1.8E-10	0.0315	II/III	[72]
2	F	Ephemerella aurivilli [late instar]→Navicula spp.	7.885E-07	2.68E-10	1.01E-10	0.0055	1.8E-08	1.5E-10	0.0315	II/III	[72]
2	F	Paraleptophlebia heteronea (McDunnough) [late instar]→Navicula spp.	9.149E-07	2.68E-10	4.83E-11	0.0055	8.8E-09	1.2E-10	0.0315	II/III	[72]
2	F	Glossiphonia complanata (Linnaeus, 1758)→Lymnaea emarginata Say [juvenile]	0.0421	3.26E-03	6.54E-08	0.65256	1E-07	9.6E-07	20.88192	I	[73]
2	F	Glossiphonia complanata (Linnaeus, 1758)→Helisoma anceps (Menke, 1830) [juvenile]	0.0421	9.48E-04	3.26E-08	0.189694	1.7E-07	1.2E-07	3.035104	II/III	[73]
2	F	Glossiphonia complanata (Linnaeus, 1758)→Physa gyrina (Say, 1821) [juvenile]	0.0421	7.37E-04	6.69E-09	0.147332	4.5E-08	1.5E-07	4.714624	I	[73]
2	T	Curinus coeruleus (Mulsant, 1850) [adult]→Heteropsylla cubana Crawford [late instar]	0.0000158	1.50E-07	1.11E-11	0.000206	5.4E-08	5.7E-11	0.001239	I	[74]
2	M	Callinectes sapidus Rathbun, 1896 [adult]→Macoma balthica (Linnaeus, 1758) [adult]	0.16201	8.43E-03	1.29E-08	0.009004	1.4E-06	4E-07	0.144068	II/III	[75]
2	M	Callinectes sapidus Rathbun, 1896 [adult]→Mya arenaria Linnaeus, 1758 [adult]	0.12974	0.0119	1.14E-08	0.066111	1.7E-07	1.4E-07	1.057778	II/III	[76]
2	T	Castor canadensis Kuhl, 1820 [adult]→Populus tremuloides Michx. [sapling]	20	0.9	5.8E-06	0.006	0.00097	1E-05	0.024	I	[77]
2	T	Canis lupus Linnaeus, 1758 [adult]→Rangifer tarandus (Linnaeus, 1758) [adult]	36	120	3.13E-05	7.2E-06	4.35368	3.4E-05	2.52E-05	II/III	[78]
2	T	Neoseiulus barkeri Hughes, 1948 [adult]→Tetranychus urticae Koch, 1836 [egg]	1.985E-08	1.44E-09	4.98E-14	7.48E-06	6.7E-09	4.4E-13	0.00012	I	[79]
2	T	Neoseiulus barkeri Hughes, 1948 [adult]→Tetranychus urticae Koch, 1836 [nymph]	1.985E-08	1.08E-08	4.05E-13	5.59E-05	7.2E-09	2.4E-12	0.000447	I	[79]
2	T	Neoseiulus barkeri Hughes, 1948 [adult]→Tetranychus urticae Koch, 1836 [adult]	1.985E-08	1.95E-08	1.32E-13	2.03E-05	6.5E-09	3.2E-13	0.000162	I	[79]
2	T	Lyctocoris campestris (Fabricius, 1794) [adult]→Plodia interpunctella (Hübner, [1813]) [larva]	5.637E-07	1.77E-05	9.5E-11	0.001944	4.9E-08	6.1E-10	0.03889	I	[80]
2	T	Lyctocoris campestris (Fabricius, 1794) [adult]→Oryzaephilus surinamensis (Linnaeus, 1758) [larva]	5.637E-07	6.00E-07	1.47E-12	6.58E-05	2.2E-08	1.8E-11	0.001315	I	[80]
2	T	Lyctocoris campestris (Fabricius, 1794) [adult]→Tribolium castaneum (Herbst, 1797) [larva]	5.637E-07	2.48E-06	2.24E-11	0.000272	8.2E-08	4.7E-11	0.002175	II/III	[80]
2	M	Metacarcinus magister (Dana, 1852) [instar 3]→Macoma balthica (Linnaeus, 1758) [adult]	0.0059136	0.00186	4.6E-08	0.111402	4.1E-07	4E-07	2.22804	I	[81]
2	M	Metacarcinus magister (Dana, 1852) [instar 5]→Macoma balthica (Linnaeus, 1758) [adult]	0.0081843	0.00186	3E-08	0.111402	2.7E-07	7.1E-07	1.67103	II/III	[81]
2	T	Surnia ulula (Linnaeus, 1758) [adult]→Microtus spp. [adult]	0.32425	0.04	3.09E-09	4.05E-06	0.00076	5.8E-07	1.9E-05	I	[82]
2	T	Surnia ulula (Linnaeus, 1758) [adult]→Lepus americanus Erxleben, 1777 [juvenile]	0.32425	0.22	1.84E-07	4.24E-05	0.00433	1.3E-06	8.96E-05	II/III	[82]
2	T	Alces alces Gray, 1821 [juvenile (1 yr)]→Acer rubrum Linnaeus [unbranched shoot]	274	0.0008	5.9E-05	6.61E-06	8.92481	9.3E-05	0.000618	II/III	[83]
2	T	Alces alces Gray, 1821 [juvenile]→Acer rubrum Linnaeus [unbranched shoot]	151	0.0008	5.29E-05	1.04E-05	5.09741	0.00012	0.000618	II/III	[83]
2	T	Odocoileus virginianus Zimmermann, 1780 [juvenile (1 yr)]→Acer rubrum Linnaeus [unbranched shoot]	67	0.0008	1.83E-05	2.13E-05	0.85911	3.4E-05	0.000618	I	[83]
2	T	Odocoileus virginianus Zimmermann, 1780 [juvenile]→Acer rubrum Linnaeus [unbranched shoot]	41	0.0008	1.1E-05	2.13E-05	0.5148	4.4E-05	0.000618	II/III	[83]
2	T	Bonasa umbellus (Linnaeus, 1766) [adult]→Trifolium repens [leaves]	0.55	4.44E-05	1.12E-06	4.44E-05	0.02518	2.6E-06	0.44444	II/III	[84]

D	H	Consumer→Resource	ConSize	ResSize	ConsRate (S)	ResDen (S)	SRate (S)	ConsRate (A)	ResDen (A)	FR	Ref
2	T	Canis lupus Linnaeus, 1758 [adult]→Alces alces Gray, 1821 [adult]	36	235	4.38E-06	0.000373	0.01177	1.7E-05	0.000645	I	[85]
2	F	Macrobiotus richtersi Murray, 1911 [adult]→Acrobeloides nanus [adult]	1.07E-08	8.00E-11	4.58E-14	1.01E-07	4.5E-07	2.4E-13	3.54E-06	II/III	[86]
2	T	Serinus canaria (Linnaeus, 1758) [adult]→seeds (Phalaris canariensis) [seed]	0.0175	6.50E-06	4.93E-08	5.47E-05	0.0009	2.3E-07	0.000657	II/III	[87]
2	T	Perdix perdix Linnaeus, 1758 [adult]→Triticum spp. [seed]	0.39	3.40E-05	3.05E-06	0.00017	0.01793	9E-06	0.0136	II/III	[88]
2	T	Fringilla coelebs Linnaeus, 1758 [adult]→Brassica napus L. [seed]	0.024	2.70E-06	2.96E-07	6.75E-05	0.00438	4.5E-07	0.00108	II/III	[89]
2	T	Macrolophus pygmaeus (Rambur, 1839) [adult]→Myzus persicae (Sulzer, 1776) [instar 1]	1.635E-06	2.25E-08	5.41E-13	5.31E-06	1E-07	2.8E-12	3.18E-05	II/III	[90]
2	T	Macrolophus pygmaeus (Rambur, 1839) [adult]→Myzus persicae (Sulzer, 1776) [instar 2]	1.635E-06	5.05E-08	1.29E-12	1.19E-05	1.1E-07	6.5E-12	5.95E-05	II/III	[90]
2	T	Macrolophus pygmaeus (Rambur, 1839) [adult]→Myzus persicae (Sulzer, 1776) [instar 3]	1.635E-06	7.93E-08	1.43E-12	1.87E-05	7.7E-08	7.3E-12	0.000112	II/III	[90]
2	T	Macrolophus pygmaeus (Rambur, 1839) [adult]→Myzus persicae (Sulzer, 1776) [instar 4]	1.635E-06	1.29E-07	2.53E-12	3.05E-05	8.3E-08	8.5E-12	0.000244	I	[90]
2	T	Cnemidophorus sexlineatus Linneaus, 1766 [adult]→Acheta domesticus (Linnaeus 1758)	0.0040091	1.25E-05	4.72E-10	3.14E-06	0.00015	4.7E-10	3.14E-06	I	[91]
2	T	Falco rusticolus Linnaeus, 1758 [adult]→Lagopus muta (Montin, 1781) [adult]	1.5053	0.537	2.69E-07	2.37E-06	0.11364	4.9E-07	6.38E-06	II/III	[92]
2	F	Sander vitreus (Mitchill, 1818) [juvenile]→Chironomus spp. [larva]	2.848E-05	1.02E-06	2.93E-09	2.55E-05	0.00011	3.1E-09	0.001022	I	[13]
2	F	Sander vitreus (Mitchill, 1818) [juvenile]→Chironomus spp. [larva]	0.0001018	1.02E-06	3.46E-09	2.55E-05	0.00014	6.2E-09	0.000511	II/III	[13]
2	F	Sander vitreus (Mitchill, 1818) [juvenile]→Chironomus spp. [larva]	0.0003731	1.02E-06	3.29E-09	2.55E-05	0.00013	1.1E-08	0.000102	II/III	[13]
2	F	Sander vitreus (Mitchill, 1818) [juvenile]→Chironomus spp. [larva]	0.0010167	1.02E-06	7.38E-09	2.55E-05	0.00029	2.1E-08	0.000511	II/III	[13]
2	F	Sander vitreus (Mitchill, 1818) [juvenile]→Chironomus spp. [larva]	0.0020616	1.02E-06	4.96E-09	2.55E-05	0.00019	3.4E-08	0.001022	II/III	[13]
2	F	Sander vitreus (Mitchill, 1818) [juvenile]→Chironomus spp. [larva]	0.0032779	1.02E-06	7.3E-09	2.55E-05	0.00029	4.1E-08	0.000511	II/III	[13]
2	F	Sander vitreus (Mitchill, 1818) [juvenile]→Chironomus spp. [larva]	0.0012491	1.02E-06	6.3E-09	2.55E-05	0.00025	3.9E-08	0.000511	II/III	[13]
2	F	Sander vitreus (Mitchill, 1818) [juvenile]→Chironomus spp. [larva]	0.0018525	1.02E-06	7.08E-09	2.55E-05	0.00028	3E-08	0.001022	II/III	[13]
2	F	Sander vitreus (Mitchill, 1818) [juvenile]→Chironomus spp. [larva]	0.0026355	1.02E-06	4.98E-09	2.55E-05	0.0002	4.4E-08	0.001022	II/III	[13]
2	F	Sander vitreus (Mitchill, 1818) [juvenile]→Chironomus spp. [larva]	0.010236	1.02E-06	4.65E-09	2.55E-05	0.00018	3.3E-08	0.001022	II/III	[13]
2	M	Cancer irroratus Say, 1817 [adult]→Placopecten magellanicus (Gmelin, 1791) [juvenile]	0.30392	0.0034	1.55E-07	0.00618	2.5E-05	2.6E-07	0.024721	I	[93]
2	M	Asterias vulgaris Verrill [adult]→Placopecten magellanicus (Gmelin, 1791) [juvenile]	0.1	0.00059	1E-08	0.006535	1.5E-06	1.2E-07	0.032677	II/III	[94]
2	M	Cancer irroratus Say, 1817 [adult]→Placopecten magellanicus (Gmelin, 1791) [juvenile]	0.31124	1.68E-03	4.24E-08	0.01869	2.3E-06	9.9E-08	0.065425	II/III	[95]
2	T	Repipta flavicans (Amyot and Serville, 1843) [adult]→Acalymma blomorum Munroe and Smith [adult]	1.286E-05	5.46E-06	3.42E-11	9.33E-05	3.7E-07	9.9E-11	0.002799	I	[96]
2	T	Canis latrans Say, 1823 [adult]→Lepus americanus Erxleben, 1777 [adult]	10	1.5	1.2E-06	1.6E-05	0.07492	9.1E-06	0.000226	II/III	[97]
2	T	Lynx canadensis Kerr, 1792 [adult]→Lepus americanus Erxleben, 1777 [adult]	11	1.5	1.64E-06	1.59E-05	0.10296	4.8E-06	0.000187	II/III	[97]
2	M	Crangon crangon (Linnaeus, 1758) [adult]→Pleuronectes platessa DO [juvenile]	0.0003203	1.86E-05	7.03E-11	3.73E-05	1.9E-06	3.9E-09	0.001193	II/III	[98]
2	M	Crangon crangon (Linnaeus, 1758) [subadult]→Macoma balthica (Linnaeus, 1758) [juvenile]	7.185E-05	5.11E-08	5.46E-11	0.000488	1.1E-07	3.3E-09	0.050614	I	[99]
2	M	Sepia officinalis Linnaeus 1758 [juvenile]→Mesopodopsis slabberi, Van Beneden, 1861 [adult]	8.186E-05	3.20E-06	7.47E-11	0.001429	5.2E-08	4.9E-10	0.005714	II/III	[100]
2	F	Salmo trutta L. [juvenile]→Gammarus sp. (dead) [adult]	0.0049951	7.62E-06	8.57E-07	3.81E-05	0.02248	3.8E-06	0.000152	II/III	[101]
2	F	Salmo trutta L. [juvenile]→Gammarus sp. (dead) [adult]	0.017643	7.62E-06	1.92E-06	3.81E-05	0.05047	8.2E-06	0.00061	II/III	[101]

D	H	Consumer→Resource	ConSize	ResSize	ConsRate (S)	ResDen (S)	SRate (S)	ConsRate (A)	ResDen (A)	FR	Ref
2	F	Salmo trutta L. [juvenile]→Gammarus sp. (dead) [adult]	0.05823	7.62E-06	2.4E-06	3.81E-05	0.06297	1.3E-05	0.00061	II/III	[101]
2	F	Salmo trutta L. [juvenile]→Musca domestica Linnaeus, 1758 [adult] (dead) [adult]	0.0049951	8.11E-05	1.07E-05	0.000406	0.02635	3.6E-05	0.006491	II/III	[101]
2	F	Salmo trutta L. [juvenile]→Musca domestica Linnaeus, 1758 [adult] (dead) [adult]	0.017643	8.11E-05	2.87E-05	0.000406	0.07081	9.3E-05	0.006491	II/III	[101]
2	F	Salmo trutta L. [juvenile]→Musca domestica Linnaeus, 1758 [adult] (dead) [adult]	0.05823	8.11E-05	3.3E-05	0.000406	0.08129	0.00013	0.006491	II/III	[101]
2	F	Orconectes propinquus [adult]→Salvelinus namaycush [egg]	9.324E-05	4.77E-05	2.5E-10	0.002982	8.4E-08	2.2E-09	0.149103	II/III	[102]
2	F	Neogobius melanostomus [adult]→Salvelinus namaycush [egg]	0.0015001	4.77E-05	7.54E-10	0.002982	2.5E-07	5.2E-09	0.149103	II/III	[102]
2	F	Cottus cognatus [adult]→Salvelinus namaycush [egg]	0.0064662	4.77E-05	1.82E-10	0.002982	6.1E-08	5E-09	0.298206	I	[102]
2	M	Melanitta fusca [adult]→Macoma balthica (Linnaeus, 1758) [adult]	1.8	7.42E-03	0.000194	0.371105	0.00052	0.00074	11.87536	II/III	[103]
2	M	Aythya affinis (Eyton, 1838) [adult]→Potamogeton pectinatus [tuber]	0.826	0.00024	1.41E-05	0.058833	0.00024	9.9E-05	0.94132	I	[104]
2	F	Aythya valisineria [Vallisneria americana]→Vallisneria americana [bud]	1.225	3.00E-04	1.2E-05	0.001147	0.01045	0.0001	0.051708	II/III	[105]

Appendix 5.2

Dataset for reaction distance for testing effects of dimensionality (Chapter 5). Data are listed by interaction dimensionality (**D**), alphabetically by habitat (**H**; F: freshwater, M: marine, T: terrestrial), and then species pair (**Consumer→Resource**) (including life stage and sex when known). **ConSize** is fresh mass of consumer (kg); **ResSize** is fresh mass of resrouce (kg); **RDist** is reaction distance (m); and **Ref** is code for the original study (see Appendix 5.4).

D	H	Consumer→Resource	ConSize	ResSize	RDist	Ref
3	F	Gymnocephalus cernuus [adult]→Chaoborus obscuripes [juvenile]	0.0138	1.55E-05	0.04	[8]
3	F	Lepomis macrochirus [adult]→Daphnia pulex [adult]	0.00416	2.63E-08	0.093	[106]
3	F	Micropterus salmoides [adult]→Danio rerio [juvenile]	0.01613	1.98E-05	0.141	[107]
3	F	Micropterus salmoides [adult]→Lepomis macrochirus [adult]	0.51109	0.001309	1.219	[108]
3	F	Micropterus salmoides [adult]→Lythrurus umbratilis [adult]	0.51109	0.00068	1.163	[108]
3	F	Perca fluviatilis [adult]→Chaoborus obscuripes [juvenile]	0.0169	1.55E-05	0.21	[8]
3	F	Salvelinus fontinalis [adult]→Daphnia pulex [adult]	0.04843	6.9E-08	0.137	[109]
3	F	Salvelinus namaycush [adult]→Daphnia magna [adult]	0.05188	8.3E-08	0.122	[109]
3	F	Thymallus arcticus [adult]→Bosmina longirostris [adult]	0.00242	6.63E-09	0.027	[110]
3	F	Thymallus arcticus [adult]→Cyclops scutifer [adult]	0.00381	6.77E-09	0.042	[110]
3	F	Thymallus arcticus [adult]→Daphnia longiremis [adult]	0.00205	1.77E-08	0.049	[110]
3	F	Thymallus arcticus [adult]→Daphnia pulex [adult]	0.00643	3.05E-08	0.083	[110]
3	F	Thymallus arcticus [adult]→Heterocope septentrionalis [adult]	0.00329	5.02E-08	0.082	[110]
3	F	Chaoborus obscuripes [Fourth-instar]→Eudiaptomus gracilis Sars [adult]	2.3E-05	1.83E-09	0.003	[111]
3	F	Notonecta maculata [5th instar]→Daphnia magna [juvenile]	0.00011	1.74E-07	0.017	[2]
3	F	Aeshna juncea (L.) [penultimate-final instar]→Chaoborus flavicans (Meig.) [larva]	0.00191	2.06E-05	0.06	[112]
3	F	Salvelinus namaycush [adult]→Oncorhynchus mykiss [juvenile]	1.09219	0.013621	0.95	[113]
3	F	Oncorhynchus clarki utah [adult]→Oncorhynchus mykiss [juvenile]	1.10583	0.013621	0.58	[113]
3	F	Oncorhynchus mykiss [adult]→Oncorhynchus mykiss [juvenile]	0.97084	0.013621	0.55	[113]
3	M	Gobiusculus flavescens (Fabricius) [adult]→Calanus finmarchicus [adult]	0.00366	3.95E-07	0.105	[114]
2	F	Gasterosteus aculeatus [adult]→Tubifex spp. [adult]	0.00277	8.6E-06	0.256	[115]
2	F	Oncorhynchus mykiss [adult]→Crangonyx richmondensis [adult]	0.03757	1.34E-06	0.255	[116]
2	T	Homo sapiens [adult]→Holbrookia propinqua [adult]	80	0.005378	2.143	[117]
2	T	Homo sapiens [adult]→Norops lineatopus [adult]	80	0.0035	1.122	[118]
2	T	Homo sapiens [adult]→Sceloporus anahuacus [adult]	80	0.002666	2.24	[119]
2	T	Homo sapiens [adult]→Sceloporus gadoviae [adult]	80	0.004147	2.313	[119]
2	T	Homo sapiens [adult]→Sceloporus mucronatus [adult]	80	0.011293	5.539	[119]
2	T	Homo sapiens [adult]→Scincella lateralis [adult]	80	0.0015	1.312	[120]
2	T	Homo sapiens [adult]→Urosaurus bicarinatus [adult]	80	0.002579	1.315	[119]
2	T	Lycaon pictus [adult]→Connochaetes gnou [juvenile]	26.75	200	460	[121]
2	T	Lycaon pictus [adult]→Gazella thomsonii [adult]	26.75	30	250	[121]
2	T	Psammodromus algirus [adult]→Calliphora spp. [adult]	0.0099	1.57E-05	0.22	[122]
2	T	Phormictopus cancerides (Latreille, 1806) [juvenile]→Acheta domestica L. [adult]	0.001	0.000335	0.043	[123]
2	T	Canis lupus familiaris [adult]→Gopherus agassizii [adult]	45.5	5.443108	13.91	[124]
2	T	Euroleon nostras (Geoffroy in Fourcroy) [3rd instar]→Tenebrio molitor L. [adult]	4.8E-05	0.000153	0.1	[125]
2	T	Myotis dasycneme [adult]→Tenebrio molitor L. [juvenile]	0.015	9.09E-05	1.1	[126]
2	T	Mephitis mephitis [adult]→Gallus gallus domesticus [egg]	3.185	0.22	20	[127]
2	T	Pardosa vancouveri Emerton [adult]→Drosophila melanogaster Meigen, 1830 [adult]	7.6E-06	6.94E-07	0.015	[49]
2	T	Fringilla coelebs Linnaeus, 1758 [adult]→Brassica napus L. [seed]	0.024	2.7E-06	0.136	[89]

Appendix 5.3

Dataset for handling time for testing effects of dimensionality (Chapter 5). Data are listed by interaction dimensionality (**D**), alphabetically by habitat (**H**; F: freshwater, M: marine, T: terrestrial), and then species pair (**Consumer→Resource**) (including life stage and sex when known). **ConSize** is fresh mass of consumer (kg); **ResSize** is fresh mass of resource (kg); **HTime** is handling time (s) (all handling times are temperature corrected, see Section 5.2.3); and **Ref** is code for the original study (see Appendix 5.4).

D	H	Consumer→Resource	ConSize	ResSize	HTime	Ref
3	T	Myotis lucifugus (LeConte, 1831) [adult]→Tenebrio molitor L. [juvenile]	0.00726	8.2E-05	15.02	[128]
3	T	Myotis lucifugus (LeConte, 1831) [Subadult]→Tenebrio molitor L. [juvenile]	0.00612	8.2E-05	24.246	[128]
3	T	Zygiella x-notata (Clerck) [adult]→Gryllus campestris [juvenile]	2.9E-05	1.6E-05	389.42	[129]
3	T	Zygiella x-notata (Clerck) [adult] →Musca domestica [adult]	2.9E-05	1.5E-05	210.52	[129]
3	T	Eptesicus fuscus (Beauvois, 1796) [adult]→Tenebrio molitor L. [juvenile]	0.0159	0.00017	3.6348	[128]
3	T	Eptesicus fuscus (Beauvois, 1796) [Subadult]→Tenebrio molitor L. [juvenile]	0.0133	0.00017	5.2161	[128]
3	F	Perca fluviatilis [adult]→Chaoborus obscuripes [juvenile]	0.0169	2E-05	1.1101	[8]
3	F	Notonecta hoffmani [adult]→Culex pipiens [juvenile]	0.00016	9.4E-06	230.03	[130]
3	F	Diacyclops bicuspidatus [adult] →Panagrolaimus sp. [adult]	3.1E-08	3E-10	111.46	[131]
3	F	Notonecta maculata [5th instar]→Daphnia magna [juvenile]	0.00011	1.7E-07	5.7748	[2]
3	F	Diplonychus indicus Venk. & Rao [adult]→Culex fatigans [4th instar]	0.00017	4.2E-06	70.167	[132]
3	F	Mesocyclops sp. [adult]→Bosminopsis deitersi	7.5E-08	4.1E-09	255.95	[133]
3	F	Mesocyclops sp. [adult]→Bosmina longirostris	7.5E-08	3E-09	115.18	[133]
3	F	Mesocyclops sp. [adult] →Scapholeberis mucronata	7.5E-08	2.6E-09	319.93	[133]
3	F	Perca fluviatilis L. [juvenile]→Daphnia magna	0.0002	6.2E-07	13.437	[134]
3	F	Aeshna juncea (L.) [juvenile]→Daphnia magna [adult]	0.00166	1.4E-06	36.653	[135]
3	F	Micropterus salmoides [juvenile]→Rana catesbeiana [juvenile]	0.30062	0.00586	4.5902	[136]
3	F	Stizostedion lucioperca (L.) [adult] →Rutilus rutilus (L.) [adult]	0.01357	0.00058	100.19	[137]
3	F	Poeciliopsis sp. [adult]→Artemia salina [adult]	0.0003	1.6E-07	1.2174	[138]
3	F	Poeciliopsis sp. [adult]→Daphnia magna [adult]	0.0003	9.1E-08	1.5415	[138]
3	F	Gasterosteus aculeatus L. [adult]→Asellus aquaticus [adult]	0.00074	1.1E-05	32.061	[139]
3	F	Perca fluviatilis L. [juvenile]→Daphnia magna [juvenile]	0.0002	1.3E-07	0.9598	[134]
3	F	Aeshna juncea (L.) [juvenile]→Daphnia magna [juvenile]	0.00166	1.7E-07	9.3217	[135]
3	F	Salvelinus alpinus (L.) [juvenile]→Daphnia longispina [adult]	0.008	3.7E-07	1.4488	[1]
3	F	Rana tigrina (Daud) [juvenile] →Culex fatigans [3rd instar]	0.0008	1.2E-06	0.8312	[140]
3	F	Micropterus salmoides [juvenile] →Lepomis macrochirus [adult]	0.30062	0.01316	64.474	[136]
3	F	Micropterus salmoides [juvenile] →Perca flavescens [juvenile]	0.30062	0.00943	27.143	[136]
2	T	Cicindela hybrida [adult] →Formicidae spp. [adult]	0.00035	7E-06	102.33	[141]
2	T	Zootoca vivipara [adult]→Acheta domesticus [juvenile]	0.004	3.8E-05	72.776	[142]
2	T	Neomys anomalus Cabrera 1907 [adult] →Tenebrio molitor L. [juvenile]	0.01	0.00012	4.7159	[143]
2	T	Sorex araneus Linnaeus, 1758 [adult] →Tenebrio molitor L. [juvenile]	0.008	0.00012	5.2156	[143]
2	T	Sorex minutus Linnaeus, 1766 [adult] →Tenebrio molitor L. [juvenile]	0.003	0.00012	8.9945	[143]
2	T	Ephippiorhynchus asiaticus [adult] →Heteropnestus fossilis [adult]	4.1	0.00951	2.0448	[144]
2	T	Ardea alba [adult]→Ictalurus punctatus [juvenile]	0.9	0.0049	10.398	[145]
2	T	Varanus albigularis [adult]→Helix sp. [adult]	1.525	0.0111	5.2029	[146]
2	T	Psammodromus algirus [adult] →Calliphora spp. [adult]	0.0099	1.6E-05	24.934	[122]
2	T	Podarcis melisellensis (Braun 1877) [adult] →Acheta domestica L. [juvenile]	0.06882	3.2E-05	5.7824	[147]
2	T	Lacerta oxycephala Dumeril & Bibron 1839 [adult] →Acheta domestica L. [juvenile]	0.06998	3.2E-05	7.6227	[147]
2	T	Lacerta oxycephala Dumeril & Bibron 1839 [adult] →Acheta domestica L. [adult]	0.06998	0.00032	72.797	[147]
2	T	Psammodromus algirus [adult]→Calliphora spp. [adult]	0.0099	1.6E-05	30.078	[122]
2	T	Eumeces laticeps [adult]→Acheta domestica L.	0.08	0.00016	3.8219	[148]
2	T	Chrysomya albiceps [Third instar larva]→Chrysomya megacephala [2nd instar]	8.2E-05	2.8E-05	174.55	[48]
2	T	Pergamasus crassipes (Linnaeus, 1758) [adult]→Onychiurus armatus (Tullberg) [adult]	3.1E-07	3.1E-07	569.18	[55]
2	T	Podarcis melisellensis (Braun 1877) [adult] →Acheta domestica L. [adult]	0.06882	0.00032	57.824	[147]
2	T	Geocoris bullatus [adult] C→Lygus spp. [juvenile]	7.3E-07	1.6E-07	1007.8	[149]
2	T	Cicindela hybrida [adult]→Collembola spp. [adult]	0.00035	1.8E-07	353.49	[141]
2	T	Parus major [adult]→Zygiella x-notata [adult]	0.018	2.8E-06	107.1	[150]
2	T	Haematopus ostralegus Linnaeus, 1758→Scrobicularia plana Da Costa, 1778	0.46	0.00034	207.74	[60]

D	H	Consumer→Resource	ConSize	ResSize	HTime	Ref
2	T	Ammodramus savannarum [adult]→Ageneotettix deorum [adult]	0.0138	0.0002	2.4869	[151]
2	T	Aphidius colemani Viereck [adult]→Aphis gossypii Glover [3rd instar]	6.7E-07	6.1E-08	2598.4	[152]
2	T	Aphidius matricariae (Haliday)→Aphis gossypii Glover [3rd instar]	5.7E-07	6.1E-08	1990.2	[152]
2	T	Zelus longipes L. [adult]→Spodoptera frugiperda (J. E. Smith) [larva]	6.3E-05	0.00013	4987.3	[153]
2	T	Pardosa vancouveri Emerton [adult]→Drosophila melanogaster Meigen, 1830 [adult]	7.6E-06	6.9E-07	12038	[49]
2	T	Neomys fodiens (Pennant, 1771) [adult] →Tenebrio molitor L. [juvenile]	0.0144	0.00012	3.7009	[143]
2	M	Crangon septemspinosa [adult] →Pseudopleuronectes americanus [juvenile]	0.00151	1.4E-05	3326.9	[40]
2	F	Gymnocephalus cernuus [adult]→Chaoborus obscuripes [juvenile]	0.0138	2E-05	3.5718	[8]
2	F	Rhyacophila dorsalis [4-5th instar] →Chironomus sp. [juvenile]	1.7E-05	2.7E-06	252.69	[46]
2	F	Perca fluviatilis [juvenile]→Leucorrhinia dubia [juvenile]	0.10989	0.00024	16.799	[154]
2	F	Dytiscus circumcinctus [2-3rd instar]→Limnephilus nigriceps (Zett.)	0.00031	1.1E-05	1063.8	[155]
2	F	Dytiscus circumcinctus [instar 2-3] →Limnephilus borealis (Zett.)	0.00031	5.1E-05	2322.7	[155]
2	F	Dytiscus latissimus L. [instar 2-3] →Limnephilus rhombicus (L.)	0.00031	3.4E-05	1662.1	[155]
2	F	Micropterus salmoides [juvenile] →Crayfish [adult]	0.30062	0.00603	64.474	[136]
2	F	Herichthys minckleyi [adult]→Cylisticus sp. [adult]	0.00609	2.4E-05	8.2515	[156]
2	F	Salmo trutta L. [juvenile]→Potamophylax cingulatus (Steph.) [larva]	0.07814	0.00012	104.76	[157]
2	F	Cottus gobio L. [adult] (Sculpin)→Glyphotaelius pellucidus (Retz.) [larva]	0.02927	0.00014	207.53	[157]
2	F	Cottus gobio L. [adult] →Limnephilus rhombicus (L.) [larva]	0.02927	0.00007	191.34	[157]
2	M	Callinectes sapidus [adult]→Crassostrea virginica [juvenile]	0.13005	0.00946	476.1	[45]
2	M	Carcinus maenas [adult]→Mytilus edulis [adult]	0.18946	0.00094	372.56	[158]
2	M	Nucella lapillus [adult]→Mytilus edulis [adult]	0.01112	0.0008	236356	[159]
2	F	Salmo trutta L. [juvenile]→Glyphotaelius pellucidus (Retz.) [larva]	0.07814	0.00015	121.85	[157]
2	F	Salmo trutta L. [juvenile]→Limnephilus pantodapus McLachl. [larva]	0.07814	0.0001	167.62	[157]
2	F	Salmo trutta L. [juvenile]→Limnephilus rhombicus (L.) [larva]	0.07814	0.00009	135.51	[157]
2	F	Dytiscus latissimus L. [instar 2-3] →Limnephilus nigriceps (Zett.)	0.00031	1.2E-05	1014.2	[155]
2	F	Dytiscus latissimus L. [instar 2-3] →Limnephilus borealis (Zett.)	0.00031	4.6E-05	1918.6	[155]
2	F	Dytiscus circumcinctus [instar 2-3] →Limnephilus rhombicus (L.)	0.00031	4.1E-05	1919.6	[155]
2	M	Phoca vitulina [adult]→Ammodytes dubius [adult]	108.6	0.02176	0.3466	[160]
2	M	Phoca vitulina [adult]→Flounder	108.6	0.22931	4.7657	[160]
2	M	Carcinus maenas [adult]→Cerastoderma edule [adult]	0.08398	0.00603	166.4	[161]

Appendix 5.4

List of references used for testing effects of dimensionality (Chapter 5). The reference number corresponds to the field **Ref** in the appropriate table (i.e, search and consumption rate (Appendix 5.1), reaction distance (Appendix 5.2), and handling time (Appendix 5.3)).

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Appendix 5.5

Consumer-resource species pairs from seven communities used to test effects of dimensionality (Chapter 5). Data are listed by interaction dimensionality (**D**), alphabetically by community (**Com**), and then by consumer-resource name (**Consumer → Resource)**. The communities are, BS: Broadstone stream (a spring-fed acidic headwater stream in Sussex, UK) (Brose *et al.* 2005; Woodward *et al.* 2005b), ES: Eastern Weddell Sea (an Antarctic Shelf ecosystem) (Brose *et al.* 2005), GM: Grand Cariçaie marsh (a marsh dominated by *Cladietum marisci*, Lake Neuchâtel, Switzerland) (Cattin *et al.* 2004; Brose *et al.* 2005), SB: Scotch Broom (a community on the Scotch Broom *Cytisis scoparius* in Berkshire, UK (Memmott *et al.* 2000; Brose *et al.* 2005; Cohen *et al.* 2005), SP: Skipwith pond (a large acidic pond in North Yorkshire, UK) (Warren 1989; Brose *et al.* 2005), TL: Tuesday lake (a small, mildly acidic lake in Michigan, USA) (Cohen *et al.* 2003; Brose *et al.* 2005; Jonsson *et al.* 2005), and UG: UK grasslands (communities from grasslands in England and Wales) (Bailey 1986; Dawah *et al.* 1995; Brose *et al.* 2005). **ConSize** is fresh mass of consumer (kg), and **ResSize** is fresh mass of resource (kg). Note that this classification shows that most consumers show a preferred foraging dimension, that is, most of the resource species of a given consumer live either in 2*D* or 3*D*. The four interactions used to illustrate differences in population cycling in 2*D* vs. 3*D* interactions in Figure 5.7 (main text) are shown in **bold** and flagged with numbers corresponding to those shown in Figure 5.7.

D	Com	Consumer → Resource	ConSize	ResSize
2	BS	Cordulegaster boltonii → Adicella reducta	9.730E-06	5.080E-07
2	BS	Cordulegaster boltonii → Asellus meridianus	9.730E-06	8.670E-07
2	BS	Cordulegaster boltonii → Brillia modesta	9.730E-06	1.310E-08
2	BS	Cordulegaster boltonii → Corynoneura lobata	9.730E-06	3.540E-09
2	BS	Cordulegaster boltonii → Dicranota sp	9.730E-06	4.750E-07
2	BS	Cordulegaster boltonii → Diptera spp	9.730E-06	4.220E-07
2	BS	Cordulegaster boltonii → Helodidae sp	9.730E-06	1.830E-06
2	BS	Cordulegaster boltonii → Heterotrissocladius marcidus	9.730E-06	5.710E-09
2	BS	Cordulegaster boltonii → Leuctra hippopus	9.730E-06	2.150E-07
2	BS	Cordulegaster boltonii → Leuctra nigra	9.730E-06	4.170E-08
2	BS	Cordulegaster boltonii → Macropelopia nebulosa	9.730E-06	1.570E-07
2	BS	Cordulegaster boltonii → Micropsectra bidentata	9.730E-06	3.800E-09
2	BS	Cordulegaster boltonii → Nemurella pictetii	9.730E-06	1.020E-07
2	BS	Cordulegaster boltonii → Oligochaete spp.	9.730E-06	6.080E-07
2	BS	Cordulegaster boltonii → Paraleptophlebia submarginata	9.730E-06	2.430E-08
2	BS	Cordulegaster boltonii → Pedicia sp	9.730E-06	6.810E-06
2	BS	Cordulegaster boltonii → Plectrocnemia conspersa	9.730E-06	7.400E-07
2	BS	Cordulegaster boltonii → Polypedilum albicorne	9.730E-06	5.090E-09
2	BS	Cordulegaster boltonii → Potamophylax cinguilatus	9.730E-06	4.080E-06
2	BS	Cordulegaster boltonii → Prodiames olivacea	9.730E-06	1.730E-07
2	BS	Cordulegaster boltonii → Sialis fuliginosa	9.730E-06	2.760E-06
2	BS	Cordulegaster boltonii → Simulium sp	9.730E-06	4.740E-08
2	BS	Cordulegaster boltonii → Siphonoperla torrentium	9.730E-06	3.260E-07
2	BS	Cordulegaster boltonii → Tipulidae spp	9.730E-06	9.490E-08
2	BS	Cordulegaster boltonii → Trissopelopia longimana	9.730E-06	3.550E-08
2	BS	Cordulegaster boltonii → Zavrelimyia barbatipes	9.730E-06	8.630E-09
2	BS	Dicranota sp → Brillia modesta	4.750E-07	1.310E-08
2	BS	Dicranota sp → Heterotrissocladius marcidus	4.750E-07	5.710E-09
2	BS	Dicranota sp → Leuctra nigra	4.750E-07	4.170E-08
2	BS	Dicranota sp → Macropelopia nebulosa	4.750E-07	1.570E-07
2	BS	Dicranota sp → Micropsectra bidentata	4.750E-07	3.800E-09
2	BS	Dicranota sp → Polypedilum albicorne	4.750E-07	5.090E-09
2	BS	Dicranota sp → Prodiames olivacea	4.750E-07	1.730E-07
2	BS	Dicranota sp → Trissopelopia longimana	4.750E-07	3.550E-08
2	BS	Dicranota sp → Zavrelimyia barbatipes	4.750E-07	8.630E-09
2	BS	Macropelopia nebulosa → Brillia modesta	1.570E-07	1.310E-08
2	BS	Macropelopia nebulosa → Corynoneura lobata	1.570E-07	3.540E-09

D	Com	Consumer → Resource	ConSize	ResSize
2	BS	Macropelopia nebulosa → Heterotrissocladius marcidus	1.570E-07	5.710E-09
2	BS	Macropelopia nebulosa → Leuctra hippopus	1.570E-07	2.150E-07
2	BS	Macropelopia nebulosa → Leuctra nigra	1.570E-07	4.170E-08
2	BS	Macropelopia nebulosa → Micropsectra bidentata	1.570E-07	3.800E-09
2	BS	Macropelopia nebulosa → Nemurella pictetii	1.570E-07	1.020E-07
2	BS	Macropelopia nebulosa → Oligochaete spp.	1.570E-07	6.080E-07
2	BS	Macropelopia nebulosa → Polypedilum albicorne	1.570E-07	5.090E-09
2	BS	Macropelopia nebulosa → Potamophylax cinguilatus	1.570E-07	4.080E-06
2	BS	Macropelopia nebulosa → Prodiames olivacea	1.570E-07	1.730E-07
2	BS	Macropelopia nebulosa → Simulium sp	1.570E-07	4.740E-08
2	BS	Macropelopia nebulosa → Tipulidae spp	1.570E-07	9.490E-08
2	BS	Macropelopia nebulosa → Trissopelopia longimana	1.570E-07	3.550E-08
2	BS	Macropelopia nebulosa → Zavrelimyia barbatipes	1.570E-07	8.630E-09
2	BS	Pedicia sp → Brillia modesta	6.810E-06	1.310E-08
2	BS	Pedicia sp → Heterotrissocladius marcidus	6.810E-06	5.710E-09
2	BS	Pedicia sp → Leuctra nigra	6.810E-06	4.170E-08
2	BS	Pedicia sp → Micropsectra bidentata	6.810E-06	3.800E-09
2	BS	Pedicia sp → Nemurella pictetii	6.810E-06	1.020E-07
2	BS	Pedicia sp → Polypedilum albicorne	6.810E-06	5.090E-09
2	BS	Pedicia sp → Prodiames olivacea	6.810E-06	1.730E-07
2	BS	Pedicia sp → Sialis fuliginosa	6.810E-06	2.760E-06
2	BS	Pedicia sp → Trissopelopia longimana	6.810E-06	3.550E-08
2	BS	Plectrocnemia conspersa → Brillia modesta	7.400E-07	1.310E-08
2	BS	Plectrocnemia conspersa → Corynoneura lobata	7.400E-07	3.540E-09
2	BS	Plectrocnemia conspersa → Dicranota sp	7.400E-07	4.750E-07
2	BS	Plectrocnemia conspersa → Heterotrissocladius marcidus	7.400E-07	5.710E-09
2	BS	Plectrocnemia conspersa → Leuctra hippopus	7.400E-07	2.150E-07
2	BS	Plectrocnemia conspersa → Leuctra nigra	7.400E-07	4.170E-08
2	BS	Plectrocnemia conspersa → Macropelopia nebulosa	7.400E-07	1.570E-07
2	BS	Plectrocnemia conspersa → Micropsectra bidentata	7.400E-07	3.800E-09
2	BS	Plectrocnemia conspersa → Nemurella pictetii	7.400E-07	1.020E-07
2	BS	Plectrocnemia conspersa → Niphargus aquilex	7.400E-07	3.800E-07
2	BS	Plectrocnemia conspersa → Oligochaete spp.	7.400E-07	6.080E-07
2	BS	Plectrocnemia conspersa → Paraleptophlebia submarginata	7.400E-07	2.430E-08
2	BS	Plectrocnemia conspersa → Pedicia sp	7.400E-07	6.810E-06
2	BS	Plectrocnemia conspersa → Polypedilum albicorne	7.400E-07	5.090E-09
2	BS	Plectrocnemia conspersa → Potamophylax cinguilatus	7.400E-07	4.080E-06
2	BS	Plectrocnemia conspersa → Prodiames olivacea	7.400E-07	1.730E-07
2	BS	Plectrocnemia conspersa → Simulium sp	7.400E-07	4.740E-08
2	BS	Plectrocnemia conspersa → Siphonoperla torrentium	7.400E-07	3.260E-07
2	BS	Plectrocnemia conspersa → Tipulidae spp	7.400E-07	9.490E-08
2	BS	Plectrocnemia conspersa → Trissopelopia longimana	7.400E-07	3.550E-08
2	BS	Plectrocnemia conspersa → Zavrelimyia barbatipes	7.400E-07	8.630E-09
2	BS	Sialis fuliginosa → Brillia modesta	2.760E-06	1.310E-08
2	BS	Sialis fuliginosa → Corynoneura lobata	2.760E-06	3.540E-09
2	BS	Sialis fuliginosa → Dicranota sp	2.760E-06	4.750E-07
2	BS	Sialis fuliginosa → Helodidae sp	2.760E-06	1.830E-06
2	BS	Sialis fuliginosa → Heterotrissocladius marcidus	2.760E-06	5.710E-09
2	BS	Sialis fuliginosa → Leuctra hippopus	2.760E-06	2.150E-07
2	BS	Sialis fuliginosa → Leuctra nigra	2.760E-06	4.170E-08
2	BS	Sialis fuliginosa → Macropelopia nebulosa	2.760E-06	1.570E-07
2	BS	Sialis fuliginosa → Micropsectra bidentata	2.760E-06	3.800E-09
2	BS	Sialis fuliginosa → Nemurella pictetii	2.760E-06	1.020E-07
2	BS	Sialis fuliginosa → Niphargus aquilex	2.760E-06	3.800E-07
2	BS	Sialis fuliginosa → Oligochaete spp.	2.760E-06	6.080E-07
2	BS	Sialis fuliginosa → Plectrocnemia conspersa	2.760E-06	7.400E-07
2	BS	Sialis fuliginosa → Polypedilum albicorne	2.760E-06	5.090E-09
2	BS	Sialis fuliginosa → Potamophylax cinguilatus	2.760E-06	4.080E-06
2	BS	Sialis fuliginosa → Prodiames olivacea	2.760E-06	1.730E-07
2	BS	Sialis fuliginosa → Simulium sp	2.760E-06	4.740E-08

D	Com	Consumer → Resource	ConSize	ResSize
2	BS	Sialis fuliginosa → Siphonoperla torrentium	2.760E-06	3.260E-07
2	BS	Sialis fuliginosa → Tipulidae spp	2.760E-06	9.490E-08
2	BS	Sialis fuliginosa → Trissopelopia longimana	2.760E-06	3.550E-08
2	BS	Sialis fuliginosa → Zavrelimyia barbatipes	2.760E-06	8.630E-09
2	BS	Siphonoperla torrentium → Corynoneura lobata	3.260E-07	3.540E-09
2	BS	Siphonoperla torrentium → Heterotrissocladius marcidus	3.260E-07	5.710E-09
2	BS	Siphonoperla torrentium → Leuctra hippopus	3.260E-07	2.150E-07
2	BS	Siphonoperla torrentium → Leuctra nigra	3.260E-07	4.170E-08
2	BS	Siphonoperla torrentium → Macropelopia nebulosa	3.260E-07	1.570E-07
2	BS	Siphonoperla torrentium → Micropsectra bidentata	3.260E-07	3.800E-09
2	BS	Siphonoperla torrentium → Nemurella pictetii	3.260E-07	1.020E-07
2	BS	Siphonoperla torrentium → Oligochaete spp.	3.260E-07	6.080E-07
2	BS	Siphonoperla torrentium → Polypedilum albicorne	3.260E-07	5.090E-09
2	BS	Siphonoperla torrentium → Prodiames olivacea	3.260E-07	1.730E-07
2	BS	Siphonoperla torrentium → Simulium sp	3.260E-07	4.740E-08
2	BS	Siphonoperla torrentium → Trissopelopia longimana	3.260E-07	3.550E-08
2	BS	Siphonoperla torrentium → Zavrelimyia barbatipes	3.260E-07	8.630E-09
2	BS	Trissopelopia longimana → Brillia modesta	3.550E-08	1.310E-08
2	BS	Trissopelopia longimana → Corynoneura lobata	3.550E-08	3.540E-09
2	BS	Trissopelopia longimana → Helodidae sp	3.550E-08	1.830E-06
2	BS	Trissopelopia longimana → Heterotrissocladius marcidus	3.550E-08	5.710E-09
2	BS	Trissopelopia longimana → Leuctra hippopus	3.550E-08	2.150E-07
2	BS	Trissopelopia longimana → Leuctra nigra	3.550E-08	4.170E-08
2	BS	Trissopelopia longimana → Micropsectra bidentata	3.550E-08	3.800E-09
2	BS	Trissopelopia longimana → Nemurella pictetii	3.550E-08	1.020E-07
2	BS	Trissopelopia longimana → Niphargus aquilex	3.550E-08	3.800E-07
2	BS	Trissopelopia longimana → Oligochaete spp.	3.550E-08	6.080E-07
2	BS	Trissopelopia longimana → Polypedilum albicorne	3.550E-08	5.090E-09
2	BS	Trissopelopia longimana → Prodiames olivacea	3.550E-08	1.730E-07
2	BS	Trissopelopia longimana → Simulium sp	3.550E-08	4.740E-08
2	BS	Trissopelopia longimana → Zavrelimyia barbatipes	3.550E-08	8.630E-09
2	BS	Zavrelimyia barbatipes → Brillia modesta	8.630E-09	1.310E-08
2	**BS**	**Zavrelimyia barbatipes → Heterotrissocladius marcidus (1)**	**8.630E-09**	**5.710E-09**
2	BS	Zavrelimyia barbatipes → Leuctra nigra	8.630E-09	4.170E-08
2	BS	Zavrelimyia barbatipes → Micropsectra bidentata	8.630E-09	3.800E-09
2	BS	Zavrelimyia barbatipes → Nemurella pictetii	8.630E-09	1.020E-07
2	BS	Zavrelimyia barbatipes → Oligochaete spp.	8.630E-09	6.080E-07
2	BS	Zavrelimyia barbatipes → Paraleptophlebia submarginata	8.630E-09	2.430E-08
2	BS	Zavrelimyia barbatipes → Polypedilum albicorne	8.630E-09	5.090E-09
2	BS	Zavrelimyia barbatipes → Prodiames olivacea	8.630E-09	1.730E-07
2	BS	Zavrelimyia barbatipes → Simulium sp	8.630E-09	4.740E-08
2	ES	Abyssorchomene nodimanus → Holothuria	2.160E-05	2.316E-02
2	ES	Acodontaster conspicuus → Haliclona dancoi	3.102E-03	1.298E-01
2	ES	Acodontaster conspicuus → Homaxinella balfourensis	3.102E-03	6.107E-02
2	ES	Acodontaster conspicuus → Kirkpatrickia variolosa	3.102E-03	7.978E-01
2	ES	Acodontaster conspicuus → Mycale (Oxymycale) acerata	3.102E-03	2.581E-01
2	ES	Acodontaster conspicuus → Rossella racovitzae	3.102E-03	7.978E-01
2	ES	Acodontaster conspicuus → Scolymastra joubini	3.102E-03	8.800
2	ES	Acodontaster conspicuus → Tetilla leptoderma	3.102E-03	5.623E-01
2	ES	Amauropis rossiana → Cyclocardia astartoides	2.730E-04	9.150E-07
2	ES	Amauropis rossiana → Euphausia superba	2.730E-04	1.960E-04
2	ES	Amauropis rossiana → Philobrya sublaevis	2.730E-04	6.080E-05
2	ES	Amauropis rossiana → Trophon longistaffi	2.730E-04	7.610E-06
2	ES	Aporocidaris milleri → Foraminifera	2.606E-03	5.650E-10
2	ES	Artedidraco loennbergi → Copepoda	1.660E-02	1.810E-06
2	ES	Artedidraco loennbergi → Cumacea	1.660E-02	7.400E-06
2	ES	Artedidraco loennbergi → Tanaidacea	1.660E-02	1.470E-04
2	ES	Artedidraco orianae → Copepoda	9.548E-02	1.810E-06
2	ES	Artedidraco orianae → Cyllopus lucasii	9.548E-02	2.640E-05
2	ES	Artedidraco orianae → Epimeria macrodonta	9.548E-02	7.010E-05

D	Com	Consumer → Resource	ConSize	ResSize
2	ES	Artedidraco orianae → Epimeria robusta	9.548E-02	9.280E-05
2	ES	Artedidraco orianae → Eunoe spica	9.548E-02	9.540E-05
2	ES	Artedidraco orianae → Euphausiacea	9.548E-02	1.580E-05
2	ES	Artedidraco orianae → Gnathia calva	9.548E-02	3.160E-06
2	ES	Artedidraco orianae → Gnathia calva	9.548E-02	3.160E-06
2	ES	Artedidraco orianae → Iphimediella cyclogena	9.548E-02	5.070E-05
2	ES	Artedidraco orianae → Liljeborgia georgiana	9.548E-02	4.060E-05
2	ES	Artedidraco orianae → Natatolana obtusata	9.548E-02	5.050E-06
2	ES	Artedidraco orianae → Ostracods	9.548E-02	2.520E-07
2	ES	Artedidraco orianae → Pantopoda	9.548E-02	4.450E-04
2	ES	Artedidraco skottsbergi → Cumacea	3.731E-02	7.400E-06
2	ES	Artedidraco skottsbergi → Ostracods	3.731E-02	2.520E-07
2	ES	Astrochlamys bruneus → Euchaeta antarctica	1.673E-03	1.980E-06
2	ES	Astrochlamys bruneus → Zooplankton	1.673E-03	1.680E-07
2	ES	Astrotoma agassizii → Calanoides acutus	3.805E-03	1.490E-06
2	ES	Astrotoma agassizii → Calanus propinquus	3.805E-03	1.550E-06
2	ES	Astrotoma agassizii → Euchaeta antarctica	3.805E-03	1.980E-06
2	ES	Astrotoma agassizii → Eukrohnia hamata	3.805E-03	2.120E-05
2	ES	Astrotoma agassizii → Euphausiacea	3.805E-03	1.580E-05
2	ES	Astrotoma agassizii → Flagellate	3.805E-03	2.540E-11
2	ES	Astrotoma agassizii → Foraminifera	3.805E-03	5.650E-10
2	ES	Astrotoma agassizii → Holothuria	3.805E-03	2.316E-02
2	ES	Astrotoma agassizii → Ostracods	3.805E-03	2.520E-07
2	ES	Astrotoma agassizii → Silicioflagellates	3.805E-03	1.510E-10
2	ES	Astrotoma agassizii → Zooplankton	3.805E-03	1.680E-07
2	ES	Austrocidaris canaliculata → Foraminifera	9.810E-04	5.650E-10
2	ES	Austrodoris kerguelenensis → Calyx arcuarius	7.650E-02	6.107E-02
2	ES	Austrodoris kerguelenensis → Haliclona dancoi	7.650E-02	1.298E-01
2	ES	Austrodoris kerguelenensis → Haliclona tenella	7.650E-02	1.298E-01
2	ES	Austrodoris kerguelenensis → Isodyctia steifera	7.650E-02	1.298E-01
2	ES	Austrodoris kerguelenensis → Mycale (Oxymycale) acerata	7.650E-02	2.581E-01
2	ES	Austrodoris kerguelenensis → Polymastia invaginata	7.650E-02	2.329E-01
2	ES	Austrodoris kerguelenensis → Rossella nuda	7.650E-02	4.141
2	ES	Austrodoris kerguelenensis → Rossella racovitzae	7.650E-02	7.978E-01
2	ES	Austrodoris kerguelenensis → Scolymastra joubini	7.650E-02	8.800
2	ES	Austrodoris kerguelenensis → Tetilla leptoderma	7.650E-02	5.623E-01
2	ES	Baseodiscus antarcticus → Adamussium colbecki	5.840	1.255E-03
2	ES	Baseodiscus antarcticus → Homaxinella balfourensis	5.840	6.107E-02
2	ES	Bathydoris clavigera → Foraminifera	7.650E-02	5.650E-10
2	ES	Bathypanoploea schellenbergi → Holothuria	1.480E-04	2.316E-02
2	ES	Chorismus antarcticus → Flagellate	2.720E-04	2.540E-11
2	ES	Chorismus antarcticus → Zooplankton	2.720E-04	1.680E-07
2	ES	Ctenocidaris gigantea → Zooplankton	1.255E-02	1.680E-07
2	ES	Ctenocidaris gilberti → Foraminifera	1.255E-02	5.650E-10
2	ES	Ctenocidaris perrieri → Eunoe spica	1.177E-02	9.540E-05
2	ES	Ctenocidaris perrieri → Foraminifera	1.177E-02	5.650E-10
2	ES	Ctenocidaris spinosa → Foraminifera	2.920E-03	5.650E-10
2	ES	Ctenocidaris spinosa → Yoldiella eightsi	2.920E-03	5.900E-04
2	ES	Ctenocidaris spinosa → Zooplankton	2.920E-03	1.680E-07
2	ES	Cylichna sp. → Scaphopoda	1.350E-05	4.660E-05
2	ES	Dacodraco hunteri → Nototheniidae	3.325E-01	1.072
2	ES	Diplasterias brucei → Yoldiella eightsi	2.713E-03	5.900E-04
2	ES	Dolloidraco longidorsalis → Scaphopoda	1.316E-02	4.660E-05
2	ES	Edwardsia meridionalis → Tanaidacea	9.010E-04	1.470E-04
2	ES	Ekmocucumis steineni → Phytoplankton	8.088E-02	1.370E-09
2	ES	Ekmocucumis turqueti → Phytoplankton	4.803E-01	1.370E-09
2	ES	Epimeria georgiana → Holothuria	9.280E-05	2.316E-02
2	ES	Epimeria macrodonta → Holothuria	7.010E-05	2.316E-02
2	ES	Epimeria macrodonta → Ostracods	7.010E-05	2.520E-07
2	ES	Epimeria macrodonta → Pantopoda	7.010E-05	4.450E-04

D	Com	Consumer → Resource	ConSize	ResSize
2	ES	Epimeria robusta → Euphausiacea	9.280E-05	1.580E-05
2	ES	Epimeria robusta → Holothuria	9.280E-05	2.316E-02
2	ES	Epimeria robusta → Taeniogyrus contortus	9.280E-05	4.805E-03
2	ES	Epimeria robusta → Zooplankton	9.280E-05	1.680E-07
2	ES	Epimeria rubrieques → Clavularia frankliniana	3.000E-04	1.120E-05
2	ES	Epimeria rubrieques → Euphausiacea	3.000E-04	1.580E-05
2	ES	Epimeria rubrieques → Taeniogyrus contortus	3.000E-04	4.805E-03
2	ES	Epimeria similis → Foraminifera	1.480E-04	5.650E-10
2	ES	Epimeriella walkeri → Holothuria	4.720E-05	2.316E-02
2	ES	Eulagisca gigantea → Pantopoda	4.777E-03	4.450E-04
2	ES	Eunoe spica spicoides → Holothuria	1.620E-04	2.316E-02
2	ES	Eunoe spica spicoides → Pantopoda	1.620E-04	4.450E-04
2	ES	Eunoe spica → Holothuria	9.540E-05	2.316E-02
2	ES	Eunoe spica → Pantopoda	9.540E-05	4.450E-04
2	ES	Eurythenes gryllus → Eurythenes gryllus	9.320E-04	9.320E-04
2	ES	Eurythenes gryllus → Holothuria	9.320E-04	2.316E-02
2	ES	Fulmarus glacialoides → Cyllopus lucasii	1.423E+01	2.640E-05
2	ES	Fulmarus glacialoides → Electrona antarctica	1.423E+01	3.906E-02
2	ES	Fulmarus glacialoides → Euphausia superba	1.423E+01	1.960E-04
2	ES	Fulmarus glacialoides → Eurythenes gryllus	1.423E+01	9.320E-04
2	ES	Fulmarus glacialoides → Galitheutis glacialis	1.423E+01	1.250
2	ES	Fulmarus glacialoides → Gonatus antarcticus	1.423E+01	5.273E-01
2	ES	Fulmarus glacialoides → Gymnoscopelus braueri	1.423E+01	2.614E-02
2	ES	Fulmarus glacialoides → Gymnoscopelus opisthopterus	1.423E+01	3.569E-02
2	ES	Fulmarus glacialoides → Notocrangon antarcticus	1.423E+01	4.490E-04
2	ES	Fulmarus glacialoides → Notolepis coatsi	1.423E+01	3.145E-03
2	ES	Fulmarus glacialoides → Protomyctophum bolini	1.423E+01	5.581E-03
2	ES	Fulmarus glacialoides → Psychroteuthis glacialis	1.423E+01	4.666E-01
2	ES	Fulmarus glacialoides → Salpa thompsoni	1.423E+01	7.750E-05
2	ES	Fulmarus glacialoides → Vibillia antarctica	1.423E+01	9.390E-08
2	ES	Fulmarus glacialoides → Vibillia stebbingi	1.423E+01	9.390E-08
2	ES	Glyptonotus antarcticus → Euphausia superba	9.320E-04	1.960E-04
2	ES	Glyptonotus antarcticus → Glyptonotus antarcticus	9.320E-04	9.320E-04
2	ES	Glyptonotus antarcticus → Limacina helicina	9.320E-04	9.390E-08
2	ES	Halobaena caerulea → Cyllopus lucasii	2.259E-01	2.640E-05
2	ES	Halobaena caerulea → Electrona antarctica	2.259E-01	3.906E-02
2	ES	Halobaena caerulea → Euphausia frigida	2.259E-01	1.690E-05
2	ES	Halobaena caerulea → Euphausia superba	2.259E-01	1.960E-04
2	ES	Halobaena caerulea → Eurythenes gryllus	2.259E-01	9.320E-04
2	ES	Halobaena caerulea → Gymnoscopelus braueri	2.259E-01	2.614E-02
2	ES	Halobaena caerulea → Gymnoscopelus opisthopterus	2.259E-01	3.569E-02
2	ES	Halobaena caerulea → Notocrangon antarcticus	2.259E-01	4.490E-04
2	ES	Halobaena caerulea → Notolepis coatsi	2.259E-01	3.145E-03
2	ES	Halobaena caerulea → Protomyctophum bolini	2.259E-01	5.581E-03
2	ES	Halobaena caerulea → Pteropoda	2.259E-01	5.540E-05
2	ES	Halobaena caerulea → Salpa thompsoni	2.259E-01	7.750E-05
2	ES	Halobaena caerulea → Thysanoessa macrura	2.259E-01	1.580E-05
2	ES	Halobaena caerulea → Vibillia antarctica	2.259E-01	9.390E-08
2	ES	Halobaena caerulea → Vibillia stebbingi	2.259E-01	9.390E-08
2	ES	Harmothoe crosetensis → Holothuria	1.330E-04	2.316E-02
2	ES	Harmothoe spinosa → Holothuria	1.400E-04	2.316E-02
2	ES	Harmothoe spinosa → Pantopoda	1.400E-04	4.450E-04
2	ES	Iphimediella cyclogena → Holothuria	5.070E-05	2.316E-02
2	ES	Lineus longifissus → Adamussium colbecki	5.840	1.255E-03
2	ES	Lineus longifissus → Homaxinella balfourensis	5.840	6.107E-02
2	ES	Lophaster gaini → Adamussium colbecki	4.686E-03	1.255E-03
2	ES	Lophaster gaini → Yoldiella eightsi	4.686E-03	5.900E-04
2	**ES**	**Macronectes giganteus → Galitheutis glacialis (3)**	**4.734**	**1.250**
2	ES	Macronectes giganteus → Gonatus antarcticus	4.734	5.273E-01
2	ES	Macronectes giganteus → Kondakovia longimama	4.734	1.758E-01

D	Com	Consumer → Resource	ConSize	ResSize
2	ES	Macronectes giganteus → Nototheniidae	4.734	1.072
2	ES	Macronectes halli → Galitheutis glacialis	4.149	1.250
2	ES	Macronectes halli → Gonatus antarcticus	4.149	5.273E-01
2	ES	Macronectes halli → Kondakovia longimama	4.149	1.758E-01
2	ES	Macronectes halli → Martialia hyadesi	4.149	1.758E-01
2	ES	Macronectes halli → Nototheniidae	4.149	1.072
2	ES	Macronectes halli → Psychroteuthis glacialis	4.149	4.666E-01
2	ES	Macronectes halli → Vampryoteuthis	4.149	2.095E-03
2	ES	Macroptychaster accrescens → Odontaster validus	1.184E-02	6.640E-04
2	ES	Macroptychaster accrescens → Sterechinus neumayeri	1.184E-02	2.760E-03
2	ES	Marseniopsis mollis → Cnemidocarpa verrucosa	2.730E-04	1.606E-02
2	ES	Marseniopsis mollis → Yoldiella eightsi	2.730E-04	5.900E-04
2	ES	Melphidippa antarctica → Holothuria	3.460E-05	2.316E-02
2	ES	Neobuccinum eatoni → Adamussium colbecki	3.580E-03	1.255E-03
2	ES	Neobuccinum eatoni → Laternula elliptica	3.580E-03	1.299E-02
2	ES	Notaeolidia gigas → Clavularia frankliniana	8.341E-03	1.120E-05
2	ES	Notaeolidia gigas → Tubularia ralphii	8.341E-03	3.210E-06
2	ES	Notasterias armata → Adamussium colbecki	1.156E-03	1.255E-03
2	ES	Notasterias armata → Yoldiella eightsi	1.156E-03	5.900E-04
2	ES	Notocrangon antarcticus → Foraminifera	4.490E-04	5.650E-10
2	ES	Notocrangon antarcticus → Holothuria	4.490E-04	2.316E-02
2	ES	Notocrangon antarcticus → Yoldiella eightsi	4.490E-04	5.900E-04
2	ES	Oceanites oceanicus → Cyllopus lucasii	6.002E-01	2.640E-05
2	ES	Oceanites oceanicus → Electrona antarctica	6.002E-01	3.906E-02
2	ES	Oceanites oceanicus → Euphausia superba	6.002E-01	1.960E-04
2	ES	Oceanites oceanicus → Protomyctophum bolini	6.002E-01	5.581E-03
2	ES	Oceanites oceanicus → Salpa thompsoni	6.002E-01	7.750E-05
2	ES	Oceanites oceanicus → Vibillia antarctica	6.002E-01	9.390E-08
2	ES	Odontaster validus → Adamussium colbecki	6.640E-04	1.255E-03
2	ES	Odontaster validus → Glyptonotus antarcticus	6.640E-04	9.320E-04
2	ES	Odontaster validus → Homaxinella balfourensis	6.640E-04	6.107E-02
2	ES	Odontaster validus → Laternula elliptica	6.640E-04	1.299E-02
2	ES	Odontaster validus → Ostracods	6.640E-04	2.520E-07
2	ES	Odontaster validus → Rossella nuda	6.640E-04	4.141
2	ES	Odontaster validus → Rossella racovitzae	6.640E-04	7.978E-01
2	ES	Odontaster validus → Scolymastra joubini	6.640E-04	8.800
2	ES	Odontaster validus → Sterechinus neumayeri	6.640E-04	2.760E-03
2	ES	Odontaster validus → Tetilla leptoderma	6.640E-04	5.623E-01
2	ES	Odontaster validus → Yoldiella eightsi	6.640E-04	5.900E-04
2	ES	Ophiosparte gigas → Adamussium colbecki	6.370E-03	1.255E-03
2	ES	Ophiosparte gigas → Chorismus antarcticus	6.370E-03	2.720E-04
2	ES	Ophiosparte gigas → Eunoe spica	6.370E-03	9.540E-05
2	ES	Ophiosparte gigas → Euphausia crystallorophias	6.370E-03	6.590E-05
2	ES	Ophiosparte gigas → Euphausia superba	6.370E-03	1.960E-04
2	ES	Ophiosparte gigas → Foraminifera	6.370E-03	5.650E-10
2	ES	Ophiosparte gigas → Laternula elliptica	6.370E-03	1.299E-02
2	ES	Ophiosparte gigas → Odontaster validus	6.370E-03	6.640E-04
2	ES	Ophiosparte gigas → Ophiacantha	6.370E-03	1.010E-04
2	ES	Ophiosparte gigas → Ophiocten	6.370E-03	5.590E-04
2	ES	Ophiosparte gigas → Ophionotus victoriae	6.370E-03	1.914E-03
2	ES	Ophiosparte gigas → Ophiosparte gigas	6.370E-03	6.370E-03
2	ES	Ophiosparte gigas → Ophiurolepis gelida	6.370E-03	3.540E-04
2	ES	Ophiosparte gigas → Ostracods	6.370E-03	2.520E-07
2	ES	Ophiosparte gigas → Pantopoda	6.370E-03	4.450E-04
2	ES	Ophiosparte gigas → Promachocrinus kerguelensis	6.370E-03	6.107E-02
2	ES	Ophiosparte gigas → Sterechinus neumayeri	6.370E-03	2.760E-03
2	ES	Ophiosparte gigas → Yoldiella eightsi	6.370E-03	5.900E-04
2	ES	Ophiurolepis brevirima → Eunoe spica	5.020E-04	9.540E-05
2	ES	Ophiurolepis brevirima → Euphausiacea	5.020E-04	1.580E-05
2	ES	Ophiurolepis brevirima → Flagellate	5.020E-04	2.540E-11

D	Com	Consumer → Resource	ConSize	ResSize
2	ES	Ophiurolepis brevirima → Foraminifera	5.020E-04	5.650E-10
2	ES	Ophiurolepis brevirima → Ostracods	5.020E-04	2.520E-07
2	ES	Ophiurolepis brevirima → Silicioflagellates	5.020E-04	1.510E-10
2	ES	Ophiurolepis gelida → Euphausiacea	3.540E-04	1.580E-05
2	ES	Ophiurolepis gelida → Flagellate	3.540E-04	2.540E-11
2	ES	Ophiurolepis gelida → Foraminifera	3.540E-04	5.650E-10
2	ES	Ophiurolepis gelida → Silicioflagellates	3.540E-04	1.510E-10
2	ES	Pachyptila desolata → Calanoides acutus	1.656E-01	1.490E-06
2	ES	Pachyptila desolata → Calanus propinquus	1.656E-01	1.550E-06
2	ES	Pachyptila desolata → Copepoda	1.656E-01	1.810E-06
2	ES	Pachyptila desolata → Cyllopus lucasii	1.656E-01	2.640E-05
2	ES	Pachyptila desolata → Cyllopus lucasii	1.656E-01	2.640E-05
2	ES	Pachyptila desolata → Electrona antarctica	1.656E-01	3.906E-02
2	ES	Pachyptila desolata → Electrona antarctica	1.656E-01	3.906E-02
2	ES	Pachyptila desolata → Euchaeta antarctica	1.656E-01	1.980E-06
2	ES	Pachyptila desolata → Euphausia frigida	1.656E-01	1.690E-05
2	ES	Pachyptila desolata → Euphausia superba	1.656E-01	1.960E-04
2	ES	Pachyptila desolata → Euphausia superba	1.656E-01	1.960E-04
2	ES	Pachyptila desolata → Gymnoscopelus braueri	1.656E-01	2.614E-02
2	ES	Pachyptila desolata → Gymnoscopelus braueri	1.656E-01	2.614E-02
2	ES	Pachyptila desolata → Gymnoscopelus nicholsi	1.656E-01	1.150E-01
2	ES	Pachyptila desolata → Metridia gerlachei	1.656E-01	8.160E-07
2	ES	Pachyptila desolata → Notocrangon antarcticus	1.656E-01	4.490E-04
2	ES	Pachyptila desolata → Notocrangon antarcticus	1.656E-01	4.490E-04
2	ES	Pachyptila desolata → Notolepis coatsi	1.656E-01	3.145E-03
2	ES	Pachyptila desolata → Primno macropa	1.656E-01	4.720E-05
2	ES	Pachyptila desolata → Protomyctophum bolini	1.656E-01	5.581E-03
2	ES	Pachyptila desolata → Protomyctophum bolini	1.656E-01	5.581E-03
2	ES	Pachyptila desolata → Rhincalanus gigas	1.656E-01	3.770E-06
2	ES	Pachyptila desolata → Salpa thompsoni	1.656E-01	7.750E-05
2	ES	Pachyptila desolata → Thysanoessa macrura	1.656E-01	1.580E-05
2	ES	Pachyptila desolata → Thysanoessa macrura	1.656E-01	1.580E-05
2	ES	Pachyptila desolata → Vibillia antarctica	1.656E-01	9.390E-08
2	ES	Pachyptila desolata → Vibillia antarctica	1.656E-01	9.390E-08
2	ES	Pagodroma nivea → Cyllopus lucasii	4.010	2.640E-05
2	ES	Pagodroma nivea → Electrona antarctica	4.010	3.906E-02
2	ES	Pagodroma nivea → Euphausia superba	4.010	1.960E-04
2	ES	Pagodroma nivea → Eurythenes gryllus	4.010	9.320E-04
2	ES	Pagodroma nivea → Galitheutis glacialis	4.010	1.250
2	ES	Pagodroma nivea → Gymnoscopelus braueri	4.010	2.614E-02
2	ES	Pagodroma nivea → Notocrangon antarcticus	4.010	4.490E-04
2	ES	Pagodroma nivea → Notolepis coatsi	4.010	3.145E-03
2	ES	Pagodroma nivea → Protomyctophum bolini	4.010	5.581E-03
2	ES	Pagodroma nivea → Psychroteuthis glacialis	4.010	4.666E-01
2	ES	Pagodroma nivea → Vibillia antarctica	4.010	9.390E-08
2	ES	Pagodroma nivea → Vibillia stebbingi	4.010	9.390E-08
2	ES	Parborlasia corrugatus → Adamussium colbecki	5.840	1.255E-03
2	ES	Parborlasia corrugatus → Homaxinella balfourensis	5.840	6.107E-02
2	ES	Pareledone charcoti → Eukrohnia hamata	7.950E-04	2.120E-05
2	ES	Pareledone charcoti → Glyptonotus antarcticus	7.950E-04	9.320E-04
2	ES	Pareledone charcoti → Sterechinus neumayeri	7.950E-04	2.760E-03
2	ES	Pareledone charcoti → Yoldiella eightsi	7.950E-04	5.900E-04
2	ES	Pelegobia longicirrata → Ostracods	3.820E-08	2.520E-07
2	ES	Perknaster fuscus → Mycale (Oxymycale) acerata	8.046E-03	2.581E-01
2	ES	Perknaster fuscus → Scolymastra joubini	8.046E-03	8.800
2	ES	Perknaster fuscus → Tetilla leptoderma	8.046E-03	5.623E-01
2	ES	Pogonophryne marmorata → Cyllopus lucasii	1.920E-01	2.640E-05
2	ES	Pogonophryne marmorata → Epimeria macrodonta	1.920E-01	7.010E-05
2	ES	Pogonophryne marmorata → Epimeria robusta	1.920E-01	9.280E-05
2	ES	Pogonophryne marmorata → Euphausiacea	1.920E-01	1.580E-05

D	Com	Consumer → Resource	ConSize	ResSize
2	ES	Pogonophryne marmorata → Iphimediella cyclogena	1.920E-01	5.070E-05
2	ES	Pogonophryne marmorata → Liljeborgia georgiana	1.920E-01	4.060E-05
2	ES	Pogonophryne marmorata → Zooplankton	1.920E-01	1.680E-07
2	ES	Pogonophryne permitini → Scaphopoda	7.951E-02	4.660E-05
2	ES	Pontiothauma ergata → Nemertini	1.607E-02	1.028
2	ES	Porania antarctica → Ostracods	1.090E-04	2.520E-07
2	ES	Primnoella sp. → Phytoplankton	4.840E-03	1.370E-09
2	ES	Procellaria aequinoctialis → Electrona antarctica	6.002E-01	3.906E-02
2	ES	Procellaria aequinoctialis → Euphausia superba	6.002E-01	1.960E-04
2	ES	Procellaria aequinoctialis → Galitheutis glacialis	6.002E-01	1.250
2	ES	Procellaria aequinoctialis → Gonatus antarcticus	6.002E-01	5.273E-01
2	ES	Procellaria aequinoctialis → Kondakovia longimama	6.002E-01	1.758E-01
2	ES	Procellaria aequinoctialis → Psychroteuthis glacialis	6.002E-01	4.666E-01
2	ES	Procellaria aequinoctialis → Salpa thompsoni	6.002E-01	7.750E-05
2	ES	Procellaria aequinoctialis → Vibillia antarctica	6.002E-01	9.390E-08
2	ES	Pteraster affinis aculeatus → Adamussium colbecki	3.900E-04	1.255E-03
2	ES	Sterna paradisaea → Cyllopus lucasii	3.845E-01	2.640E-05
2	ES	Sterna paradisaea → Electrona antarctica	3.845E-01	3.906E-02
2	ES	Sterna paradisaea → Euphausia superba	3.845E-01	1.960E-04
2	ES	Sterna paradisaea → Thysanoessa macrura	3.845E-01	1.580E-05
2	ES	Sterna paradisaea → Vibillia antarctica	3.845E-01	9.390E-08
2	ES	Sterna vittata → Electrona antarctica	4.163E-01	3.906E-02
2	ES	Sterna vittata → Euphausia superba	4.163E-01	1.960E-04
2	ES	Thalassoica antarctica → Cyllopus lucasii	6.002E-01	2.640E-05
2	ES	Thalassoica antarctica → Electrona antarctica	6.002E-01	3.906E-02
2	ES	Thalassoica antarctica → Euphausia superba	6.002E-01	1.960E-04
2	ES	Thalassoica antarctica → Eurythenes gryllus	6.002E-01	9.320E-04
2	ES	Thalassoica antarctica → Galitheutis glacialis	6.002E-01	1.250
2	ES	Thalassoica antarctica → Gonatus antarcticus	6.002E-01	5.273E-01
2	ES	Thalassoica antarctica → Gymnoscopelus braueri	6.002E-01	2.614E-02
2	ES	Thalassoica antarctica → Gymnoscopelus nicholsi	6.002E-01	1.150E-01
2	ES	Thalassoica antarctica → Gymnoscopelus opisthopterus	6.002E-01	3.569E-02
2	ES	Thalassoica antarctica → Notocrangon antarcticus	6.002E-01	4.490E-04
2	ES	Thalassoica antarctica → Notolepis coatsi	6.002E-01	3.145E-03
2	ES	Thalassoica antarctica → Protomyctophum bolini	6.002E-01	5.581E-03
2	ES	Thalassoica antarctica → Psychroteuthis glacialis	6.002E-01	4.666E-01
2	ES	Thalassoica antarctica → Vibillia antarctica	6.002E-01	9.390E-08
2	ES	Thalassoica antarctica → Vibillia stebbingi	6.002E-01	9.390E-08
2	ES	Tritoniella belli → Cephalodiscus sp.	8.341E-03	1.960E-04
2	ES	Trophon longistaffi → Yoldiella eightsi	7.610E-06	5.900E-04
2	ES	Urticinopsis antarctica → Diplasterias brucei	6.107E-02	2.713E-03
2	ES	Urticinopsis antarctica → Odontaster validus	6.107E-02	6.640E-04
2	ES	Urticinopsis antarctica → Perknaster fuscus	6.107E-02	8.046E-03
2	ES	Urticinopsis antarctica → Sterechinus neumayeri	6.107E-02	2.760E-03
2	ES	Waldeckia obesa → Eurythenes gryllus	7.010E-05	9.320E-04
2	ES	Waldeckia obesa → Holothuria	7.010E-05	2.316E-02
2	GM	Acari (pred) → Acari (phyto)	1.000E-08	1.000E-08
2	GM	Acupalpus flavicollis → Anisus leucostoma	7.000E-07	5.400E-06
2	GM	Acupalpus flavicollis → Euconulus alderi	7.000E-07	1.600E-06
2	GM	Acupalpus flavicollis → Oxyloma elegans	7.000E-07	2.800E-06
2	GM	Acupalpus flavicollis → Oxyloma elegans	7.000E-07	2.800E-06
2	GM	Acupalpus flavicollis → Succinea putris	7.000E-07	3.200E-06
2	GM	Acupalpus flavicollis → Trichia sericea	7.000E-07	1.200E-06
2	GM	Acupalpus flavicollis → Vertigo antivertigo	7.000E-07	6.670E-07
2	GM	Acupalpus flavicollis → Vertigo moulinsiana	7.000E-07	6.750E-07
2	GM	Anguis fragilis → Brachycera sp	2.000E-02	2.800E-07
2	GM	Anguis fragilis → Ligidium hypnorum	2.000E-02	2.190E-06
2	GM	Anguis fragilis → Paederus riparius	2.000E-02	2.800E-06
2	GM	Anguis fragilis → Porcellium conspersum	2.000E-02	4.300E-06
2	GM	Anguis fragilis → Trachelipus rathkei	2.000E-02	5.530E-06

D	Com	Consumer → Resource	ConSize	ResSize
2	GM	Antistea elegans → Bryaxis sp	3.730E-07	4.300E-08
2	GM	Antistea elegans → Chaetarthria seminulum	3.730E-07	1.000E-07
2	GM	Antistea elegans → Cicadina sp	3.730E-07	7.930E-08
2	GM	Antistea elegans → Edaphus blühweissi	3.730E-07	2.740E-08
2	GM	Antistea elegans → Euaesthetus ruficapillus	3.730E-07	9.700E-08
2	GM	Antistea elegans → Hebrus pusillus	3.730E-07	1.560E-06
2	GM	Antistea elegans → Hebrus ruficeps	3.730E-07	1.560E-06
2	GM	Antistea elegans → Ligidium hypnorum	3.730E-07	2.190E-06
2	GM	Bryaxis sp → Acari (phyto)	4.300E-08	1.000E-08
2	GM	Bryaxis sp → Acari (pred)	4.300E-08	1.000E-08
2	GM	Chrysops relictus → Capreolus capreolus	6.050E-06	2.000E+01
2	GM	Chrysops relictus → Vulpes vulpes	6.050E-06	5.000
2	GM	Clubiona sp → Cicadina sp	2.570E-07	7.930E-08
2	GM	Clubiona sp → Hebrus pusillus	2.570E-07	1.560E-06
2	GM	Clubiona sp → Hebrus ruficeps	2.570E-07	1.560E-06
2	GM	Clubiona sp → Ootetrastichus sp	2.570E-07	8.000E-08
2	GM	Clubiona sp → Thanatus sp	2.570E-07	1.000E-07
2	GM	Clubiona subtilis → Cicadina sp	2.270E-07	7.930E-08
2	GM	Clubiona subtilis → Clubiona sp	2.270E-07	2.570E-07
2	GM	Clubiona subtilis → Hebrus pusillus	2.270E-07	1.560E-06
2	GM	Clubiona subtilis → Hebrus ruficeps	2.270E-07	1.560E-06
2	GM	Clubiona subtilis → Thanatus sp	2.270E-07	1.000E-07
2	GM	Dolomedes fimbriatus → Anisus leucostoma	2.430E-05	5.400E-06
2	GM	Dolomedes fimbriatus → Argiope bruennichi	2.430E-05	4.230E-05
2	GM	Dolomedes fimbriatus → Caelifera sp	2.430E-05	6.660E-05
2	GM	Dolomedes fimbriatus → Chorthippus montanus	2.430E-05	6.160E-05
2	GM	Dolomedes fimbriatus → Chrysops relictus	2.430E-05	6.050E-06
2	GM	Dolomedes fimbriatus → Dolichovespula sylvestris	2.430E-05	2.310E-05
2	GM	Dolomedes fimbriatus → Haematopota sp	2.430E-05	9.300E-06
2	GM	Dolomedes fimbriatus → Ilione albiseta	2.430E-05	6.000E-06
2	GM	Dolomedes fimbriatus → Larinioides cornutus	2.430E-05	2.970E-05
2	GM	Dolomedes fimbriatus → Marpissa radiate	2.430E-05	4.180E-06
2	GM	Dolomedes fimbriatus → Oxyloma elegans	2.430E-05	2.800E-06
2	GM	Dolomedes fimbriatus → Pisaura mirabilis	2.430E-05	8.770E-06
2	GM	Dolomedes fimbriatus → Succinea putris	2.430E-05	3.200E-06
2	GM	Dolomedes fimbriatus → Sympetrum sanguineum	2.430E-05	5.060E-05
2	GM	Dolomedes fimbriatus → Sympetrum sp	2.430E-05	8.300E-05
2	GM	Dolomedes fimbriatus → Sympetrum striolatum	2.430E-05	1.750E-04
2	GM	Dolomedes fimbriatus → Sympetrum vulgatum	2.430E-05	6.960E-05
2	GM	Dolomedes fimbriatus → Tetrix sp	2.430E-05	5.800E-06
2	GM	Dolomedes fimbriatus → Tetrix subulata	2.430E-05	4.600E-06
2	GM	Dolomedes fimbriatus → Trichia sericea	2.430E-05	1.200E-06
2	GM	Dolomedes sp → Anisus leucostoma	3.360E-06	5.400E-06
2	GM	Dolomedes sp → Anthocomus coccineus	3.360E-06	3.180E-06
2	GM	Dolomedes sp → Argiope bruennichi	3.360E-06	4.230E-05
2	GM	Dolomedes sp → Chrysops relictus	3.360E-06	6.050E-06
2	GM	Dolomedes sp → Cloeon simile	3.360E-06	1.200E-06
2	GM	Dolomedes sp → Culex sp	3.360E-06	2.500E-07
2	GM	Dolomedes sp → Dolomedes sp	3.360E-06	3.360E-06
2	GM	Dolomedes sp → Euconulus alderi	3.360E-06	1.600E-06
2	GM	Dolomedes sp → Evarcha arcuata	3.360E-06	5.000E-06
2	GM	Dolomedes sp → Formica sp	3.360E-06	7.000E-07
2	GM	Dolomedes sp → Haematopota sp	3.360E-06	9.300E-06
2	GM	Dolomedes sp → Herina parva	3.360E-06	4.950E-07
2	GM	Dolomedes sp → Ilione albiseta	3.360E-06	6.000E-06
2	GM	Dolomedes sp → Larinioides cornutus	3.360E-06	2.970E-05
2	GM	Dolomedes sp → Larinioides sp	3.360E-06	3.150E-06
2	GM	Dolomedes sp → Limonia sp	3.360E-06	1.000E-07
2	GM	Dolomedes sp → Marpissa radiate	3.360E-06	4.180E-06
2	GM	Dolomedes sp → Micrommata virescens	3.360E-06	1.340E-05

D	Com	Consumer → Resource	ConSize	ResSize
2	GM	Dolomedes sp → Muscidae copro	3.360E-06	4.500E-07
2	GM	Dolomedes sp → Muscidae flor	3.360E-06	4.500E-07
2	GM	Dolomedes sp → Oxyloma elegans	3.360E-06	2.800E-06
2	GM	Dolomedes sp → Oxyloma elegans	3.360E-06	2.800E-06
2	GM	Dolomedes sp → Philaenus spumarius	3.360E-06	2.400E-06
2	GM	Dolomedes sp → Pisaura mirabilis	3.360E-06	8.770E-06
2	GM	Dolomedes sp → Psacadina zernyi	3.360E-06	2.300E-06
2	GM	Dolomedes sp → Stalia boops	3.360E-06	2.500E-06
2	GM	Dolomedes sp → Succinea putris	3.360E-06	3.200E-06
2	GM	Dolomedes sp → Tetramorium sp	3.360E-06	7.000E-07
2	GM	Dolomedes sp → Tibellus sp	3.360E-06	4.600E-06
2	GM	Dolomedes sp → Trichia sericea	3.360E-06	1.200E-06
2	GM	Dolomedes sp → Vertigo antivertigo	3.360E-06	6.670E-07
2	GM	Edaphus blühweissi → Acanthinula aculeata	2.740E-08	4.330E-07
2	GM	Edaphus blühweissi → Acari (phyto)	2.740E-08	1.000E-08
2	GM	Edaphus blühweissi → Acari (pred)	2.740E-08	1.000E-08
2	GM	Euaesthetus ruficapillus → Acanthinula aculeata	9.700E-08	4.330E-07
2	GM	Euaesthetus ruficapillus → Antistea elegans	9.700E-08	3.730E-07
2	GM	Euaesthetus ruficapillus → Bryaxis sp	9.700E-08	4.300E-08
2	GM	Euaesthetus ruficapillus → Chaetarthria seminulum	9.700E-08	1.000E-07
2	GM	Euaesthetus ruficapillus → Cicadina	9.700E-08	7.930E-08
2	GM	Euaesthetus ruficapillus → Edaphus blühweissi	9.700E-08	2.740E-08
2	GM	Euaesthetus ruficapillus → Gongylidiellum murcidum	9.700E-08	1.000E-07
2	GM	Euaesthetus ruficapillus → Hebrus pusillus	9.700E-08	1.560E-06
2	GM	Euaesthetus ruficapillus → Hebrus ruficeps	9.700E-08	1.560E-06
2	GM	Euaesthetus ruficapillus → Ligidium hypnorum	9.700E-08	2.190E-06
2	GM	Euaesthetus ruficapillus → Neon valentulus	9.700E-08	1.210E-07
2	GM	Euaesthetus ruficapillus → Vertigo antivertigo	9.700E-08	6.670E-07
2	GM	Euaesthetus ruficapillus → Vertigo moulinsiana	9.700E-08	6.750E-07
2	GM	Euaesthetus ruficapillus → Zora sp	9.700E-08	8.280E-08
2	GM	Formica sp → Acanthinula aculeata	7.000E-07	4.330E-07
2	GM	Formica sp → Acupalpus flavicollis	7.000E-07	7.000E-07
2	GM	Formica sp → Anisus leucostoma	7.000E-07	5.400E-06
2	GM	Formica sp → Anthocomus coccineus	7.000E-07	3.180E-06
2	GM	Formica sp → Bryaxis sp	7.000E-07	4.300E-08
2	GM	Formica sp → Chaetarthria seminulum	7.000E-07	1.000E-07
2	GM	Formica sp → Chartoscirta cincta	7.000E-07	1.590E-06
2	GM	Formica sp → Cicadina	7.000E-07	7.930E-08
2	GM	Formica sp → Clubiona sp	7.000E-07	2.570E-07
2	GM	Formica sp → Clubiona subtilis	7.000E-07	2.270E-07
2	GM	Formica sp → Dryops auriculatus	7.000E-07	1.690E-06
2	GM	Formica sp → Dryops sp	7.000E-07	1.850E-06
2	GM	Formica sp → Edaphus blühweissi	7.000E-07	2.740E-08
2	GM	Formica sp → Euaesthetus ruficapillus	7.000E-07	9.700E-08
2	GM	Formica sp → Euconulus alderi	7.000E-07	1.600E-06
2	GM	Formica sp → Evarcha arcuata	7.000E-07	5.000E-06
2	GM	Formica sp → Evarcha sp	7.000E-07	1.100E-06
2	GM	Formica sp → Hebrus pusillus	7.000E-07	1.560E-06
2	GM	Formica sp → Hebrus ruficeps	7.000E-07	1.560E-06
2	GM	Formica sp → Lesteva sicula	7.000E-07	5.000E-07
2	GM	Formica sp → Ligidium hypnorum	7.000E-07	2.190E-06
2	GM	Formica sp → Micrommata virescens	7.000E-07	1.340E-05
2	GM	Formica sp → Neon valentulus	7.000E-07	1.210E-07
2	GM	Formica sp → Nestus carbonarius	7.000E-07	3.000E-07
2	GM	Formica sp → Oxyloma elegans	7.000E-07	2.800E-06
2	GM	Formica sp → Ozyptila sp	7.000E-07	1.320E-06
2	GM	Formica sp → Pardosa sp	7.000E-07	2.810E-07
2	GM	Formica sp → Philaenus spumarius	7.000E-07	2.400E-06
2	GM	Formica sp → Pirata sp	7.000E-07	6.670E-07
2	GM	Formica sp → Thanatus sp	7.000E-07	1.000E-07

D	Com	Consumer → Resource	ConSize	ResSize
2	GM	Formica sp → Tibellus sp	7.000E-07	4.600E-06
2	GM	Formica sp → Trichia sericea	7.000E-07	1.200E-06
2	GM	Formica sp → Vertigo antivertigo	7.000E-07	6.670E-07
2	GM	Formica sp → Vertigo moulinsiana	7.000E-07	6.750E-07
2	GM	Formica sp → Zelotes sp	7.000E-07	9.370E-06
2	GM	Formica sp → Zora sp	7.000E-07	8.280E-08
2	GM	Gongylidiellum murcidum → Edaphus blühweissi	1.000E-07	2.740E-08
2	GM	Haematopota sp → Capreolus capreolus	9.300E-06	2.000E+01
2	GM	Haematopota sp → Vulpes vulpes	9.300E-06	5.000
2	GM	Lacerta agilis → Brachycera	1.000E-02	2.800E-07
2	GM	Lacerta agilis → Caelifera	1.000E-02	6.660E-05
2	GM	Lacerta agilis → Chorthippus montanus	1.000E-02	6.160E-05
2	GM	Lacerta agilis → Ligidium hypnorum	1.000E-02	2.190E-06
2	GM	Lacerta agilis → Paederus riparius	1.000E-02	2.800E-06
2	GM	Lacerta agilis → Porcellium conspersum	1.000E-02	4.300E-06
2	GM	Lacerta agilis → Tetrix sp	1.000E-02	5.800E-06
2	GM	Lacerta agilis → Tetrix subulata	1.000E-02	4.600E-06
2	GM	Lacerta agilis → Trachelipus rathkei	1.000E-02	5.530E-06
2	GM	Lesteva sicula → Antistea elegans	5.000E-07	3.730E-07
2	GM	Lesteva sicula → Antistea elegans	5.000E-07	3.730E-07
2	GM	Lesteva sicula → Bryaxis sp	5.000E-07	4.300E-08
2	GM	Lesteva sicula → Chaetarthria seminulum	5.000E-07	1.000E-07
2	GM	Lesteva sicula → Chartoscirta cincta	5.000E-07	1.590E-06
2	GM	Lesteva sicula → Cicadina	5.000E-07	7.930E-08
2	GM	Lesteva sicula → Edaphus blühweissi	5.000E-07	2.740E-08
2	GM	Lesteva sicula → Euaesthetus ruficapillus	5.000E-07	9.700E-08
2	GM	Lesteva sicula → Euconulus alderi	5.000E-07	1.600E-06
2	GM	Lesteva sicula → Gongylidiellum murcidum	5.000E-07	1.000E-07
2	GM	Lesteva sicula → Hebrus pusillus	5.000E-07	1.560E-06
2	GM	Lesteva sicula → Hebrus ruficeps	5.000E-07	1.560E-06
2	GM	Lesteva sicula → Ligidium hypnorum	5.000E-07	2.190E-06
2	GM	Lesteva sicula → Neon valentulus	5.000E-07	1.210E-07
2	GM	Lesteva sicula → Oxyloma elegans	5.000E-07	2.800E-06
2	GM	Lesteva sicula → Ozyptila sp	5.000E-07	1.320E-06
2	GM	Lesteva sicula → Pardosa sp	5.000E-07	2.810E-07
2	GM	Lesteva sicula → Pirata sp	5.000E-07	6.670E-07
2	GM	Lesteva sicula → Robertus sp	5.000E-07	4.500E-07
2	GM	Lesteva sicula → Vertigo antivertigo	5.000E-07	6.670E-07
2	GM	Lesteva sicula → Vertigo moulinsiana	5.000E-07	6.750E-07
2	GM	Lesteva sicula → Zora sp	5.000E-07	8.280E-08
2	GM	Locustella naevia → Acupalpus flavicollis	1.300E-02	7.000E-07
2	GM	Locustella naevia → Anisus leucostoma	1.300E-02	5.400E-06
2	GM	Locustella naevia → Anthocomus coccineus	1.300E-02	3.180E-06
2	GM	Locustella naevia → Brachycera	1.300E-02	2.800E-07
2	GM	Locustella naevia → Caelifera	1.300E-02	6.660E-05
2	GM	Locustella naevia → Chartoscirta cincta	1.300E-02	1.590E-06
2	GM	Locustella naevia → Chorthippus montanus	1.300E-02	6.160E-05
2	GM	Locustella naevia → Cloeon simile	1.300E-02	1.200E-06
2	GM	Locustella naevia → Clubiona sp	1.300E-02	2.570E-07
2	GM	Locustella naevia → Clubiona subtilis	1.300E-02	2.270E-07
2	GM	Locustella naevia → Dolichovespula sylvestris	1.300E-02	2.310E-05
2	GM	Locustella naevia → Dolomedes fimbriatus	1.300E-02	2.430E-05
2	GM	Locustella naevia → Dolomedes sp	1.300E-02	3.360E-06
2	GM	Locustella naevia → Dryops auriculatus	1.300E-02	1.690E-06
2	GM	Locustella naevia → Dryops sp	1.300E-02	1.850E-06
2	GM	Locustella naevia → Euconulus alderi	1.300E-02	1.600E-06
2	GM	Locustella naevia → Evarcha arcuata	1.300E-02	5.000E-06
2	GM	Locustella naevia → Evarcha sp	1.300E-02	1.100E-06
2	GM	Locustella naevia → Formica sp	1.300E-02	7.000E-07
2	GM	Locustella naevia → Lesteva sicula	1.300E-02	5.000E-07

D	Com	Consumer → Resource	ConSize	ResSize
2	GM	Locustella naevia → Ligidium hypnorum	1.300E-02	2.190E-06
2	GM	Locustella naevia → Ligidium hypnorum	1.300E-02	2.190E-06
2	GM	Locustella naevia → Limonia sp	1.300E-02	1.000E-07
2	GM	Locustella naevia → Marpissa radiate	1.300E-02	4.180E-06
2	GM	Locustella naevia → Micrommata virescens	1.300E-02	1.340E-05
2	GM	Locustella naevia → Neon valentulus	1.300E-02	1.210E-07
2	GM	Locustella naevia → Nestus carbonarius	1.300E-02	3.000E-07
2	GM	Locustella naevia → Orthetrum cancellatum	1.300E-02	7.930E-05
2	GM	Locustella naevia → Oxyloma elegans	1.300E-02	2.800E-06
2	GM	Locustella naevia → Oxyloma elegans	1.300E-02	2.800E-06
2	GM	Locustella naevia → Ozyptila sp	1.300E-02	1.320E-06
2	GM	Locustella naevia → Paederus riparius	1.300E-02	2.800E-06
2	GM	Locustella naevia → Pardosa sp	1.300E-02	2.810E-07
2	GM	Locustella naevia → Philaenus spumarius	1.300E-02	2.400E-06
2	GM	Locustella naevia → Pirata sp	1.300E-02	6.670E-07
2	GM	Locustella naevia → Pisaura mirabilis	1.300E-02	8.770E-06
2	GM	Locustella naevia → Porcellium conspersum	1.300E-02	4.300E-06
2	GM	Locustella naevia → Robertus sp	1.300E-02	4.500E-07
2	GM	Locustella naevia → Somatochlora sp	1.300E-02	1.070E-04
2	GM	Locustella naevia → Stalia boops	1.300E-02	2.500E-06
2	GM	Locustella naevia → Succinea putris	1.300E-02	3.200E-06
2	GM	Locustella naevia → Sympetrum sanguineum	1.300E-02	5.060E-05
2	GM	Locustella naevia → Sympetrum sp	1.300E-02	8.300E-05
2	GM	Locustella naevia → Sympetrum striolatum	1.300E-02	1.750E-04
2	GM	Locustella naevia → Sympetrum vulgatum	1.300E-02	6.960E-05
2	GM	Locustella naevia → Tetragnatha extensa	1.300E-02	2.000E-06
2	GM	Locustella naevia → Tetramorium sp	1.300E-02	7.000E-07
2	GM	Locustella naevia → Tetrix sp	1.300E-02	5.800E-06
2	GM	Locustella naevia → Tetrix subulata	1.300E-02	4.600E-06
2	GM	Locustella naevia → Thanatus sp	1.300E-02	1.000E-07
2	GM	Locustella naevia → Tibellus sp	1.300E-02	4.600E-06
2	GM	Locustella naevia → Tibellus sp	1.300E-02	4.600E-06
2	GM	Locustella naevia → Trachelipus rathkei	1.300E-02	5.530E-06
2	GM	Locustella naevia → Trichia sericea	1.300E-02	1.200E-06
2	GM	Locustella naevia → Zelotes sp	1.300E-02	9.370E-06
2	GM	Micrommata virescens → Chartoscirta cincta	1.340E-05	1.590E-06
2	GM	Micrommata virescens → Culex sp	1.340E-05	2.500E-07
2	GM	Micrommata virescens → Evarcha sp	1.340E-05	1.100E-06
2	GM	Micrommata virescens → Herina parva	1.340E-05	4.950E-07
2	GM	Micrommata virescens → Limonia sp	1.340E-05	1.000E-07
2	GM	Micrommata virescens → Muscidae copro	1.340E-05	4.500E-07
2	GM	Micrommata virescens → Muscidae flor	1.340E-05	4.500E-07
2	GM	Micrommata virescens → Tetramorium sp	1.340E-05	7.000E-07
2	GM	Natrix natrix → Anguis fragilis	1.000E-01	2.000E-02
2	GM	Natrix natrix → Lacerta agilis	1.000E-01	1.000E-02
2	GM	Natrix natrix → Microtus agrestis	1.000E-01	3.500E-02
2	GM	Neon valentulus → Bryaxis sp	1.210E-07	4.300E-08
2	GM	Neon valentulus → Chaetarthria seminulum	1.210E-07	1.000E-07
2	GM	Neon valentulus → Edaphus blühweissi	1.210E-07	2.740E-08
2	GM	Nestus carbonarius → Anisus leucostoma	3.000E-07	5.400E-06
2	GM	Nestus carbonarius → Antistea elegans	3.000E-07	3.730E-07
2	GM	Nestus carbonarius → Antistea elegans	3.000E-07	3.730E-07
2	GM	Nestus carbonarius → Bryaxis sp	3.000E-07	4.300E-08
2	GM	Nestus carbonarius → Chaetarthria seminulum	3.000E-07	1.000E-07
2	GM	Nestus carbonarius → Chartoscirta cincta	3.000E-07	1.590E-06
2	GM	Nestus carbonarius → Cicadina	3.000E-07	7.930E-08
2	GM	Nestus carbonarius → Edaphus blühweissi	3.000E-07	2.740E-08
2	GM	Nestus carbonarius → Euaesthetus ruficapillus	3.000E-07	9.700E-08
2	GM	Nestus carbonarius → Euconulus alderi	3.000E-07	1.600E-06
2	GM	Nestus carbonarius → Gongylidiellum murcidum	3.000E-07	1.000E-07

D	Com	Consumer → Resource	ConSize	ResSize
2	GM	Nestus carbonarius → Hebrus pusillus	3.000E-07	1.560E-06
2	GM	Nestus carbonarius → Hebrus ruficeps	3.000E-07	1.560E-06
2	GM	Nestus carbonarius → Lesteva sicula	3.000E-07	5.000E-07
2	GM	Nestus carbonarius → Ligidium hypnorum	3.000E-07	2.190E-06
2	GM	Nestus carbonarius → Neon valentulus	3.000E-07	1.210E-07
2	GM	Nestus carbonarius → Oxyloma elegans	3.000E-07	2.800E-06
2	GM	Nestus carbonarius → Ozyptila sp	3.000E-07	1.320E-06
2	GM	Nestus carbonarius → Pardosa sp	3.000E-07	2.810E-07
2	GM	Nestus carbonarius → Pirata sp	3.000E-07	6.670E-07
2	GM	Nestus carbonarius → Robertus sp	3.000E-07	4.500E-07
2	GM	Nestus carbonarius → Vertigo antivertigo	3.000E-07	6.670E-07
2	GM	Nestus carbonarius → Vertigo moulinsiana	3.000E-07	6.750E-07
2	GM	Nestus carbonarius → Zelotes sp	3.000E-07	9.370E-06
2	GM	Nestus carbonarius → Zora sp	3.000E-07	8.280E-08
2	GM	Ozyptila sp → Acupalpus flavicollis	1.320E-06	7.000E-07
2	GM	Ozyptila sp → Anthocomus coccineus	1.320E-06	3.180E-06
2	GM	Ozyptila sp → Chartoscirta cincta	1.320E-06	1.590E-06
2	GM	Ozyptila sp → Cicadina	1.320E-06	7.930E-08
2	GM	Ozyptila sp → Clubiona sp	1.320E-06	2.570E-07
2	GM	Ozyptila sp → Clubiona subtilis	1.320E-06	2.270E-07
2	GM	Ozyptila sp → Culex sp	1.320E-06	2.500E-07
2	GM	Ozyptila sp → Dryops auriculatus	1.320E-06	1.690E-06
2	GM	Ozyptila sp → Dryops sp	1.320E-06	1.850E-06
2	GM	Ozyptila sp → Euaesthetus ruficapillus	1.320E-06	9.700E-08
2	GM	Ozyptila sp → Evarcha arcuata	1.320E-06	5.000E-06
2	GM	Ozyptila sp → Evarcha sp	1.320E-06	1.100E-06
2	GM	Ozyptila sp → Hebrus pusillus	1.320E-06	1.560E-06
2	GM	Ozyptila sp → Hebrus ruficeps	1.320E-06	1.560E-06
2	GM	Ozyptila sp → Herina parva	1.320E-06	4.950E-07
2	GM	Ozyptila sp → Lesteva sicula	1.320E-06	5.000E-07
2	GM	Ozyptila sp → Ligidium hypnorum	1.320E-06	2.190E-06
2	GM	Ozyptila sp → Limonia sp	1.320E-06	1.000E-07
2	GM	Ozyptila sp → Muscidae copro	1.320E-06	4.500E-07
2	GM	Ozyptila sp → Muscidae flor	1.320E-06	4.500E-07
2	GM	Ozyptila sp → Neon valentulus	1.320E-06	1.210E-07
2	GM	Ozyptila sp → Nestus carbonarius	1.320E-06	3.000E-07
2	GM	Ozyptila sp → Ozyptila sp	1.320E-06	1.320E-06
2	GM	Ozyptila sp → Philaenus spumarius	1.320E-06	2.400E-06
2	GM	Ozyptila sp → Tetramorium sp	1.320E-06	7.000E-07
2	GM	Ozyptila sp → Zelotes sp	1.320E-06	9.370E-06
2	GM	Ozyptila sp → Zora sp	1.320E-06	8.280E-08
2	GM	Paederus riparius → Acupalpus flavicollis	2.800E-06	7.000E-07
2	GM	Paederus riparius → Anisus leucostoma	2.800E-06	5.400E-06
2	GM	Paederus riparius → Antistea elegans	2.800E-06	3.730E-07
2	GM	Paederus riparius → Chartoscirta cincta	2.800E-06	1.590E-06
2	GM	Paederus riparius → Dryops auriculatus	2.800E-06	1.690E-06
2	GM	Paederus riparius → Dryops sp	2.800E-06	1.850E-06
2	GM	Paederus riparius → Formica sp	2.800E-06	7.000E-07
2	GM	Paederus riparius → Lesteva sicula	2.800E-06	5.000E-07
2	GM	Paederus riparius → Ligidium hypnorum	2.800E-06	2.190E-06
2	GM	Paederus riparius → Nestus carbonarius	2.800E-06	3.000E-07
2	GM	Paederus riparius → Oxyloma elegans	2.800E-06	2.800E-06
2	GM	Paederus riparius → Oxyloma elegans	2.800E-06	2.800E-06
2	GM	Paederus riparius → Ozyptila sp	2.800E-06	1.320E-06
2	GM	Paederus riparius → Pardosa sp	2.800E-06	2.810E-07
2	GM	Paederus riparius → Philaenus spumarius	2.800E-06	2.400E-06
2	GM	Paederus riparius → Pirata sp	2.800E-06	6.670E-07
2	GM	Paederus riparius → Porcellium conspersum	2.800E-06	4.300E-06
2	GM	Paederus riparius → Robertus sp	2.800E-06	4.500E-07
2	GM	Paederus riparius → Stalia boops	2.800E-06	2.500E-06

D	Com	Consumer → Resource	ConSize	ResSize
2	GM	Paederus riparius → Succinea putris	2.800E-06	3.200E-06
2	GM	Paederus riparius → Tetramorium sp	2.800E-06	7.000E-07
2	GM	Paederus riparius → Trachelipus rathkei	2.800E-06	5.530E-06
2	GM	Paederus riparius → Trichia sericea	2.800E-06	1.200E-06
2	GM	Paederus riparius → Zelotes sp	2.800E-06	9.370E-06
2	GM	Pardosa sp → Bryaxis sp	2.810E-07	4.300E-08
2	GM	Pardosa sp → Chaetarthria seminulum	2.810E-07	1.000E-07
2	GM	Pardosa sp → Cicadina	2.810E-07	7.930E-08
2	GM	Pardosa sp → Hebrus pusillus	2.810E-07	1.560E-06
2	GM	Pardosa sp → Hebrus ruficeps	2.810E-07	1.560E-06
2	GM	Pardosa sp → Ligidium hypnorum	2.810E-07	2.190E-06
2	GM	Pardosa sp → Zora sp	2.810E-07	8.280E-08
2	GM	Pirata sp → Cicadina	6.670E-07	7.930E-08
2	GM	Pirata sp → Euaesthetus ruficapillus	6.670E-07	9.700E-08
2	GM	Pirata sp → Hebrus pusillus	6.670E-07	1.560E-06
2	GM	Pirata sp → Hebrus ruficeps	6.670E-07	1.560E-06
2	GM	Pirata sp → Ligidium hypnorum	6.670E-07	2.190E-06
2	GM	Pirata sp → Neon valentulus	6.670E-07	1.210E-07
2	GM	Pirata sp → Pardosa sp	6.670E-07	2.810E-07
2	GM	Pirata sp → Zora sp	6.670E-07	8.280E-08
2	GM	Pisaura mirabilis → Anthocomus coccineus	8.770E-06	3.180E-06
2	GM	Pisaura mirabilis → Chrysops relictus	8.770E-06	6.050E-06
2	GM	Pisaura mirabilis → Cloeon simile	8.770E-06	1.200E-06
2	GM	Pisaura mirabilis → Dolomedes fimbriatus	8.770E-06	2.430E-05
2	GM	Pisaura mirabilis → Dolomedes sp	8.770E-06	3.360E-06
2	GM	Pisaura mirabilis → Formica sp	8.770E-06	7.000E-07
2	GM	Pisaura mirabilis → Haematopota sp	8.770E-06	9.300E-06
2	GM	Pisaura mirabilis → Ilione albiseta	8.770E-06	6.000E-06
2	GM	Pisaura mirabilis → Marpissa radiata	8.770E-06	4.180E-06
2	GM	Pisaura mirabilis → Micrommata virescens	8.770E-06	1.340E-05
2	GM	Pisaura mirabilis → Pisaura mirabilis	8.770E-06	8.770E-06
2	GM	Pisaura mirabilis → Psacadina zernyi	8.770E-06	2.300E-06
2	GM	Pisaura mirabilis → Stalia boops	8.770E-06	2.500E-06
2	GM	Pisaura mirabilis → Tetrix sp	8.770E-06	5.800E-06
2	GM	Pisaura mirabilis → Tetrix subulata	8.770E-06	4.600E-06
2	GM	Pisaura mirabilis → Tibellus sp	8.770E-06	4.600E-06
2	GM	Pisaura mirabilis → Tibellus sp	8.770E-06	4.600E-06
2	GM	Robertus sp → Acupalpus flavicollis	4.500E-07	7.000E-07
2	GM	Robertus sp → Brachycera	4.500E-07	2.800E-07
2	GM	Robertus sp → Bryaxis sp	4.500E-07	4.300E-08
2	GM	Robertus sp → Chaetarthria seminulum	4.500E-07	1.000E-07
2	GM	Robertus sp → Chartoscirta cincta	4.500E-07	1.590E-06
2	GM	Robertus sp → Cicadina	4.500E-07	7.930E-08
2	GM	Robertus sp → Dryops auriculatus	4.500E-07	1.690E-06
2	GM	Robertus sp → Dryops sp	4.500E-07	1.850E-06
2	GM	Robertus sp → Euaesthetus ruficapillus	4.500E-07	9.700E-08
2	GM	Robertus sp → Formica sp	4.500E-07	7.000E-07
2	GM	Robertus sp → Hebrus pusillus	4.500E-07	1.560E-06
2	GM	Robertus sp → Hebrus ruficeps	4.500E-07	1.560E-06
2	GM	Robertus sp → Lesteva sicula	4.500E-07	5.000E-07
2	GM	Robertus sp → Ligidium hypnorum	4.500E-07	2.190E-06
2	GM	Robertus sp → Nestus carbonarius	4.500E-07	3.000E-07
2	GM	Robertus sp → Ozyptila sp	4.500E-07	1.320E-06
2	GM	Robertus sp → Paederus riparius	4.500E-07	2.800E-06
2	GM	Robertus sp → Philaenus spumarius	4.500E-07	2.400E-06
2	GM	Robertus sp → Stalia boops	4.500E-07	2.500E-06
2	GM	Robertus sp → Tetramorium sp	4.500E-07	7.000E-07
2	GM	Robertus sp → Zelotes sp	4.500E-07	9.370E-06
2	GM	Robertus sp → Zora sp	4.500E-07	8.280E-08
2	GM	Stalia boops → Acari (phyto)	2.500E-06	1.000E-08

D	Com	Consumer → Resource	ConSize	ResSize
2	GM	Stalia boops → Acari (pred)	2.500E-06	1.000E-08
2	GM	Stalia boops → Brachycera	2.500E-06	2.800E-07
2	GM	Stalia boops → Chartoscirta cincta	2.500E-06	1.590E-06
2	GM	Stalia boops → Cicadina	2.500E-06	7.930E-08
2	GM	Stalia boops → Evarcha sp	2.500E-06	1.100E-06
2	GM	Stalia boops → Hebrus pusillus	2.500E-06	1.560E-06
2	GM	Stalia boops → Hebrus ruficeps	2.500E-06	1.560E-06
2	GM	Stalia boops → Ligidium hypnorum	2.500E-06	2.190E-06
2	GM	Stalia boops → Ligidium hypnorum	2.500E-06	2.190E-06
2	GM	Stalia boops → Neon valentulus	2.500E-06	1.210E-07
2	GM	Stalia boops → Ozyptila sp	2.500E-06	1.320E-06
2	GM	Stalia boops → Pardosa sp	2.500E-06	2.810E-07
2	GM	Stalia boops → Philaenus spumarius	2.500E-06	2.400E-06
2	GM	Stalia boops → Pirata sp	2.500E-06	6.670E-07
2	GM	Stalia boops → Porcellium conspersum	2.500E-06	4.300E-06
2	GM	Stalia boops → Stalia boops	2.500E-06	2.500E-06
2	GM	Stalia boops → Thanatus sp	2.500E-06	1.000E-07
2	GM	Stalia boops → Zelotes sp	2.500E-06	9.370E-06
2	GM	Stalia boops → Zora sp	2.500E-06	8.280E-08
2	GM	Tetramorium sp → Acanthinula aculeata	7.000E-07	4.330E-07
2	GM	Tetramorium sp → Acupalpus flavicollis	7.000E-07	7.000E-07
2	GM	Tetramorium sp → Anisus leucostoma	7.000E-07	5.400E-06
2	GM	Tetramorium sp → Bryaxis sp	7.000E-07	4.300E-08
2	GM	Tetramorium sp → Chaetarthria seminulum	7.000E-07	1.000E-07
2	GM	Tetramorium sp → Chartoscirta cincta	7.000E-07	1.590E-06
2	GM	Tetramorium sp → Cicadina	7.000E-07	7.930E-08
2	GM	Tetramorium sp → Edaphus blühweissi	7.000E-07	2.740E-08
2	GM	Tetramorium sp → Euaesthetus ruficapillus	7.000E-07	9.700E-08
2	GM	Tetramorium sp → Euconulus alderi	7.000E-07	1.600E-06
2	GM	Tetramorium sp → Hebrus pusillus	7.000E-07	1.560E-06
2	GM	Tetramorium sp → Hebrus ruficeps	7.000E-07	1.560E-06
2	GM	Tetramorium sp → Lesteva sicula	7.000E-07	5.000E-07
2	GM	Tetramorium sp → Ligidium hypnorum	7.000E-07	2.190E-06
2	GM	Tetramorium sp → Neon valentulus	7.000E-07	1.210E-07
2	GM	Tetramorium sp → Oxyloma elegans	7.000E-07	2.800E-06
2	GM	Tetramorium sp → Ozyptila sp	7.000E-07	1.320E-06
2	GM	Tetramorium sp → Pirata sp	7.000E-07	6.670E-07
2	GM	Tetramorium sp → Vertigo antivertigo	7.000E-07	6.670E-07
2	GM	Tetramorium sp → Vertigo moulinsiana	7.000E-07	6.750E-07
2	GM	Tetramorium sp → Zelotes sp	7.000E-07	9.370E-06
2	GM	Tetramorium sp → Zora sp	7.000E-07	8.280E-08
2	GM	Thanatus sp → Cicadina	1.000E-07	7.930E-08
2	GM	Thanatus sp → Hebrus pusillus	1.000E-07	1.560E-06
2	GM	Thanatus sp → Hebrus ruficeps	1.000E-07	1.560E-06
2	GM	Thanatus sp → Ootetrastichus sp	1.000E-07	8.000E-08
2	GM	Thanatus sp → Ozyptila sp	1.000E-07	1.320E-06
2	GM	Thanatus sp → Thanatus sp	1.000E-07	1.000E-07
2	GM	Tibellus sp → Anthocomus coccineus	4.600E-06	3.180E-06
2	GM	Tibellus sp → Anthocomus coccineus	4.600E-06	3.180E-06
2	GM	Tibellus sp → Chartoscirta cincta	4.600E-06	1.590E-06
2	GM	Tibellus sp → Chrysops relictus	4.600E-06	6.050E-06
2	GM	Tibellus sp → Cloeon simile	4.600E-06	1.200E-06
2	GM	Tibellus sp → Culex sp	4.600E-06	2.500E-07
2	GM	Tibellus sp → Dolomedes sp	4.600E-06	3.360E-06
2	GM	Tibellus sp → Evarcha arcuata	4.600E-06	5.000E-06
2	GM	Tibellus sp → Evarcha sp	4.600E-06	1.100E-06
2	GM	Tibellus sp → Haematopota sp	4.600E-06	9.300E-06
2	GM	Tibellus sp → Herina parva	4.600E-06	4.950E-07
2	GM	Tibellus sp → Ilione albiseta	4.600E-06	6.000E-06
2	GM	Tibellus sp → Limonia sp	4.600E-06	1.000E-07

D	Com	Consumer → Resource	ConSize	ResSize
2	GM	Tibellus sp → Limonia sp	4.600E-06	1.000E-07
2	GM	Tibellus sp → Marpissa radiata	4.600E-06	4.180E-06
2	GM	Tibellus sp → Muscidae copro	4.600E-06	4.500E-07
2	GM	Tibellus sp → Muscidae flor	4.600E-06	4.500E-07
2	GM	Tibellus sp → Ozyptila sp	4.600E-06	1.320E-06
2	GM	Tibellus sp → Philaenus spumarius	4.600E-06	2.400E-06
2	GM	Tibellus sp → Pisaura mirabilis	4.600E-06	8.770E-06
2	GM	Tibellus sp → Psacadina zernyi	4.600E-06	2.300E-06
2	GM	Tibellus sp → Stalia boops	4.600E-06	2.500E-06
2	GM	Tibellus sp → Tetrix sp	4.600E-06	5.800E-06
2	GM	Tibellus sp → Tetrix subulata	4.600E-06	4.600E-06
2	GM	Vulpes vulpes → Caelifera	5.000	6.660E-05
2	GM	Vulpes vulpes → Chorthippus montanus	5.000	6.160E-05
2	GM	Vulpes vulpes → Microtus agrestis	5.000	3.500E-02
2	GM	Vulpes vulpes → Tetrix sp	5.000	5.800E-06
2	GM	Vulpes vulpes → Tetrix subulata	5.000	4.600E-06
2	GM	Zelotes sp → Acupalpus flavicollis	9.370E-06	7.000E-07
2	GM	Zelotes sp → Chartoscirta cincta	9.370E-06	1.590E-06
2	GM	Zelotes sp → Lesteva sicula	9.370E-06	5.000E-07
2	GM	Zelotes sp → Ozyptila sp	9.370E-06	1.320E-06
2	GM	Zelotes sp → Pardosa sp	9.370E-06	2.810E-07
2	GM	Zelotes sp → Pirata sp	9.370E-06	6.670E-07
2	GM	Zora sp → Bryaxis sp	8.280E-08	4.300E-08
2	GM	Zora sp → Chaetarthria seminulum	8.280E-08	1.000E-07
2	GM	Zora sp → Edaphus blühweissi	8.280E-08	2.740E-08
2	SB	Abax parellelopipedus → Phytodecta olivacea	2.540E-04	4.300E-06
2	SB	Abax parellelopipedus → Sitona regensteinensis	2.540E-04	6.250E-06
2	SB	Ablaxis sp. → Phoeophthorus rhododactylus	1.210E-07	4.160E-07
2	SB	Acyrthosiphon pisum → Cytisus scoparius	1.740E-06	7.298E-02
2	SB	Adalia bipunctata → Acyrthosiphon pisum	6.250E-06	1.740E-06
2	SB	Adalia bipunctata → Aphis sarathamni	6.250E-06	1.610E-06
2	SB	Adalia bipunctata → Arytaina genistae	6.250E-06	1.340E-06
2	SB	Adalia bipunctata → Arytaina spartii	6.250E-06	1.340E-06
2	SB	Adalia decempunctata → Acyrthosiphon pisum	5.380E-06	1.740E-06
2	SB	Adalia decempunctata → Aphis sarathamni	5.380E-06	1.610E-06
2	SB	Adalia decempunctata → Arytaina genistae	5.380E-06	1.340E-06
2	SB	Adalia decempunctata → Arytaina spartii	5.380E-06	1.340E-06
2	SB	Anaphes autumnalis → Orthotylus virescens	9.220E-08	5.220E-06
2	SB	Anatis ocellata → Acyrthosiphon pisum	3.310E-05	1.740E-06
2	SB	Anatis ocellata → Aphis sarathamni	3.310E-05	1.610E-06
2	SB	Anatis ocellata → Arytaina genistae	3.310E-05	1.340E-06
2	SB	Anatis ocellata → Arytaina spartii	3.310E-05	1.340E-06
2	SB	Anthocoris nemoralis → Acyrthosiphon pisum	3.240E-06	1.740E-06
2	SB	Anthocoris nemoralis → Aphis sarathamni	3.240E-06	1.610E-06
2	SB	Anthocoris nemoralis → Arytaina genistae	3.240E-06	1.340E-06
2	SB	Anthocoris nemoralis → Arytaina spartii	3.240E-06	1.340E-06
2	SB	Anthocoris nemoralis → Asciodema obsoletum	3.240E-06	4.590E-06
2	SB	Anthocoris nemoralis → Heterocordylus tibialis	3.240E-06	8.020E-06
2	SB	Anthocoris nemoralis → Orthotylus adenocarpi	3.240E-06	5.220E-06
2	SB	Anthocoris nemoralis → Orthotylus concolor	3.240E-06	5.220E-06
2	SB	Anthocoris nemoralis → Orthotylus virescens	3.240E-06	5.220E-06
2	SB	Anthocoris nemoralis → Phytodecta olivacea	3.240E-06	4.300E-06
2	SB	Anthocoris nemorum → Acyrthosiphon pisum	3.240E-06	1.740E-06
2	SB	Anthocoris nemorum → Aphis sarathamni	3.240E-06	1.610E-06
2	SB	Anthocoris nemorum → Arytaina genistae	3.240E-06	1.340E-06
2	SB	Anthocoris nemorum → Arytaina spartii	3.240E-06	1.340E-06
2	SB	Anthocoris nemorum → Asciodema obsoletum	3.240E-06	4.590E-06
2	SB	Anthocoris nemorum → Heterocordylus tibialis	3.240E-06	8.020E-06
2	SB	Anthocoris nemorum → Orthotylus adenocarpi	3.240E-06	5.220E-06
2	SB	Anthocoris nemorum → Orthotylus concolor	3.240E-06	5.220E-06

D	Com	Consumer → Resource	ConSize	ResSize
2	SB	Anthocoris nemorum → Orthotylus virescens	3.240E-06	5.220E-06
2	SB	Anthocoris nemorum → Phytodecta olivacea	3.240E-06	4.300E-06
2	SB	Anthocoris sarothamni → Acyrthosiphon pisum	3.610E-06	1.740E-06
2	SB	Anthocoris sarothamni → Aphis sarathamni	3.610E-06	1.610E-06
2	SB	Anthocoris sarothamni → Arytaina genistae	3.610E-06	1.340E-06
2	SB	Anthocoris sarothamni → Arytaina spartii	3.610E-06	1.340E-06
2	SB	Anthocoris sarothamni → Asciodema obsoletum	3.610E-06	4.590E-06
2	SB	Anthocoris sarothamni → Heterocordylus tibialis	3.610E-06	8.020E-06
2	SB	Anthocoris sarothamni → Orthotylus adenocarpi	3.610E-06	5.220E-06
2	SB	Anthocoris sarothamni → Orthotylus concolor	3.610E-06	5.220E-06
2	SB	Anthocoris sarothamni → Orthotylus virescens	3.610E-06	5.220E-06
2	SB	Anthocoris sarothamni → Phytodecta olivacea	3.610E-06	4.300E-06
2	SB	Anystis baccarum → Asciodema obsoletum	2.180E-07	4.590E-06
2	SB	Anystis baccarum → Bruchidius ater	2.180E-07	1.770E-06
2	SB	Anystis baccarum → Heterocordylus tibialis	2.180E-07	8.020E-06
2	SB	Anystis baccarum → Orthotylus adenocarpi	2.180E-07	5.220E-06
2	SB	Anystis baccarum → Orthotylus concolor	2.180E-07	5.220E-06
2	SB	Anystis baccarum → Orthotylus virescens	2.180E-07	5.220E-06
2	SB	Anystis baccarum → Phytodecta olivacea	2.180E-07	4.300E-06
2	SB	Apanteles fulvipes → Chesias legatella	1.980E-06	4.050E-05
2	SB	Apanteles vitripennis → Chesias legatella	2.310E-06	4.050E-05
2	SB	Apanteles vitripennis → Chesias rufata	2.310E-06	2.360E-04
2	SB	Aphanoginus venustus → Lestodiplosis sp.	1.960E-07	3.510E-07
2	SB	Aphidius sp.1 → Acyrthosiphon pisum	1.200E-06	1.740E-06
2	SB	Aphidius sp.2 → Acyrthosiphon pisum	1.640E-06	1.740E-06
2	SB	Aphis sarathamni → Cytisus scoparius	1.610E-06	7.298E-02
2	SB	Apion fuscirostre → Cytisus scoparius	9.820E-07	7.298E-02
2	SB	Apion immune → Cytisus scoparius	1.270E-06	7.298E-02
2	SB	Aprostocetus brevicornis → Asphondylia sarothamni	9.590E-07	8.490E-07
2	SB	Aprostocetus brevicornis → Trotteria sarothamni	9.590E-07	7.470E-07
2	SB	Aprostocetus sp. nr.aethiops → Contarinia pulchripes	9.590E-07	7.470E-07
2	SB	Aprostocetus tibialis → Habrocytus sequester	5.750E-07	9.470E-07
2	SB	Arytaina genistae → Cytisus scoparius	1.340E-06	7.298E-02
2	SB	Arytaina spartii → Cytisus scoparius	1.340E-06	7.298E-02
2	SB	Asaphes sp. → Acyrthosiphon pisum	4.220E-07	1.740E-06
2	SB	Asaphes sp. → Aphidius sp.1	4.220E-07	1.200E-06
2	SB	Asaphes sp. → Aphidius sp.2	4.220E-07	1.640E-06
2	SB	Asaphes sp. → Ephedrus sp.	4.220E-07	3.500E-07
2	SB	Asaphes sp. → Praon sp.	4.220E-07	7.470E-07
2	SB	Asciodema obsoletum → Acyrthosiphon pisum	4.590E-06	1.740E-06
2	SB	Asciodema obsoletum → Aphis sarathamni	4.590E-06	1.610E-06
2	SB	Asciodema obsoletum → Arytaina genistae	4.590E-06	1.340E-06
2	SB	Asciodema obsoletum → Arytaina spartii	4.590E-06	1.340E-06
2	SB	Asciodema obsoletum → Cytisus scoparius	4.590E-06	7.298E-02
2	SB	Asciodema obsoletum → Orthotylus adenocarpi	4.590E-06	5.220E-06
2	SB	Asciodema obsoletum → Orthotylus concolor	4.590E-06	5.220E-06
2	SB	Asciodema obsoletum → Orthotylus virescens	4.590E-06	5.220E-06
2	SB	Asciodema obsoletum → Phytodecta olivacea	4.590E-06	4.300E-06
2	SB	Asolcus sp.1 → Ptezodoratus lituratus	1.210E-07	1.340E-06
2	SB	Asolcus sp.2 → Ptezodoratus lituratus	1.960E-07	1.340E-06
2	SB	Asphondylia sarothamni → Cytisus scoparius	8.490E-07	7.298E-02
2	SB	Bruchidius ater → Cytisus scoparius	1.770E-06	7.298E-02
2	SB	Centistes excrucians → Sitona regensteinensis	1.020E-06	6.250E-06
2	SB	Charips sp. → Aphidius sp.1	5.670E-07	1.200E-06
2	SB	Charips sp. → Aphidius sp.2	5.670E-07	1.640E-06
2	SB	Charips sp. → Ephedrus sp.	5.670E-07	3.500E-07
2	SB	Charips sp. → Praon sp.	5.670E-07	7.470E-07
2	SB	Cheiropachys colon → Phoeophthorus rhododactylus	2.350E-06	4.160E-07
2	SB	Chesias legatella → Cytisus scoparius	4.050E-05	7.298E-02
2	SB	Chesias rufata → Cytisus scoparius	2.360E-04	7.298E-02

D	Com	Consumer → Resource	ConSize	ResSize
2	SB	Chrysocharis gemma → Leucoptera spartifoliella	7.570E-07	1.020E-06
2	SB	Chrysopa carnea → Acyrthosiphon pisum	1.470E-04	1.740E-06
2	SB	Chrysopa carnea → Aphis sarathamni	1.470E-04	1.610E-06
2	SB	Clinodiplosis sarothamni → Cytisus scoparius	7.470E-07	7.298E-02
2	SB	Coccinella septempunctata → Acyrthosiphon pisum	1.700E-05	1.740E-06
2	SB	Coccinella septempunctata → Aphis sarathamni	1.700E-05	1.610E-06
2	SB	Coccinella septempunctata → Arytaina genistae	1.700E-05	1.340E-06
2	SB	Coccinella septempunctata → Arytaina spartii	1.700E-05	1.340E-06
2	SB	Contarinia pulchripes → Cytisus scoparius	7.470E-07	7.298E-02
2	SB	Deraeocoris ruber → Arytaina genistae	4.590E-06	1.340E-06
2	SB	Deraeocoris ruber → Arytaina spartii	4.590E-06	1.340E-06
2	SB	Diasparsis bidentulus → Halystinus obscurus	1.210E-07	3.510E-07
2	SB	Diasparsis bidentulus → Phoeophthorus rhododactylus	1.210E-07	4.160E-07
2	SB	Diasparsis sp. → Laemophloeus sp.	7.470E-07	2.770E-06
2	SB	Diospilus ephippium → Laemophloeus sp.	7.470E-07	2.770E-06
2	SB	Ectobius lapponicus → Acyrthosiphon pisum	3.840E-05	1.740E-06
2	SB	Ectobius lapponicus → Aphis sarathamni	3.840E-05	1.610E-06
2	SB	Entodon sp. nr.cyanellus → Halystinus obscurus	3.510E-07	3.510E-07
2	SB	Entodon sp. nr.cyanellus → Phoeophthorus rhododactylus	3.510E-07	4.160E-07
2	SB	Ephedrus sp. → Acyrthosiphon pisum	3.500E-07	1.740E-06
2	SB	Erythmelus goochi → Asciodema obsoletum	9.220E-08	4.590E-06
2	SB	Eupelmella vesicularis → Halystinus obscurus	5.670E-07	3.510E-07
2	SB	Eupelmella vesicularis → Phoeophthorus rhododactylus	5.670E-07	4.160E-07
2	SB	Eupelmus urozonus → Habrocytus sequester	6.530E-07	9.470E-07
2	SB	Eupelmus urozonus → Halystinus obscurus	6.530E-07	3.510E-07
2	SB	Eupelmus urozonus → Phoeophthorus rhododactylus	6.530E-07	4.160E-07
2	SB	Eurytoma dentata → Aprostocetus brevicornis	7.470E-07	9.590E-07
2	SB	Eurytoma dentata → Asphondylia sarothamni	7.470E-07	8.490E-07
2	SB	Eurytoma sp. nr.morio → Phoeophthorus rhododactylus	2.350E-06	4.160E-07
2	SB	Evarcha arcuata → Arytaina genistae	1.330E-05	1.340E-06
2	SB	Evarcha arcuata → Arytaina spartii	1.330E-05	1.340E-06
2	SB	Evarcha arcuata → Orthotylus adenocarpi	1.330E-05	5.220E-06
2	SB	Evarcha arcuata → Orthotylus concolor	1.330E-05	5.220E-06
2	SB	Evarcha arcuata → Orthotylus virescens	1.330E-05	5.220E-06
2	SB	Exochomus quadripustulatus → Acyrthosiphon pisum	4.590E-06	1.740E-06
2	SB	Exochomus quadripustulatus → Aphis sarathamni	4.590E-06	1.610E-06
2	SB	Feronia madidus → Phytodecta olivacea	1.470E-04	4.300E-06
2	SB	Feronia madidus → Sitona regensteinensis	1.470E-04	6.250E-06
2	SB	Feronia nigra → Sitona regensteinensis	1.470E-04	6.250E-06
2	SB	Forficula auricularia → Acyrthosiphon pisum	7.300E-05	1.740E-06
2	SB	Forficula auricularia → Aphis sarathamni	7.300E-05	1.610E-06
2	SB	Forficula auricularia → Arytaina genistae	7.300E-05	1.340E-06
2	SB	Forficula auricularia → Arytaina spartii	7.300E-05	1.340E-06
2	SB	Forficula auricularia → Leucoptera spartifoliella	7.300E-05	1.020E-06
2	SB	Forficula auricularia → Phytodecta olivacea	7.300E-05	4.300E-06
2	SB	Fringilla coelebs → Acyrthosiphon pisum	4.274E-02	1.740E-06
2	SB	Fringilla coelebs → Aphis sarathamni	4.274E-02	1.610E-06
2	SB	Fringilla coelebs → Arytaina genistae	4.274E-02	1.340E-06
2	SB	Fringilla coelebs → Arytaina spartii	4.274E-02	1.340E-06
2	SB	Habrocytus sequester → Apion fuscirostre	9.470E-07	9.820E-07
2	SB	Habrocytus sequester → Bruchidius ater	9.470E-07	1.770E-06
2	SB	Halystinus obscurus → Cytisus scoparius	3.510E-07	7.298E-02
2	SB	Halyzia sedecimguttata → Acyrthosiphon pisum	8.240E-06	1.740E-06
2	SB	Halyzia sedecimguttata → Aphis sarathamni	8.240E-06	1.610E-06
2	SB	Harpulus rubripes → Phytodecta olivacea	4.430E-05	4.300E-06
2	SB	Hemerobius sp. → Arytaina genistae	3.840E-05	1.340E-06
2	SB	Hemerobius sp. → Arytaina spartii	3.840E-05	1.340E-06
2	SB	Heterocordylus tibialis → Acyrthosiphon pisum	8.020E-06	1.740E-06
2	SB	Heterocordylus tibialis → Aphis sarathamni	8.020E-06	1.610E-06
2	SB	Heterocordylus tibialis → Arytaina genistae	8.020E-06	1.340E-06

D	Com	Consumer → Resource	ConSize	ResSize
2	SB	Heterocordylus tibialis → Arytaina spartii	8.020E-06	1.340E-06
2	SB	Heterocordylus tibialis → Asciodema obsoletum	8.020E-06	4.590E-06
2	SB	Heterocordylus tibialis → Cytisus scoparius	8.020E-06	7.298E-02
2	SB	Heterocordylus tibialis → Orthotylus adenocarpi	8.020E-06	5.220E-06
2	SB	Heterocordylus tibialis → Orthotylus concolor	8.020E-06	5.220E-06
2	SB	Heterocordylus tibialis → Orthotylus virescens	8.020E-06	5.220E-06
2	SB	Heterocordylus tibialis → Phytodecta olivacea	8.020E-06	4.300E-06
2	SB	Heterotoma merioptera → Acyrthosiphon pisum	8.240E-06	1.740E-06
2	SB	Heterotoma merioptera → Aphis sarathamni	8.240E-06	1.610E-06
2	SB	Heterotoma merioptera → Arytaina genistae	8.240E-06	1.340E-06
2	SB	Heterotoma merioptera → Arytaina spartii	8.240E-06	1.340E-06
2	SB	Heterotoma merioptera → Orthotylus adenocarpi	8.240E-06	5.220E-06
2	SB	Heterotoma merioptera → Orthotylus concolor	8.240E-06	5.220E-06
2	SB	Heterotoma merioptera → Orthotylus virescens	8.240E-06	5.220E-06
2	SB	Heterotoma merioptera → Phytodecta olivacea	8.240E-06	4.300E-06
2	SB	Himacerus apterus → Arytaina genistae	4.190E-05	1.340E-06
2	SB	Himacerus apterus → Arytaina spartii	4.190E-05	1.340E-06
2	SB	Himacerus apterus → Phytodecta olivacea	4.190E-05	4.300E-06
2	SB	Ilyobates nigricollis → Sitona regensteinensis	3.880E-06	6.250E-06
2	SB	Inostemma lycon → Contarinia pulchripes	1.960E-07	7.470E-07
2	SB	Laemophloeus sp. → Halystinus obscurus	2.770E-06	3.510E-07
2	SB	Laemophloeus sp. → Phoeophthorus rhododactylus	2.770E-06	4.160E-07
2	SB	Leiophron apicalis → Asciodema obsoletum	7.470E-07	4.590E-06
2	SB	Leiophron apicalis → Orthotylus adenocarpi	7.470E-07	5.220E-06
2	SB	Leiophron apicalis → Orthotylus concolor	7.470E-07	5.220E-06
2	SB	Leiophron apicalis → Orthotylus virescens	7.470E-07	5.220E-06
2	SB	Leiophron heterocordyli → Asciodema obsoletum	7.470E-07	4.590E-06
2	SB	Leiophron heterocordyli → Heterocordylus tibialis	7.470E-07	8.020E-06
2	SB	Leiophron heterocordyli → Orthotylus adenocarpi	7.470E-07	5.220E-06
2	SB	Leiophron orthotyli → Asciodema obsoletum	7.470E-07	4.590E-06
2	SB	Leiophron orthotyli → Orthotylus adenocarpi	7.470E-07	5.220E-06
2	SB	Leiophron orthotyli → Orthotylus concolor	7.470E-07	5.220E-06
2	SB	Leiophron orthotyli → Orthotylus virescens	7.470E-07	5.220E-06
2	SB	Leistus sp. → Sitona regensteinensis	2.820E-05	6.250E-06
2	SB	Lestodiplosis sp. → Clinodiplosis sarothamni	3.510E-07	7.470E-07
2	SB	Leucoptera spartifoliella → Cytisus scoparius	1.020E-06	7.298E-02
2	SB	Lygocerus sp. → Aphidius sp.1	1.960E-07	1.200E-06
2	SB	Lygocerus sp. → Aphidius sp.2	1.960E-07	1.640E-06
2	SB	Lygocerus sp. → Ephedrus sp.	1.960E-07	3.500E-07
2	SB	Lygocerus sp. → Praon sp.	1.960E-07	7.470E-07
2	SB	Macquartia brevicornis → Phytodecta olivacea	3.840E-05	4.300E-06
2	SB	Meigenia mutabilis → Phytodecta olivacea	3.110E-05	4.300E-06
2	SB	Mesochorus sp. → Microlitis fordi	2.160E-06	4.160E-07
2	SB	Mesopolobus mediterraneus → Habrocytus sequester	4.030E-07	9.470E-07
2	SB	Mesopolobus mediterraneus → Triaspis sp. nr.obscurellus	4.030E-07	7.470E-07
2	SB	Meta segmentata → Arytaina genistae	1.640E-05	1.340E-06
2	SB	Meta segmentata → Arytaina spartii	1.640E-05	1.340E-06
2	SB	Meta segmentata → Asciodema obsoletum	1.640E-05	4.590E-06
2	SB	Meta segmentata → Leucoptera spartifoliella	1.640E-05	1.020E-06
2	SB	Meta segmentata → Orthotylus adenocarpi	1.640E-05	5.220E-06
2	SB	Meta segmentata → Orthotylus concolor	1.640E-05	5.220E-06
2	SB	Meta segmentata → Orthotylus virescens	1.640E-05	5.220E-06
2	SB	Microctonus aethiops/secalis → Apion immune	8.280E-07	1.270E-06
2	SB	Microlitis fordi → Chesias legatella	4.160E-07	4.050E-05
2	SB	Microlitis fordi → Chesias rufata	4.160E-07	2.360E-04
2	SB	Nabis flavomarginatus → Acyrthosiphon pisum	2.820E-05	1.740E-06
2	SB	Nabis flavomarginatus → Aphis sarathamni	2.820E-05	1.610E-06
2	SB	Necremnus metalarus → Leucoptera spartifoliella	4.510E-07	1.020E-06
2	SB	Necremnus sp. → Leucoptera spartifoliella	2.930E-07	1.020E-06
2	SB	Nepiesta sp. → Phytodecta olivacea	7.470E-07	4.300E-06

D	Com	Consumer → Resource	ConSize	ResSize
2	SB	Ocypus compressus → Phytodecta olivacea	3.110E-04	4.300E-06
2	SB	Orthotylus adenocarpi → Acyrthosiphon pisum	5.220E-06	1.740E-06
2	SB	Orthotylus adenocarpi → Aphis sarathamni	5.220E-06	1.610E-06
2	SB	Orthotylus adenocarpi → Arytaina genistae	5.220E-06	1.340E-06
2	SB	Orthotylus adenocarpi → Arytaina spartii	5.220E-06	1.340E-06
2	SB	Orthotylus adenocarpi → Cytisus scoparius	5.220E-06	7.298E-02
2	SB	Orthotylus adenocarpi → Orthotylus concolor	5.220E-06	5.220E-06
2	SB	Orthotylus adenocarpi → Orthotylus virescens	5.220E-06	5.220E-06
2	SB	Orthotylus adenocarpi → Phytodecta olivacea	5.220E-06	4.300E-06
2	SB	Orthotylus concolor → Acyrthosiphon pisum	5.220E-06	1.740E-06
2	SB	Orthotylus concolor → Aphis sarathamni	5.220E-06	1.610E-06
2	SB	Orthotylus concolor → Arytaina genistae	5.220E-06	1.340E-06
2	SB	Orthotylus concolor → Arytaina spartii	5.220E-06	1.340E-06
2	SB	Orthotylus concolor → Cytisus scoparius	5.220E-06	7.298E-02
2	SB	Orthotylus concolor → Phytodecta olivacea	5.220E-06	4.300E-06
2	SB	Orthotylus virescens → Acyrthosiphon pisum	5.220E-06	1.740E-06
2	SB	Orthotylus virescens → Aphis sarathamni	5.220E-06	1.610E-06
2	SB	Orthotylus virescens → Arytaina genistae	5.220E-06	1.340E-06
2	SB	Orthotylus virescens → Arytaina spartii	5.220E-06	1.340E-06
2	SB	Orthotylus virescens → Cytisus scoparius	5.220E-06	7.298E-02
2	SB	Orthotylus virescens → Orthotylus concolor	5.220E-06	5.220E-06
2	SB	Orthotylus virescens → Phytodecta olivacea	5.220E-06	4.300E-06
2	SB	Oxypoda longiuscula → Sitona regensteinensis	2.660E-06	6.250E-06
2	SB	Parus caeruleus → Acyrthosiphon pisum	1.972E-02	1.740E-06
2	SB	Parus caeruleus → Aphis sarathamni	1.972E-02	1.610E-06
2	SB	Parus caeruleus → Arytaina genistae	1.972E-02	1.340E-06
2	SB	Parus caeruleus → Arytaina spartii	1.972E-02	1.340E-06
2	SB	Parus caeruleus → Halystinus obscurus	1.972E-02	3.510E-07
2	SB	Parus caeruleus → Laemophloeus sp.	1.972E-02	2.770E-06
2	SB	Parus caeruleus → Phoeophthorus rhododactylus	1.972E-02	4.160E-07
2	SB	Parus major → Halystinus obscurus	3.381E-02	3.510E-07
2	SB	Parus major → Laemophloeus sp.	3.381E-02	2.770E-06
2	SB	Parus major → Phoeophthorus rhododactylus	3.381E-02	4.160E-07
2	SB	Patasson brachygaster → Orthotylus concolor	9.220E-08	5.220E-06
2	SB	Patasson diana → Sitona regensteinensis	9.220E-08	6.250E-06
2	SB	Pergamasus crassipes → Sitona regensteinensis	1.210E-07	6.250E-06
2	SB	Perilitus dubius → Phytodecta olivacea	7.470E-07	4.300E-06
2	SB	Phaenobremia sp. → Acyrthosiphon pisum	1.340E-06	1.740E-06
2	SB	Phaenobremia sp. → Aphis sarathamni	1.340E-06	1.610E-06
2	SB	Philodromus aurelolus → Arytaina genistae	8.240E-06	1.340E-06
2	SB	Philodromus aurelolus → Arytaina spartii	8.240E-06	1.340E-06
2	SB	Philodromus aurelolus → Leucoptera spartifoliella	8.240E-06	1.020E-06
2	SB	Philodromus aurelolus → Orthotylus adenocarpi	8.240E-06	5.220E-06
2	SB	Philodromus aurelolus → Orthotylus concolor	8.240E-06	5.220E-06
2	SB	Philodromus aurelolus → Orthotylus virescens	8.240E-06	5.220E-06
2	SB	Philonthus politus → Sitona regensteinensis	8.620E-05	6.250E-06
2	SB	Phoeophthorus rhododactylus → Cytisus scoparius	4.160E-07	7.298E-02
2	SB	Phoridae sp. → Chesias legatella	4.590E-06	4.050E-05
2	SB	Phoridae sp. → Chesias rufata	4.590E-06	2.360E-04
2	SB	Phytodecta olivacea → Cytisus scoparius	4.300E-06	7.298E-02
2	SB	Pisaura mirabilis → Arytaina genistae	1.110E-04	1.340E-06
2	SB	Pisaura mirabilis → Arytaina spartii	1.110E-04	1.340E-06
2	SB	Pisaura mirabilis → Orthotylus adenocarpi	1.110E-04	5.220E-06
2	SB	Pisaura mirabilis → Orthotylus concolor	1.110E-04	5.220E-06
2	SB	Pisaura mirabilis → Orthotylus virescens	1.110E-04	5.220E-06
2	SB	Plagiognathus arbustorum → Acyrthosiphon pisum	4.960E-06	1.740E-06
2	SB	Plagiognathus arbustorum → Aphis sarathamni	4.960E-06	1.610E-06
2	SB	Plagiognathus arbustorum → Arytaina genistae	4.960E-06	1.340E-06
2	SB	Plagiognathus arbustorum → Arytaina spartii	4.960E-06	1.340E-06
2	SB	Platybunus triangularis → Phytodecta olivacea	9.830E-06	4.300E-06

D	Com	Consumer → Resource	ConSize	ResSize
2	SB	Platycheirus scutatus → Acyrthosiphon pisum	2.380E-05	1.740E-06
2	SB	Platycheirus scutatus → Aphis sarathamni	2.380E-05	1.610E-06
2	SB	Platygaster sp. → Clinodiplosis sarothamni	1.960E-07	7.470E-07
2	SB	Platygerrhus dolosus → Laemophloeus sp.	2.420E-07	2.770E-06
2	SB	Praon sp. → Acyrthosiphon pisum	7.470E-07	1.740E-06
2	SB	Pringalio soemias → Leucoptera spartifoliella	7.760E-07	1.020E-06
2	SB	Prionomitus mitratus → Arytaina genistae	4.160E-07	1.340E-06
2	SB	Propylea quatuordecimpunctata → Acyrthosiphon pisum	4.590E-06	1.740E-06
2	SB	Propylea quatuordecimpunctata → Aphis sarathamni	4.590E-06	1.610E-06
2	SB	Propylea quatuordecimpunctata → Arytaina genistae	4.590E-06	1.340E-06
2	SB	Propylea quatuordecimpunctata → Arytaina spartii	4.590E-06	1.340E-06
2	SB	Prunella modularis → Acyrthosiphon pisum	2.200E-02	1.740E-06
2	SB	Prunella modularis → Aphis sarathamni	2.200E-02	1.610E-06
2	SB	Prunella modularis → Arytaina genistae	2.200E-02	1.340E-06
2	SB	Prunella modularis → Arytaina spartii	2.200E-02	1.340E-06
2	SB	Pseudocatolaccus thoracicus → Asphondylia sarothamni	1.960E-07	8.490E-07
2	SB	Ptezodoratus lituratus → Cytisus scoparius	1.340E-06	7.298E-02
2	SB	Raphitelus maculatus → Phoeophthorus rhododactylus	1.960E-07	4.160E-07
2	SB	Rhagonycha elongata → Acyrthosiphon pisum	1.990E-05	1.740E-06
2	SB	Rhagonycha elongata → Aphis sarathamni	1.990E-05	1.610E-06
2	SB	Sitona regensteinensis → Cytisus scoparius	6.250E-06	7.298E-02
2	SB	Spathius rubidus → Halystinus obscurus	3.240E-06	3.510E-07
2	SB	Spathius rubidus → Phoeophthorus rhododactylus	3.240E-06	4.160E-07
2	SB	Staphylinus sp. → Sitona regensteinensis	6.500E-05	6.250E-06
2	SB	Stenus sp. → Sitona regensteinensis	8.240E-06	6.250E-06
2	SB	Sylvia curruca → Acyrthosiphon pisum	1.250E-02	1.740E-06
2	SB	Sylvia curruca → Aphis sarathamni	1.250E-02	1.610E-06
2	SB	Sylvia curruca → Arytaina genistae	1.250E-02	1.340E-06
2	SB	Sylvia curruca → Arytaina spartii	1.250E-02	1.340E-06
2	SB	Syrphus calteatus → Acyrthosiphon pisum	7.300E-05	1.740E-06
2	SB	Syrphus calteatus → Aphis sarathamni	7.300E-05	1.610E-06
2	SB	Syrphus luniger → Acyrthosiphon pisum	6.500E-05	1.740E-06
2	SB	Syrphus luniger → Aphis sarathamni	6.500E-05	1.610E-06
2	SB	Syrphus vitripennis → Acyrthosiphon pisum	8.160E-05	1.740E-06
2	SB	Syrphus vitripennis → Aphis sarathamni	8.160E-05	1.610E-06
2	SB	Systasis encyrtoides → Contarinia pulchripes	1.210E-07	7.470E-07
2	SB	Tachynus rufipes → Sitona regensteinensis	1.160E-05	6.250E-06
2	SB	Telenomus sp.1 → Ptezodoratus lituratus	2.420E-07	1.340E-06
2	SB	Telenomus sp.2 → Ptezodoratus lituratus	2.670E-07	1.340E-06
2	SB	Tetrastichus sp. nr.attalus → Halystinus obscurus	4.160E-07	3.510E-07
2	SB	Tetrastichus sp. nr.attalus → Phoeophthorus rhododactylus	4.160E-07	4.160E-07
2	SB	Tetrastichus sp. nr.attalus → Raphitelus maculatus	4.160E-07	1.960E-07
2	SB	Tetrastichus sp. nr.flavovarius → Phoeophthorus rhododactylus	4.160E-07	4.160E-07
2	SB	Tetrastichus sp. nr.flavovarius → Raphitelus maculatus	4.160E-07	1.960E-07
2	SB	Tetrastichus sp. nr.glactopus → Leucoptera spartifoliella	4.160E-07	1.020E-06
2	SB	Tetrastichus sp. → Phytodecta olivacea	4.160E-07	4.300E-06
2	SB	Theridion (Enoplognatha) ovatum → Orthotylus adenocarpi	1.060E-05	5.220E-06
2	SB	Theridion (Enoplognatha) ovatum → Orthotylus concolor	1.060E-05	5.220E-06
2	SB	Theridion (Enoplognatha) ovatum → Orthotylus virescens	1.060E-05	5.220E-06
2	SB	Theridion redimitum → Arytaina spartii	1.060E-05	1.340E-06
2	SB	Torymus sp. nr.micropterus → Habrocytus sequester	1.210E-07	9.470E-07
2	SB	Torymus sp. nr.microstigma → Aprostocetus brevicornis	1.210E-07	9.590E-07
2	SB	Torymus sp. nr.microstigma → Habrocytus sequester	1.210E-07	9.470E-07
2	SB	Torymus sp. nr.microstigma → Trotteria sarothamni	1.210E-07	7.470E-07
2	SB	Triaspis sp. nr.obscurellus → Bruchidius ater	7.470E-07	1.770E-06
2	SB	Trichogramma sp.1 → Bruchidius ater	6.770E-08	1.770E-06
2	SB	Trichogramma sp.2 → Phytodecta olivacea	9.220E-08	4.300E-06
2	SB	Trotteria sarothamni → Cytisus scoparius	7.470E-07	7.298E-02
2	SB	Xantholinus linearis → Arytaina genistae	2.380E-05	1.340E-06
2	SB	Xantholinus linearis → Sitona regensteinensis	2.380E-05	6.250E-06

D	Com	Consumer → Resource	ConSize	ResSize
2	SB	Xysticus audax → Asciodema obsoletum	1.060E-05	4.590E-06
2	SB	Xysticus audax → Orthotylus adenocarpi	1.060E-05	5.220E-06
2	SB	Xysticus audax → Orthotylus concolor	1.060E-05	5.220E-06
2	SB	Xysticus audax → Orthotylus virescens	1.060E-05	5.220E-06
2	SB	Xysticus cristatus → Arytaina genistae	1.390E-05	1.340E-06
2	SB	Xysticus cristatus → Arytaina spartii	1.390E-05	1.340E-06
2	SB	Xysticus cristatus → Asciodema obsoletum	1.390E-05	4.590E-06
2	SB	Xysticus cristatus → Leucoptera spartifoliella	1.390E-05	1.020E-06
2	SB	Xysticus cristatus → Orthotylus adenocarpi	1.390E-05	5.220E-06
2	SB	Xysticus cristatus → Orthotylus concolor	1.390E-05	5.220E-06
2	SB	Xysticus cristatus → Orthotylus virescens	1.390E-05	5.220E-06
2	SB	Xysticus cristatus → Phytodecta olivacea	1.390E-05	4.300E-06
2	SP	Aeshna juncea → Acanthocyclops vernalis	2.700E-04	6.410E-08
2	SP	Aeshna juncea → Agabus bipustulatus	2.700E-04	6.120E-05
2	SP	Aeshna juncea → Agabus sturmii	2.700E-04	2.820E-05
2	SP	Aeshna juncea → Arctocorisa germari	2.700E-04	2.180E-05
2	SP	Aeshna juncea → Argyroneta aquatica	2.700E-04	2.720E-05
2	SP	Aeshna juncea → Callicorixa praeusta	2.700E-04	1.990E-05
2	SP	Aeshna juncea → Chironomus dorsalis	2.700E-04	1.470E-05
2	SP	Aeshna juncea → Chydorus latus	2.700E-04	5.850E-09
2	SP	Aeshna juncea → Corixa dentipes	2.700E-04	9.670E-05
2	SP	Aeshna juncea → Corixa punctata	2.700E-04	9.280E-05
2	SP	Aeshna juncea → Corynoneura scutellata	2.700E-04	8.590E-07
2	SP	Aeshna juncea → Enallagma cyathigerum	2.700E-04	7.280E-06
2	SP	Aeshna juncea → Enchytraidae sp.	2.700E-04	6.000E-08
2	SP	Aeshna juncea → Glyptotendipes pallens	2.700E-04	7.730E-06
2	SP	Aeshna juncea → Hesperocorixa linnei	2.700E-04	2.060E-05
2	SP	Aeshna juncea → Hesperocorixa sahlbergi	2.700E-04	2.140E-05
2	SP	Aeshna juncea → Holocentropus picicornis	2.700E-04	1.060E-05
2	SP	Aeshna juncea → Hydroporus erythrocephalus	2.700E-04	4.740E-06
2	SP	Aeshna juncea → Illybius fuliginosus	2.700E-04	6.500E-05
2	SP	Aeshna juncea → Lestes sponsa	2.700E-04	7.810E-05
2	SP	Aeshna juncea → Limnephilus marmoratus	2.700E-04	8.080E-05
2	SP	Aeshna juncea → Lumbriculus variegatus	2.700E-04	8.000E-06
2	SP	Aeshna juncea → Notonecta glauca	2.700E-04	1.440E-04
2	SP	Aeshna juncea → Other Chironomidae spp.	2.700E-04	3.820E-06
2	SP	Aeshna juncea → Procladius sagittalis	2.700E-04	4.410E-06
2	SP	Aeshna juncea → Scapaloberis mucronata	2.700E-04	3.210E-08
2	SP	Aeshna juncea → Sialis lutaria	2.700E-04	5.250E-05
2	SP	Aeshna juncea → Sigara semistriata	2.700E-04	1.220E-05
2	SP	Aeshna juncea → Sympetrum scoticum	2.700E-04	8.430E-05
2	SP	Aeshna juncea → Tanytarsus bruchonidae	2.700E-04	1.300E-06
2	SP	Agabus bipustulatus → Agabus sturmii	6.120E-05	2.820E-05
2	SP	Agabus bipustulatus → Arctocorisa germari	6.120E-05	2.180E-05
2	SP	Agabus bipustulatus → Callicorixa praeusta	6.120E-05	1.990E-05
2	SP	Agabus bipustulatus → Chironomus dorsalis	6.120E-05	1.470E-05
2	SP	Agabus bipustulatus → Corixa dentipes	6.120E-05	9.670E-05
2	SP	Agabus bipustulatus → Corixa punctata	6.120E-05	9.280E-05
2	SP	Agabus bipustulatus → Corynoneura scutellata	6.120E-05	8.590E-07
2	SP	Agabus bipustulatus → Enallagma cyathigerum	6.120E-05	7.280E-06
2	SP	Agabus bipustulatus → Enchytraidae sp.	6.120E-05	6.000E-08
2	SP	Agabus bipustulatus → Glyptotendipes pallens	6.120E-05	7.730E-06
2	SP	Agabus bipustulatus → Hesperocorixa linnei	6.120E-05	2.060E-05
2	SP	Agabus bipustulatus → Hesperocorixa sahlbergi	6.120E-05	2.140E-05
2	SP	Agabus bipustulatus → Holocentropus picicornis	6.120E-05	1.060E-05
2	SP	Agabus bipustulatus → Hydroporus erythrocephalus	6.120E-05	4.740E-06
2	SP	Agabus bipustulatus → Limnephilus marmoratus	6.120E-05	8.080E-05
2	SP	Agabus bipustulatus → Lumbriculus variegatus	6.120E-05	8.000E-06
2	SP	Agabus bipustulatus → Other Chironomidae spp.	6.120E-05	3.820E-06
2	SP	Agabus bipustulatus → Procladius sagittalis	6.120E-05	4.410E-06

D	Com	Consumer → Resource	ConSize	ResSize
2	SP	Agabus bipustulatus → Sialis lutaria	6.120E-05	5.250E-05
2	SP	Agabus bipustulatus → Sigara semistriata	6.120E-05	1.220E-05
2	SP	Agabus bipustulatus → Tanytarsus bruchonidae	6.120E-05	1.300E-06
2	SP	Agabus sturmii → Arctocorisa germari	2.820E-05	2.180E-05
2	SP	Agabus sturmii → Callicorixa praeusta	2.820E-05	1.990E-05
2	SP	Agabus sturmii → Chironomus dorsalis	2.820E-05	1.470E-05
2	SP	Agabus sturmii → Corixa dentipes	2.820E-05	9.670E-05
2	SP	Agabus sturmii → Corixa punctata	2.820E-05	9.280E-05
2	SP	Agabus sturmii → Corynoneura scutellata	2.820E-05	8.590E-07
2	SP	Agabus sturmii → Enallagma cyathigerum	2.820E-05	7.280E-06
2	SP	Agabus sturmii → Enchytraidae sp.	2.820E-05	6.000E-08
2	SP	Agabus sturmii → Glyptotendipes pallens	2.820E-05	7.730E-06
2	SP	Agabus sturmii → Hesperocorixa linnei	2.820E-05	2.060E-05
2	SP	Agabus sturmii → Hesperocorixa sahlbergi	2.820E-05	2.140E-05
2	SP	Agabus sturmii → Holocentropus picicornis	2.820E-05	1.060E-05
2	SP	Agabus sturmii → Hydroporus erythrocephalus	2.820E-05	4.740E-06
2	SP	Agabus sturmii → Limnephilus marmoratus	2.820E-05	8.080E-05
2	SP	Agabus sturmii → Lumbriculus variegatus	2.820E-05	8.000E-06
2	SP	Agabus sturmii → Other Chironomidae spp.	2.820E-05	3.820E-06
2	SP	Agabus sturmii → Procladius sagittalis	2.820E-05	4.410E-06
2	SP	Agabus sturmii → Sialis lutaria	2.820E-05	5.250E-05
2	SP	Agabus sturmii → Sigara semistriata	2.820E-05	1.220E-05
2	SP	Agabus sturmii → Tanytarsus bruchonidae	2.820E-05	1.300E-06
2	SP	Argyroneta aquatica → Arctocorisa germari	2.720E-05	2.180E-05
2	SP	Argyroneta aquatica → Callicorixa praeusta	2.720E-05	1.990E-05
2	SP	Argyroneta aquatica → Chironomus dorsalis	2.720E-05	1.470E-05
2	SP	Argyroneta aquatica → Corixa dentipes	2.720E-05	9.670E-05
2	SP	Argyroneta aquatica → Corixa punctata	2.720E-05	9.280E-05
2	SP	Argyroneta aquatica → Corynoneura scutellata	2.720E-05	8.590E-07
2	SP	Argyroneta aquatica → Glyptotendipes pallens	2.720E-05	7.730E-06
2	SP	Argyroneta aquatica → Hesperocorixa linnei	2.720E-05	2.060E-05
2	SP	Argyroneta aquatica → Hesperocorixa sahlbergi	2.720E-05	2.140E-05
2	SP	Argyroneta aquatica → Holocentropus picicornis	2.720E-05	1.060E-05
2	SP	Argyroneta aquatica → Limnephilus marmoratus	2.720E-05	8.080E-05
2	SP	Argyroneta aquatica → Lumbriculus variegatus	2.720E-05	8.000E-06
2	SP	Argyroneta aquatica → Other Chironomidae spp.	2.720E-05	3.820E-06
2	SP	Argyroneta aquatica → Procladius sagittalis	2.720E-05	4.410E-06
2	SP	Argyroneta aquatica → Sigara semistriata	2.720E-05	1.220E-05
2	SP	Argyroneta aquatica → Tanytarsus bruchonidae	2.720E-05	1.300E-06
2	SP	Callicorixa praeusta → Chironomus dorsalis	1.990E-05	1.470E-05
2	SP	Callicorixa praeusta → Corynoneura scutellata	1.990E-05	8.590E-07
2	SP	Callicorixa praeusta → Glyptotendipes pallens	1.990E-05	7.730E-06
2	SP	Callicorixa praeusta → Other Chironomidae spp.	1.990E-05	3.820E-06
2	SP	Callicorixa praeusta → Procladius sagittalis	1.990E-05	4.410E-06
2	SP	Callicorixa praeusta → Tanytarsus bruchonidae	1.990E-05	1.300E-06
2	SP	Dytiscus marginalis → Aeshna juncea	5.020E-04	2.700E-04
2	SP	Dytiscus marginalis → Agabus bipustulatus	5.020E-04	6.120E-05
2	SP	Dytiscus marginalis → Agabus sturmii	5.020E-04	2.820E-05
2	SP	Dytiscus marginalis → Arctocorisa germari	5.020E-04	2.180E-05
2	SP	Dytiscus marginalis → Callicorixa praeusta	5.020E-04	1.990E-05
2	SP	Dytiscus marginalis → Chironomus dorsalis	5.020E-04	1.470E-05
2	SP	Dytiscus marginalis → Corixa dentipes	5.020E-04	9.670E-05
2	SP	Dytiscus marginalis → Corixa punctata	5.020E-04	9.280E-05
2	SP	Dytiscus marginalis → Corynoneura scutellata	5.020E-04	8.590E-07
2	SP	Dytiscus marginalis → Enallagma cyathigerum	5.020E-04	7.280E-06
2	SP	Dytiscus marginalis → Glyptotendipes pallens	5.020E-04	7.730E-06
2	SP	Dytiscus marginalis → Hesperocorixa linnei	5.020E-04	2.060E-05
2	SP	Dytiscus marginalis → Hesperocorixa sahlbergi	5.020E-04	2.140E-05
2	SP	Dytiscus marginalis → Holocentropus picicornis	5.020E-04	1.060E-05
2	SP	Dytiscus marginalis → Hydroporus erythrocephalus	5.020E-04	4.740E-06

D	Com	Consumer → Resource	ConSize	ResSize
2	SP	Dytiscus marginalis → Illybius fuliginosus	5.020E-04	6.500E-05
2	SP	Dytiscus marginalis → Lestes sponsa	5.020E-04	7.810E-05
2	SP	Dytiscus marginalis → Limnephilus marmoratus	5.020E-04	8.080E-05
2	SP	Dytiscus marginalis → Lumbriculus variegatus	5.020E-04	8.000E-06
2	SP	Dytiscus marginalis → Notonecta glauca	5.020E-04	1.440E-04
2	SP	Dytiscus marginalis → Other Chironomidae spp.	5.020E-04	3.820E-06
2	SP	Dytiscus marginalis → Procladius sagittalis	5.020E-04	4.410E-06
2	SP	Dytiscus marginalis → Sialis lutaria	5.020E-04	5.250E-05
2	SP	Dytiscus marginalis → Sigara semistriata	5.020E-04	1.220E-05
2	SP	Dytiscus marginalis → Sympetrum scoticum	5.020E-04	8.430E-05
2	SP	Dytiscus marginalis → Tanytarsus bruchonidae	5.020E-04	1.300E-06
2	SP	Enallagma cyathigerum → Arctocorisa germari	7.280E-06	2.180E-05
2	SP	Enallagma cyathigerum → Callicorixa praeusta	7.280E-06	1.990E-05
2	SP	Enallagma cyathigerum → Chironomus dorsalis	7.280E-06	1.470E-05
2	SP	Enallagma cyathigerum → Corixa dentipes	7.280E-06	9.670E-05
2	SP	Enallagma cyathigerum → Corixa punctata	7.280E-06	9.280E-05
2	SP	Enallagma cyathigerum → Corynoneura scutellata	7.280E-06	8.590E-07
2	SP	Enallagma cyathigerum → Enchytraidae sp.	7.280E-06	6.000E-08
2	SP	Enallagma cyathigerum → Glyptotendipes pallens	7.280E-06	7.730E-06
2	SP	Enallagma cyathigerum → Hesperocorixa linnei	7.280E-06	2.060E-05
2	SP	Enallagma cyathigerum → Hesperocorixa sahlbergi	7.280E-06	2.140E-05
2	SP	Enallagma cyathigerum → Hydroporus erythrocephalus	7.280E-06	4.740E-06
2	SP	Enallagma cyathigerum → Lumbriculus variegatus	7.280E-06	8.000E-06
2	SP	Enallagma cyathigerum → Other Chironomidae spp.	7.280E-06	3.820E-06
2	SP	Enallagma cyathigerum → Procladius sagittalis	7.280E-06	4.410E-06
2	SP	Enallagma cyathigerum → Sialis lutaria	7.280E-06	5.250E-05
2	SP	Enallagma cyathigerum → Sigara semistriata	7.280E-06	1.220E-05
2	SP	Enallagma cyathigerum → Tanytarsus bruchonidae	7.280E-06	1.300E-06
2	SP	Holocentropus picicornis → Arctocorisa germari	1.060E-05	2.180E-05
2	SP	Holocentropus picicornis → Callicorixa praeusta	1.060E-05	1.990E-05
2	SP	Holocentropus picicornis → Chironomus dorsalis	1.060E-05	1.470E-05
2	SP	Holocentropus picicornis → Corixa dentipes	1.060E-05	9.670E-05
2	SP	Holocentropus picicornis → Corixa punctata	1.060E-05	9.280E-05
2	SP	Holocentropus picicornis → Corynoneura scutellata	1.060E-05	8.590E-07
2	SP	Holocentropus picicornis → Enchytraidae sp.	1.060E-05	6.000E-08
2	SP	Holocentropus picicornis → Glyptotendipes pallens	1.060E-05	7.730E-06
2	SP	Holocentropus picicornis → Hesperocorixa linnei	1.060E-05	2.060E-05
2	SP	Holocentropus picicornis → Hesperocorixa sahlbergi	1.060E-05	2.140E-05
2	SP	Holocentropus picicornis → Hydroporus erythrocephalus	1.060E-05	4.740E-06
2	SP	Holocentropus picicornis → Other Chironomidae spp.	1.060E-05	3.820E-06
2	SP	Holocentropus picicornis → Procladius sagittalis	1.060E-05	4.410E-06
2	SP	Holocentropus picicornis → Sigara semistriata	1.060E-05	1.220E-05
2	SP	Holocentropus picicornis → Tanytarsus bruchonidae	1.060E-05	1.300E-06
2	SP	Hydroporus erythrocephalus → Chironomus dorsalis	4.740E-06	1.470E-05
2	SP	Hydroporus erythrocephalus → Corynoneura scutellata	4.740E-06	8.590E-07
2	SP	Hydroporus erythrocephalus → Enchytraidae sp.	4.740E-06	6.000E-08
2	SP	Hydroporus erythrocephalus → Glyptotendipes pallens	4.740E-06	7.730E-06
2	SP	Hydroporus erythrocephalus → Other Chironomidae spp.	4.740E-06	3.820E-06
2	SP	Hydroporus erythrocephalus → Procladius sagittalis	4.740E-06	4.410E-06
2	SP	Hydroporus erythrocephalus → Tanytarsus bruchonidae	4.740E-06	1.300E-06
2	SP	Illybius fuliginosus → Agabus bipustulatus	6.500E-05	6.120E-05
2	SP	Illybius fuliginosus → Agabus sturmii	6.500E-05	2.820E-05
2	SP	Illybius fuliginosus → Arctocorisa germari	6.500E-05	2.180E-05
2	SP	Illybius fuliginosus → Callicorixa praeusta	6.500E-05	1.990E-05
2	SP	Illybius fuliginosus → Chironomus dorsalis	6.500E-05	1.470E-05
2	SP	Illybius fuliginosus → Corixa dentipes	6.500E-05	9.670E-05
2	SP	Illybius fuliginosus → Corixa punctata	6.500E-05	9.280E-05
2	SP	Illybius fuliginosus → Corynoneura scutellata	6.500E-05	8.590E-07
2	SP	Illybius fuliginosus → Enallagma cyathigerum	6.500E-05	7.280E-06
2	SP	Illybius fuliginosus → Enchytraidae sp.	6.500E-05	6.000E-08

D	Com	Consumer → Resource	ConSize	ResSize
2	SP	Illybius fuliginosus → Glyptotendipes pallens	6.500E-05	7.730E-06
2	SP	Illybius fuliginosus → Hesperocorixa linnei	6.500E-05	2.060E-05
2	SP	Illybius fuliginosus → Hesperocorixa sahlbergi	6.500E-05	2.140E-05
2	SP	Illybius fuliginosus → Holocentropus picicornis	6.500E-05	1.060E-05
2	SP	Illybius fuliginosus → Hydroporus erythrocephalus	6.500E-05	4.740E-06
2	SP	Illybius fuliginosus → Limnephilus marmoratus	6.500E-05	8.080E-05
2	SP	Illybius fuliginosus → Lumbriculus variegatus	6.500E-05	8.000E-06
2	SP	Illybius fuliginosus → Other Chironomidae spp.	6.500E-05	3.820E-06
2	SP	Illybius fuliginosus → Procladius sagittalis	6.500E-05	4.410E-06
2	SP	Illybius fuliginosus → Sialis lutaria	6.500E-05	5.250E-05
2	SP	Illybius fuliginosus → Sigara semistriata	6.500E-05	1.220E-05
2	SP	Illybius fuliginosus → Tanytarsus bruchonidae	6.500E-05	1.300E-06
2	SP	Lestes sponsa → Agabus bipustulatus	7.810E-05	6.120E-05
2	SP	Lestes sponsa → Agabus sturmii	7.810E-05	2.820E-05
2	SP	Lestes sponsa → Arctocorisa germari	7.810E-05	2.180E-05
2	SP	Lestes sponsa → Callicorixa praeusta	7.810E-05	1.990E-05
2	SP	Lestes sponsa → Chironomus dorsalis	7.810E-05	1.470E-05
2	SP	Lestes sponsa → Corixa dentipes	7.810E-05	9.670E-05
2	SP	Lestes sponsa → Corixa punctata	7.810E-05	9.280E-05
2	SP	Lestes sponsa → Corynoneura scutellata	7.810E-05	8.590E-07
2	SP	Lestes sponsa → Enallagma cyathigerum	7.810E-05	7.280E-06
2	SP	Lestes sponsa → Enchytraidae sp.	7.810E-05	6.000E-08
2	SP	Lestes sponsa → Glyptotendipes pallens	7.810E-05	7.730E-06
2	SP	Lestes sponsa → Hesperocorixa linnei	7.810E-05	2.060E-05
2	SP	Lestes sponsa → Hesperocorixa sahlbergi	7.810E-05	2.140E-05
2	SP	Lestes sponsa → Hydroporus erythrocephalus	7.810E-05	4.740E-06
2	SP	Lestes sponsa → Illybius fuliginosus	7.810E-05	6.500E-05
2	SP	Lestes sponsa → Lumbriculus variegatus	7.810E-05	8.000E-06
2	SP	Lestes sponsa → Other Chironomidae spp.	7.810E-05	3.820E-06
2	SP	Lestes sponsa → Procladius sagittalis	7.810E-05	4.410E-06
2	SP	Lestes sponsa → Sialis lutaria	7.810E-05	5.250E-05
2	SP	Lestes sponsa → Sigara semistriata	7.810E-05	1.220E-05
2	SP	Lestes sponsa → Tanytarsus bruchonidae	7.810E-05	1.300E-06
2	SP	Limnephilus marmoratus → Chironomus dorsalis	8.080E-05	1.470E-05
2	SP	Limnephilus marmoratus → Corynoneura scutellata	8.080E-05	8.590E-07
2	SP	Limnephilus marmoratus → Enchytraidae sp.	8.080E-05	6.000E-08
2	SP	Limnephilus marmoratus → Glyptotendipes pallens	8.080E-05	7.730E-06
2	SP	Limnephilus marmoratus → Lumbriculus variegatus	8.080E-05	8.000E-06
2	SP	Limnephilus marmoratus → Other Chironomidae spp.	8.080E-05	3.820E-06
2	SP	Limnephilus marmoratus → Tanytarsus bruchonidae	8.080E-05	1.300E-06
2	SP	Polycelis tenuis → Chironomus dorsalis	4.000E-06	1.470E-05
2	SP	Polycelis tenuis → Corynoneura scutellata	4.000E-06	8.590E-07
2	SP	Polycelis tenuis → Enchytraidae sp.	4.000E-06	6.000E-08
2	SP	Polycelis tenuis → Glyptotendipes pallens	4.000E-06	7.730E-06
2	SP	Polycelis tenuis → Lumbriculus variegatus	4.000E-06	8.000E-06
2	SP	Polycelis tenuis → Other Chironomidae spp.	4.000E-06	3.820E-06
2	SP	Polycelis tenuis → Procladius sagittalis	4.000E-06	4.410E-06
2	SP	Polycelis tenuis → Tanytarsus bruchonidae	4.000E-06	1.300E-06
2	SP	Procladius sagittalis → Chironomus dorsalis	4.410E-06	1.470E-05
2	SP	Procladius sagittalis → Corynoneura scutellata	4.410E-06	8.590E-07
2	SP	Procladius sagittalis → Enchytraidae sp.	4.410E-06	6.000E-08
2	SP	Procladius sagittalis → Glyptotendipes pallens	4.410E-06	7.730E-06
2	SP	Procladius sagittalis → Other Chironomidae spp.	4.410E-06	3.820E-06
2	SP	Procladius sagittalis → Tanytarsus bruchonidae	4.410E-06	1.300E-06
2	SP	Sialis lutaria → Acanthocyclops vernalis	5.250E-05	6.410E-08
2	SP	Sialis lutaria → Arctocorisa germari	5.250E-05	2.180E-05
2	SP	Sialis lutaria → Callicorixa praeusta	5.250E-05	1.990E-05
2	SP	Sialis lutaria → Chironomus dorsalis	5.250E-05	1.470E-05
2	SP	Sialis lutaria → Chydorus latus	5.250E-05	5.850E-09
2	SP	Sialis lutaria → Corixa dentipes	5.250E-05	9.670E-05

D	Com	Consumer → Resource	ConSize	ResSize
2	SP	Sialis lutaria → Corixa punctata	5.250E-05	9.280E-05
2	SP	Sialis lutaria → Corynoneura scutellata	5.250E-05	8.590E-07
2	SP	Sialis lutaria → Enchytraidae sp.	5.250E-05	6.000E-08
2	SP	Sialis lutaria → Glyptotendipes pallens	5.250E-05	7.730E-06
2	SP	Sialis lutaria → Hesperocorixa linnei	5.250E-05	2.060E-05
2	SP	Sialis lutaria → Hesperocorixa sahlbergi	5.250E-05	2.140E-05
2	SP	Sialis lutaria → Hydroporus erythrocephalus	5.250E-05	4.740E-06
2	SP	Sialis lutaria → Lumbriculus variegatus	5.250E-05	8.000E-06
2	SP	Sialis lutaria → Other Chironomidae spp.	5.250E-05	3.820E-06
2	SP	Sialis lutaria → Procladius sagittalis	5.250E-05	4.410E-06
2	SP	Sialis lutaria → Scapaloberis mucronata	5.250E-05	3.210E-08
2	SP	Sialis lutaria → Sigara semistriata	5.250E-05	1.220E-05
2	SP	Sialis lutaria → Tanytarsus bruchonidae	5.250E-05	1.300E-06
2	SP	Sympetrum scoticum → Agabus bipustulatus	8.430E-05	6.120E-05
2	SP	Sympetrum scoticum → Agabus sturmii	8.430E-05	2.820E-05
2	SP	Sympetrum scoticum → Arctocorisa germari	8.430E-05	2.180E-05
2	SP	Sympetrum scoticum → Argyroneta aquatica	8.430E-05	2.720E-05
2	SP	Sympetrum scoticum → Callicorixa praeusta	8.430E-05	1.990E-05
2	SP	Sympetrum scoticum → Chironomus dorsalis	8.430E-05	1.470E-05
2	SP	Sympetrum scoticum → Corixa dentipes	8.430E-05	9.670E-05
2	SP	Sympetrum scoticum → Corixa punctata	8.430E-05	9.280E-05
2	SP	Sympetrum scoticum → Corynoneura scutellata	8.430E-05	8.590E-07
2	SP	Sympetrum scoticum → Enallagma cyathigerum	8.430E-05	7.280E-06
2	SP	Sympetrum scoticum → Enchytraidae sp.	8.430E-05	6.000E-08
2	SP	Sympetrum scoticum → Glyptotendipes pallens	8.430E-05	7.730E-06
2	SP	Sympetrum scoticum → Hesperocorixa linnei	8.430E-05	2.060E-05
2	SP	Sympetrum scoticum → Hesperocorixa sahlbergi	8.430E-05	2.140E-05
2	SP	Sympetrum scoticum → Hydroporus erythrocephalus	8.430E-05	4.740E-06
2	SP	Sympetrum scoticum → Illybius fuliginosus	8.430E-05	6.500E-05
2	SP	Sympetrum scoticum → Lestes sponsa	8.430E-05	7.810E-05
2	SP	Sympetrum scoticum → Lumbriculus variegatus	8.430E-05	8.000E-06
2	SP	Sympetrum scoticum → Other Chironomidae spp.	8.430E-05	3.820E-06
2	SP	Sympetrum scoticum → Procladius sagittalis	8.430E-05	4.410E-06
2	SP	Sympetrum scoticum → Sialis lutaria	8.430E-05	5.250E-05
2	SP	Sympetrum scoticum → Sigara semistriata	8.430E-05	1.220E-05
2	SP	Sympetrum scoticum → Tanytarsus bruchonidae	8.430E-05	1.300E-06
2	TL	Micropterus salmoides → Chaoborys punctipennis	1.950E-01	2.580E-07
2	UG	Ahtola atra → Alopecurus pratensis	5.220E-06	3.500E-02
2	UG	Bracon erythrostictus → Tetramesa hyalipennis	2.160E-06	3.480E-06
2	UG	Bracon sp. → Tetramesa brevicomis	2.160E-06	1.480E-06
2	UG	Bracon sp. → Tetramesa calamagrostidis	2.160E-06	7.400E-06
2	UG	Bracon sp. → Tetramesa longicomis	2.160E-06	3.740E-06
2	UG	Chlorocytus agropyri → Tetramesa comuta	1.640E-06	3.000E-06
2	UG	Chlorocytus deschampiae → Eurytoma appendigaster	1.980E-06	4.590E-06
2	UG	Chlorocytus deschampiae → Pediobius deschampiae	1.980E-06	1.980E-06
2	UG	Chlorocytus deschampiae → Tetramesa petiolata	1.980E-06	4.590E-06
2	UG	Chlorocytus harmolitae → Tetramesa eximia	5.220E-06	1.330E-05
2	UG	Chlorocytus phalaridis → Bracon sp.	2.160E-06	2.160E-06
2	UG	Chlorocytus phalaridis → Tetramesa longicomis	2.160E-06	3.740E-06
2	UG	Chlorocytus pulchripes → Ahtola atra	1.980E-06	5.220E-06
2	UG	Chlorocytus pulchripes → Tetramesa angustipennis	1.980E-06	5.220E-06
2	UG	Chlorocytus sp. → Tetramesa airae	3.740E-06	2.560E-06
2	UG	Endromopoda sp. → Bracon erythrostictus	2.820E-05	2.160E-06
2	UG	Endromopoda sp. → Eurytoma appendigaster	2.820E-05	4.590E-06
2	UG	Endromopoda sp. → Eurytoma roseni	2.820E-05	1.340E-06
2	UG	Endromopoda sp. → Tetramesa angustipennis	2.820E-05	5.220E-06
2	UG	Endromopoda sp. → Tetramesa calamagrostidis	2.820E-05	7.400E-06
2	UG	Endromopoda sp. → Tetramesa hyalipennis	2.820E-05	3.480E-06
2	UG	Endromopoda sp. → Tetramesa longicomis	2.820E-05	3.740E-06
2	UG	Endromopoda sp. → Tetramesa petiolata	2.820E-05	4.590E-06

D	Com	Consumer → Resource	ConSize	ResSize
2	UG	Eupelmus atropurpureus → Eurytoma sp.	6.250E-06	1.980E-06
2	UG	Eupelmus atropurpureus → Eurytoma sp. nr. steffani	6.250E-06	1.800E-06
2	UG	Eupelmus atropurpureus → Homoporus fulviventris	6.250E-06	1.800E-06
2	UG	Eupelmus atropurpureus → Syntomaspis baudysi	6.250E-06	2.160E-06
2	UG	Eupelmus atropurpureus → Tetramesa brevicomis	6.250E-06	1.480E-06
2	UG	Eupelmus atropurpureus → Tetramesa eximia	6.250E-06	1.330E-05
2	UG	Eurytoma appendigaster → Tetramesa petiolata	4.590E-06	4.590E-06
2	UG	Eurytoma castor → Tetramesa airae	3.480E-06	2.560E-06
2	UG	Eurytoma danuvica → Tetramesa eximia	6.250E-06	1.330E-05
2	UG	Eurytoma erdoesi → Tetramesa longula	2.160E-06	2.560E-06
2	UG	Eurytoma flavimana → Tetramesa linearis	1.480E-06	1.800E-06
2	UG	Eurytoma phalaridis → Tetramesa longicomis	1.980E-06	3.740E-06
2	UG	Eurytoma pollux → Tetramesa calamagrostidis	5.220E-06	7.400E-06
2	UG	Eurytoma roseni → Tetramesa hyalipennis	1.340E-06	3.480E-06
2	UG	Eurytoma sp. nr. apicalis → Tetramesa linearis	1.640E-06	1.800E-06
2	UG	Eurytoma sp. nr. festucae → Tetramesa brevicomis	2.560E-06	1.480E-06
2	UG	Eurytoma sp. nr. steffani → Tetramesa eximia	1.800E-06	1.330E-05
2	UG	Eurytoma sp. → Calamagrostis epigejos	1.980E-06	5.250E-02
2	UG	Eurytoma sp. → Deschampsia cespitosa	1.980E-06	5.500E-02
2	UG	Eurytoma sp. → Tetramesa brevicollis	1.980E-06	2.560E-06
2	UG	Eurytoma tapio → Tetramesa angustipennis	4.300E-06	5.220E-06
2	UG	Homoporus febriculosus → Tetramesa angustipennis	2.160E-06	5.220E-06
2	UG	Homoporus fulviventris → Tetramesa eximia	1.800E-06	1.330E-05
2	UG	Homoporus luniger → Tetramesa calamagrostidis	2.160E-06	7.400E-06
2	UG	Homoporus sp. → Tetramesa brevicomis	2.520E-06	1.480E-06
2	UG	Homoporus sp. → Tetramesa eximia	2.520E-06	1.330E-05
2	UG	Homoporus sp. → Tetramesa linearis	2.520E-06	1.800E-06
2	UG	Homoporus sp. → Tetramesa petiolata	2.520E-06	4.590E-06
2	UG	Macroneura vesicularis → Ahtola atra	1.330E-05	5.220E-06
2	UG	Macroneura vesicularis → Bracon sp.	1.330E-05	2.160E-06
2	UG	Macroneura vesicularis → Chlorocytus harmolitae	1.330E-05	5.220E-06
2	UG	Macroneura vesicularis → Eurytoma sp.	1.330E-05	1.980E-06
2	UG	Macroneura vesicularis → Eurytoma sp.	1.330E-05	1.980E-06
2	UG	Macroneura vesicularis → Eurytoma sp. nr. festucae	1.330E-05	2.560E-06
2	UG	Macroneura vesicularis → Eurytoma sp. nr. steffani	1.330E-05	1.800E-06
2	UG	Macroneura vesicularis → Homoporus luniger	1.330E-05	2.160E-06
2	UG	Macroneura vesicularis → Homoporus sp.	1.330E-05	2.520E-06
2	UG	Macroneura vesicularis → Syntomaspis baudysi	1.330E-05	2.160E-06
2	UG	Macroneura vesicularis → Tetramesa airae	1.330E-05	2.560E-06
2	UG	Macroneura vesicularis → Tetramesa angustipennis	1.330E-05	5.220E-06
2	UG	Macroneura vesicularis → Tetramesa brevicollis	1.330E-05	2.560E-06
2	UG	Macroneura vesicularis → Tetramesa brevicomis	1.330E-05	1.480E-06
2	UG	Macroneura vesicularis → Tetramesa calamagrostidis	1.330E-05	7.400E-06
2	UG	Macroneura vesicularis → Tetramesa eximia	1.330E-05	1.330E-05
2	UG	Macroneura vesicularis → Tetramesa linearis	1.330E-05	1.800E-06
2	UG	Mesopolobus graminum → Chlorocytus phalaridis	1.230E-06	2.160E-06
2	UG	Mesopolobus graminum → Eurytoma pollux	1.230E-06	5.220E-06
2	UG	Mesopolobus graminum → Eurytoma roseni	1.230E-06	1.340E-06
2	UG	Mesopolobus graminum → Eurytoma sp.	1.230E-06	1.980E-06
2	UG	Mesopolobus graminum → Eurytoma sp.	1.230E-06	1.980E-06
2	UG	Mesopolobus graminum → Pediobius dactylicola	1.230E-06	3.740E-06
2	UG	Mesopolobus graminum → Pediobius phalaridis	1.230E-06	3.480E-06
2	UG	Mesopolobus graminum → Tetramesa calamagrostidis	1.230E-06	7.400E-06
2	UG	Mesopolobus graminum → Tetramesa hyalipennis	1.230E-06	3.480E-06
2	UG	Mesopolobus graminum → Tetramesa longicomis	1.230E-06	3.740E-06
2	UG	Mesopolobus graminum → Tetramesa longula	1.230E-06	2.560E-06
2	UG	Pediobius alaspharus → Tetramesa comuta	1.200E-06	3.000E-06
2	UG	Pediobius calamagrostidis → Eurytoma pollux	3.000E-06	5.220E-06
2	UG	Pediobius calamagrostidis → Tetramesa calamagrostidis	3.000E-06	7.400E-06
2	UG	Pediobius dactylicola → Eurytoma erdoesi	3.740E-06	2.160E-06

D	Com	Consumer → Resource	ConSize	ResSize
2	UG	Pediobius dactylicola → Tetramesa longula	3.740E-06	2.560E-06
2	UG	Pediobius deschampiae → Eurytoma appendigaster	1.980E-06	4.590E-06
2	UG	Pediobius deschampiae → Tetramesa petiolata	1.980E-06	4.590E-06
2	UG	Pediobius eubius → Eurytoma tapio	2.160E-06	4.300E-06
2	UG	Pediobius eubius → Tetramesa angustipennis	2.160E-06	5.220E-06
2	UG	Pediobius festucae → Eurytoma sp.	7.470E-07	1.980E-06
2	UG	Pediobius festucae → Tetramesa brevicollis	7.470E-07	2.560E-06
2	UG	Pediobius phalaridis → Eurytoma phalaridis	3.480E-06	1.980E-06
2	UG	Pediobius phalaridis → Tetramesa longicomis	3.480E-06	3.740E-06
2	UG	Pediobius sp. nr. claridgei → Tetramesa linearis	1.980E-06	1.800E-06
2	UG	Pediobius sp. nr. phalaridis → Tetramesa airae	1.800E-06	2.560E-06
2	UG	Sycophila sp. → Tetramesa angustipennis	1.020E-06	5.220E-06
2	UG	Sycophila sp. → Tetramesa brevicomis	1.020E-06	1.480E-06
2	UG	Sycophila sp. → Tetramesa eximia	1.020E-06	1.330E-05
2	UG	Sycophila sp. → Tetramesa linearis	1.020E-06	1.800E-06
2	UG	Syntomaspis baudysi → Tetramesa calamagrostidis	2.160E-06	7.400E-06
2	UG	Syntomaspis baudysi → Tetramesa eximia	2.160E-06	1.330E-05
2	UG	Tetramesa airae → Deschampsia cespitosa	2.560E-06	5.500E-02
2	UG	Tetramesa angustipennis → Alopecurus pratensis	5.220E-06	3.500E-02
2	UG	Tetramesa brevicollis → Festuca rubra	2.560E-06	2.625E-02
2	UG	Tetramesa brevicomis → Festuca rubra	1.480E-06	2.625E-02
2	UG	Tetramesa calamagrostidis → Calamagrostis epigejos	7.400E-06	5.250E-02
2	UG	Tetramesa comuta → Elymus repens	3.000E-06	4.750E-02
2	UG	Tetramesa eximia → Ammophila arenaria	1.330E-05	4.250E-02
2	UG	Tetramesa eximia → Calamagrostis epigejos	1.330E-05	5.250E-02
2	UG	Tetramesa hyalipennis → Elymus repens	3.480E-06	4.750E-02
2	UG	Tetramesa linearis → Elymus repens	1.800E-06	4.750E-02
2	UG	Tetramesa longicomis → Phalaris arundinaceae	3.740E-06	5.000E-02
2	UG	Tetramesa longula → Dactylis glomerata	2.560E-06	3.875E-02
2	UG	Tetramesa petiolata → Deschampsia cespitosa	4.590E-06	5.500E-02
3	ES	Abyssocucumis liouvillei → Phytoplankton	7.676E-03	1.370E-09
3	ES	Abyssorchomene plebs → Euphausia superba	3.460E-05	1.960E-04
3	ES	Abyssorchomene rossi → Copepoda	9.280E-05	1.810E-06
3	ES	Aethotaxis mitopteryx → Copepoda	4.857E-02	1.810E-06
3	ES	Aethotaxis mitopteryx → Cumacea	4.857E-02	7.400E-06
3	ES	Alacia belgicae → Phytoplankton	2.520E-07	1.370E-09
3	ES	Alacia hettacra → Phytoplankton	2.520E-07	1.370E-09
3	ES	Alcyonidium sp. → Nanoplankton	9.730E-06	1.080E-11
3	ES	Alcyonium antarcticum → Phytoplankton	2.490E-06	1.370E-09
3	ES	Alluroteuthis antarcticus → Euphausia superba	1.000E-02	1.960E-04
3	ES	Alluroteuthis antarcticus → Pleuragramma antarcticum	1.000E-02	3.006E-01
3	ES	Alluroteuthis antarcticus → Psychroteuthis glacialis	1.000E-02	4.666E-01
3	ES	Antarctomysis maxima → Zooplankton	3.670E-04	1.680E-07
3	ES	Anthomastus bathyproctus → Salpa thompsoni	4.560E-05	7.750E-05
3	ES	Anthometra adriani → Phytoplankton	6.107E-02	1.370E-09
3	ES	Aplidium vastum → Bacteria	4.487E-03	2.810E-10
3	ES	Aplidium vastum → Nanoplankton	4.487E-03	1.080E-11
3	ES	Aptenodytes forsteri → Electrona antarctica	1.084E+01	3.906E-02
3	ES	Aptenodytes forsteri → Euphausia superba	1.084E+01	1.960E-04
3	ES	Aptenodytes forsteri → Galitheutis glacialis	1.084E+01	1.250
3	**ES**	**Aptenodytes forsteri → Gonatus antarcticus (4)**	**1.084E+01**	**5.273E-01**
3	ES	Aptenodytes forsteri → Gymnoscopelus braueri	1.084E+01	2.614E-02
3	ES	Aptenodytes forsteri → Gymnoscopelus opisthopterus	1.084E+01	3.569E-02
3	ES	Aptenodytes forsteri → Kondakovia longimama	1.084E+01	1.758E-01
3	ES	Aptenodytes forsteri → Notolepis coatsi	1.084E+01	3.145E-03
3	ES	Aptenodytes forsteri → Protomyctophum bolini	1.084E+01	5.581E-03
3	ES	Aptenodytes forsteri → Psychroteuthis glacialis	1.084E+01	4.666E-01
3	ES	Aptenodytes forsteri → Thysanoessa macrura	1.084E+01	1.580E-05
3	ES	Arctocephalus gazella → Chaenodraco wilsoni	2.205E+02	2.139E-01
3	ES	Arctocephalus gazella → Chionodraco	2.205E+02	3.664E-01

D	Com	Consumer → Resource	ConSize	ResSize
3	ES	Arctocephalus gazella → Dissostichus mawsoni	2.205E+02	2.425E+01
3	ES	Arctocephalus gazella → Electrona antarctica	2.205E+02	3.906E-02
3	ES	Arctocephalus gazella → Euphausiacea	2.205E+02	1.580E-05
3	ES	Arctocephalus gazella → Gymnoscopelus braueri	2.205E+02	2.614E-02
3	ES	Arctocephalus gazella → Gymnoscopelus nicholsi	2.205E+02	1.150E-01
3	ES	Arctocephalus gazella → Myctophidae	2.205E+02	1.967E-02
3	ES	Arctocephalus gazella → Nototheniidae	2.205E+02	1.072
3	ES	Arctocephalus gazella → Pleuragramma antarcticum	2.205E+02	3.006E-01
3	ES	Arctocephalus gazella → Protomyctophum bolini	2.205E+02	5.581E-03
3	ES	Arctocephalus gazella → Pygoscelis adeliae	2.205E+02	8.802E-01
3	ES	Arctocephalus gazella → Trematomus eulepidotus	2.205E+02	4.803E-01
3	ES	Ascidia challengeri → Bacteria	3.240E-04	2.810E-10
3	ES	Ascidia challengeri → Nanoplankton	3.240E-04	1.080E-11
3	ES	Axociella nidificata → Bacteria	1.475E-01	2.810E-10
3	ES	Axociella nidificata → Phytoplankton	1.475E-01	1.370E-09
3	ES	Balaenoptera acutorostrata → Euphausiacea	1.423E+04	1.580E-05
3	ES	Balaenoptera acutorostrata → Myctophidae	1.423E+04	1.967E-02
3	ES	Balaenoptera acutorostrata → Zooplankton	1.423E+04	1.680E-07
3	ES	Balaenoptera musculus → Champsocephalus gunnari	2.399E+05	3.644
3	ES	Balaenoptera musculus → Dissostichus mawsoni	2.399E+05	2.425E+01
3	ES	Balaenoptera musculus → Euphausiacea	2.399E+05	1.580E-05
3	ES	Balaenoptera musculus → Myctophidae	2.399E+05	1.967E-02
3	ES	Balaenoptera musculus → Zooplankton	2.399E+05	1.680E-07
3	ES	Balaenoptera physalus → Champsocephalus gunnari	1.400E+05	3.644
3	ES	Balaenoptera physalus → Dissostichus mawsoni	1.400E+05	2.425E+01
3	ES	Balaenoptera physalus → Euphausiacea	1.400E+05	1.580E-05
3	ES	Balaenoptera physalus → Myctophidae	1.400E+05	1.967E-02
3	ES	Balaenoptera physalus → Zooplankton	1.400E+05	1.680E-07
3	ES	Bargmannia sp. → Euphausiacea	1.810E-05	1.580E-05
3	ES	Bargmannia sp. → Zooplankton	1.810E-05	1.680E-07
3	ES	Bathylagus antarcticus → Copepoda	2.652E-02	1.810E-06
3	ES	Bathylagus antarcticus → Euchaeta antarctica	2.652E-02	1.980E-06
3	ES	Bathylagus antarcticus → Eukrohnia hamata	2.652E-02	2.120E-05
3	ES	Bathylagus antarcticus → Euphausia superba	2.652E-02	1.960E-04
3	ES	Bathylagus antarcticus → Foraminifera	2.652E-02	5.650E-10
3	ES	Bathylagus antarcticus → Limacina helicina	2.652E-02	9.390E-08
3	ES	Bathylagus antarcticus → Metridia gerlachei	2.652E-02	8.160E-07
3	ES	Bathylagus antarcticus → Oithona sp.	2.652E-02	9.350E-09
3	ES	Bathylagus antarcticus → Oncea curvata	2.652E-02	9.350E-09
3	ES	Bathylagus antarcticus → Pelegobia longicirrata	2.652E-02	3.820E-08
3	ES	Bathylagus antarcticus → Sagitta marri	2.652E-02	9.980E-04
3	ES	Bathylagus antarcticus → Zooplankton	2.652E-02	1.680E-07
3	ES	Beroe cucumis → Pelegobia longicirrata	4.900E-04	3.820E-08
3	ES	Boroecia antipoda → Phytoplankton	2.520E-07	1.370E-09
3	ES	Bostrychopora dentata → Nanoplankton	7.030E-07	1.080E-11
3	ES	Calanoides acutus → Copepoda	1.490E-06	1.810E-06
3	ES	Calanoides acutus → Flagellate	1.490E-06	2.540E-11
3	ES	Calanoides acutus → Oithona sp.	1.490E-06	9.350E-09
3	ES	Calanoides acutus → Oncea curvata	1.490E-06	9.350E-09
3	ES	Calanoides acutus → Pelegobia longicirrata	1.490E-06	3.820E-08
3	ES	Calanoides acutus → Silicioflagellates	1.490E-06	1.510E-10
3	ES	Calanoides acutus → Tintinnid	1.490E-06	4.010E-08
3	ES	Calanus propinquus → Copepoda	1.550E-06	1.810E-06
3	ES	Calanus propinquus → Euchaeta antarctica	1.550E-06	1.980E-06
3	ES	Calanus propinquus → Flagellate	1.550E-06	2.540E-11
3	ES	Calanus propinquus → Oithona sp.	1.550E-06	9.350E-09
3	ES	Calanus propinquus → Silicioflagellates	1.550E-06	1.510E-10
3	ES	Calanus propinquus → Tintinnid	1.550E-06	4.010E-08
3	ES	Callianira antarctica → Copepoda	2.188E-02	1.810E-06
3	ES	Callianira antarctica → Zooplankton	2.188E-02	1.680E-07

D	Com	Consumer → Resource	ConSize	ResSize
3	ES	Calyx arcuarius → Bacteria	6.107E-02	2.810E-10
3	ES	Calyx arcuarius → Phytoplankton	6.107E-02	1.370E-09
3	ES	Camptoplites tricornis → Nanoplankton	9.730E-06	1.080E-11
3	ES	Cellarinella sp. → Nanoplankton	1.400E-06	1.080E-11
3	ES	Chaenodraco wilsoni → Euphausiacea	2.139E-01	1.580E-05
3	ES	Chionodraco hamatus → Copepoda	1.072	1.810E-06
3	ES	Chionodraco hamatus → Euphausiacea	1.072	1.580E-05
3	ES	Chionodraco myersi → Euphausiacea	3.664E-01	1.580E-05
3	ES	Chorismus antarcticus → Barrukia cristata	2.720E-04	9.000E-05
3	ES	Chorismus antarcticus → Corethron sp.	2.720E-04	6.460E-10
3	ES	Chorismus antarcticus → Eucranta mollis	2.720E-04	1.070E-04
3	ES	Chorismus antarcticus → Eulagisca gigantea	2.720E-04	4.777E-03
3	ES	Chorismus antarcticus → Eunoe spica	2.720E-04	9.540E-05
3	ES	Chorismus antarcticus → Foraminifera	2.720E-04	5.650E-10
3	ES	Chorismus antarcticus → Laetmonice producta	2.720E-04	2.583E-03
3	ES	Chorismus antarcticus → Taeniogyrus contortus	2.720E-04	4.805E-03
3	ES	Chorismus antarcticus → Yoldiella eightsi	2.720E-04	5.900E-04
3	ES	Cinachyra antarctica → Bacteria	6.692E-03	2.810E-10
3	ES	Cinachyra antarctica → Phytoplankton	6.692E-03	1.370E-09
3	ES	Cinachyra barbata → Bacteria	6.692E-03	2.810E-10
3	ES	Cinachyra barbata → Phytoplankton	6.692E-03	1.370E-09
3	ES	Clavularia frankliniana → Foraminifera	1.120E-05	5.650E-10
3	ES	Clavularia frankliniana → Phytoplankton	1.120E-05	1.370E-09
3	ES	Clavularia frankliniana → Zooplankton	1.120E-05	1.680E-07
3	ES	Clio pyramitata → Copepoda	1.710E-05	1.810E-06
3	ES	Clio pyramitata → Gnathia calva	1.710E-05	3.160E-06
3	ES	Clio pyramitata → Oithona sp.	1.710E-05	9.350E-09
3	ES	Clio pyramitata → Pelegobia longicirrata	1.710E-05	3.820E-08
3	ES	Clione antarctica → Limacina helicina	1.030E-04	9.390E-08
3	ES	Clione limacina → Clione antarctica	1.350E-05	1.030E-04
3	ES	Clione limacina → Limacina helicina	1.350E-05	9.390E-08
3	ES	Cnemidocarpa verrucosa → Bacteria	1.606E-02	2.810E-10
3	ES	Cnemidocarpa verrucosa → Nanoplankton	1.606E-02	1.080E-11
3	ES	Corella eumyota → Bacteria	4.487E-03	2.810E-10
3	ES	Corella eumyota → Nanoplankton	4.487E-03	1.080E-11
3	ES	Cryodraco antarcticus → Euphausiacea	1.278	1.580E-05
3	ES	Cryodraco antarcticus → Pleuragramma antarcticum	1.278	3.006E-01
3	ES	Cygnodraco mawsoni → Euphausia crystallorophias	7.565E-01	6.590E-05
3	ES	Cygnodraco mawsoni → Pteropoda	7.565E-01	5.540E-05
3	ES	Cyllopus lucasii → Calanus propinquus	2.640E-05	1.550E-06
3	ES	Cyllopus lucasii → Copepoda	2.640E-05	1.810E-06
3	ES	Cyllopus lucasii → Eukrohnia hamata	2.640E-05	2.120E-05
3	ES	Cyllopus lucasii → Euphausia superba	2.640E-05	1.960E-04
3	ES	Cyllopus lucasii → Flagellate	2.640E-05	2.540E-11
3	ES	Cyllopus lucasii → Metridia gerlachei	2.640E-05	8.160E-07
3	ES	Cyllopus lucasii → Oithona sp.	2.640E-05	9.350E-09
3	ES	Cyllopus lucasii → Oncea curvata	2.640E-05	9.350E-09
3	ES	Cyllopus lucasii → Ostracods	2.640E-05	2.520E-07
3	ES	Cyllopus lucasii → Pelegobia longicirrata	2.640E-05	3.820E-08
3	ES	Cyllopus lucasii → Tintinnid	2.640E-05	4.010E-08
3	ES	Cyllopus lucasii → Zooplankton	2.640E-05	1.680E-07
3	ES	Daption capense → Cyllopus lucasii	5.537	2.640E-05
3	ES	Daption capense → Electrona antarctica	5.537	3.906E-02
3	ES	Daption capense → Euphausia superba	5.537	1.960E-04
3	ES	Daption capense → Galitheutis glacialis	5.537	1.250
3	ES	Daption capense → Gonatus antarcticus	5.537	5.273E-01
3	ES	Daption capense → Gymnoscopelus braueri	5.537	2.614E-02
3	ES	Daption capense → Gymnoscopelus nicholsi	5.537	1.150E-01
3	ES	Daption capense → Gymnoscopelus opisthopterus	5.537	3.569E-02
3	ES	Daption capense → Notocrangon antarcticus	5.537	4.490E-04

D	Com	Consumer → Resource	ConSize	ResSize
3	ES	Daption capense → Notolepis coatsi	5.537	3.145E-03
3	ES	Daption capense → Protomyctophum bolini	5.537	5.581E-03
3	ES	Daption capense → Psychroteuthis glacialis	5.537	4.666E-01
3	ES	Daption capense → Salpa thompsoni	5.537	7.750E-05
3	ES	Daption capense → Vibillia antarctica	5.537	9.390E-08
3	ES	Daption capense → Vibillia stebbingi	5.537	9.390E-08
3	ES	Desmonema glaciale → Euphausiacea	1.800	1.580E-05
3	ES	Desmonema glaciale → Nemertini	1.800	1.028
3	ES	Desmonema glaciale → Odontaster validus	1.800	6.640E-04
3	ES	Dipulmaris antarctica → Clione antarctica	1.640E-02	1.030E-04
3	ES	Dipulmaris antarctica → Copepoda	1.640E-02	1.810E-06
3	ES	Dipulmaris antarctica → Limacina helicina	1.640E-02	9.390E-08
3	ES	Dipulmaris antarctica → Pteropoda	1.640E-02	5.540E-05
3	ES	Dipulmaris antarctica → Zooplankton	1.640E-02	1.680E-07
3	ES	Dipulmaris antarctica → Zooplankton	1.640E-02	1.680E-07
3	ES	Dissostichus mawsoni → Bathylagus antarcticus	2.425E+01	2.652E-02
3	ES	Dissostichus mawsoni → Dissostichus mawsoni	2.425E+01	2.425E+01
3	ES	Dissostichus mawsoni → Galitheutis glacialis	2.425E+01	1.250
3	ES	Dissostichus mawsoni → Gonatus antarcticus	2.425E+01	5.273E-01
3	ES	Dissostichus mawsoni → Harpagifer antarcticus	2.425E+01	3.645E-02
3	ES	Dissostichus mawsoni → Kondakovia longimama	2.425E+01	1.758E-01
3	ES	Dissostichus mawsoni → Macrourus whitsoni	2.425E+01	5.061
3	ES	Dissostichus mawsoni → Moroteuthis ingens	2.425E+01	3.052E-01
3	ES	Dissostichus mawsoni → Myctophidae	2.425E+01	1.967E-02
3	ES	Dissostichus mawsoni → Nototheniidae	2.425E+01	1.072
3	ES	Dissostichus mawsoni → Vampryoteuthis	2.425E+01	2.095E-03
3	ES	Djerboa furcipes → Phytoplankton	5.050E-06	1.370E-09
3	ES	Dolloidraco longidorsalis → Copepoda	1.316E-02	1.810E-06
3	ES	Dolloidraco longidorsalis → Cumacea	1.316E-02	7.400E-06
3	ES	Dolloidraco longidorsalis → Euphausiacea	1.316E-02	1.580E-05
3	ES	Dolloidraco longidorsalis → Ostracods	1.316E-02	2.520E-07
3	ES	Dolloidraco longidorsalis → Tanaidacea	1.316E-02	1.470E-04
3	ES	Echinopsolus acanthocola → Phytoplankton	6.530E-04	1.370E-09
3	ES	Edwardsia meridionalis → Copepoda	9.010E-04	1.810E-06
3	ES	Edwardsia meridionalis → Zooplankton	9.010E-04	1.680E-07
3	ES	Electrona antarctica → Calanus propinquus	3.906E-02	1.550E-06
3	ES	Electrona antarctica → Copepoda	3.906E-02	1.810E-06
3	ES	Electrona antarctica → Euchaeta antarctica	3.906E-02	1.980E-06
3	ES	Electrona antarctica → Eukrohnia hamata	3.906E-02	2.120E-05
3	ES	Electrona antarctica → Euphausia frigida	3.906E-02	1.690E-05
3	ES	Electrona antarctica → Euphausia superba	3.906E-02	1.960E-04
3	ES	Electrona antarctica → Euphausiacea	3.906E-02	1.580E-05
3	ES	Electrona antarctica → Metridia gerlachei	3.906E-02	8.160E-07
3	ES	Electrona antarctica → Oncea curvata	3.906E-02	9.350E-09
3	ES	Electrona antarctica → Ostracods	3.906E-02	2.520E-07
3	ES	Electrona antarctica → Pelegobia longicirrata	3.906E-02	3.820E-08
3	ES	Electrona antarctica → Rhincalanus gigas	3.906E-02	3.770E-06
3	ES	Electrona antarctica → Thysanoessa macrura	3.906E-02	1.580E-05
3	ES	Epimeria georgiana → Foraminifera	9.280E-05	5.650E-10
3	ES	Epimeria georgiana → Zooplankton	9.280E-05	1.680E-07
3	ES	Epimeria macrodonta → Euphausiacea	7.010E-05	1.580E-05
3	ES	Epimeria macrodonta → Foraminifera	7.010E-05	5.650E-10
3	ES	Epimeria rubrieques → Zooplankton	3.000E-04	1.680E-07
3	ES	Euchaeta antarctica → Copepoda	1.980E-06	1.810E-06
3	ES	Euchaeta antarctica → Cyllopus lucasii	1.980E-06	2.640E-05
3	ES	Euchaeta antarctica → Euchaeta antarctica	1.980E-06	1.980E-06
3	ES	Euchaeta antarctica → Eukrohnia hamata	1.980E-06	2.120E-05
3	ES	Euchaeta antarctica → Flagellate	1.980E-06	2.540E-11
3	ES	Euchaeta antarctica → Metridia gerlachei	1.980E-06	8.160E-07
3	ES	Euchaeta antarctica → Oithona sp.	1.980E-06	9.350E-09

D	Com	Consumer → Resource	ConSize	ResSize
3	ES	Euchaeta antarctica → Oncea curvata	1.980E-06	9.350E-09
3	ES	Euchaeta antarctica → Pelegobia longicirrata	1.980E-06	3.820E-08
3	ES	Euchaeta antarctica → Silicioflagellates	1.980E-06	1.510E-10
3	ES	Euchaeta antarctica → Tintinnid	1.980E-06	4.010E-08
3	ES	Euchaetomera antarcticus → Zooplankton	1.020E-05	1.680E-07
3	ES	Eucopia australis → Zooplankton	1.740E-04	1.680E-07
3	ES	Eudorella splendida → Bacteria	7.400E-06	2.810E-10
3	ES	Eukrohnia hamata → Calanus propinquus	2.120E-05	1.550E-06
3	ES	Eukrohnia hamata → Copepoda	2.120E-05	1.810E-06
3	ES	Eukrohnia hamata → Metridia gerlachei	2.120E-05	8.160E-07
3	ES	Euphausia crystallorophias → Phytoplankton	6.590E-05	1.370E-09
3	ES	Euphausia frigida → Copepoda	1.690E-05	1.810E-06
3	ES	Euphausia frigida → Flagellate	1.690E-05	2.540E-11
3	ES	Euphausia frigida → Foraminifera	1.690E-05	5.650E-10
3	ES	Euphausia frigida → Phytoplankton	1.690E-05	1.370E-09
3	ES	Euphausia frigida → Pteropoda	1.690E-05	5.540E-05
3	ES	Euphausia frigida → Tintinnid	1.690E-05	4.010E-08
3	ES	Euphausia superba → Chaetoceros sp.	1.960E-04	6.460E-10
3	ES	Euphausia superba → Copepoda	1.960E-04	1.810E-06
3	ES	Euphausia superba → Distephanus sp.	1.960E-04	6.460E-10
3	ES	Euphausia superba → Entomoneis sp.	1.960E-04	6.460E-10
3	ES	Euphausia superba → Flagellate	1.960E-04	2.540E-11
3	ES	Euphausia superba → Fragilariopsis	1.960E-04	6.460E-10
3	ES	Euphausia superba → Nitzschia sp.	1.960E-04	6.460E-10
3	ES	Euphausia superba → Oithona sp.	1.960E-04	9.350E-09
3	ES	Eusirus antarcticus → Copepoda	1.460E-05	1.810E-06
3	ES	Galitheutis glacialis → Euphausia superba	1.250	1.960E-04
3	ES	Gerlachea australis → Euphausia crystallorophias	2.592E-01	6.590E-05
3	ES	Gerlachea australis → Euphausiacea	2.592E-01	1.580E-05
3	ES	Gersemia antarctica → Foraminifera	4.525	5.650E-10
3	ES	Gnathia calva → Zooplankton	3.160E-06	1.680E-07
3	ES	Gonatus antarcticus → Cyllopus lucasii	5.273E-01	2.640E-05
3	ES	Gonatus antarcticus → Euphausia superba	5.273E-01	1.960E-04
3	ES	Gorgonocephalus chiliensis → Copepoda	2.606E-03	1.810E-06
3	ES	Gymnodraco acuticeps → Euphausiacea	1.362	1.580E-05
3	ES	Gymnodraco acuticeps → Zooplankton	1.362	1.680E-07
3	ES	Gymnoscopelus braueri → Clio pyramitata	2.614E-02	1.710E-05
3	ES	Gymnoscopelus braueri → Copepoda	2.614E-02	1.810E-06
3	ES	Gymnoscopelus braueri → Cyllopus lucasii	2.614E-02	2.640E-05
3	ES	Gymnoscopelus braueri → Euchaeta antarctica	2.614E-02	1.980E-06
3	ES	Gymnoscopelus braueri → Euchaeta antarctica	2.614E-02	1.980E-06
3	ES	Gymnoscopelus braueri → Eukrohnia hamata	2.614E-02	2.120E-05
3	ES	Gymnoscopelus braueri → Euphausia superba	2.614E-02	1.960E-04
3	ES	Gymnoscopelus braueri → Limacina helicina	2.614E-02	9.390E-08
3	ES	Gymnoscopelus braueri → Metridia gerlachei	2.614E-02	8.160E-07
3	ES	Gymnoscopelus braueri → Pelegobia longicirrata	2.614E-02	3.820E-08
3	ES	Gymnoscopelus braueri → Sagitta marri	2.614E-02	9.980E-04
3	ES	Gymnoscopelus braueri → Salpa thompsoni	2.614E-02	7.750E-05
3	ES	Gymnoscopelus braueri → Zooplankton	2.614E-02	1.680E-07
3	ES	Gymnoscopelus nicholsi → Calanus propinquus	1.150E-01	1.550E-06
3	ES	Gymnoscopelus nicholsi → Chaetognatha	1.150E-01	4.410E-04
3	ES	Gymnoscopelus nicholsi → Copepoda	1.150E-01	1.810E-06
3	ES	Gymnoscopelus nicholsi → Euchaeta antarctica	1.150E-01	1.980E-06
3	ES	Gymnoscopelus nicholsi → Euphausia crystallorophias	1.150E-01	6.590E-05
3	ES	Gymnoscopelus nicholsi → Euphausia frigida	1.150E-01	1.690E-05
3	ES	Gymnoscopelus nicholsi → Euphausia superba	1.150E-01	1.960E-04
3	ES	Gymnoscopelus nicholsi → Euphausiacea	1.150E-01	1.580E-05
3	ES	Gymnoscopelus nicholsi → Metridia gerlachei	1.150E-01	8.160E-07
3	ES	Gymnoscopelus nicholsi → Oncea curvata	1.150E-01	9.350E-09
3	ES	Gymnoscopelus nicholsi → Ostracods	1.150E-01	2.520E-07

D	Com	Consumer → Resource	ConSize	ResSize
3	ES	Gymnoscopelus nicholsi → Protomyctophum bolini	1.150E-01	5.581E-03
3	ES	Gymnoscopelus nicholsi → Rhincalanus gigas	1.150E-01	3.770E-06
3	ES	Gymnoscopelus nicholsi → Thysanoessa macrura	1.150E-01	1.580E-05
3	ES	Gymnoscopelus opisthopterus → Clio pyramitata	3.569E-02	1.710E-05
3	ES	Gymnoscopelus opisthopterus → Copepoda	3.569E-02	1.810E-06
3	ES	Gymnoscopelus opisthopterus → Cyllopus lucasii	3.569E-02	2.640E-05
3	ES	Gymnoscopelus opisthopterus → Eukrohnia hamata	3.569E-02	2.120E-05
3	ES	Gymnoscopelus opisthopterus → Euphausia superba	3.569E-02	1.960E-04
3	ES	Gymnoscopelus opisthopterus → Limacina helicina	3.569E-02	9.390E-08
3	ES	Gymnoscopelus opisthopterus → Metridia gerlachei	3.569E-02	8.160E-07
3	ES	Gymnoscopelus opisthopterus → Oithona sp.	3.569E-02	9.350E-09
3	ES	Gymnoscopelus opisthopterus → Pelegobia longicirrata	3.569E-02	3.820E-08
3	ES	Gymnoscopelus opisthopterus → Sagitta marri	3.569E-02	9.980E-04
3	ES	Gymnoscopelus opisthopterus → Salpa thompsoni	3.569E-02	7.750E-05
3	ES	Gymnoscopelus opisthopterus → Zooplankton	3.569E-02	1.680E-07
3	ES	Haliclona dancoi → Bacteria	1.298E-01	2.810E-10
3	ES	Haliclona dancoi → Phytoplankton	1.298E-01	1.370E-09
3	ES	Haliclona tenella → Bacteria	1.298E-01	2.810E-10
3	ES	Haliclona tenella → Phytoplankton	1.298E-01	1.370E-09
3	ES	Haplocheira plumosa → Phytoplankton	5.050E-06	1.370E-09
3	ES	Harpagifer antarcticus → Chiton	3.645E-02	3.365E-03
3	ES	Harpagifer antarcticus → Djerboa furcipes	3.645E-02	5.050E-06
3	ES	Harpagifer antarcticus → Epimeria robusta	3.645E-02	9.280E-05
3	ES	Harpagifer antarcticus → Euphausia superba	3.645E-02	1.960E-04
3	ES	Harpagifer antarcticus → Natatolana meridionalis	3.645E-02	5.050E-06
3	ES	Harpagifer antarcticus → Notocrangon antarcticus	3.645E-02	4.490E-04
3	ES	Harpagifer antarcticus → Oradarea edentata	3.645E-02	5.050E-06
3	ES	Harpovoluta charcoti → Phytoplankton	6.899E-03	1.370E-09
3	ES	Heterophoxus videns → Copepoda	5.050E-06	1.810E-06
3	ES	Heterophoxus videns → Eucranta mollis	5.050E-06	1.070E-04
3	ES	Heterophoxus videns → Eunoe spica	5.050E-06	9.540E-05
3	ES	Heterophoxus videns → Foraminifera	5.050E-06	5.650E-10
3	ES	Heterophoxus videns → Laetmonice producta	5.050E-06	2.583E-03
3	ES	Heterophoxus videns → Tanaidacea	5.050E-06	1.470E-04
3	ES	Homaxinella balfourensis → Bacteria	6.107E-02	2.810E-10
3	ES	Homaxinella balfourensis → Phytoplankton	6.107E-02	1.370E-09
3	ES	Hydrurga leptonyx → Arctocephalus gazella	7.216E+02	2.205E+02
3	ES	Hydrurga leptonyx → Euphausiacea	7.216E+02	1.580E-05
3	ES	Hydrurga leptonyx → Kondakovia longimama	7.216E+02	1.758E-01
3	ES	Hydrurga leptonyx → Psychroteuthis glacialis	7.216E+02	4.666E-01
3	ES	Hyperia macrocephala → Limacina helicina	3.170E-05	9.390E-08
3	ES	Hyperia macrocephala → Pteropoda	3.170E-05	5.540E-05
3	ES	Hyperia macrocephala → Salpa thompsoni	3.170E-05	7.750E-05
3	ES	Hyperia macrocephala → Scyphozoa	3.170E-05	1.640E-02
3	ES	Hyperiella dilatata → Copepoda	1.550E-06	1.810E-06
3	ES	Hyperiella dilatata → Flagellate	1.550E-06	2.540E-11
3	ES	Hyperiella dilatata → Oithona sp.	1.550E-06	9.350E-09
3	ES	Hyperiella dilatata → Oncea curvata	1.550E-06	9.350E-09
3	ES	Hyperiella dilatata → Tintinnid	1.550E-06	4.010E-08
3	ES	Ihlea racovitzai → Phytoplankton	1.110E-06	1.370E-09
3	ES	Iophon radiatus → Bacteria	6.107E-02	2.810E-10
3	ES	Iophon radiatus → Phytoplankton	6.107E-02	1.370E-09
3	ES	Isodyctia steifera → Bacteria	1.298E-01	2.810E-10
3	ES	Isodyctia steifera → Phytoplankton	1.298E-01	1.370E-09
3	ES	Isoschizoporella tricuspis → Nanoplankton	9.730E-06	1.080E-11
3	ES	Isotealia antarctica → Copepoda	1.914E-03	1.810E-06
3	ES	Isotealia antarctica → Eunoe spica	1.914E-03	9.540E-05
3	ES	Kirkpatrickia variolosa → Bacteria	7.978E-01	2.810E-10
3	ES	Kirkpatrickia variolosa → Phytoplankton	7.978E-01	1.370E-09
3	ES	Kondakovia longimama → Euphausia superba	1.758E-01	1.960E-04

D	Com	Consumer → Resource	ConSize	ResSize
3	ES	Lagenorhynchus cruciger → Champsocephalus gunnari	1.742E+02	3.644
3	ES	Lagenorhynchus cruciger → Dissostichus mawsoni	1.742E+02	2.425E+01
3	ES	Lagenorhynchus cruciger → Euphausiacea	1.742E+02	1.580E-05
3	ES	Lagenorhynchus cruciger → Myctophidae	1.742E+02	1.967E-02
3	ES	Leptonychotes weddelli → Aethotaxis mitopteryx	4.529E+02	4.857E-02
3	ES	Leptonychotes weddelli → Dissostichus mawsoni	4.529E+02	2.425E+01
3	ES	Leptonychotes weddelli → Euphausia crystallorophias	4.529E+02	6.590E-05
3	ES	Leptonychotes weddelli → Pleuragramma antarcticum	4.529E+02	3.006E-01
3	ES	Leptonychotes weddelli → Trematomus hansoni	4.529E+02	3.006E-01
3	ES	Liljeborgia georgiana → Copepoda	4.060E-05	1.810E-06
3	ES	Liljeborgia georgiana → Eucranta mollis	4.060E-05	1.070E-04
3	ES	Liljeborgia georgiana → Eunoe spica	4.060E-05	9.540E-05
3	ES	Liljeborgia georgiana → Euphausiacea	4.060E-05	1.580E-05
3	ES	Limacina helicina → Zooplankton	9.390E-08	1.680E-07
3	ES	Lobodon carcinophagus → Euphausia superba	4.403E+02	1.960E-04
3	ES	Lobodon carcinophagus → Euphausiacea	4.403E+02	1.580E-05
3	ES	Lyrocteis flavopallidus → Phytoplankton	4.253E-03	1.370E-09
3	ES	Lysasterias perrieri → Ostracods	3.561E-03	2.520E-07
3	ES	Martialia hyadesi → Chionodraco hamatus	1.758E-01	1.072
3	ES	Martialia hyadesi → Euphausia superba	1.758E-01	1.960E-04
3	ES	Martialia hyadesi → Gonatus antarcticus	1.758E-01	5.273E-01
3	ES	Martialia hyadesi → Gymnoscopelus nicholsi	1.758E-01	1.150E-01
3	ES	Martialia hyadesi → Protomyctophum bolini	1.758E-01	5.581E-03
3	ES	Martialia hyadesi → Psychroteuthis glacialis	1.758E-01	4.666E-01
3	ES	Megaptera novaeangliae → Euphausiacea	5.575E+04	1.580E-05
3	ES	Melicerita obliqua → Nanoplankton	9.730E-06	1.080E-11
3	ES	Melphidippa antarctica → Euchaeta antarctica	3.460E-05	1.980E-06
3	ES	Melphidippa antarctica → Euphausiacea	3.460E-05	1.580E-05
3	ES	Mertensiid ctenophore → Clione antarctica	1.006E-03	1.030E-04
3	ES	Mertensiid ctenophore → Copepoda	1.006E-03	1.810E-06
3	ES	Mertensiid ctenophore → Euchaeta antarctica	1.006E-03	1.980E-06
3	ES	Mertensiid ctenophore → Pteropoda	1.006E-03	5.540E-05
3	ES	Mertensiid ctenophore → Zooplankton	1.006E-03	1.680E-07
3	ES	Mesonychoteuthis hamiltoni → Eukrohnia hamata	1.563E+02	2.120E-05
3	ES	Metaconchoecia isocheira → Phytoplankton	2.520E-07	1.370E-09
3	ES	Metridia gerlachei → Copepoda	8.160E-07	1.810E-06
3	ES	Metridia gerlachei → Flagellate	8.160E-07	2.540E-11
3	ES	Metridia gerlachei → Oithona sp.	8.160E-07	9.350E-09
3	ES	Metridia gerlachei → Oncea curvata	8.160E-07	9.350E-09
3	ES	Metridia gerlachei → Silicioflagellates	8.160E-07	1.510E-10
3	ES	Metridia gerlachei → Tintinnid	8.160E-07	4.010E-08
3	ES	Mirounga leonina → Alluroteuthis antarcticus	2.067E+03	1.000E-02
3	ES	Mirounga leonina → Chionodraco	2.067E+03	3.664E-01
3	ES	Mirounga leonina → Chionodraco hamatus	2.067E+03	1.072
3	ES	Mirounga leonina → Dissostichus mawsoni	2.067E+03	2.425E+01
3	ES	Mirounga leonina → Electrona antarctica	2.067E+03	3.906E-02
3	ES	Mirounga leonina → Galitheutis glacialis	2.067E+03	1.250
3	ES	Mirounga leonina → Gonatus antarcticus	2.067E+03	5.273E-01
3	ES	Mirounga leonina → Gymnoscopelus nicholsi	2.067E+03	1.150E-01
3	ES	Mirounga leonina → Kondakovia longimama	2.067E+03	1.758E-01
3	ES	Mirounga leonina → Martialia hyadesi	2.067E+03	1.758E-01
3	ES	Mirounga leonina → Mesonychoteuthis hamiltoni	2.067E+03	1.563E+02
3	ES	Mirounga leonina → Moroteuthis ingens	2.067E+03	3.052E-01
3	ES	Mirounga leonina → Myctophidae	2.067E+03	1.967E-02
3	ES	Mirounga leonina → Nototheniidae	2.067E+03	1.072
3	ES	Mirounga leonina → Pleuragramma antarcticum	2.067E+03	3.006E-01
3	ES	Mirounga leonina → Psychroteuthis glacialis	2.067E+03	4.666E-01
3	ES	Mirounga leonina → Trematomus eulepidotus	2.067E+03	4.803E-01
3	ES	Mirounga leonina → Trematomus hansoni	2.067E+03	3.006E-01
3	ES	Mirounga leonina → Trematomus pennellii	2.067E+03	3.006E-01

D	Com	Consumer → Resource	ConSize	ResSize
3	ES	Mirounga leonina → Trematomus scotti	2.067E+03	9.548E-02
3	ES	Molgula pedunculata → Bacteria	1.045E-02	2.810E-10
3	ES	Molgula pedunculata → Nanoplankton	1.045E-02	1.080E-11
3	ES	Monocaulus parvula → Copepoda	6.550E-04	1.810E-06
3	ES	Monocaulus parvula → Zooplankton	6.550E-04	1.680E-07
3	ES	Morotheutis ingens → Copepoda	5.273E-01	1.810E-06
3	ES	Morotheutis ingens → Cyllopus lucasii	5.273E-01	2.640E-05
3	ES	Morotheutis ingens → Electrona antarctica	5.273E-01	3.906E-02
3	ES	Morotheutis ingens → Epimeria robusta	5.273E-01	9.280E-05
3	ES	Morotheutis ingens → Myctophidae	5.273E-01	1.967E-02
3	ES	Mycale (Oxymycale) acerata → Bacteria	2.581E-01	2.810E-10
3	ES	Mycale (Oxymycale) acerata → Phytoplankton	2.581E-01	1.370E-09
3	ES	Myodocopia → Zooplankton	2.520E-07	1.680E-07
3	ES	Mysidae → Zooplankton	7.010E-05	1.680E-07
3	ES	Nematocarcinus lanceopes → Euchaeta antarctica	1.279E-03	1.980E-06
3	ES	Nematocarcinus lanceopes → Flagellate	1.279E-03	2.540E-11
3	ES	Nematocarcinus lanceopes → Phytoplankton	1.279E-03	1.370E-09
3	ES	Nematocarcinus lanceopes → Tintinnid	1.279E-03	4.010E-08
3	ES	Nematocarcinus lanceopes → Zooplankton	1.279E-03	1.680E-07
3	ES	Notolepis coatsi → Copepoda	3.145E-03	1.810E-06
3	ES	Notolepis coatsi → Euchaeta antarctica	3.145E-03	1.980E-06
3	ES	Notolepis coatsi → Eukrohnia hamata	3.145E-03	2.120E-05
3	ES	Notolepis coatsi → Euphausia superba	3.145E-03	1.960E-04
3	ES	Notolepis coatsi → Limacina helicina	3.145E-03	9.390E-08
3	ES	Notolepis coatsi → Metridia gerlachei	3.145E-03	8.160E-07
3	ES	Notolepis coatsi → Notocrangon antarcticus	3.145E-03	4.490E-04
3	ES	Notolepis coatsi → Oithona sp.	3.145E-03	9.350E-09
3	ES	Notolepis coatsi → Oncea curvata	3.145E-03	9.350E-09
3	ES	Notolepis coatsi → Pelegobia longicirrata	3.145E-03	3.820E-08
3	ES	Notolepis coatsi → Sagitta marri	3.145E-03	9.980E-04
3	ES	Notolepis coatsi → Salpa thompsoni	3.145E-03	7.750E-05
3	ES	Nototanais antarcticus → Bacteria	1.470E-04	2.810E-10
3	ES	Nototanais dimorphus → Bacteria	1.470E-04	2.810E-10
3	ES	Notothenia marmorata → Euphausia superba	8.555	1.960E-04
3	ES	Notothenia marmorata → Salpa thompsoni	8.555	7.750E-05
3	ES	Nuttallochiton mirandus → Foraminifera	6.899E-03	5.650E-10
3	ES	Oediceroides calmani → Phytoplankton	5.070E-05	1.370E-09
3	ES	Oediceroides emarginatus → Phytoplankton	2.170E-04	1.370E-09
3	ES	Ommatophoca rossii → Alluroteuthis antarcticus	1.725E+02	1.000E-02
3	ES	Ommatophoca rossii → Galitheutis glacialis	1.725E+02	1.250
3	ES	Ommatophoca rossii → Kondakovia longimama	1.725E+02	1.758E-01
3	ES	Ommatophoca rossii → Psychroteuthis glacialis	1.725E+02	4.666E-01
3	ES	Ophiacantha antarctica → Copepoda	1.010E-04	1.810E-06
3	ES	Ophiacantha antarctica → Foraminifera	1.010E-04	5.650E-10
3	ES	Ophiacantha pentacis → Copepoda	1.470E-04	1.810E-06
3	ES	Ophiacantha vivipara → Copepoda	1.010E-04	1.810E-06
3	ES	Ophioceres incipiens → Flagellate	6.500E-05	2.540E-11
3	ES	Ophioceres incipiens → Foraminifera	6.500E-05	5.650E-10
3	ES	Ophioceres incipiens → Silicioflagellates	6.500E-05	1.510E-10
3	ES	Ophionotus victoriae → Euphausiacea	1.914E-03	1.580E-05
3	ES	Ophionotus victoriae → Foraminifera	1.914E-03	5.650E-10
3	ES	Ophioperla koehleri → Copepoda	1.673E-03	1.810E-06
3	ES	Ophioperla koehleri → Euphausiacea	1.673E-03	1.580E-05
3	ES	Ophioperla koehleri → Foraminifera	1.673E-03	5.650E-10
3	ES	Oradarea edentata → Phytoplankton	5.050E-06	1.370E-09
3	ES	Orcinus orca → Arctocephalus gazella	1.145E+04	2.205E+02
3	ES	Orcinus orca → Balaenoptera acutorostrata	1.145E+04	1.423E+04
3	ES	Orcinus orca → Dissostichus mawsoni	1.145E+04	2.425E+01
3	ES	Orcinus orca → Halobaena caerulea	1.145E+04	2.259E-01
3	ES	Orcinus orca → Hydrurga leptonyx	1.145E+04	7.216E+02

D	Com	Consumer → Resource	ConSize	ResSize
3	ES	Orcinus orca → Leptonychotes weddelli	1.145E+04	4.529E+02
3	ES	Orcinus orca → Lobodon carcinophagus	1.145E+04	4.403E+02
3	ES	Orcinus orca → Mirounga leonina	1.145E+04	2.067E+03
3	ES	Orcinus orca → Myctophidae	1.145E+04	1.967E-02
3	ES	Orcinus orca → Ommatophoca rossii	1.145E+04	1.725E+02
3	ES	Orcinus orca → Pygoscelis adeliae	1.145E+04	8.802E-01
3	ES	Orcinus orca → Thalassoica antarctica	1.145E+04	6.002E-01
3	ES	Pagetopsis maculatus → Euphausia crystallorophias	8.088E-02	6.590E-05
3	ES	Pagetopsis maculatus → Euphausia superba	8.088E-02	1.960E-04
3	ES	Pagetopsis maculatus → Euphausiacea	8.088E-02	1.580E-05
3	ES	Pemmatoporella sp. → Nanoplankton	7.030E-07	1.080E-11
3	ES	Physeter macrocephalus → Champsocephalus gunnari	5.141E+04	3.644
3	ES	Physeter macrocephalus → Dissostichus mawsoni	5.141E+04	2.425E+01
3	ES	Physeter macrocephalus → Euphausiacea	5.141E+04	1.580E-05
3	ES	Physeter macrocephalus → Myctophidae	5.141E+04	1.967E-02
3	ES	Pleuragramma antarcticum → Copepoda	3.006E-01	1.810E-06
3	ES	Pleuragramma antarcticum → Cyllopus lucasii	3.006E-01	2.640E-05
3	ES	Pleuragramma antarcticum → Euphausiacea	3.006E-01	1.580E-05
3	ES	Pleuragramma antarcticum → Myctophidae	3.006E-01	1.967E-02
3	ES	Pleuragramma antarcticum → Salpa thompsoni	3.006E-01	7.750E-05
3	ES	Podocopida → Zooplankton	2.520E-07	1.680E-07
3	ES	Primnoisis antarctica → Phytoplankton	3.170E-04	1.370E-09
3	ES	Primnoisis antarctica → Zooplankton	3.170E-04	1.680E-07
3	ES	Promachocrinus kerguelensis → Phytoplankton	6.107E-02	1.370E-09
3	ES	Protomyctophum bolini → Calanus propinquus	5.581E-03	1.550E-06
3	ES	Protomyctophum bolini → Chaetognatha	5.581E-03	4.410E-04
3	ES	Protomyctophum bolini → Copepoda	5.581E-03	1.810E-06
3	ES	Protomyctophum bolini → Euchaeta antarctica	5.581E-03	1.980E-06
3	ES	Protomyctophum bolini → Euphausiacea	5.581E-03	1.580E-05
3	ES	Protomyctophum bolini → Metridia gerlachei	5.581E-03	8.160E-07
3	ES	Protomyctophum bolini → Oncea curvata	5.581E-03	9.350E-09
3	ES	Protomyctophum bolini → Ostracods	5.581E-03	2.520E-07
3	ES	Protomyctophum bolini → Rhincalanus gigas	5.581E-03	3.770E-06
3	ES	Protomyctophum bolini → Thysanoessa macrura	5.581E-03	1.580E-05
3	ES	Psolus antarcticus → Phytoplankton	4.805E-03	1.370E-09
3	ES	Psolus charcoti → Phytoplankton	3.665E-03	1.370E-09
3	ES	Psolus dubiosus → Phytoplankton	4.805E-03	1.370E-09
3	ES	Psychroteuthis glacialis → Chaenodraco wilsoni	4.666E-01	2.139E-01
3	ES	Psychroteuthis glacialis → Chionodraco hamatus	4.666E-01	1.072
3	ES	Psychroteuthis glacialis → Euphausia superba	4.666E-01	1.960E-04
3	ES	Psychroteuthis glacialis → Myctophidae	4.666E-01	1.967E-02
3	ES	Psychroteuthis glacialis → Pleuragramma antarcticum	4.666E-01	3.006E-01
3	ES	Psychroteuthis glacialis → Psychroteuthis glacialis	4.666E-01	4.666E-01
3	ES	Pterodroma brevirostris → Cyllopus lucasii	3.257E-01	2.640E-05
3	ES	Pterodroma brevirostris → Electrona antarctica	3.257E-01	3.906E-02
3	ES	Pterodroma brevirostris → Euphausia superba	3.257E-01	1.960E-04
3	ES	Pterodroma brevirostris → Eurythenes gryllus	3.257E-01	9.320E-04
3	ES	Pterodroma brevirostris → Galitheutis glacialis	3.257E-01	1.250
3	ES	Pterodroma brevirostris → Gymnoscopelus braueri	3.257E-01	2.614E-02
3	ES	Pterodroma brevirostris → Notocrangon antarcticus	3.257E-01	4.490E-04
3	ES	Pterodroma brevirostris → Notolepis coatsi	3.257E-01	3.145E-03
3	ES	Pterodroma brevirostris → Protomyctophum bolini	3.257E-01	5.581E-03
3	ES	Pterodroma brevirostris → Vibillia antarctica	3.257E-01	9.390E-08
3	ES	Puncturella conica → Foraminifera	3.150E-05	5.650E-10
3	ES	Pygoscelis adeliae → Cyllopus lucasii	8.802E-01	2.640E-05
3	ES	Pygoscelis adeliae → Electrona antarctica	8.802E-01	3.906E-02
3	ES	Pygoscelis adeliae → Euphausia superba	8.802E-01	1.960E-04
3	ES	Pygoscelis adeliae → Euphausia superba	8.802E-01	1.960E-04
3	ES	Pygoscelis adeliae → Kondakovia longimama	8.802E-01	1.758E-01
3	ES	Pygoscelis adeliae → Psychroteuthis glacialis	8.802E-01	4.666E-01

D	Com	Consumer → Resource	ConSize	ResSize
3	ES	Pygoscelis adeliae → Thysanoessa macrura	8.802E-01	1.580E-05
3	ES	Racovitzia glacialis → Tanaidacea	4.286E-01	1.470E-04
3	ES	Reteporella hippocrepis → Nanoplankton	4.520E-05	1.080E-11
3	ES	Rhachotropis antarctica → Copepoda	1.730E-05	1.810E-06
3	ES	Rhachotropis antarctica → Euphausiacea	1.730E-05	1.580E-05
3	ES	Rhincalanus gigas → Flagellate	3.770E-06	2.540E-11
3	ES	Rhincalanus gigas → Oithona sp.	3.770E-06	9.350E-09
3	ES	Rhincalanus gigas → Oncea curvata	3.770E-06	9.350E-09
3	ES	Rhincalanus gigas → Silicioflagellates	3.770E-06	1.510E-10
3	ES	Rhincalanus gigas → Tintinnid	3.770E-06	4.010E-08
3	ES	Rhynchonereella bongraini → Ostracods	3.820E-08	2.520E-07
3	ES	Rossella antarctica → Bacteria	2.581E-01	2.810E-10
3	ES	Rossella antarctica → Phytoplankton	2.581E-01	1.370E-09
3	ES	Rossella nuda → Bacteria	4.141	2.810E-10
3	ES	Rossella nuda → Phytoplankton	4.141	1.370E-09
3	ES	Rossella racovitzae → Bacteria	7.978E-01	2.810E-10
3	ES	Rossella racovitzae → Phytoplankton	7.978E-01	1.370E-09
3	ES	Sagitta gazellae → Euchaeta antarctica	2.200E-04	1.980E-06
3	ES	Sagitta gazellae → Metridia gerlachei	2.200E-04	8.160E-07
3	ES	Sagitta marri → Copepoda	9.980E-04	1.810E-06
3	ES	Sagitta marri → Metridia gerlachei	9.980E-04	8.160E-07
3	ES	Sagitta marri → Oithona sp.	9.980E-04	9.350E-09
3	ES	Sagitta marri → Oncea curvata	9.980E-04	9.350E-09
3	ES	Sagitta marri → Ostracods	9.980E-04	2.520E-07
3	ES	Sagitta marri → Pelegobia longicirrata	9.980E-04	3.820E-08
3	ES	Salpa gerlachei → Phytoplankton	1.110E-06	1.370E-09
3	ES	Salpa thompsoni → Calanus propinquus	7.750E-05	1.550E-06
3	ES	Salpa thompsoni → Copepoda	7.750E-05	1.810E-06
3	ES	Salpa thompsoni → Euchaeta antarctica	7.750E-05	1.980E-06
3	ES	Salpa thompsoni → Eukrohnia hamata	7.750E-05	2.120E-05
3	ES	Salpa thompsoni → Flagellate	7.750E-05	2.540E-11
3	ES	Salpa thompsoni → Foraminifera	7.750E-05	5.650E-10
3	ES	Salpa thompsoni → Limacina helicina	7.750E-05	9.390E-08
3	ES	Salpa thompsoni → Metridia gerlachei	7.750E-05	8.160E-07
3	ES	Salpa thompsoni → Oithona sp.	7.750E-05	9.350E-09
3	ES	Salpa thompsoni → Oncea curvata	7.750E-05	9.350E-09
3	ES	Salpa thompsoni → Pelegobia longicirrata	7.750E-05	3.820E-08
3	ES	Salpa thompsoni → Phytoplankton	7.750E-05	1.370E-09
3	ES	Salpa thompsoni → Silicioflagellates	7.750E-05	1.510E-10
3	ES	Salpa thompsoni → Tintinnid	7.750E-05	4.010E-08
3	ES	Salpa thompsoni → Zooplankton	7.750E-05	1.680E-07
3	ES	Salpa thompsoni → Zooplankton	7.750E-05	1.680E-07
3	ES	Scolymastra joubini → Bacteria	8.800	2.810E-10
3	ES	Scolymastra joubini → Bacteria	8.800	2.810E-10
3	ES	Scolymastra joubini → Phytoplankton	8.800	1.370E-09
3	ES	Silicularia rosea → Tintinnid	1.650E-07	4.010E-08
3	ES	Silicularia rosea → Zooplankton	1.650E-07	1.680E-07
3	ES	Solmundella bitentaculata → Eukrohnia hamata	2.841E-02	2.120E-05
3	ES	Solmundella bitentaculata → Euphausiacea	2.841E-02	1.580E-05
3	ES	Solmundella bitentaculata → Limacina helicina	2.841E-02	9.390E-08
3	ES	Solmundella bitentaculata → Pteropoda	2.841E-02	5.540E-05
3	ES	Solmundella bitentaculata → Salpa thompsoni	2.841E-02	7.750E-05
3	ES	Sterechinus antarcticus → Foraminifera	7.107E-03	5.650E-10
3	ES	Sterechinus neumayeri → Foraminifera	2.760E-03	5.650E-10
3	ES	Stylocordyla borealis → Bacteria	7.978E-01	2.810E-10
3	ES	Stylocordyla borealis → Phytoplankton	7.978E-01	1.370E-09
3	ES	Synoicum adareanum → Bacteria	3.010E-03	2.810E-10
3	ES	Synoicum adareanum → Nanoplankton	3.010E-03	1.080E-11
3	ES	Systenopora contracta → Nanoplankton	1.122E-03	1.080E-11
3	ES	Taeniogyrus contortus → Phytoplankton	4.805E-03	1.370E-09

D	Com	Consumer → Resource	ConSize	ResSize
3	ES	Tetilla leptoderma → Bacteria	5.623E-01	2.810E-10
3	ES	Tetilla leptoderma → Phytoplankton	5.623E-01	1.370E-09
3	ES	Thysanoessa macrura → Copepoda	1.580E-05	1.810E-06
3	ES	Thysanoessa macrura → Flagellate	1.580E-05	2.540E-11
3	ES	Thysanoessa macrura → Foraminifera	1.580E-05	5.650E-10
3	ES	Thysanoessa macrura → Phytoplankton	1.580E-05	1.370E-09
3	ES	Thysanoessa macrura → Pteropoda	1.580E-05	5.540E-05
3	ES	Thysanoessa macrura → Tintinnid	1.580E-05	4.010E-08
3	ES	Trematomus bernacchii → Copepoda	2.426E-01	1.810E-06
3	ES	Trematomus bernacchii → Cyllopus lucasii	2.426E-01	2.640E-05
3	ES	Trematomus bernacchii → Echiurida	2.426E-01	1.180E-05
3	ES	Trematomus bernacchii → Epimeria robusta	2.426E-01	9.280E-05
3	ES	Trematomus bernacchii → Metridia gerlachei	2.426E-01	8.160E-07
3	ES	Trematomus bernacchii → Ostracods	2.426E-01	2.520E-07
3	ES	Trematomus bernacchii → Tanaidacea	2.426E-01	1.470E-04
3	ES	Trematomus bernacchii → Yoldiella eightsi	2.426E-01	5.900E-04
3	ES	Trematomus bernacchii → Zooplankton	2.426E-01	1.680E-07
3	ES	Trematomus eulepidotus → Copepoda	4.803E-01	1.810E-06
3	ES	Trematomus eulepidotus → Cyllopus lucasii	4.803E-01	2.640E-05
3	ES	Trematomus eulepidotus → Cyllopus lucasii	4.803E-01	2.640E-05
3	ES	Trematomus eulepidotus → Epimeria robusta	4.803E-01	9.280E-05
3	ES	Trematomus eulepidotus → Euchaeta antarctica	4.803E-01	1.980E-06
3	ES	Trematomus eulepidotus → Euphausia crystallorophias	4.803E-01	6.590E-05
3	ES	Trematomus eulepidotus → Euphausia superba	4.803E-01	1.960E-04
3	ES	Trematomus eulepidotus → Metridia gerlachei	4.803E-01	8.160E-07
3	ES	Trematomus eulepidotus → Oncea curvata	4.803E-01	9.350E-09
3	ES	Trematomus eulepidotus → Ostracods	4.803E-01	2.520E-07
3	ES	Trematomus eulepidotus → Zooplankton	4.803E-01	1.680E-07
3	ES	Trematomus hansoni → Ceratoserolis meridionalis	3.006E-01	3.980E-04
3	ES	Trematomus hansoni → Copepoda	3.006E-01	1.810E-06
3	ES	Trematomus hansoni → Cyllopus lucasii	3.006E-01	2.640E-05
3	ES	Trematomus hansoni → Euphausia crystallorophias	3.006E-01	6.590E-05
3	ES	Trematomus hansoni → Euphausia superba	3.006E-01	1.960E-04
3	ES	Trematomus hansoni → Metridia gerlachei	3.006E-01	8.160E-07
3	ES	Trematomus hansoni → Neobuccinum eatoni	3.006E-01	3.580E-03
3	ES	Trematomus hansoni → Pantopoda	3.006E-01	4.450E-04
3	ES	Trematomus hansoni → Pentanymphon antarcticum	3.006E-01	9.590E-07
3	ES	Trematomus hansoni → Trematomus eulepidotus	3.006E-01	4.803E-01
3	ES	Trematomus hansoni → Trematomus pennellii	3.006E-01	3.006E-01
3	ES	Trematomus hansoni → Zooplankton	3.006E-01	1.680E-07
3	ES	Trematomus lepidorhinus → Copepoda	1.485E-01	1.810E-06
3	ES	Trematomus lepidorhinus → Epimeria robusta	1.485E-01	9.280E-05
3	ES	Trematomus lepidorhinus → Eunoe spica	1.485E-01	9.540E-05
3	ES	Trematomus lepidorhinus → Euphausia crystallorophias	1.485E-01	6.590E-05
3	ES	Trematomus lepidorhinus → Euphausia superba	1.485E-01	1.960E-04
3	ES	Trematomus lepidorhinus → Laternula elliptica	1.485E-01	1.299E-02
3	ES	Trematomus lepidorhinus → Metridia gerlachei	1.485E-01	8.160E-07
3	ES	Trematomus lepidorhinus → Ostracods	1.485E-01	2.520E-07
3	ES	Trematomus loennbergii → Copepoda	2.454E-01	1.810E-06
3	ES	Trematomus loennbergii → Cumacea	2.454E-01	7.400E-06
3	ES	Trematomus loennbergii → Cyllopus lucasii	2.454E-01	2.640E-05
3	ES	Trematomus loennbergii → Eukrohnia hamata	2.454E-01	2.120E-05
3	ES	Trematomus loennbergii → Euphausia crystallorophias	2.454E-01	6.590E-05
3	ES	Trematomus loennbergii → Euphausia superba	2.454E-01	1.960E-04
3	ES	Trematomus loennbergii → Pteropoda	2.454E-01	5.540E-05
3	ES	Trematomus loennbergii → Salpa thompsoni	2.454E-01	7.750E-05
3	ES	Trematomus nicolai → Calanus acutus	6.625E-01	1.490E-06
3	ES	Trematomus nicolai → Copepoda	6.625E-01	1.810E-06
3	ES	Trematomus nicolai → Epimeria robusta	6.625E-01	9.280E-05
3	ES	Trematomus nicolai → Euphausia crystallorophias	6.625E-01	6.590E-05

D	Com	Consumer → Resource	ConSize	ResSize
3	ES	Trematomus nicolai → Euphausia superba	6.625E-01	1.960E-04
3	ES	Trematomus nicolai → Metridia gerlachei	6.625E-01	8.160E-07
3	ES	Trematomus nicolai → Tanaidacea	6.625E-01	1.470E-04
3	ES	Trematomus pennellii → Aega antarctica	3.006E-01	4.060E-05
3	ES	Trematomus pennellii → Ceratoserolis meridionalis	3.006E-01	3.980E-04
3	ES	Trematomus pennellii → Copepoda	3.006E-01	1.810E-06
3	ES	Trematomus pennellii → Cyllopus lucasii	3.006E-01	2.640E-05
3	ES	Trematomus pennellii → Epimeria robusta	3.006E-01	9.280E-05
3	ES	Trematomus pennellii → Euphausia crystallorophias	3.006E-01	6.590E-05
3	ES	Trematomus pennellii → Euphausia superba	3.006E-01	1.960E-04
3	ES	Trematomus pennellii → Glyptonotus antarcticus	3.006E-01	9.320E-04
3	ES	Trematomus pennellii → Gnathia calva	3.006E-01	3.160E-06
3	ES	Trematomus pennellii → Natatolana obtusata	3.006E-01	5.050E-06
3	ES	Trematomus pennellii → Ostracods	3.006E-01	2.520E-07
3	ES	Trematomus pennellii → Pentanymphon antarcticum	3.006E-01	9.590E-07
3	ES	Trematomus pennellii → Tanaidacea	3.006E-01	1.470E-04
3	ES	Trematomus scotti → Calanus acutus	9.548E-02	1.490E-06
3	ES	Trematomus scotti → Calanus propinquus	9.548E-02	1.550E-06
3	ES	Trematomus scotti → Copepoda	9.548E-02	1.810E-06
3	ES	Trematomus scotti → Cumacea	9.548E-02	7.400E-06
3	ES	Trematomus scotti → Cyllopus lucasii	9.548E-02	2.640E-05
3	ES	Trematomus scotti → Epimeria robusta	9.548E-02	9.280E-05
3	ES	Trematomus scotti → Euchaeta antarctica	9.548E-02	1.980E-06
3	ES	Trematomus scotti → Eunoe hartmanae	9.548E-02	1.349E-03
3	ES	Trematomus scotti → Eunoe spica	9.548E-02	9.540E-05
3	ES	Trematomus scotti → Euphausia crystallorophias	9.548E-02	6.590E-05
3	ES	Trematomus scotti → Euphausia superba	9.548E-02	1.960E-04
3	ES	Trematomus scotti → Gnathia calva	9.548E-02	3.160E-06
3	ES	Trematomus scotti → Metridia gerlachei	9.548E-02	8.160E-07
3	ES	Trematomus scotti → Natatolana obtusata	9.548E-02	5.050E-06
3	ES	Trematomus scotti → Ostracods	9.548E-02	2.520E-07
3	ES	Trematomus scotti → Pantopoda	9.548E-02	4.450E-04
3	ES	Trematomus scotti → Tanaidacea	9.548E-02	1.470E-04
3	ES	Trematomus scotti → Zooplankton	9.548E-02	1.680E-07
3	ES	Tritonia antarctica → Cephalodiscus sp.	4.530E-03	1.960E-04
3	ES	Tubularia ralphii → Copepoda	3.210E-06	1.810E-06
3	ES	Tubularia ralphii → Zooplankton	3.210E-06	1.680E-07
3	ES	Tursiops truncatus → Champsocephalus gunnari	1.110E+03	3.644
3	ES	Tursiops truncatus → Dissostichus mawsoni	1.110E+03	2.425E+01
3	ES	Tursiops truncatus → Euphausiacea	1.110E+03	1.580E-05
3	ES	Tursiops truncatus → Myctophidae	1.110E+03	1.967E-02
3	ES	Uristes gigas → Euphausiacea	4.060E-05	1.580E-05
3	ES	Vaunthompsonia indermis → Bacteria	7.400E-06	2.810E-10
3	ES	Vibillia antarctica → Zooplankton	9.390E-08	1.680E-07
3	ES	Vibillia stebbingi → Zooplankton	9.390E-08	1.680E-07
3	GM	Argiope bruennichi → Caelifera	4.230E-05	6.660E-05
3	GM	Argiope bruennichi → Chorthippus montanus	4.230E-05	6.160E-05
3	GM	Argiope bruennichi → Orthetrum cancellatum	4.230E-05	7.930E-05
3	GM	Argiope bruennichi → Somatochlora sp	4.230E-05	1.070E-04
3	GM	Argiope bruennichi → Sympetrum sanguineum	4.230E-05	5.060E-05
3	GM	Argiope bruennichi → Sympetrum sp	4.230E-05	8.300E-05
3	GM	Argiope bruennichi → Sympetrum striolatum	4.230E-05	1.750E-04
3	GM	Argiope bruennichi → Sympetrum vulgatum	4.230E-05	6.960E-05
3	GM	Argiope bruennichi → Tetragnatha extensa	4.230E-05	2.000E-06
3	GM	Argiope bruennichi → Tetrix sp	4.230E-05	5.800E-06
3	GM	Argiope bruennichi → Tetrix subulata	4.230E-05	4.600E-06
3	GM	Culex sp → Locustella naevia	2.500E-07	1.300E-02
3	GM	Dolichovespula sylvestris → Brachycera	2.310E-05	2.800E-07
3	GM	Dolichovespula sylvestris → Chrysops relictus	2.310E-05	6.050E-06
3	GM	Dolichovespula sylvestris → Culex sp	2.310E-05	2.500E-07

D	Com	Consumer → Resource	ConSize	ResSize
3	GM	Dolichovespula sylvestris → Haematopota sp	2.310E-05	9.300E-06
3	GM	Dolichovespula sylvestris → Herina parva	2.310E-05	4.950E-07
3	GM	Dolichovespula sylvestris → Ilione albiseta	2.310E-05	6.000E-06
3	GM	Dolichovespula sylvestris → Limonia sp	2.310E-05	1.000E-07
3	GM	Dolichovespula sylvestris → Muscidae copro	2.310E-05	4.500E-07
3	GM	Dolichovespula sylvestris → Muscidae flor	2.310E-05	4.500E-07
3	GM	Dolichovespula sylvestris → Psacadina zernyi	2.310E-05	2.300E-06
3	GM	Evarcha arcuata → Chartoscirta cincta	5.000E-06	1.590E-06
3	GM	Evarcha arcuata → Clubiona sp	5.000E-06	2.570E-07
3	GM	Evarcha arcuata → Clubiona subtilis	5.000E-06	2.270E-07
3	GM	Evarcha arcuata → Culex sp	5.000E-06	2.500E-07
3	GM	Evarcha arcuata → Evarcha sp	5.000E-06	1.100E-06
3	GM	Evarcha arcuata → Herina parva	5.000E-06	4.950E-07
3	GM	Evarcha arcuata → Muscidae copro	5.000E-06	4.500E-07
3	GM	Evarcha arcuata → Muscidae flor	5.000E-06	4.500E-07
3	GM	Evarcha arcuata → Ozyptila sp	5.000E-06	1.320E-06
3	GM	Evarcha sp → Cicadina	1.100E-06	7.930E-08
3	GM	Evarcha sp → Hebrus pusillus	1.100E-06	1.560E-06
3	GM	Evarcha sp → Hebrus ruficeps	1.100E-06	1.560E-06
3	GM	Evarcha sp → Thanatus sp	1.100E-06	1.000E-07
3	GM	Falco subbuteo → Chorthippus montanus	2.100E-01	6.160E-05
3	GM	Falco subbuteo → Orthetrum cancellatum	2.100E-01	7.930E-05
3	GM	Falco subbuteo → Somatochlora sp	2.100E-01	1.070E-04
3	GM	Falco subbuteo → Sympetrum sanguineum	2.100E-01	5.060E-05
3	GM	Falco subbuteo → Sympetrum sp	2.100E-01	8.300E-05
3	GM	Falco subbuteo → Sympetrum striolatum	2.100E-01	1.750E-04
3	GM	Falco subbuteo → Sympetrum vulgatum	2.100E-01	6.960E-05
3	GM	Larinioides cornutus → Chrysops relictus	2.970E-05	6.050E-06
3	GM	Larinioides cornutus → Cloeon simile	2.970E-05	1.200E-06
3	GM	Larinioides cornutus → Dolichovespula sylvestris	2.970E-05	2.310E-05
3	GM	Larinioides cornutus → Haematopota sp	2.970E-05	9.300E-06
3	GM	Larinioides cornutus → Ilione albiseta	2.970E-05	6.000E-06
3	GM	Larinioides cornutus → Philaenus spumarius	2.970E-05	2.400E-06
3	GM	Larinioides cornutus → Psacadina zernyi	2.970E-05	2.300E-06
3	GM	Larinioides cornutus → Stalia boops	2.970E-05	2.500E-06
3	GM	Larinioides cornutus → Sympetrum sanguineum	2.970E-05	5.060E-05
3	GM	Larinioides cornutus → Sympetrum sp	2.970E-05	8.300E-05
3	GM	Larinioides cornutus → Sympetrum striolatum	2.970E-05	1.750E-04
3	GM	Larinioides cornutus → Sympetrum vulgatum	2.970E-05	6.960E-05
3	GM	Larinioides sp → Anthocomus coccineus	3.150E-06	3.180E-06
3	GM	Larinioides sp → Chartoscirta cincta	3.150E-06	1.590E-06
3	GM	Larinioides sp → Cloeon simile	3.150E-06	1.200E-06
3	GM	Larinioides sp → Culex sp	3.150E-06	2.500E-07
3	GM	Larinioides sp → Herina parva	3.150E-06	4.950E-07
3	GM	Larinioides sp → Limonia sp	3.150E-06	1.000E-07
3	GM	Larinioides sp → Muscidae copro	3.150E-06	4.500E-07
3	GM	Larinioides sp → Muscidae flor	3.150E-06	4.500E-07
3	GM	Larinioides sp → Philaenus spumarius	3.150E-06	2.400E-06
3	GM	Larinioides sp → Psacadina zernyi	3.150E-06	2.300E-06
3	GM	Larinioides sp → Stalia boops	3.150E-06	2.500E-06
3	GM	Mangora acalypha (Walckenaer 1802) → Hebrus pusillus	1.000E-07	1.560E-06
3	GM	Mangora acalypha (Walckenaer 1802) → Hebrus ruficeps	1.000E-07	1.560E-06
3	GM	Mangora acalypha (Walckenaer 1802) → Ootetrastichus sp	1.000E-07	8.000E-08
3	GM	Marpissa radiata → Anthocomus coccineus	4.180E-06	3.180E-06
3	GM	Marpissa radiata → Evarcha arcuata	4.180E-06	5.000E-06
3	GM	Marpissa radiata → Herina parva	4.180E-06	4.950E-07
3	GM	Marpissa radiata → Limonia sp	4.180E-06	1.000E-07
3	GM	Marpissa radiata → Micrommata virescens	4.180E-06	1.340E-05
3	GM	Marpissa radiata → Muscidae copro	4.180E-06	4.500E-07
3	GM	Marpissa radiata → Muscidae flor	4.180E-06	4.500E-07

D	Com	Consumer → Resource	ConSize	ResSize
3	GM	Marpissa radiata → Philaenus spumarius	4.180E-06	2.400E-06
3	GM	Marpissa radiata → Tibellus sp	4.180E-06	4.600E-06
3	GM	Orthetrum cancellatum → Anthocomus coccineus	7.930E-05	3.180E-06
3	GM	Orthetrum cancellatum → Chrysops relictus	7.930E-05	6.050E-06
3	GM	Orthetrum cancellatum → Cloeon simile	7.930E-05	1.200E-06
3	GM	Orthetrum cancellatum → Culex sp	7.930E-05	2.500E-07
3	GM	Orthetrum cancellatum → Dolichovespula sylvestris	7.930E-05	2.310E-05
3	GM	Orthetrum cancellatum → Haematopota sp	7.930E-05	9.300E-06
3	GM	Orthetrum cancellatum → Herina parva	7.930E-05	4.950E-07
3	GM	Orthetrum cancellatum → Ilione albiseta	7.930E-05	6.000E-06
3	GM	Orthetrum cancellatum → Limonia sp	7.930E-05	1.000E-07
3	GM	Orthetrum cancellatum → Muscidae copro	7.930E-05	4.500E-07
3	GM	Orthetrum cancellatum → Muscidae flor	7.930E-05	4.500E-07
3	GM	Orthetrum cancellatum → Ootetrastichus sp	7.930E-05	8.000E-08
3	GM	Orthetrum cancellatum → Psacadina zernyi	7.930E-05	2.300E-06
3	GM	Somatochlora sp → Anthocomus coccineus	1.070E-04	3.180E-06
3	GM	Somatochlora sp → Chrysops relictus	1.070E-04	6.050E-06
3	GM	Somatochlora sp → Cloeon simile	1.070E-04	1.200E-06
3	GM	Somatochlora sp → Culex sp	1.070E-04	2.500E-07
3	GM	Somatochlora sp → Dolichovespula sylvestris	1.070E-04	2.310E-05
3	GM	Somatochlora sp → Haematopota sp	1.070E-04	9.300E-06
3	GM	Somatochlora sp → Herina parva	1.070E-04	4.950E-07
3	GM	Somatochlora sp → Ilione albiseta	1.070E-04	6.000E-06
3	GM	Somatochlora sp → Limonia sp	1.070E-04	1.000E-07
3	GM	Somatochlora sp → Muscidae copro	1.070E-04	4.500E-07
3	GM	Somatochlora sp → Muscidae flor	1.070E-04	4.500E-07
3	GM	Somatochlora sp → Ootetrastichus sp	1.070E-04	8.000E-08
3	GM	Somatochlora sp → Psacadina zernyi	1.070E-04	2.300E-06
3	GM	Sympetrum sanguineum → Anthocomus coccineus	5.060E-05	3.180E-06
3	GM	Sympetrum sanguineum → Chrysops relictus	5.060E-05	6.050E-06
3	GM	Sympetrum sanguineum → Cloeon simile	5.060E-05	1.200E-06
3	GM	Sympetrum sanguineum → Culex sp	5.060E-05	2.500E-07
3	GM	Sympetrum sanguineum → Dolichovespula sylvestris	5.060E-05	2.310E-05
3	GM	Sympetrum sanguineum → Haematopota sp	5.060E-05	9.300E-06
3	GM	Sympetrum sanguineum → Herina parva	5.060E-05	4.950E-07
3	GM	Sympetrum sanguineum → Ilione albiseta	5.060E-05	6.000E-06
3	GM	Sympetrum sanguineum → Limonia sp	5.060E-05	1.000E-07
3	GM	Sympetrum sanguineum → Muscidae copro	5.060E-05	4.500E-07
3	GM	Sympetrum sanguineum → Muscidae flor	5.060E-05	4.500E-07
3	GM	Sympetrum sanguineum → Ootetrastichus sp	5.060E-05	8.000E-08
3	GM	Sympetrum sanguineum → Psacadina zernyi	5.060E-05	2.300E-06
3	GM	Sympetrum sp → Anthocomus coccineus	8.300E-05	3.180E-06
3	GM	Sympetrum sp → Chrysops relictus	8.300E-05	6.050E-06
3	GM	Sympetrum sp → Cloeon simile	8.300E-05	1.200E-06
3	GM	Sympetrum sp → Culex sp	8.300E-05	2.500E-07
3	GM	Sympetrum sp → Dolichovespula sylvestris	8.300E-05	2.310E-05
3	GM	Sympetrum sp → Haematopota sp	8.300E-05	9.300E-06
3	GM	Sympetrum sp → Herina parva	8.300E-05	4.950E-07
3	GM	Sympetrum sp → Ilione albiseta	8.300E-05	6.000E-06
3	GM	Sympetrum sp → Limonia sp	8.300E-05	1.000E-07
3	GM	Sympetrum sp → Muscidae copro	8.300E-05	4.500E-07
3	GM	Sympetrum sp → Muscidae flor	8.300E-05	4.500E-07
3	GM	Sympetrum sp → Ootetrastichus sp	8.300E-05	8.000E-08
3	GM	Sympetrum sp → Psacadina zernyi	8.300E-05	2.300E-06
3	GM	Sympetrum striolatum → Anthocomus coccineus	1.750E-04	3.180E-06
3	GM	Sympetrum striolatum → Chrysops relictus	1.750E-04	6.050E-06
3	GM	Sympetrum striolatum → Cloeon simile	1.750E-04	1.200E-06
3	GM	Sympetrum striolatum → Culex sp	1.750E-04	2.500E-07
3	GM	Sympetrum striolatum → Dolichovespula sylvestris	1.750E-04	2.310E-05
3	GM	Sympetrum striolatum → Haematopota sp	1.750E-04	9.300E-06

D	Com	Consumer → Resource	ConSize	ResSize
3	GM	Sympetrum striolatum → Herina parva	1.750E-04	4.950E-07
3	GM	Sympetrum striolatum → Ilione albiseta	1.750E-04	6.000E-06
3	GM	Sympetrum striolatum → Limonia sp	1.750E-04	1.000E-07
3	GM	Sympetrum striolatum → Muscidae copro	1.750E-04	4.500E-07
3	GM	Sympetrum striolatum → Muscidae flor	1.750E-04	4.500E-07
3	GM	Sympetrum striolatum → Ootetrastichus sp	1.750E-04	8.000E-08
3	GM	Sympetrum striolatum → Psacadina zernyi	1.750E-04	2.300E-06
3	GM	Sympetrum vulgatum → Anthocomus coccineus	6.960E-05	3.180E-06
3	GM	Sympetrum vulgatum → Chrysops relictus	6.960E-05	6.050E-06
3	GM	Sympetrum vulgatum → Cloeon simile	6.960E-05	1.200E-06
3	GM	Sympetrum vulgatum → Culex sp	6.960E-05	2.500E-07
3	GM	Sympetrum vulgatum → Dolichovespula sylvestris	6.960E-05	2.310E-05
3	GM	Sympetrum vulgatum → Haematopota sp	6.960E-05	9.300E-06
3	GM	Sympetrum vulgatum → Herina parva	6.960E-05	4.950E-07
3	GM	Sympetrum vulgatum → Ilione albiseta	6.960E-05	6.000E-06
3	GM	Sympetrum vulgatum → Limonia sp	6.960E-05	1.000E-07
3	GM	Sympetrum vulgatum → Muscidae copro	6.960E-05	4.500E-07
3	GM	Sympetrum vulgatum → Muscidae flor	6.960E-05	4.500E-07
3	GM	Sympetrum vulgatum → Ootetrastichus sp	6.960E-05	8.000E-08
3	GM	Sympetrum vulgatum → Psacadina zernyi	6.960E-05	2.300E-06
3	GM	Tetragnatha extensa → Anthocomus coccineus	2.000E-06	3.180E-06
3	GM	Tetragnatha extensa → Cloeon simile	2.000E-06	1.200E-06
3	GM	Tetragnatha extensa → Herina parva	2.000E-06	4.950E-07
3	GM	Tetragnatha extensa → Limonia sp	2.000E-06	1.000E-07
3	GM	Tetragnatha extensa → Muscidae copro	2.000E-06	4.500E-07
3	GM	Tetragnatha extensa → Muscidae flor	2.000E-06	4.500E-07
3	GM	Tetragnatha extensa → Philaenus spumarius	2.000E-06	2.400E-06
3	GM	Tetragnatha extensa → Psacadina zernyi	2.000E-06	2.300E-06
3	GM	Tetragnatha extensa → Stalia boops	2.000E-06	2.500E-06
3	SB	Araneus diadematus → Arytaina genistae	8.160E-05	1.340E-06
3	SB	Araneus diadematus → Arytaina spartii	8.160E-05	1.340E-06
3	SB	Araneus diadematus → Asciodema obsoletum	8.160E-05	4.590E-06
3	SB	Araneus diadematus → Orthotylus adenocarpi	8.160E-05	5.220E-06
3	SB	Araneus diadematus → Orthotylus concolor	8.160E-05	5.220E-06
3	SB	Araneus diadematus → Orthotylus virescens	8.160E-05	5.220E-06
3	SB	Araneus sp. → Leucoptera spartifoliella	8.240E-06	1.020E-06
3	SB	Linyphia triangularis → Arytaina genistae	8.240E-06	1.340E-06
3	SB	Linyphia triangularis → Arytaina spartii	8.240E-06	1.340E-06
3	SB	Linyphia triangularis → Asciodema obsoletum	8.240E-06	4.590E-06
3	SB	Linyphia triangularis → Heterocordylus tibialis	8.240E-06	8.020E-06
3	SB	Linyphia triangularis → Leucoptera spartifoliella	8.240E-06	1.020E-06
3	SB	Linyphia triangularis → Orthotylus adenocarpi	8.240E-06	5.220E-06
3	SB	Linyphia triangularis → Orthotylus concolor	8.240E-06	5.220E-06
3	SB	Linyphia triangularis → Orthotylus virescens	8.240E-06	5.220E-06
3	SP	Acanthocyclops vernalis → Chydorus latus	6.410E-08	5.850E-09
3	SP	Acanthocyclops vernalis → Corynoneura scutellata	6.410E-08	8.590E-07
3	SP	Acanthocyclops vernalis → Enchytraidae sp.	6.410E-08	6.000E-08
3	SP	Acanthocyclops vernalis → Other Chironomidae spp.	6.410E-08	3.820E-06
3	SP	Acanthocyclops vernalis → Tanytarsus bruchonidae	6.410E-08	1.300E-06
3	SP	Agabus bipustulatus → Acanthocyclops vernalis	6.120E-05	6.410E-08
3	SP	Agabus bipustulatus → Scapaloberis mucronata	6.120E-05	3.210E-08
3	SP	Agabus sturmii → Acanthocyclops vernalis	2.820E-05	6.410E-08
3	SP	Agabus sturmii → Scapaloberis mucronata	2.820E-05	3.210E-08
3	SP	Argyroneta aquatica → Acanthocyclops vernalis	2.720E-05	6.410E-08
3	SP	Argyroneta aquatica → Chydorus latus	2.720E-05	5.850E-09
3	SP	Argyroneta aquatica → Scapaloberis mucronata	2.720E-05	3.210E-08
3	SP	Enallagma cyathigerum → Acanthocyclops vernalis	7.280E-06	6.410E-08
3	SP	Enallagma cyathigerum → Chydorus latus	7.280E-06	5.850E-09
3	SP	Enallagma cyathigerum → Scapaloberis mucronata	7.280E-06	3.210E-08
3	SP	Holocentropus picicornis → Chydorus latus	1.060E-05	5.850E-09

D	Com	Consumer → Resource	ConSize	ResSize
3	SP	Holocentropus picicornis → Scapaloberis mucronata	1.060E-05	3.210E-08
3	SP	Hydroporus erythrocephalus → Chydorus latus	4.740E-06	5.850E-09
3	SP	Hydroporus erythrocephalus → Scapaloberis mucronata	4.740E-06	3.210E-08
3	SP	Illybius fuliginosus → Acanthocyclops vernalis	6.500E-05	6.410E-08
3	SP	Illybius fuliginosus → Scapaloberis mucronata	6.500E-05	3.210E-08
3	SP	Lestes sponsa → Acanthocyclops vernalis	7.810E-05	6.410E-08
3	SP	Lestes sponsa → Chydorus latus	7.810E-05	5.850E-09
3	SP	Lestes sponsa → Scapaloberis mucronata	7.810E-05	3.210E-08
3	SP	Notonecta glauca → Acanthocyclops vernalis	1.440E-04	6.410E-08
3	SP	Notonecta glauca → Agabus bipustulatus	1.440E-04	6.120E-05
3	SP	Notonecta glauca → Agabus sturmii	1.440E-04	2.820E-05
3	SP	Notonecta glauca → Arctocorisa germari	1.440E-04	2.180E-05
3	SP	Notonecta glauca → Callicorixa praeusta	1.440E-04	1.990E-05
3	SP	Notonecta glauca → Chironomus dorsalis	1.440E-04	1.470E-05
3	SP	Notonecta glauca → Chydorus latus	1.440E-04	5.850E-09
3	SP	Notonecta glauca → Corixa dentipes	1.440E-04	9.670E-05
3	SP	Notonecta glauca → Corixa punctata	1.440E-04	9.280E-05
3	SP	Notonecta glauca → Corynoneura scutellata	1.440E-04	8.590E-07
3	SP	Notonecta glauca → Enallagma cyathigerum	1.440E-04	7.280E-06
3	SP	Notonecta glauca → Glyptotendipes pallens	1.440E-04	7.730E-06
3	SP	Notonecta glauca → Hesperocorixa linnei	1.440E-04	2.060E-05
3	SP	Notonecta glauca → Hesperocorixa sahlbergi	1.440E-04	2.140E-05
3	SP	Notonecta glauca → Holocentropus picicornis	1.440E-04	1.060E-05
3	SP	Notonecta glauca → Hydroporus erythrocephalus	1.440E-04	4.740E-06
3	SP	Notonecta glauca → Illybius fuliginosus	1.440E-04	6.500E-05
3	SP	Notonecta glauca → Lestes sponsa	1.440E-04	7.810E-05
3	SP	Notonecta glauca → Limnephilus marmoratus	1.440E-04	8.080E-05
3	SP	Notonecta glauca → Lumbriculus variegatus	1.440E-04	8.000E-06
3	SP	Notonecta glauca → Other Chironomidae spp.	1.440E-04	3.820E-06
3	SP	Notonecta glauca → Procladius sagittalis	1.440E-04	4.410E-06
3	SP	Notonecta glauca → Scapaloberis mucronata	1.440E-04	3.210E-08
3	SP	Notonecta glauca → Sialis lutaria	1.440E-04	5.250E-05
3	SP	Notonecta glauca → Sigara semistriata	1.440E-04	1.220E-05
3	SP	Notonecta glauca → Tanytarsus bruchonidae	1.440E-04	1.300E-06
3	SP	Procladius sagittalis → Acanthocyclops vernalis	4.410E-06	6.410E-08
3	SP	Procladius sagittalis → Chydorus latus	4.410E-06	5.850E-09
3	SP	Procladius sagittalis → Scapaloberis mucronata	4.410E-06	3.210E-08
3	SP	Sympetrum scoticum → Acanthocyclops vernalis	8.430E-05	6.410E-08
3	SP	Sympetrum scoticum → Chydorus latus	8.430E-05	5.850E-09
3	SP	Sympetrum scoticum → Notonecta glauca	8.430E-05	1.440E-04
3	SP	Sympetrum scoticum → Scapaloberis mucronata	8.430E-05	3.210E-08
3	TL	Ascomorpha eucadis → Chromulina sp.	2.700E-10	3.030E-14
3	TL	Ascomorpha eucadis → Chroococcus dispersus	2.700E-10	2.390E-13
3	TL	Ascomorpha eucadis → Chroococcus limneticus	2.700E-10	1.310E-12
3	TL	Ascomorpha eucadis → Cryptomonas sp. 1	2.700E-10	2.030E-13
3	TL	Ascomorpha eucadis → Selenastrum minutum	2.700E-10	2.720E-13
3	TL	Ascomorpha eucadis → Trachelomonas sp.	2.700E-10	1.750E-13
3	TL	Ascomorpha eucadis → Unclassified flagellates	2.700E-10	3.460E-13
3	TL	Ascomorpha eucadis → Unclassified microflagellates	2.700E-10	1.020E-13
3	TL	Bosmina longirostris → Chromulina sp.	1.550E-09	3.030E-14
3	TL	Bosmina longirostris → Chroococcus dispersus	1.550E-09	2.390E-13
3	TL	Bosmina longirostris → Cryptomonas sp. 1	1.550E-09	2.030E-13
3	TL	Bosmina longirostris → Cryptomonas sp. 2	1.550E-09	1.510E-12
3	TL	Bosmina longirostris → Dictyosphaerium pulchellum	1.550E-09	4.630E-13
3	TL	Bosmina longirostris → Dinobryon sociale	1.550E-09	6.410E-13
3	TL	Bosmina longirostris → Glenodinium quadridens	1.550E-09	7.540E-12
3	TL	Bosmina longirostris → Peridinium pulsillum	1.550E-09	1.580E-12
3	TL	Bosmina longirostris → Selenastrum minutum	1.550E-09	2.720E-13
3	TL	Bosmina longirostris → Trachelomonas sp.	1.550E-09	1.750E-13
3	TL	Bosmina longirostris → Unclassified flagellates	1.550E-09	3.460E-13

D	Com	Consumer → Resource	ConSize	ResSize
3	TL	Chaoborys punctipennis → Ascomorpha eucadis	2.580E-07	2.700E-10
3	TL	Chaoborys punctipennis → Bosmina longirostris	2.580E-07	1.550E-09
3	TL	Chaoborys punctipennis → Conochiloides dossuarius	2.580E-07	1.600E-10
3	TL	Chaoborys punctipennis → Conochilus (solitary)	2.580E-07	3.500E-11
3	TL	Chaoborys punctipennis → Cyclops varians rubellus	2.580E-07	2.240E-08
3	TL	Chaoborys punctipennis → Daphnia pulex	2.580E-07	5.150E-08
3	TL	Chaoborys punctipennis → Daphnia rosea	2.580E-07	1.360E-08
3	TL	Chaoborys punctipennis → Diaphanosoma leuchtenbergianum	2.580E-07	2.240E-09
3	TL	Chaoborys punctipennis → Diaptomus oregonensis	2.580E-07	1.440E-08
3	TL	Chaoborys punctipennis → Filinia longispina	2.580E-07	1.800E-10
3	TL	Chaoborys punctipennis → Gastropus hyptopus	2.580E-07	1.350E-10
3	TL	Chaoborys punctipennis → Gastropus stylifer	2.580E-07	1.160E-10
3	TL	Chaoborys punctipennis → Glenodinium quadridens	2.580E-07	7.540E-12
3	TL	Chaoborys punctipennis → Kelicottia bostoniensis	2.580E-07	2.000E-11
3	TL	Chaoborys punctipennis → Kelicottia longispina	2.580E-07	4.500E-11
3	TL	Chaoborys punctipennis → Kellicottia sp.	2.580E-07	2.000E-11
3	TL	Chaoborys punctipennis → Keratella cochlearis	2.580E-07	1.000E-11
3	TL	Chaoborys punctipennis → Keratella testudo	2.580E-07	1.250E-11
3	TL	Chaoborys punctipennis → Leptodiaptomus siciloides	2.580E-07	8.800E-09
3	TL	Chaoborys punctipennis → Orthocyclops modestus	2.580E-07	2.740E-08
3	TL	Chaoborys punctipennis → Ploesoma sp.	2.580E-07	1.050E-10
3	TL	Chaoborys punctipennis → Polyarthra vulgaris	2.580E-07	3.630E-10
3	TL	Chaoborys punctipennis → Synchaeta sp.	2.580E-07	6.600E-10
3	TL	Chaoborys punctipennis → Trichocerca cylindrica	2.580E-07	4.850E-10
3	TL	Chaoborys punctipennis → Trichocerca multicorinis	2.580E-07	1.600E-10
3	TL	Chaoborys punctipennis → Tropocyclops prasinus	2.580E-07	7.870E-09
3	TL	Conochiloides dossuarius → Chromulina sp.	1.600E-10	3.030E-14
3	TL	Conochiloides dossuarius → Chroococcus dispersus	1.600E-10	2.390E-13
3	TL	Conochiloides dossuarius → Chroococcus limneticus	1.600E-10	1.310E-12
3	TL	Conochiloides dossuarius → Closteriopsis longissimus	1.600E-10	2.180E-13
3	TL	Conochiloides dossuarius → Cryptomonas sp. 1	1.600E-10	2.030E-13
3	TL	Conochiloides dossuarius → Selenastrum minutum	1.600E-10	2.720E-13
3	TL	Conochiloides dossuarius → Trachelomonas sp.	1.600E-10	1.750E-13
3	TL	Conochiloides dossuarius → Unclassified flagellates	1.600E-10	3.460E-13
3	TL	Conochiloides dossuarius → Unclassified microflagellates	1.600E-10	1.020E-13
3	TL	Conochilus (colonial) → Chromulina sp.	1.460E-08	3.030E-14
3	TL	Conochilus (colonial) → Chroococcus dispersus	1.460E-08	2.390E-13
3	TL	Conochilus (colonial) → Chroococcus limneticus	1.460E-08	1.310E-12
3	TL	Conochilus (colonial) → Closteriopsis longissimus	1.460E-08	2.180E-13
3	TL	Conochilus (colonial) → Cryptomonas sp. 1	1.460E-08	2.030E-13
3	TL	Conochilus (colonial) → Selenastrum minutum	1.460E-08	2.720E-13
3	TL	Conochilus (colonial) → Unclassified microflagellates	1.460E-08	1.020E-13
3	TL	Conochilus (solitary) → Chromulina sp.	3.500E-11	3.030E-14
3	TL	Conochilus (solitary) → Chroococcus dispersus	3.500E-11	2.390E-13
3	TL	Conochilus (solitary) → Closteriopsis longissimus	3.500E-11	2.180E-13
3	TL	Conochilus (solitary) → Cryptomonas sp. 1	3.500E-11	2.030E-13
3	TL	Conochilus (solitary) → Selenastrum minutum	3.500E-11	2.720E-13
3	TL	Conochilus (solitary) → Trachelomonas sp.	3.500E-11	1.750E-13
3	TL	Conochilus (solitary) → Unclassified flagellates	3.500E-11	3.460E-13
3	TL	Cyclops varians rubellus → Ascomorpha eucadis	2.240E-08	2.700E-10
3	TL	Cyclops varians rubellus → Conochiloides dossuarius	2.240E-08	1.600E-10
3	TL	Cyclops varians rubellus → Conochilus (solitary)	2.240E-08	3.500E-11
3	TL	Cyclops varians rubellus → Diaptomus oregonensis	2.240E-08	1.440E-08
3	TL	Cyclops varians rubellus → Filinia longispina	2.240E-08	1.800E-10
3	TL	Cyclops varians rubellus → Gastropus hyptopus	2.240E-08	1.350E-10
3	TL	Cyclops varians rubellus → Gastropus stylifer	2.240E-08	1.160E-10
3	TL	Cyclops varians rubellus → Kelicottia bostoniensis	2.240E-08	2.000E-11
3	TL	Cyclops varians rubellus → Kelicottia longispina	2.240E-08	4.500E-11
3	TL	Cyclops varians rubellus → Kellicottia sp.	2.240E-08	2.000E-11
3	TL	Cyclops varians rubellus → Keratella cochlearis	2.240E-08	1.000E-11

D	Com	Consumer → Resource	ConSize	ResSize
3	TL	Cyclops varians rubellus → Keratella testudo	2.240E-08	1.250E-11
3	TL	Cyclops varians rubellus → Leptodiaptomus siciloides	2.240E-08	8.800E-09
3	TL	Cyclops varians rubellus → Ploesoma sp.	2.240E-08	1.050E-10
3	TL	Cyclops varians rubellus → Polyarthra vulgaris	2.240E-08	3.630E-10
3	TL	Cyclops varians rubellus → Synchaeta sp.	2.240E-08	6.600E-10
3	TL	Cyclops varians rubellus → Trichocerca cylindrica	2.240E-08	4.850E-10
3	TL	Cyclops varians rubellus → Trichocerca multicorinis	2.240E-08	1.600E-10
3	TL	Cyclops varians rubellus → Tropocyclops prasinus	2.240E-08	7.870E-09
3	TL	Daphnia pulex → Arthrodesmus sp.	5.150E-08	1.520E-12
3	TL	Daphnia pulex → Ascomorpha eucadis	5.150E-08	2.700E-10
3	TL	Daphnia pulex → Chromulina sp.	5.150E-08	3.030E-14
3	TL	Daphnia pulex → Chroococcus dispersus	5.150E-08	2.390E-13
3	TL	Daphnia pulex → Chroococcus limneticus	5.150E-08	1.310E-12
3	TL	Daphnia pulex → Closteriopsis longissimus	5.150E-08	2.180E-13
3	TL	Daphnia pulex → Cosmarium sp.	5.150E-08	3.710E-12
3	TL	Daphnia pulex → Cryptomonas sp. 1	5.150E-08	2.030E-13
3	TL	Daphnia pulex → Cryptomonas sp. 2	5.150E-08	1.510E-12
3	TL	Daphnia pulex → Cryptomonas sp. 3	5.150E-08	6.720E-13
3	TL	Daphnia pulex → Cryptomonas sp. 4	5.150E-08	1.640E-12
3	TL	Daphnia pulex → Dactylococcopsis fascicularis	5.150E-08	1.320E-13
3	TL	Daphnia pulex → Dictyosphaerium pulchellum	5.150E-08	4.630E-13
3	TL	Daphnia pulex → Dinobryon bavaricum	5.150E-08	3.870E-12
3	TL	Daphnia pulex → Dinobryon cylindricum	5.150E-08	2.150E-12
3	TL	Daphnia pulex → Dinobryon sertularia	5.150E-08	9.250E-12
3	TL	Daphnia pulex → Dinobryon sociale	5.150E-08	6.410E-13
3	TL	Daphnia pulex → Glenodinium pulvisculus	5.150E-08	5.200E-12
3	TL	Daphnia pulex → Glenodinium quadridens	5.150E-08	7.540E-12
3	TL	Daphnia pulex → Gloeocystis sp.	5.150E-08	9.460E-11
3	TL	Daphnia pulex → Keratella cochlearis	5.150E-08	1.000E-11
3	TL	Daphnia pulex → Mallomonas sp. 1	5.150E-08	1.030E-12
3	TL	Daphnia pulex → Mallomonas sp. 2	5.150E-08	1.410E-12
3	TL	Daphnia pulex → Microcystis aeruginosa	5.150E-08	1.620E-11
3	TL	Daphnia pulex → Nostoc sp.	5.150E-08	7.970E-13
3	TL	Daphnia pulex → Oocystis sp. 1	5.150E-08	3.860E-12
3	TL	Daphnia pulex → Oocystis sp. 2	5.150E-08	6.320E-12
3	TL	Daphnia pulex → Oscillatoria sp.	5.150E-08	1.610E-12
3	TL	Daphnia pulex → Peridinium cinctum	5.150E-08	4.060E-11
3	TL	Daphnia pulex → Peridinium limbatum	5.150E-08	6.460E-11
3	TL	Daphnia pulex → Peridinium pulsillum	5.150E-08	1.580E-12
3	TL	Daphnia pulex → Peridinium wisconsinense	5.150E-08	3.560E-11
3	TL	Daphnia pulex → Quadrigula lacustris	5.150E-08	7.130E-12
3	TL	Daphnia pulex → Quadrigula sp. 2	5.150E-08	9.480E-13
3	TL	Daphnia pulex → Schroederia setigera	5.150E-08	6.370E-13
3	TL	Daphnia pulex → Selenastrum minutum	5.150E-08	2.720E-13
3	TL	Daphnia pulex → Sphaerocystis schroeteri	5.150E-08	1.080E-11
3	TL	Daphnia pulex → Synchaeta sp.	5.150E-08	6.600E-10
3	TL	Daphnia pulex → Synedra sp.	5.150E-08	4.610E-11
3	TL	Daphnia pulex → Trachelomonas sp.	5.150E-08	1.750E-13
3	TL	Daphnia pulex → Unclassified flagellates	5.150E-08	3.460E-13
3	TL	Daphnia pulex → Unclassified microflagellates	5.150E-08	1.020E-13
3	TL	Daphnia rosea → Ankyra judayi	1.360E-08	1.530E-13
3	TL	Daphnia rosea → Ascomorpha eucadis	1.360E-08	2.700E-10
3	TL	Daphnia rosea → Chromulina sp.	1.360E-08	3.030E-14
3	TL	Daphnia rosea → Chroococcus dispersus	1.360E-08	2.390E-13
3	TL	Daphnia rosea → Chroococcus limneticus	1.360E-08	1.310E-12
3	TL	Daphnia rosea → Cosmarium sp.	1.360E-08	3.710E-12
3	TL	Daphnia rosea → Cryptomonas sp. 1	1.360E-08	2.030E-13
3	TL	Daphnia rosea → Cryptomonas sp. 3	1.360E-08	6.720E-13
3	TL	Daphnia rosea → Cryptomonas sp. 4	1.360E-08	1.640E-12
3	TL	Daphnia rosea → Dactylococcopsis fascicularis	1.360E-08	1.320E-13

D	Com	Consumer → Resource	ConSize	ResSize
3	TL	Daphnia rosea → Dictyosphaerium pulchellum	1.360E-08	4.630E-13
3	TL	Daphnia rosea → Dinobryon sertularia	1.360E-08	9.250E-12
3	TL	Daphnia rosea → Glenodinium pulvisculus	1.360E-08	5.200E-12
3	TL	Daphnia rosea → Keratella cochlearis	1.360E-08	1.000E-11
3	TL	Daphnia rosea → Oocystis sp. 1	1.360E-08	3.860E-12
3	TL	Daphnia rosea → Oocystis sp. 2	1.360E-08	6.320E-12
3	TL	Daphnia rosea → Oscillatoria sp.	1.360E-08	1.610E-12
3	TL	Daphnia rosea → Peridinium pulsillum	1.360E-08	1.580E-12
3	TL	Daphnia rosea → Schroederia setigera	1.360E-08	6.370E-13
3	TL	Daphnia rosea → Selenastrum minutum	1.360E-08	2.720E-13
3	TL	Daphnia rosea → Sphaerocystis schroeteri	1.360E-08	1.080E-11
3	TL	Daphnia rosea → Synchaeta sp.	1.360E-08	6.600E-10
3	TL	Daphnia rosea → Unclassified microflagellates	1.360E-08	1.020E-13
3	TL	Diaphanosoma leuchtenbergianum → Chromulina sp.	2.240E-09	3.030E-14
3	TL	Diaphanosoma leuchtenbergianum → Chroococcus dispersus	2.240E-09	2.390E-13
3	TL	Diaphanosoma leuchtenbergianum → Cryptomonas sp. 1	2.240E-09	2.030E-13
3	TL	Diaphanosoma leuchtenbergianum → Cryptomonas sp. 2	2.240E-09	1.510E-12
3	TL	Diaphanosoma leuchtenbergianum → Dactylococcopsis fascicularis	2.240E-09	1.320E-13
3	TL	Diaphanosoma leuchtenbergianum → Dictyosphaerium pulchellum	2.240E-09	4.630E-13
3	TL	Diaphanosoma leuchtenbergianum → Dinobryon cylindricum	2.240E-09	2.150E-12
3	TL	Diaphanosoma leuchtenbergianum → Dinobryon sociale	2.240E-09	6.410E-13
3	TL	Diaphanosoma leuchtenbergianum → Glenodinium quadridens	2.240E-09	7.540E-12
3	TL	Diaphanosoma leuchtenbergianum → Nostoc sp.	2.240E-09	7.970E-13
3	TL	Diaphanosoma leuchtenbergianum → Peridinium pulsillum	2.240E-09	1.580E-12
3	TL	Diaphanosoma leuchtenbergianum → Selenastrum minutum	2.240E-09	2.720E-13
3	TL	Diaphanosoma leuchtenbergianum → Trachelomonas sp.	2.240E-09	1.750E-13
3	TL	Diaphanosoma leuchtenbergianum → Unclassified flagellates	2.240E-09	3.460E-13
3	TL	Diaptomus oregonensis → Chromulina sp.	1.440E-08	3.030E-14
3	TL	Diaptomus oregonensis → Chroococcus dispersus	1.440E-08	2.390E-13
3	TL	Diaptomus oregonensis → Chroococcus limneticus	1.440E-08	1.310E-12
3	TL	Diaptomus oregonensis → Cosmarium sp.	1.440E-08	3.710E-12
3	TL	Diaptomus oregonensis → Cryptomonas sp. 1	1.440E-08	2.030E-13
3	TL	Diaptomus oregonensis → Cryptomonas sp. 3	1.440E-08	6.720E-13
3	TL	Diaptomus oregonensis → Cryptomonas sp. 4	1.440E-08	1.640E-12
3	TL	Diaptomus oregonensis → Dactylococcopsis fascicularis	1.440E-08	1.320E-13
3	TL	Diaptomus oregonensis → Dictyosphaerium pulchellum	1.440E-08	4.630E-13
3	TL	Diaptomus oregonensis → Dinobryon sertularia	1.440E-08	9.250E-12
3	TL	Diaptomus oregonensis → Glenodinium pulvisculus	1.440E-08	5.200E-12
3	TL	Diaptomus oregonensis → Oocystis sp. 1	1.440E-08	3.860E-12
3	TL	Diaptomus oregonensis → Oocystis sp. 2	1.440E-08	6.320E-12
3	TL	Diaptomus oregonensis → Peridinium pulsillum	1.440E-08	1.580E-12
3	TL	Diaptomus oregonensis → Schroederia setigera	1.440E-08	6.370E-13
3	TL	Diaptomus oregonensis → Selenastrum minutum	1.440E-08	2.720E-13
3	TL	Diaptomus oregonensis → Sphaerocystis schroeteri	1.440E-08	1.080E-11
3	TL	Diaptomus oregonensis → Unclassified microflagellates	1.440E-08	1.020E-13
3	TL	Filinia longispina → Chromulina sp.	1.800E-10	3.030E-14
3	TL	Filinia longispina → Chroococcus dispersus	1.800E-10	2.390E-13
3	TL	Filinia longispina → Cryptomonas sp. 1	1.800E-10	2.030E-13
3	TL	Filinia longispina → Selenastrum minutum	1.800E-10	2.720E-13
3	TL	Filinia longispina → Trachelomonas sp.	1.800E-10	1.750E-13
3	TL	Filinia longispina → Unclassified flagellates	1.800E-10	3.460E-13
3	TL	Gastropus hyptopus → Chromulina sp.	1.350E-10	3.030E-14
3	TL	Gastropus hyptopus → Chroococcus dispersus	1.350E-10	2.390E-13
3	TL	Gastropus hyptopus → Chroococcus limneticus	1.350E-10	1.310E-12
3	TL	Gastropus hyptopus → Cryptomonas sp. 1	1.350E-10	2.030E-13
3	TL	Gastropus hyptopus → Selenastrum minutum	1.350E-10	2.720E-13
3	TL	Gastropus hyptopus → Unclassified microflagellates	1.350E-10	1.020E-13
3	TL	Gastropus stylifer → Ankyra judayi	1.160E-10	1.530E-13

D	Com	Consumer → Resource	ConSize	ResSize
3	TL	Gastropus stylifer → Chromulina sp.	1.160E-10	3.030E-14
3	TL	Gastropus stylifer → Chroococcus dispersus	1.160E-10	2.390E-13
3	TL	Gastropus stylifer → Chroococcus limneticus	1.160E-10	1.310E-12
3	TL	Gastropus stylifer → Cryptomonas sp. 1	1.160E-10	2.030E-13
3	TL	Gastropus stylifer → Selenastrum minutum	1.160E-10	2.720E-13
3	TL	Gastropus stylifer → Trachelomonas sp.	1.160E-10	1.750E-13
3	TL	Gastropus stylifer → Unclassified flagellates	1.160E-10	3.460E-13
3	TL	Gastropus stylifer → Unclassified microflagellates	1.160E-10	1.020E-13
3	TL	Holopedium gibberum → Arthrodesmus sp.	6.870E-08	1.520E-12
3	TL	Holopedium gibberum → Chromulina sp.	6.870E-08	3.030E-14
3	TL	Holopedium gibberum → Chroococcus dispersus	6.870E-08	2.390E-13
3	TL	Holopedium gibberum → Chroococcus limneticus	6.870E-08	1.310E-12
3	TL	Holopedium gibberum → Cosmarium sp.	6.870E-08	3.710E-12
3	TL	Holopedium gibberum → Cryptomonas sp. 1	6.870E-08	2.030E-13
3	TL	Holopedium gibberum → Cryptomonas sp. 2	6.870E-08	1.510E-12
3	TL	Holopedium gibberum → Cryptomonas sp. 3	6.870E-08	6.720E-13
3	TL	Holopedium gibberum → Cryptomonas sp. 4	6.870E-08	1.640E-12
3	TL	Holopedium gibberum → Dactylococcopsis fascicularis	6.870E-08	1.320E-13
3	TL	Holopedium gibberum → Dictyosphaerium pulchellum	6.870E-08	4.630E-13
3	TL	Holopedium gibberum → Dinobryon cylindricum	6.870E-08	2.150E-12
3	TL	Holopedium gibberum → Dinobryon sertularia	6.870E-08	9.250E-12
3	TL	Holopedium gibberum → Dinobryon sociale	6.870E-08	6.410E-13
3	TL	Holopedium gibberum → Glenodinium pulvisculus	6.870E-08	5.200E-12
3	TL	Holopedium gibberum → Glenodinium quadridens	6.870E-08	7.540E-12
3	TL	Holopedium gibberum → Mallomonas sp. 1	6.870E-08	1.030E-12
3	TL	Holopedium gibberum → Mallomonas sp. 2	6.870E-08	1.410E-12
3	TL	Holopedium gibberum → Nostoc sp.	6.870E-08	7.970E-13
3	TL	Holopedium gibberum → Oocystis sp. 1	6.870E-08	3.860E-12
3	TL	Holopedium gibberum → Oocystis sp. 2	6.870E-08	6.320E-12
3	TL	Holopedium gibberum → Peridinium cinctum	6.870E-08	4.060E-11
3	TL	Holopedium gibberum → Peridinium pulsillum	6.870E-08	1.580E-12
3	TL	Holopedium gibberum → Schroederia setigera	6.870E-08	6.370E-13
3	TL	Holopedium gibberum → Selenastrum minutum	6.870E-08	2.720E-13
3	TL	Holopedium gibberum → Sphaerocystis schroeteri	6.870E-08	1.080E-11
3	TL	Holopedium gibberum → Trachelomonas sp.	6.870E-08	1.750E-13
3	TL	Holopedium gibberum → Unclassified flagellates	6.870E-08	3.460E-13
3	TL	Holopedium gibberum → Unclassified microflagellates	6.870E-08	1.020E-13
3	TL	Kelicottia bostoniensis → Chromulina sp.	2.000E-11	3.030E-14
3	TL	Kelicottia bostoniensis → Chroococcus dispersus	2.000E-11	2.390E-13
3	TL	Kelicottia bostoniensis → Chroococcus limneticus	2.000E-11	1.310E-12
3	TL	Kelicottia bostoniensis → Cryptomonas sp. 1	2.000E-11	2.030E-13
3	TL	Kelicottia bostoniensis → Selenastrum minutum	2.000E-11	2.720E-13
3	TL	Kelicottia bostoniensis → Unclassified microflagellates	2.000E-11	1.020E-13
3	TL	Kelicottia longispina → Chromulina sp.	4.500E-11	3.030E-14
3	TL	Kelicottia longispina → Chroococcus dispersus	4.500E-11	2.390E-13
3	TL	Kelicottia longispina → Chroococcus limneticus	4.500E-11	1.310E-12
3	TL	Kelicottia longispina → Cryptomonas sp. 1	4.500E-11	2.030E-13
3	TL	Kelicottia longispina → Selenastrum minutum	4.500E-11	2.720E-13
3	TL	Kelicottia longispina → Unclassified microflagellates	4.500E-11	1.020E-13
3	TL	Kellicottia sp. → Chromulina sp.	2.000E-11	3.030E-14
3	TL	Kellicottia sp. → Chroococcus dispersus	2.000E-11	2.390E-13
3	TL	Kellicottia sp. → Cryptomonas sp. 1	2.000E-11	2.030E-13
3	TL	Kellicottia sp. → Selenastrum minutum	2.000E-11	2.720E-13
3	TL	Kellicottia sp. → Trachelomonas sp.	2.000E-11	1.750E-13
3	TL	Kellicottia sp. → Unclassified flagellates	2.000E-11	3.460E-13
3	TL	Keratella cochlearis → Chromulina sp.	1.000E-11	3.030E-14
3	TL	Keratella cochlearis → Chroococcus dispersus	1.000E-11	2.390E-13
3	TL	Keratella cochlearis → Chroococcus limneticus	1.000E-11	1.310E-12
3	TL	Keratella cochlearis → Cryptomonas sp. 1	1.000E-11	2.030E-13
3	TL	Keratella cochlearis → Selenastrum minutum	1.000E-11	2.720E-13

D	Com	Consumer → Resource	ConSize	ResSize
3	TL	Keratella cochlearis → Trachelomonas sp.	1.000E-11	1.750E-13
3	TL	Keratella cochlearis → Unclassified flagellates	1.000E-11	3.460E-13
3	TL	Keratella cochlearis → Unclassified microflagellates	1.000E-11	1.020E-13
3	TL	Keratella testudo → Chromulina sp.	1.250E-11	3.030E-14
3	TL	Keratella testudo → Chroococcus dispersus	1.250E-11	2.390E-13
3	TL	Keratella testudo → Chroococcus limneticus	1.250E-11	1.310E-12
3	TL	Keratella testudo → Cryptomonas sp. 1	1.250E-11	2.030E-13
3	TL	Keratella testudo → Selenastrum minutum	1.250E-11	2.720E-13
3	TL	Keratella testudo → Trachelomonas sp.	1.250E-11	1.750E-13
3	TL	Keratella testudo → Unclassified flagellates	1.250E-11	3.460E-13
3	TL	Keratella testudo → Unclassified microflagellates	1.250E-11	1.020E-13
3	TL	Leptodiaptomus siciloides → Arthrodesmus sp.	8.800E-09	1.520E-12
3	TL	Leptodiaptomus siciloides → Chromulina sp.	8.800E-09	3.030E-14
3	TL	Leptodiaptomus siciloides → Chroococcus dispersus	8.800E-09	2.390E-13
3	TL	Leptodiaptomus siciloides → Cryptomonas sp. 1	8.800E-09	2.030E-13
3	TL	Leptodiaptomus siciloides → Cryptomonas sp. 2	8.800E-09	1.510E-12
3	TL	Leptodiaptomus siciloides → Dactylococcopsis fascicularis	8.800E-09	1.320E-13
3	TL	Leptodiaptomus siciloides → Dictyosphaerium pulchellum	8.800E-09	4.630E-13
3	TL	Leptodiaptomus siciloides → Dinobryon cylindricum	8.800E-09	2.150E-12
3	TL	Leptodiaptomus siciloides → Dinobryon sociale	8.800E-09	6.410E-13
3	TL	Leptodiaptomus siciloides → Glenodinium quadridens	8.800E-09	7.540E-12
3	TL	Leptodiaptomus siciloides → Mallomonas sp. 2	8.800E-09	1.410E-12
3	TL	Leptodiaptomus siciloides → Nostoc sp.	8.800E-09	7.970E-13
3	TL	Leptodiaptomus siciloides → Peridinium pulsillum	8.800E-09	1.580E-12
3	TL	Leptodiaptomus siciloides → Selenastrum minutum	8.800E-09	2.720E-13
3	TL	Leptodiaptomus siciloides → Trachelomonas sp.	8.800E-09	1.750E-13
3	TL	Leptodiaptomus siciloides → Unclassified flagellates	8.800E-09	3.460E-13
3	TL	Micropterus salmoides → Daphnia pulex	1.950E-01	5.150E-08
3	TL	Micropterus salmoides → Holopedium gibberum	1.950E-01	6.870E-08
3	TL	Orthocyclops modestus → Ascomorpha eucadis	2.740E-08	2.700E-10
3	TL	Orthocyclops modestus → Conochiloides dossuarius	2.740E-08	1.600E-10
3	TL	Orthocyclops modestus → Conochilus (solitary)	2.740E-08	3.500E-11
3	TL	Orthocyclops modestus → Cyclops varians rubellus	2.740E-08	2.240E-08
3	TL	Orthocyclops modestus → Diaptomus oregonensis	2.740E-08	1.440E-08
3	TL	Orthocyclops modestus → Filinia longispina	2.740E-08	1.800E-10
3	TL	Orthocyclops modestus → Gastropus hyptopus	2.740E-08	1.350E-10
3	TL	Orthocyclops modestus → Gastropus stylifer	2.740E-08	1.160E-10
3	TL	Orthocyclops modestus → Kelicottia bostoniensis	2.740E-08	2.000E-11
3	TL	Orthocyclops modestus → Kelicottia longispina	2.740E-08	4.500E-11
3	TL	Orthocyclops modestus → Kellicottia sp.	2.740E-08	2.000E-11
3	TL	Orthocyclops modestus → Keratella cochlearis	2.740E-08	1.000E-11
3	TL	Orthocyclops modestus → Keratella testudo	2.740E-08	1.250E-11
3	TL	Orthocyclops modestus → Leptodiaptomus siciloides	2.740E-08	8.800E-09
3	TL	Orthocyclops modestus → Ploesoma sp.	2.740E-08	1.050E-10
3	TL	Orthocyclops modestus → Polyarthra vulgaris	2.740E-08	3.630E-10
3	TL	Orthocyclops modestus → Synchaeta sp.	2.740E-08	6.600E-10
3	TL	Orthocyclops modestus → Trichocerca cylindrica	2.740E-08	4.850E-10
3	TL	Orthocyclops modestus → Trichocerca multicorinis	2.740E-08	1.600E-10
3	TL	Orthocyclops modestus → Tropocyclops prasinus	2.740E-08	7.870E-09
3	TL	Phoxinus eos → Bosmina longirostris	1.010E-03	1.550E-09
3	TL	Phoxinus eos → Chaoborys punctipennis	1.010E-03	2.580E-07
3	TL	Phoxinus eos → Cyclops varians rubellus	1.010E-03	2.240E-08
3	TL	Phoxinus eos → Daphnia pulex	1.010E-03	5.150E-08
3	TL	Phoxinus eos → Diaphanosoma leuchtenbergianum	1.010E-03	2.240E-09
3	TL	Phoxinus eos → Holopedium gibberum	1.010E-03	6.870E-08
3	TL	Phoxinus eos → Leptodiaptomus siciloides	1.010E-03	8.800E-09
3	TL	Phoxinus eos → Orthocyclops modestus	1.010E-03	2.740E-08
3	TL	Phoxinus eos → Tropocyclops prasinus	1.010E-03	7.870E-09
3	TL	Phoxinys neogaeus → Bosmina longirostris	1.170E-03	1.550E-09
3	TL	Phoxinys neogaeus → Chaoborys punctipennis	1.170E-03	2.580E-07

D	Com	Consumer → Resource	ConSize	ResSize
3	TL	Phoxinys neogaeus → Cyclops varians rubellus	1.170E-03	2.240E-08
3	TL	Phoxinys neogaeus → Daphnia pulex	1.170E-03	5.150E-08
3	TL	Phoxinys neogaeus → Diaphanosoma leuchtenbergianum	1.170E-03	2.240E-09
3	TL	Phoxinys neogaeus → Holopedium gibberum	1.170E-03	6.870E-08
3	TL	Phoxinys neogaeus → Leptodiaptomus siciloides	1.170E-03	8.800E-09
3	TL	Phoxinys neogaeus → Orthocyclops modestus	1.170E-03	2.740E-08
3	TL	Phoxinys neogaeus → Tropocyclops prasinus	1.170E-03	7.870E-09
3	TL	Ploesoma sp. → Chromulina sp.	1.050E-10	3.030E-14
3	TL	Ploesoma sp. → Chroococcus dispersus	1.050E-10	2.390E-13
3	TL	Ploesoma sp. → Cryptomonas sp. 1	1.050E-10	2.030E-13
3	TL	Ploesoma sp. → Selenastrum minutum	1.050E-10	2.720E-13
3	TL	Ploesoma sp. → Trachelomonas sp.	1.050E-10	1.750E-13
3	TL	Ploesoma sp. → Unclassified flagellates	1.050E-10	3.460E-13
3	TL	Polyarthra vulgaris → Chromulina sp.	3.630E-10	3.030E-14
3	TL	Polyarthra vulgaris → Chroococcus dispersus	3.630E-10	2.390E-13
3	TL	Polyarthra vulgaris → Chroococcus limneticus	3.630E-10	1.310E-12
3	TL	Polyarthra vulgaris → Cryptomonas sp. 1	3.630E-10	2.030E-13
3	TL	Polyarthra vulgaris → Selenastrum minutum	3.630E-10	2.720E-13
3	TL	Polyarthra vulgaris → Trachelomonas sp.	3.630E-10	1.750E-13
3	TL	Polyarthra vulgaris → Unclassified flagellates	3.630E-10	3.460E-13
3	TL	Polyarthra vulgaris → Unclassified microflagellates	3.630E-10	1.020E-13
3	TL	Synchaeta sp. → Chromulina sp.	6.600E-10	3.030E-14
3	TL	Synchaeta sp. → Chroococcus dispersus	6.600E-10	2.390E-13
3	TL	Synchaeta sp. → Chroococcus limneticus	6.600E-10	1.310E-12
3	TL	Synchaeta sp. → Cryptomonas sp. 1	6.600E-10	2.030E-13
3	TL	Synchaeta sp. → Selenastrum minutum	6.600E-10	2.720E-13
3	TL	Synchaeta sp. → Trachelomonas sp.	6.600E-10	1.750E-13
3	TL	Synchaeta sp. → Unclassified flagellates	6.600E-10	3.460E-13
3	TL	Synchaeta sp. → Unclassified microflagellates	6.600E-10	1.020E-13
3	TL	Trichocerca cylindrica → Chromulina sp.	4.850E-10	3.030E-14
3	TL	Trichocerca cylindrica → Chroococcus dispersus	4.850E-10	2.390E-13
3	TL	Trichocerca cylindrica → Chroococcus limneticus	4.850E-10	1.310E-12
3	TL	Trichocerca cylindrica → Cryptomonas sp. 1	4.850E-10	2.030E-13
3	TL	Trichocerca cylindrica → Selenastrum minutum	4.850E-10	2.720E-13
3	TL	Trichocerca cylindrica → Trachelomonas sp.	4.850E-10	1.750E-13
3	TL	Trichocerca cylindrica → Unclassified flagellates	4.850E-10	3.460E-13
3	TL	Trichocerca cylindrica → Unclassified microflagellates	4.850E-10	1.020E-13
3	TL	Trichocerca multicorinis → Chromulina sp.	1.600E-10	3.030E-14
3	TL	Trichocerca multicorinis → Chroococcus dispersus	1.600E-10	2.390E-13
3	TL	Trichocerca multicorinis → Chroococcus limneticus	1.600E-10	1.310E-12
3	TL	Trichocerca multicorinis → Cryptomonas sp. 1	1.600E-10	2.030E-13
3	TL	Trichocerca multicorinis → Selenastrum minutum	1.600E-10	2.720E-13
3	TL	Trichocerca multicorinis → Trachelomonas sp.	1.600E-10	1.750E-13
3	TL	Trichocerca multicorinis → Unclassified flagellates	1.600E-10	3.460E-13
3	TL	Trichocerca multicorinis → Unclassified microflagellates	1.600E-10	1.020E-13
3	TL	Tropocyclops prasinus → Ascomorpha eucadis	7.870E-09	2.700E-10
3	TL	Tropocyclops prasinus → Conochiloides dossuarius	7.870E-09	1.600E-10
3	TL	Tropocyclops prasinus → Conochilus (solitary)	7.870E-09	3.500E-11
3	TL	Tropocyclops prasinus → Diaptomus oregonensis	7.870E-09	1.440E-08
3	TL	Tropocyclops prasinus → Filinia longispina	7.870E-09	1.800E-10
3	TL	Tropocyclops prasinus → Gastropus hyptopus	7.870E-09	1.350E-10
3	TL	Tropocyclops prasinus → Gastropus stylifer	7.870E-09	1.160E-10
3	TL	Tropocyclops prasinus → Kelicottia bostoniensis	7.870E-09	2.000E-11
3	TL	Tropocyclops prasinus → Kelicottia longispina	7.870E-09	4.500E-11
3	TL	Tropocyclops prasinus → Kellicottia sp.	7.870E-09	2.000E-11
3	TL	Tropocyclops prasinus → Keratella cochlearis	7.870E-09	1.000E-11
3	TL	Tropocyclops prasinus → Keratella testudo	7.870E-09	1.250E-11
3	**TL**	**Tropocyclops prasinus → Leptodiaptomus siciloides (2)**	**7.870E-09**	**8.800E-09**
3	TL	Tropocyclops prasinus → Ploesoma sp.	7.870E-09	1.050E-10
3	TL	Tropocyclops prasinus → Polyarthra vulgaris	7.870E-09	3.630E-10

D	Com	Consumer → Resource	ConSize	ResSize
3	TL	Tropocyclops prasinus → Synchaeta sp.	7.870E-09	6.600E-10
3	TL	Tropocyclops prasinus → Trichocerca cylindrica	7.870E-09	4.850E-10
3	TL	Tropocyclops prasinus → Trichocerca multicorinis	7.870E-09	1.600E-10
3	TL	Umbra limi → Bosmina longirostris	1.290E-03	1.550E-09
3	TL	Umbra limi → Chaoborys punctipennis	1.290E-03	2.580E-07
3	TL	Umbra limi → Cyclops varians rubellus	1.290E-03	2.240E-08
3	TL	Umbra limi → Daphnia pulex	1.290E-03	5.150E-08
3	TL	Umbra limi → Diaphanosoma leuchtenbergianum	1.290E-03	2.240E-09
3	TL	Umbra limi → Holopedium gibberum	1.290E-03	6.870E-08
3	TL	Umbra limi → Leptodiaptomus siciloides	1.290E-03	8.800E-09
3	TL	Umbra limi → Orthocyclops modestus	1.290E-03	2.740E-08
3	TL	Umbra limi → Phoxinus eos	1.290E-03	1.010E-03
3	TL	Umbra limi → Phoxinys neogaeus	1.290E-03	1.170E-03
3	TL	Umbra limi → Tropocyclops prasinus	1.290E-03	7.870E-09

Appendix 5.6

Criteria used to determine foraging strategy and consumer-resource interaction dimensionality (Chapter 5). **D** is interaction dimensionality.

Consumer foraging movement and location in habitat	Resource movement and location in habitat	D	Foraging strategy
Actively flying in air or swimming in water column	Actively flying in air or swimming in water column	3*D*	Active capture
Actively moving on land or on bottom or surface of water	Actively flying in air or swimming in water column	3*D*	Active capture
Actively flying in air or swimming in water column	Actively moving on land or on bottom or surface of water	2*D*	Active capture
Actively flying in air or swimming in water column	Actively moving on land or on bottom or surface of water	2*D*	Active capture
Actively moving on land or bottom or surface of water	Actively moving on land or on bottom or surface of water	2*D*	Active capture
Sessile on land or on bottom or surface of water or in water column	Actively flying in air or swimming in water column	3*D*	Sit-and-wait
Sessile on land or on bottom or surface of water	Actively moving on land or on bottom or surface of water	2*D*	Sit-and-wait
Actively swimming in water column	Sessile or passive in water column	3*D*	Grazing
Actively flying in air or swimming in water column	Sessile on land or on bottom of water or on surface of water	2*D*	Grazing
Actively moving on land or on bottom or surface of water	Sessile on land or on bottom or surface of water	2*D*	Grazing

Appendix 5.7

Parameterisation of the body mass scaling in the Rosenzweig-MacArthur model (Chapter 5).

Parameter	Description	Parameter values	Source
β	Exponent for metabolic scaling with body mass	0.75	(Brown *et al.* 2004; Savage *et al.* 2004)
p_v	Exponent of velocity scaling with body mass	0.26	This study
p_d	Exponent of detection distance scaling with consumer and resource body masses	0.20	This study
r_0	Scaling constant for resource biomass production rate	7.5×10^{-1}	(Brown *et al.* 2004; Savage *et al.* 2004)
z_0	Scaling constant for consumer's biomass loss rate	4×10^{-2}	(Brown *et al.* 2004; Savage *et al.* 2004)
K_0	Scaling constant for resource carrying capacity	10^6 (2*D*) or 10^9 (3*D*)	(Peters 1983)
α_0	Scaling constant for consumer mass-specific search rate for resource biomass	$10^{-3.08}$ (2*D*) or $10^{-1.77}$ (3*D*)	This study
$t_{h,0}$	Scaling constant for consumer mass-specific handling time of resource biomass	0–10	This study