Habitat **c**omplexity **r**educes the feed**i**ng s**t**reng**t**h of fr**e**shwater p**r**edators (CRITTER)

Supplemental Statistics Report

Björn C. Rall*   Mireia Aranbarri†   Lorea Flores‡   Ioar de Guzmán§

Aitor Larrañaga¶   Julia Reiss‖

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*Aquatic Ecology and Evolution Group | Limnological Institute | University of Konstanz | Mainaustraße 252, 78464 Konstanz/Egg, Germany | bjoern.rall@uni-konstanz.de | https://orcid.org/0000-0002-3191-8389

†Laboratory of Stream Ecology | Department of Plant Biology and Ecology | Faculty of Science and Technology | University of the Basque Country | UPV/EHU PO Box 644, 48080 Bilbao, Spain | mireia.arambarri@ehu.eus | https://orcid.org/0009-0001-3506-0914

‡Laboratory of Stream Ecology | Department of Plant Biology and Ecology | Faculty of Science and Technology | University of the Basque Country | UPV/EHU PO Box 644, 48080 Bilbao, Spain | lflorescompais@gmail.com | https://orcid.org/0000-0002-0082-4072

§Laboratory of Stream Ecology | Department of Plant Biology and Ecology | Faculty of Science and Technology | University of the Basque Country | UPV/EHU PO Box 644, 48080 Bilbao, Spain | mirenioar.deguzman@ehu.eus | https://orcid.org/0000-0001-8894-8477

¶Laboratory of Stream Ecology | Department of Plant Biology and Ecology | Faculty of Science and Technology | University of the Basque Country | UPV/EHU PO Box 644, 48080 Bilbao, Spain | aitor.larranagaa@ehu.eus | https://orcid.org/0000-0002-0185-9154

‖Centre for Pollution Research and Policy, Brunel University of London | Uxbridge, UB8 3PH, UK | julia.reiss@brunel.ac.uk | https://orcid.org/0000-0002-3740-0046

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Overview

Summary

This statistics report is a supplement of our preprint article by Aranbarri et al. (2025) in which we investigate how habitat affects the strength of the feeding functional response of two freshwater invertebrate predators. Find below information on related works and the location of the data and code.

License

How to cite this report

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Related Works

- Data on Zenodo (Flores et al., 2025)

- Data on GitHub

- R-Code on Zenodo (Rall et al., 2025b)

- R-Code on GitHub

- Statistical Report on Zenodo (Rall et al., 2025a)

- Statistical Report on GitHub

- Scientific Preprint Article (Aranbarri et al., 2025)

Methods

Theoretical Background

The feeding functional response describes how a consumer's feeding rate reacts to its resource density (Holling, 1959a). The most basic shape of the feeding functional response is a hyperbolic curve, also called the type II functional response (Jeschke et al., 2002). The attack rate, a, controls the initial increase in the feeding rate, F, with increasing resource density, N (Holling, 1959a), and the handling time, T_h controls the satiation of the curve:

$$F = \frac{aN}{(1 + aT_hN)}. \tag{1}$$

If the attack rate is a function of resource density, the functional response becomes s-shaped (Holling, 1959b; Kalinkat et al., 2023). In the simplest form of this **type III functional response**, the attack rate is a linear function of resource density (Juliano, 2001):

$$a = bN, \tag{2}$$

in which b is the attack coefficient. The functional response becomes

$$F = \frac{bN^2}{(1 + bT_hN^2)}.$$
(3)

(Real, 1977, 1979) presented an alternative formulation of the functional response inspired by chemical reactions and the Michaelis-Menten kinetics (Barcroft & Hill, 1910). By substituting

$$T_h = \frac{1}{F_{max}}$$
(4)

and

$$a = \frac{F_{max}}{N_{half}},$$
(5)

the **type II functional response** becomes

$$F = \frac{F_{max}N}{N_{half} + N}.$$
(6)

Here, the curve's satiation is controlled by the maximum feeding rate, F_{max}, and the half saturation density, N_{half} controls the steepness of the functional response curve. The **type III functional response** written in this style is as follows:

$$F = \frac{F_{max}^2 N}{N_{half}^2 + N^2}.$$
(7)

The above-described **type III functional response** model has a linearly increasing attack rate, but the attack rate can also be a more complex function of resource density (Juliano, 2001; Kalinkat et al., 2023). A commonly used version is a power law function of the resource density (Kalinkat et al., 2023; Rall et al., 2008; Williams & Martinez, 2004):

$$a = b^q.$$
(8)

The Holling-style functional response becomes (Vucic-Pestic et al., 2010):

$$F = \frac{bN^{1+q}}{(1 + bT_hN^{1+q})},$$
(9)

and the Real-style functional response becomes (Rall et al., 2008; Williams & Martinez, 2004):

$$F = \frac{F_{max}^{1+q} N}{N_{half}^{1+q} + N^{1+q}}.$$
(10)

We will refer to the above-mentioned functional response models as either the Holling-style or the Real-style **generalized functional response** model. Note that many other functional response models exist, but the ones presented above are most practical and most often used to analyze laboratory functional response experiments (Jeschke et al., 2002; Juliano, 2001; Kalinkat et al., 2023). In our analyses, we will focus on the **generalized functional response** models and, if statistically appropriate, on the **type II or type III functional response** models.

Functional response statistics

Independence of variables

Scientific laboratory experiments are designed to manipulate one or more external variables that are typically called the **independent** or **explanatory variables**. We measure a response of our experimental system, and this measure is normally called the **dependent**, or **response variable**. See, e.g., Zar (2010), chapter 17, or Crawley (2012) chapter 10, for details. In functional response experiments, we manipulate the resource density, N, and measure the number of prey eaten, N_{eaten}, at the end of the experiment. This means that during the experiment, the prey density decreases over time. In contrast, in all the above-mentioned functional response models, the feeding rate, F, depends on a constant prey density, N. To account for the decay of resource density over time, we set up a differential equation, describing the temporal process:

$$\frac{dN}{dt} = -F. \tag{11}$$

The **change of resource density**, dN, over a given **time span**, dt, is described by the negative of the feeding rate F. F can be any of the functional response models introduced above (or described elsewhere). This differential equation model can not be fitted directly to data, but it needs to be solved beforehand. The solution depends on the type of functional response. For a **type II functional response**, the solution is (Rogers, 1972; Rosenbaum & Rall, 2018; Royama, 1971):

$$N_{eaten} = N_{inital}(1 - e^{a(N_{eaten}T_h - Pt)}). \tag{12}$$

The number of resources eaten, N_{eaten} at the time t (e.g., the end of the experiment) depends on the initial number of resources, $N_{initial}$. All other parameters are as described above. This equation is commonly known as **Roger's Random Predator Equation** (RRPE). By substituting $T_h = \frac{1}{F_{max}}$ and $a = \frac{F_{max}}{N_{half}}$ into Roger's Random Predator Equation, we get the version for the Real-style functional response model:

$$N_{eaten} = N_{inital}(1 - e^{\frac{N_{eaten}}{N_{half}} - \frac{Pt}{F_{max}}}). \tag{13}$$

Model parameters are as described above.

These equations share the issue that N_{eaten} appears on both sides of the equation. Traditionally, this problem is solved using Newton's method, an iterative numerical procedure (Juliano, 2001; Vonesh & Bolker, 2005), but Bolker (2008) found that the Lambert **W** function (Corless et al., 1996) allows for an analytical solution:

$$N_{eaten} = N_{inital} - \frac{W(aT_h N_{initial}e^{-a(Pt-T_h N_{initial})})}{aT_h}. \tag{14}$$

The Real-style version is:

$$N_{eaten} = N_{inital} - \frac{W(\frac{1}{N_{half}}N_{initial}e^{-\frac{F_{max}}{N_{half}}(Pt-\frac{N_{initial}}{F_{max}})})}{\frac{1}{N_{half}}}. \tag{15}$$

All parameters are as described above.

Neither the type III nor the generalized functional response can be solved analytically and must be solved using numerical simulations (Rosenbaum & Rall, 2018). We follow the methods published by Rosenbaum & Rall (2018), but find more details in the section "Brief Code Description" below.

Data distribution

So far, we described the mathematical model describing the average number of resources eaten throughout the experimental trials. Each experimentally derived replicate, however, must deviate from this overall model mean (see, e.g., Zar (2010), chapter 17, or Crawley (2012) chapter 10, for assumptions of regression statistics). Our dependent data, N_{eaten}, has the following characteristics: integer numbers (0, 1, 2,..., n), and the number of prey eaten cannot exceed the number of initially available resource items ($N_{initial}$). Data following these characteristics are known as proportion data and well described by a binomial probability distribution; see

Crawley (2012) chapter 16 for further explanations. We also apply this distribution to our data, as it is commonly used for functional response fitting (Bolker, 2008; Rosenbaum & Rall, 2018). Please also read the description of our code in the corresponding README file, either directly in our repository or download it from Zenodo (Rall et al., 2025b).

Functional response type selection

As the initial step, we analyzed which functional response type describes our data best (Juliano, 2001). We used two methods: (1) the phenomenological test after Juliano, implemented in the `frair` package (Juliano, 2001; Pritchard, Paterson, et al., 2017)[^1]; and (2) by fitting the Real-style **generalized functional response model** and test if q is significantly different from zero (Rall et al., 2008; Rosenbaum & Rall, 2018; Vucic-Pestic et al., 2010; Williams & Martinez, 2004). If the tests suggest, that at least one functional response treatment is not of type II, we will analyze our data further using the **generalized functional response** model. If the tests suggest that **all** treatments are type II, we will analyze our data further using the **Roger's Random Predator Equation** models.

Habitat complexity as an independent variable

The main scientific question of this project is to figure out how habitat complexity affects the interaction strength of two freshwater invertebrate predators (the consumers) on their prey (the resources). We have three different ways to address this question given the data: (1) the absence and presence of habitat; (2) the amount of habitat (either 0, 2, or 3 plastic ring structures); (3) five levels of complexity (0 to 5). The complexity levels originate from different spatial arrangements of the artificial ring structures, where 0 rings are complexity level 0, 2 rings comprise complexity levels 2 and 3, and 3 rings comprise complexity levels 4 and 5. See Flores et al. (2016) and Aranbarri et al. (2025) for further details. Contrasting the above-described analysis of the functional response type, we use here all data at once, separated by predator species. Each functional response parameter can react to habitat independently of the other parameters. For example, the attack rate can be different for all five complexity levels, whereas the handling time is a function of ring number. For each parameter, we can formulate the following hypotheses:

- H_0: Habitat has no effect on the functional response parameters.

- H_1: The sheer presence of habitat changes the functional response parameters.

- H_2: The amount of habitat structure (number of rings, continuous) alters the functional response parameters.

- H_3: The spatial arrangements modify the functional response parameters in addition to the amount of habitat structure.

Any functional response parameter independently can fulfill one of the above-stated hypotheses. If we want to test all possible combinations, we need 4×4 models (4 hypotheses per parameter) for each functional response style (Real-style and Holling style), in the case of a **type II functional response**, resulting in 32 statistical models per predator species. In the case of **generalized functional response**, we would have to test 64 statistical models for each functional response style, resulting in 128 models per species. Note that some of these models of how habitat affects the functional response are interchangeable, but not all. We will show for which models this is true in the results part below ([Habitat presence, amount, and complexity statistics]).

Data Availability

You can either download the data from our data publication on Zenodo (Flores et al., 2025), or from our GitHub repository.

Code availability

You can either download the code from our code publication on Zenodo (Rall et al., 2025b), or from our GitHub repository.

Results

The functional response type

Using the phenomenological test

Table 1: The results of testing for the functional response type by using the phenomenological test (Juliano 2001, Pritchard et al. 2017). We found for all unique treatments (complexity times predator identity) that a type II functional response explains the data best.

Predator	Complexity	Linear (Q)	Quadratic (Q)	Linear (L)	Type
Ischnura elegans	0	-(n.s.)	+(n.s.)	-(*)	II
Ischnura elegans	1	-(n.s.)	+(n.s.)	-(*)	II
Ischnura elegans	2	-(n.s.)	+(n.s.)	-(***)	II
Ischnura elegans	3	-(n.s.)	+(n.s.)	-(**)	II
Ischnura elegans	4	+(n.s.)	-(n.s.)	-(**)	II
Notonecta glauca	0	-(***)	+(***)	-(***)	II
Notonecta glauca	1	-(***)	+(***)	-(***)	II
Notonecta glauca	2	-(***)	+(**)	-(***)	II
Notonecta glauca	3	-(n.s.)	-(n.s.)	-(***)	II
Notonecta glauca	4	-(*)	-(n.s.)	-(***)	II

We analyzed our data using the so-called the phenomenological test by fitting this test to all ten treatments separately, i.e., two predators with five complexity levels each (Juliano, 2001; Pritchard, Paterson, et al., 2017; Pritchard, Barrios-O'Neill, et al., 2017; Rall et al., 2025b). The only case in which the results suggest a hump-shaped pattern in the proportion data is *Ischnura elegans* at the complexity level of 4, as the linear term is positive, and the quadratic term is negative (table 1). However, both estimates are not significant. The complexity levels 3 and 4 for *Notonecta glauca* show a negative quadratic term, which could also indicate a type III functional response, but both results are not significant. All other treatments have both a negative linear and a positive quadratic term, indicating in all these cases a declining proportion of eaten prey and therewith type II functional responses (table 1).

Direct shape estimation using the generalized functional response model

Table 2: The significance of the shape parameter q of all ten separately fitted generalized functional response models.

Predator Name	Complexity	q	Significance	Type-o-Response
Ischnura elegans	0	0.116	n.s.	II
Ischnura elegans	1	0.047	n.s.	II
Ischnura elegans	2	-0.001	n.s.	II
Ischnura elegans	3	-0.001	n.s.	II
Ischnura elegans	4	0.193	n.s.	II
Notonecta glauca	0	-0.011	n.s.	II
Notonecta glauca	1	-0.006	n.s.	II
Notonecta glauca	2	0.194	n.s.	II
Notonecta glauca	3	-0.002	n.s.	II
Notonecta glauca	4	-0.001	n.s.	II

We analyzed our data using the generalized functional response model by fitting this model to all ten treatments separately, i.e., two predators with five complexity levels each (Rall et al., 2008; Rosenbaum & Rall, 2018; Vucic-Pestic et al., 2010; Williams & Martinez, 2004). The shape parameter q is not significantly different from zero (see table 2). This means that in all cases, a simpler type II functional response can be used to describe the

data properly. This is in line with the phenomenological test shown above, and we will subsequently use the Roger's Random Predator Equation.

Habitat presence, amount, and complexity results

As the type II functional response model is the most appropriate model to describe our data across all treatments (see section "The functional response type" above), we continue our analyses using this functional response model. Based on our hypotheses (see section "Habitat complexity as an independent variable" above), we need to test in total 64 statistical functional response models: 16 models for the Holling-style and 16 models for the Real-style RRPE, resulting in 32 models, and we repeated these 32 models for the two predator species. In the following, we present the description of the 32 models and how habitat affects the functional response parameters:

- Model 01h | 01r: Habitat has no effect on F_{max} | T_h, (H_0), and N_{half} | a is also not affected by habitat presence (H_0).

- Model 02h | 02r: Habitat has no effect on F_{max} | T_h, (H_0), and N_{half} | a is affected by habitat presence (H_1).

- Model 03h | 03r: Habitat has no effect on F_{max} | T_h, (H_0), and N_{half} | a is affected by the amount of habitat structure (H_2).

- Model 04h | 04r: Habitat has no effect on F_{max} | T_h, (H_0), and N_{half} | a is affected by complexity (H_3).

- Model 05h | 05r: Habitat presence affects F_{max} | T_h, (H_0), and N_{half} | a is not affected by habitat presence (H_0).

- Model 06h | 06r: Habitat presence affects F_{max} | T_h, (H_0), and N_{half} | a is affected by habitat presence (H_1).

- Model 07h | 07r: Habitat presence affects F_{max} | T_h, (H_0), and N_{half} | a is affected by the amount of habitat structure (H_2).

- Model 08h | 08r: Habitat presence affects F_{max} | T_h, (H_0), and N_{half} | a is affected by complexity (H_3).

- Model 09h | 09r: The amount of habitat affects F_{max} | T_h, (H_0), and N_{half} | a is not affected by habitat presence (H_0).

- Model 10h | 10r: The amount of habitat affects F_{max} | T_h, (H_0), and N_{half} | a is affected by habitat presence (H_1).

- Model 11h | 11r: The amount of habitat affects F_{max} | T_h, (H_0), and N_{half} | a is affected by the amount of habitat structure (H_2).

- Model 12h | 12r: The amount of habitat affects F_{max} | T_h, (H_0), and N_{half} | a is affected by complexity (H_3).

- Model 13h | 13r: Complexity affects F_{max} | T_h, (H_0), and N_{half} | a is not affected by habitat presence (H_0).

- Model 14h | 14r: Complexity affects F_{max} | T_h, (H_0), and N_{half} | a is affected by habitat presence (H_1).

- Model 15h | 15r: Complexity affects F_{max} | T_h, (H_0), and N_{half} | a is affected by the amount of habitat structure (H_2).

- Model 16h | 16r: Complexity affects F_{max} | T_h, (H_0), and N_{half} | a is affected by complexity (H_3).

The maximum feeding rate, F_{max}, and the handling time, T_h are always interchangeable as $F_{max} = \frac{1}{T_h}$. However, the attack rate, a, is not only a function of the half saturation density, N_{half}, but also a function of the maximum feeding rate: $a = \frac{F_{max}}{N_{half}}$, $N_{half} = \frac{F_{max}}{a}$. This circumstance leads to the fact that the interchangeability of these parameters is context-dependent:

1. Attack rate and half saturation density are interchangeable if the maximum feeding rate is a constant across treatments (models 01 to 04).

2. Attack rate and half saturation density are also interchangeable if we fit a model testing for all complexity levels (H_3) for the half saturation density (models 04, 08, 12, and 16).

3. Attack rate and half saturation density are also interchangeable if we fit a model testing for the same hypothesis (models 01, 06, 11, and 16).

The remaining models (5, 7, 9, 10, 13, 14, 15) will deliver different results.

We will compare all models using common information criteria, the AIC, and the BIC (Akaike, 1974; Schwarz, 1978). The AIC selects models with more parameters, whereas the BIC tends to select models with a lower number of parameters (Schwarz, 1978). Please find the results of all fits saved as `*.rds` files in the folders `results_hab_ie` and `results_hab_ng` online (https://github.com/b-c-r/CRITTERstatistics).

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Ischnura elegans results

Table 3: AIC / BIC table of the six most parsimonious out of 32 possible models for *Ischnura elegans*. Find all results below in table .

Model (AIC)	df	dAIC	Model (BIC)	df	dBIC
Model 5r	3	0.000	Model 5r	3	0.000
Model 7r	4	0.265	Model 5h	3	1.583
Model 6h	4	0.952	Model 7r	4	2.731
Model 6r	4	0.952	Model 6h	4	3.418
Model 5h	3	1.583	Model 6r	4	3.418
Model 13r	6	2.107	Model 7h	4	4.718

The most parsimonious model according to AIC and BIC is model 5r (table 3). The maximum feeding rate in the case of no habitat is 28.08 $[\frac{items_{prey}}{day}]$ and in the case of habitat present 14.58 $[\frac{items_{prey}}{day}]$, which is a drop of about half (table 4). Expressed as handling time, T_h, *I. elegans* predators need 0.04 $[days]$ if no habitat is present and 0.07 $[\frac{days}{items_{prey}}]$ if habitat is present to subdue and feed on a prey item. The half saturation density, N_{half} is not affected by habitat at all ($N_{half} = 57 \frac{items_{prey}}{volume_{arena}}$, table 4). As the attack rate a depends on both, the maximum feeding rate F_{max} and the half saturation density N_{half}, we can calculate two attack rates for (1) no habitat ($a = 0.49$ $[\frac{volume_{arena}}{days}]$) and (2) for the case that habitat is present ($a = 0.26$ $[\frac{volume_{arena}}{days}]$). Note that the change in attack rate matches the change in maximum feeding rate, resulting in the fact that the strength of feeding is influenced equally across the whole range of prey densities (as N_{half} is constant).

We found four more models within a range of two delta units of both information criteria, all with three to four parameters (3), and we will discuss these models below. Please find the full table 18 in the Appendix below.

Table 4: Results of model 5 (Real style) fitted to the data of *Ischnura elegans*.

Parameter Name	Point Estimate	Lower CI	Upper CI
F_{max} (habitat absent)	28.081	19.321	40.605
F_{max} (habitat present)	14.578	10.632	19.829
N_{half}	57.000	34.477	93.429

The models within 2 delta AIC/BIC units

Model 7r (table 5) is more complex than model 5r by one degree of freedom (i.e., one more model parameter). Not only F_{max} depends on the presence of the habitat, but also N_{half} is a negative function of habitat amount

Figure 1: The feeding functional response of *Ischnura elegans* as function of the density of *Asellus aquaticus*. We found that model 5r was the most appropriate to describe the data (table 3). This model includes a unique maximum feeding rate for the cases if habitat is absent (a) or present (b) and a half saturation density that is not affected by habitat (table 4). The regression lines of the best fit point estimates are displayed in black, and the light gray area shows the 95% confidence limits of the best fit.

(the number of rings). However, the slope of this relationship (-0.09) is not significant (p = 0.203). In addition, a likelihood ratio test reveals, that adding this model parameter doesn't make the fit significantly better compared to model 5r (p = 0.188).

Table 5: Results of model 7 (Real style) fitted to the data of *Ischnura elegans*.

Parameter Name	Point Estimate	Lower CI	Upper CI
F_{max} (habitat absent)	36.596	20.080	66.566
F_{max} (habitat present)	13.563	9.833	18.564
$N_{half}(intercept)$	86.008	37.437	194.251
$N_{half}(slope)$	-0.094	-0.235	0.049

Model 6h (table 6) is more complex than model 5r by one degree of freedom. Model 6h is interchangeable with model 6r below. Not only T_h depends on the presence of the habitat but also a. If habitat is present, the attack rate is reduced from 0.42 $\frac{items_{prey}}{volume_{arena}}$ to 0.27. A likelihood ratio test reveals, that adding this model parameter doesn't make the fit significantly better compared to model 5r (p = 0.306).

Table 6: Results of model 6 (Holling style) fitted to the data of *Ischnura elegans*.

Parameter Name	Point Estimate	Lower CI	Upper CI
T_h (habitat absent)	0.026	0.012	0.057
T_h (habitat present)	0.075	0.053	0.105
a (habitat absent)	0.419	0.275	0.637
a (habitat present)	0.275	0.205	0.369

Model 6r (table 7) is more complex than model 5r by one degree of freedom. Model 6r is interchangeable with model 6h above. Not only F_{max} depends on the presence of the habitat but also N_{half}. If habitat is present, the half saturation density drops from 90.24 $\frac{items_{prey}}{volume_{arena}}$ to 48.65. A likelihood ratio test reveals, that adding this model parameter doesn't make the fit significantly better compared to model 5r (p = 0.306).

Table 7: Results of model 6 (Real style) fitted to the data of *Ischnura elegans*.

Parameter Name	Point Estimate	Lower CI	Upper CI
F_{max} (habitat absent)	37.807	17.025	84.326
F_{max} (habitat present)	13.361	9.626	18.548
N_{half} (habitat absent)	90.245	29.676	279.805
N_{half} (habitat present)	48.647	27.788	85.412

Model 5h (table 8) is as complex as model 5r, and both have three model parameters. T_h depends on the presence of the habitat, and a is not affected by habitat at all (0.32 $\frac{items_{prey}}{volume_{arena}}$). The respective half saturation densities are for the case without habitat: $N_{half} = 195.409$; and with habitat: $N_{half} = 38.273$. Especially the half saturation density for the case without habitat seems highly unlikely as it is above the tested range of prey densities. We did not apply a likelihood ratio test, as both models share the same number of parameters.

Table 8: Results of model 5 (Holling style) fitted to the data of *Ischnura elegans*.

Parameter Name	Point Estimate	Lower CI	Upper CI
T_h (habitat absent)	0.016	0.006	0.048
T_h (habitat present)	0.082	0.062	0.111
a	0.317	0.248	0.406

In summary, all models in the range of 2 delta AIC units suggest that (1) the maximum feeding rate drops dramatically by up to 50% when adding habitat structure. The half saturation density is likely to be habitat-

independent, according to the most likely model 5r. Eventually, the half saturation density may also decrease by adding habitat (model 6r), or may even decrease as a function of habitat amount (model 7r), which leads to a decrease in attack rates that is less pronounced as the drop of maximum feeding rates (model 6h) or the attack rate may be constant (model 5h). This result would indicate that the effect of habitat is predominantly acting at high prey densities. However, the alternative models are not contributing significantly to the explanation of the data (see above), leaving this phenomenon open for discussion. The results, however, show, that the higher-order complexity of the habitat structure does not influence the feeding rate of *Ischnura elegans*.

Notonecta glauca results

Table 9: AIC / BIC table of the seven most parsimonious out of 32 possible models for *Notonecta glauca*.

Model (AIC)	df	dAIC	Model (BIC)	df	dBIC
Model 15h	7	0.000	Model 15h	7	0.000
Model 16h	10	1.274	Model 9r	3	1.004
Model 16r	10	1.274	Model 11h	4	1.485
Model 15r	7	1.990	Model 11r	4	1.485
Model 14r	7	4.189	Model 13r	6	1.507
Model 13r	6	4.854	Model 15r	7	1.990
Model 12h	7	8.352	Model 7h	4	2.516

Both, AIC and BIC select for model 15h as the most parsimonious choice (table 9). Within two delta AIC units, models 16h, 16r, and 15r were selected. These models have 7 or more parameters, and in all cases either F_{max} or T_h are affected by habitat complexity. We found the models 9r, 11h, 11r, 13r, and 15r within two delta BIC units, all of them have equal or fewer parameters compared to model 15h (table 9, but see also the full table 19 in the Appendix). These selections highlight the quality of model 15h, as BIC is known to rather select models with fewer parameters (Schwarz, 1978).

Table 10: Results of model 15 (Holling style) fitted to the data of *Notonecta glauca*.

Parameter Name	Point Estimate	Lower CI	Upper CI
T_h (C0)	0.032	0.028	0.038
T_h (C1)	0.057	0.048	0.068
T_h (C2)	0.036	0.030	0.042
T_h (C3)	0.046	0.037	0.057
T_h (C4)	0.053	0.043	0.065
$a(intercept)$	1.280	1.010	1.627
$a(slope)$	-0.144	-0.191	-0.097

In model 15h, complexity affects the handling time (one measure of handling time per complexity level, table 10). The corresponding maximum feeding rates are 30.84 $\left[\frac{items_{prey}}{day}\right]$ (C0), 17.5 $\left[\frac{items_{prey}}{day}\right]$ (C1), 28.06 $\left[\frac{items_{prey}}{day}\right]$ (C2), 21.65 $\left[\frac{items_{prey}}{day}\right]$ (C3), 18.9 $\left[\frac{items_{prey}}{day}\right]$ (C4). The maximum feeding rates are generally lower if habitat is present (complexity levels 1-4), but especially at level 2, the value is rather comparable to the case without habitat.

The attack rate, a is a decreasing function of the amount of habitat (table 10) with an intercept of ($a_{intercept} = 1.28 \left[\frac{volume_{arena}}{days}\right]$. The intercept is the attack rate when the habitat is absent. The slope of the attack rate is -0.14, indicating that the successful search and attack of prey at low densities decrease with increasing amounts of habitat.

The half saturation density N_{half} depends on both, the handling time T_h and the attack rate a ($N_{half} = \frac{1}{aT_h}$) leading to five half saturation densities, one for each complexity level: 24.1 $\left[\frac{items_{prey}}{volume_{arena}}\right]$ (C0); 26.57 $\left[\frac{items_{prey}}{volume_{arena}}\right]$ (C1); 42.6 $\left[\frac{items_{prey}}{volume_{arena}}\right]$ (C2); 45.81 $\left[\frac{items_{prey}}{volume_{arena}}\right.$ (C3); 39.99 $\left[\frac{items_{prey}}{volume_{arena}}\right]$ (C4).

In general, the half saturation densities are increasing with increasing amounts of habitat, highlighting the effect of a decreasing hunting success at lower prey densities.
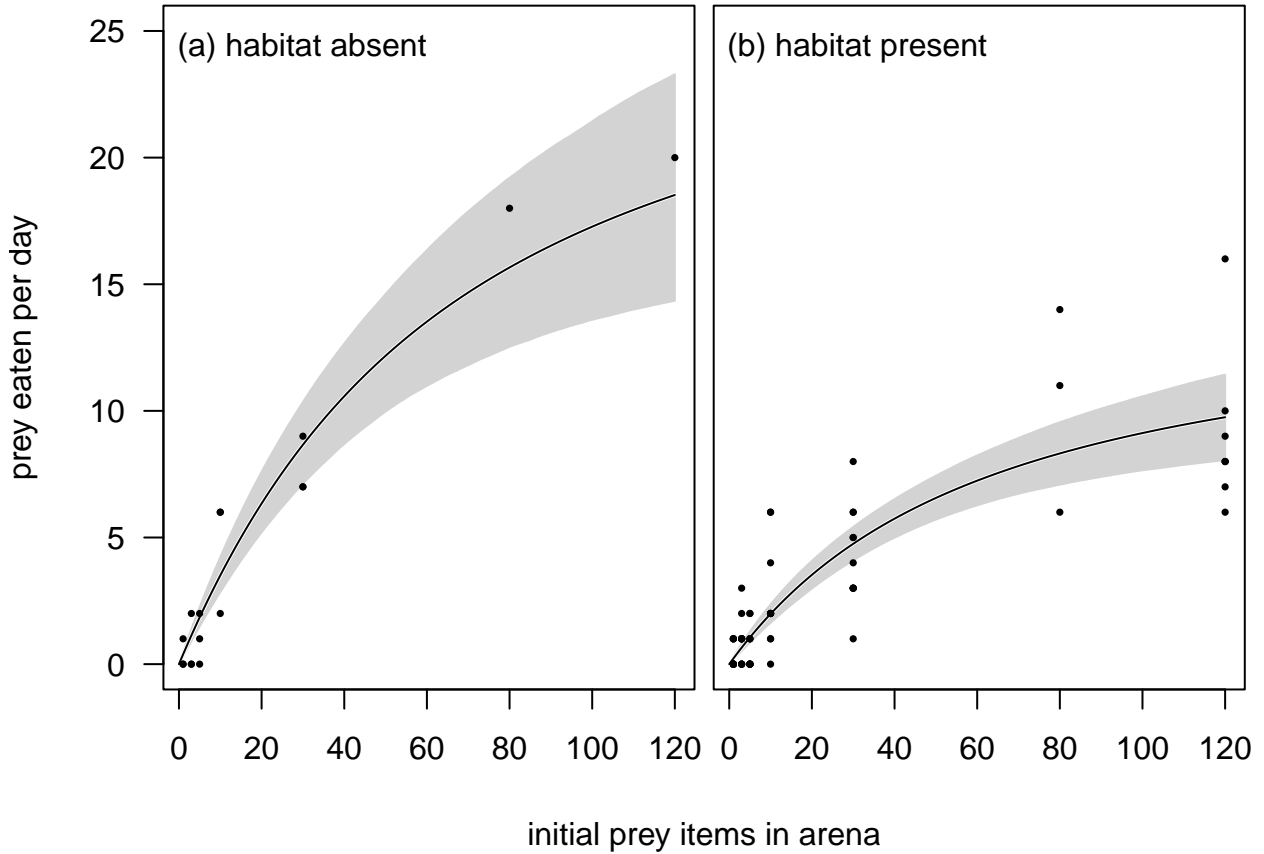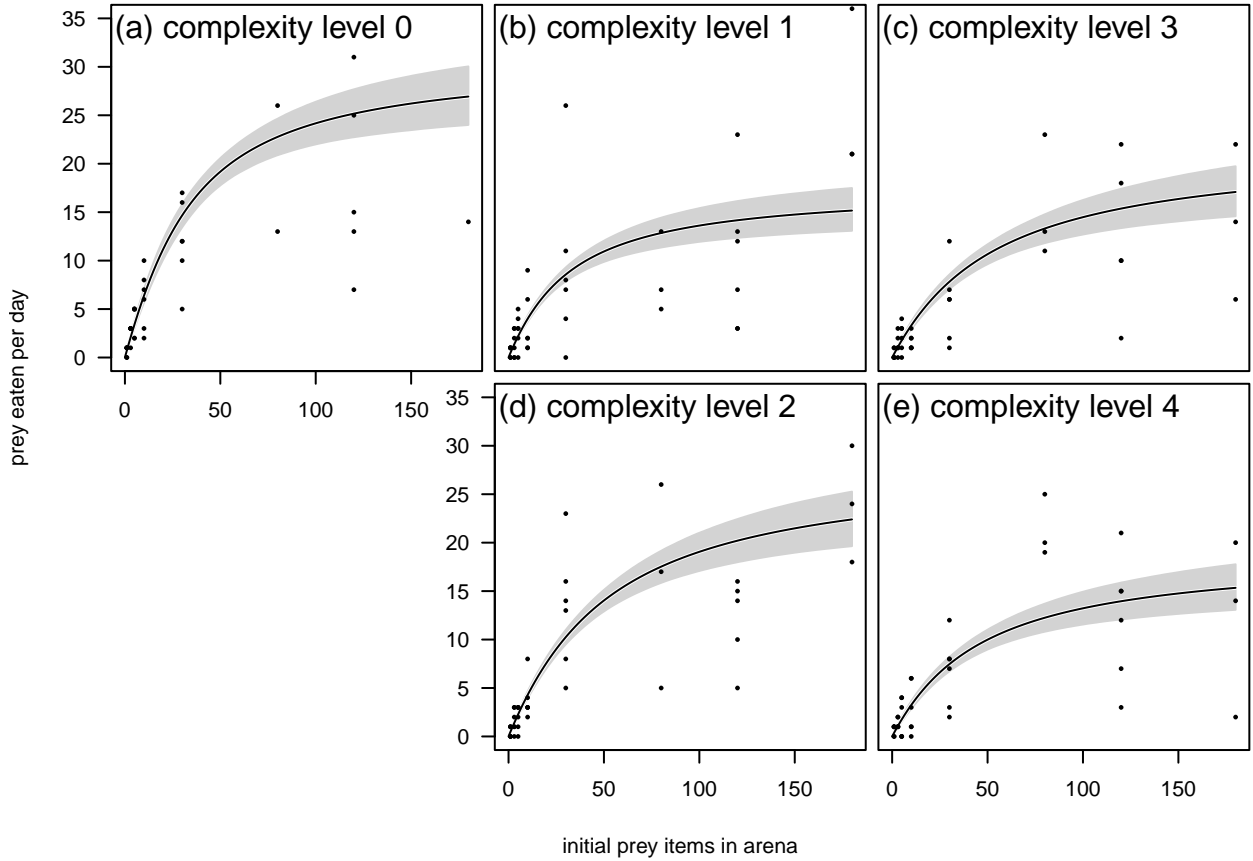
Figure 2: The feeding functional response of *Notonecta glauca* as function of the density of *Asellus aquaticus*. We found that model 15h was the most appropriate to describe the data (table 9). This model includes a unique maximum feeding rate for each complexity level and a decreasing attack rate as a function of the amount of habitat (table 10). The complexity levels (0-4) are displayed in the separate subplots: (a) = 0; (b) = 1; (c) = 3; (d) = 2; and (e) = 4. The amount of habitat structure increases from left to right, whereas the results for 0 rings are displayed in (a), 2 rings are displayed in (b, d), and 3 rings are displayed in (c, e). The regression lines of the best fit point estimates are displayed in black, and the light gray area shows the 95% confidence limits of the best fit.

The models within 2 delta AIC/BIC units

Model 16h and model 16r are interchangeable and are the most complex models we could fit to data. Both functional response parameters are affected by complexity level (see tables 11 and 12). The patterns of how habitat affects the parameters are similar to model 15h, i.e., handling time increases and maximum feeding decreases with increasing complexity, but we see an up-and-down pattern around this general trend. Attack rates are much higher when habitat is absent, complexity levels 1 and 2 (2 habitat rings in model 15h) show an intermediate attack rate, and complexity levels C3 and C4 have the lowest attack rates (3 rings in model 15h). The effect on half saturation densities is rather neutral, with a slight tendency to increase, in line with the fact that the general decrease in attack rates is more pronounced than the increase in attack rates with an increase in levels of complexity.

Table 11: Results of model 16 (Holling style) fitted to the data of *Notonecta glauca*.

Parameter Name	Point Estimate	Lower CI	Upper CI
T_h (C0)	0.032	0.027	0.037
T_h (C1)	0.059	0.048	0.072
T_h (C2)	0.038	0.031	0.045
T_h (C3)	0.039	0.029	0.053
T_h (C4)	0.055	0.044	0.069
a (C0)	1.212	0.949	1.558
a (C1)	0.707	0.509	0.984
a (C2)	0.750	0.579	0.969
a (C3)	0.363	0.269	0.489
a (C4)	0.526	0.385	0.717

Table 12: Results of model 16 (Real style) fitted to the data of *Notonecta glauca*.

Parameter Name	Point Estimate	Lower CI	Upper CI
F_{max} (C0)	31.487	27.018	36.829
F_{max} (C1)	17.046	13.944	20.996
F_{max} (C2)	26.492	21.992	31.871
F_{max} (C3)	25.453	18.998	34.338
F_{max} (C4)	18.057	14.446	22.559
N_{half} (C0)	25.971	18.140	37.413
N_{half} (C1)	24.113	14.799	38.956
N_{half} (C2)	35.334	23.811	52.444
N_{half} (C3)	70.211	40.706	121.087
N_{half} (C4)	34.349	21.480	54.941

Model 15r (table 13) is in line with the above-mentioned models and shows a general increase of F_{max} with the up-and-down pattern with increasing complexity levels as for the models above. The half saturation increases slightly with an increasing amount of habitat. This effect is similar to the effect of complexity in model 16r above.

Table 13: Results of model 15 (Real style) fitted to the data of *Notonecta glauca*.

Parameter Name	Point Estimate	Lower CI	Upper CI
F_{max} (C0)	30.741	26.526	35.636
F_{max} (C1)	19.646	17.084	22.546
F_{max} (C2)	26.474	23.305	30.060
F_{max} (C3)	20.181	17.099	23.940
F_{max} (C4)	19.703	16.635	23.416
N_{half} (intercept)	24.285	17.170	34.304
N_{half} (slope)	0.081	0.009	0.153

Model 9r (table 14) is the by far the simplest model and chosen by the AIC, and not by the BIC selection. It comprises a decreasing maximum feeding rate with an increasing amount of habitat and a constant half saturation density. The generally decreasing trend of maximum feeding rate with increasing amount of habitat is in line with the models above, only ignoring the up-and-down with complexity levels. We also already saw above (e.g., models 15r and 16r) that the effect of habitat on half saturation is rather weak.

Table 14: Results of model 9 (Real style) fitted to the data of *Notonecta glauca.*

Parameter Name	Point Estimate	Lower CI	Upper CI
F_{max} (intercept)	34.831	31.160	38.914
F_{max} (slope)	-0.094	-0.110	-0.077
N_{half}	33.937	27.862	41.222

Model 11h and model 11r are interchangeable, and the functional response parameters both depend on the amount of habitat present (tables 15 and 16). Handling time increases, and, of course, maximum feeding rate increases with the same strength. Attack rates decrease, while half saturation densities increase slightly. These results are in line with the above-mentioned models, only missing the up-and-down with complexity levels as in the more complex models.

Table 15: Results of model 11 (Holling style) fitted to the data of *Notonecta glauca.*

Parameter Name	Point Estimate	Lower CI	Upper CI
T_h (intercept)	0.033	0.028	0.038
T_h (slope)	0.063	0.031	0.095
a (intercept)	1.265	1.002	1.599
a (slope)	-0.144	-0.190	-0.097

Table 16: Results of model 11 (Real style) fitted to the data of *Notonecta glauca.*

Parameter Name	Point Estimate	Lower CI	Upper CI
F_{max} (intercept)	30.745	26.444	35.602
F_{max} (slope)	-0.063	-0.095	-0.031
N_{half} (intercept)	24.304	17.073	34.213
N_{half} (slope)	0.081	0.011	0.153

Model 13r (table 17) shows the well-known up-and-down pattern of maximum feeding, including a general increase with increasing complexity level. The half saturation density is constant, in line with the rather weak (but significant) positive effect of habitat amount in the models above.

Table 17: Results of model 13 (Real style) fitted to the data of *Notonecta glauca.*

Parameter Name	Point Estimate	Lower CI	Upper CI
F_{max} (C0)	34.784	30.962	38.947
F_{max} (C1)	19.350	16.853	22.174
F_{max} (C2)	26.070	22.997	29.537
F_{max} (C3)	18.371	15.939	21.157
F_{max} (C4)	17.969	15.610	20.752
N_{half}	33.928	27.841	41.201

In summary, all models in the range of 2 delta AIC and BIC units suggest that (1) the handling times increase with increasing amount of habitat available, altered by complexity levels. This leads to a decrease in maximum feeding rates, with the mirrored up-and-down effect of habitat complexity. We compared models 15h (the

most parsimonious model) with model 11h (the next simple model nested in model 15h) and found that if the amount of habitat is medium (2 rings), the results for complexity levels 2 and 3 differ from the prediction of the simpler model (figure 3). The attack rates decrease with increasing amounts of habitat, and this effect is slightly stronger than the effect on handling time, leading to a slightly increasing half saturation density. An even more complex effect of habitat complexity is given as models 16h and 16r are also within 2 delta AIC units, but as the AIC rather selects models that overfit data, we consider this effect as rather irrelevant.
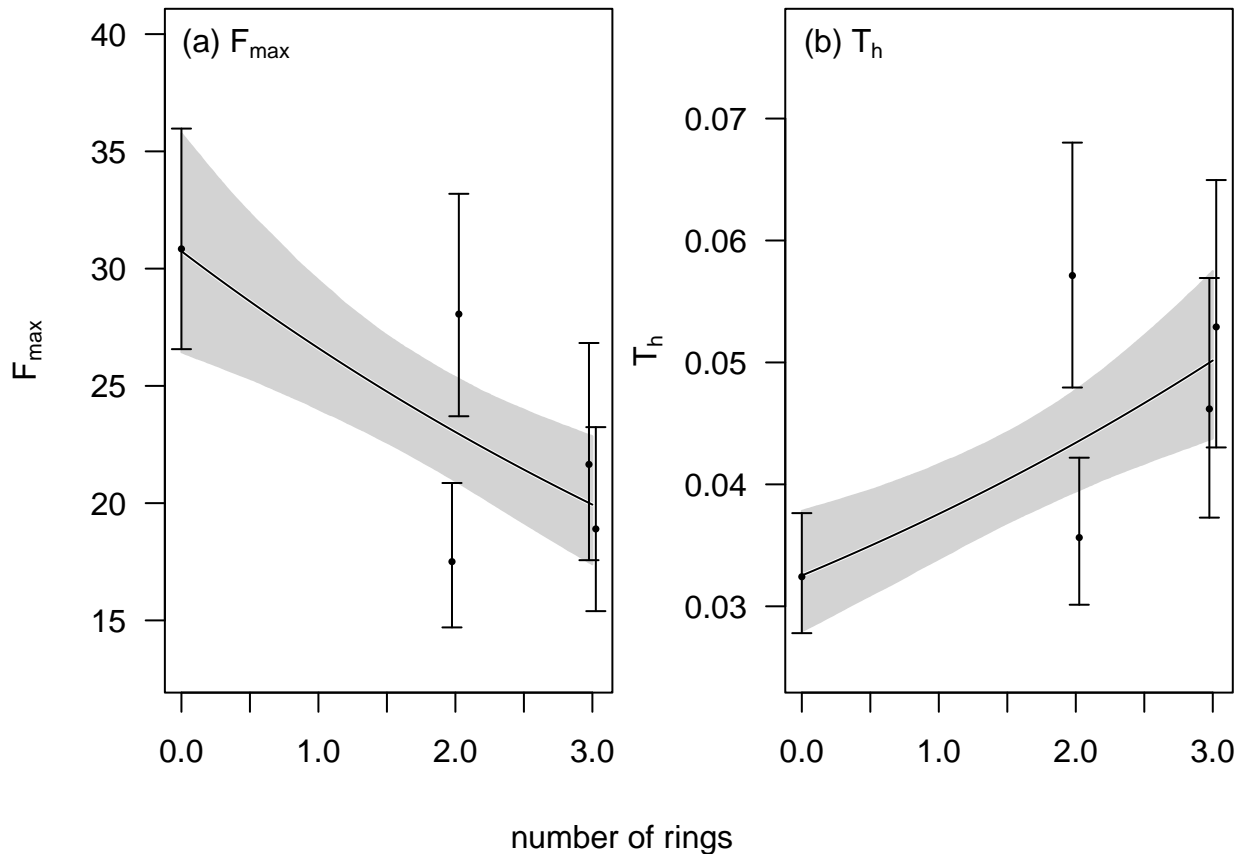
Figure 3: The functional feeding response parameters F_{max} (a) and T_h of *Notonecta glauca* feeding on *Asellus aquaticus*. We found that model 15h was the most appropriate to describe the data (table 9). This model includes a unique maximum feeding rate for each complexity level and a decreasing attack rate as a function of the amount of habitat provided (table 10). The next simpler model, including the decreasing attack rate with ring count, is model 11h (table 15). We consider the complexity levels as variants of the respective ring levels.

Funding Information

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Appendix

Phenomenological Test Rationale

Instead of fitting the number eaten prey items as depended variable as a function of the initial prey density, the ratio of prey eaten and initial prey items is used as depended variable (Juliano, 2001; Pritchard, Paterson, et al., 2017; Pritchard, Barrios-O'Neill, et al., 2017). In the case of a type II functional response, the proportion of eaten prey is constantly declining with increasing prey density, whereas in the case of a type III functional response, the proportion of prey eaten increases at low prey densities and declines after reaching a maximum proportion rate. The main trend of any functional response, if looking at the proportion data, is negative. This negative trend is caused by the fact, that initial prey density linearly increases, whereas the eaten prey items are leveling off. Please see Juliano (2001) for a full description. Pritchard, Paterson, et al. (2017) implemented this test using generalized linear models with a binomial distribution, a standard method to analyze proportion data based on yes/no data (i.e., whether a prey item is eaten or not eaten), but see Crawley (2012), chapter 16, for an introduction on this topic.

We use here the customized function `phen_type_test()` which is a wrapper around the `frair_test()` function from the `frair` package (Pritchard, Barrios-O'Neill, et al., 2017). `phen_type_table()` creates a high-quality PDF report table based on the output of `phen_type_test()`. Both functions are located in the project's sub-folder `functions`.

Full AIC / BIC tables

Ischnura elegans

Table 18: AIC / BIC table of all 32 possible models for *Ischnura elegans*.

Model (AIC)	df	dAIC	Model (BIC)	df	dBIC
Model 5r	3	0.000	Model 5r	3	0.000
Model 7r	4	0.265	Model 5h	3	1.583
Model 6h	4	0.952	Model 7r	4	2.731
Model 6r	4	0.952	Model 6h	4	3.418
Model 5h	3	1.583	Model 6r	4	3.418
Model 13r	6	2.107	Model 7h	4	4.718
Model 7h	4	2.252	Model 2h	3	7.001
Model 8h	7	2.446	Model 2r	3	7.001
Model 8r	7	2.446	Model 9r	3	7.189
Model 14r	7	2.928	Model 10h	4	7.768
Model 15r	7	3.495	Model 13r	6	9.505
Model 14h	7	3.834	Model 10r	4	10.128
Model 13h	6	4.026	Model 9h	3	11.069
Model 15h	7	4.039	Model 13h	6	11.424
Model 12h	7	5.271	Model 11h	4	11.468
Model 12r	7	5.271	Model 11r	4	11.468
Model 10h	4	5.303	Model 3h	3	11.887
Model 16h	10	5.945	Model 3r	3	11.887
Model 16r	10	5.945	Model 8h	7	12.309
Model 2h	3	7.001	Model 8r	7	12.309
Model 2r	3	7.001	Model 14r	7	12.791
Model 9r	3	7.189	Model 15r	7	13.358
Model 10r	4	7.663	Model 14h	7	13.697
Model 4h	6	8.317	Model 15h	7	13.902
Model 4r	6	8.317	Model 12h	7	15.135
Model 11h	4	9.002	Model 12r	7	15.135
Model 11r	4	9.002	Model 4h	6	15.715
Model 9h	3	11.069	Model 4r	6	15.715
Model 3h	3	11.887	Model 1h	2	19.128
Model 3r	3	11.887	Model 1r	2	19.128
Model 1h	2	21.594	Model 16h	10	23.206
Model 1r	2	21.594	Model 16r	10	23.206

Notonecta glauca

Table 19: AIC / BIC table of all 32 possible models for *Notonecta glauca*.

Model (AIC)	df	dAIC	Model (BIC)	df	dBIC
Model 15h	7	0.000	Model 15h	7	0.000
Model 16h	10	1.274	Model 9r	3	1.004
Model 16r	10	1.274	Model 11h	4	1.485
Model 15r	7	1.990	Model 11r	4	1.485
Model 14r	7	4.189	Model 13r	6	1.507
Model 13r	6	4.854	Model 15r	7	1.990
Model 12h	7	8.352	Model 7h	4	2.516
Model 12r	7	8.352	Model 14r	7	4.189
Model 8h	7	8.459	Model 10r	4	4.478
Model 8r	7	8.459	Model 7r	4	5.947
Model 14h	7	9.938	Model 12h	7	8.352
Model 11h	4	11.526	Model 12r	7	8.352
Model 11r	4	11.526	Model 8h	7	8.459
Model 7h	4	12.557	Model 8r	7	8.459
Model 9r	3	14.392	Model 14h	7	9.938
Model 10r	4	14.519	Model 3h	3	10.853
Model 7r	4	15.988	Model 3r	3	10.853
Model 4h	6	20.141	Model 16h	10	11.316
Model 4r	6	20.141	Model 16r	10	11.316
Model 10h	4	21.456	Model 10h	4	11.415
Model 3h	3	24.241	Model 5r	3	16.378
Model 3r	3	24.241	Model 4h	6	16.794
Model 6h	4	28.922	Model 4r	6	16.794
Model 6r	4	28.922	Model 6h	4	18.880
Model 5r	3	29.767	Model 6r	4	18.880
Model 13h	6	33.151	Model 13h	6	29.804
Model 2h	3	43.253	Model 2h	3	29.864
Model 2r	3	43.253	Model 2r	3	29.864
Model 9h	3	44.833	Model 9h	3	31.445
Model 5h	3	53.840	Model 5h	3	40.451
Model 1h	2	125.439	Model 1h	2	108.704
Model 1r	2	125.439	Model 1r	2	108.704

All summary including original `bbmle::summary` outputs

The tables below are build using the function `bbmle::summary` from the `bbmle` package (Bolker et al., 2023). This means that all values *except the slopes* are displayed on log_{10} scale in the column **Orig. Est.** (original estimate). The column **Estimate.** displays the values on normal scale. The significance values are all tested against "0", in the case of the log_{10}-transformed parameters they are tested against a value of 1 on normal scale. As example, the maximum feeding rate value is tested if it differs significantly from 1 $\frac{items_{prey}}{day}$ eaten, not if F_{max} differs between treatments. Therefore, the significance for the log_{10}-transformed parameters are not relevant. Only the significance for the slopes is of interest as it tells if the model finds a significant effect of the amount of habitat in the experimental trial (0, 2, or 3 ring structures).

Ischnura elegans

Table 20: All 32 summary tables from *Ischnura elegans* model fits.

Name	Orig. Est.	SE	z	p	Estimate	CI low	CI up
Model 1h							
t_h_log10	-1.204	0.065	-18.648	0.0000	0.063	0.046	0.083
a_log10	-0.510	0.054	-9.505	0.0000	0.309	0.243	0.395
Model 1r							
f_max_log10	1.204	0.065	18.648	0.0000	15.996	11.964	21.488
n_half_log10	1.714	0.107	16.036	0.0000	51.718	32.057	83.246
Model 2h							
t_h_log10	-1.277	0.077	-16.592	0.0000	0.053	0.037	0.075
a_hab0_log10	-0.257	0.085	-3.038	0.0024	0.553	0.379	0.812
a_hab1_log10	-0.643	0.061	-10.541	0.0000	0.228	0.173	0.302
Model 2r							
f_max_log10	1.277	0.077	16.592	0.0000	18.906	13.370	26.736
n_half_hab0_log10	1.534	0.134	11.424	0.0000	34.166	18.696	62.684
n_half_hab1_log10	1.920	0.126	15.274	0.0000	83.088	47.051	146.742
Model 3h							
t_h_log10	-1.254	0.073	-17.191	0.0000	0.056	0.040	0.077
a_intercept_log10	-0.307	0.082	-3.746	0.0002	0.493	0.339	0.717
a_slope	-0.121	0.034	-3.509	0.0005	-0.121	-0.188	-0.053
Model 3r							
f_max_log10	1.254	0.073	17.191	0.0000	17.957	12.905	24.865
n_half_intercept_log10	1.562	0.129	12.102	0.0000	36.451	20.440	64.660
n_half_slope	0.121	0.034	3.509	0.0005	0.121	0.053	0.188
Model 4h							
t_h_log10	-1.277	0.075	-16.930	0.0000	0.053	0.038	0.075
a_0_log10	-0.257	0.084	-3.047	0.0023	0.553	0.378	0.809
a_1_log10	-0.813	0.099	-8.248	0.0000	0.154	0.098	0.240
a_2_log10	-0.554	0.104	-5.319	0.0000	0.279	0.175	0.448
a_3_log10	-0.612	0.094	-6.534	0.0000	0.244	0.159	0.376
a_4_log10	-0.589	0.105	-5.636	0.0000	0.257	0.160	0.412
Model 4r							
f_max_log10	1.277	0.075	16.930	0.0000	18.907	13.526	26.523
n_half_0_log10	1.534	0.132	11.576	0.0000	34.168	18.865	62.238
n_half_1_log10	2.089	0.142	14.724	0.0000	122.880	64.789	231.519
n_half_2_log10	1.831	0.152	12.023	0.0000	67.712	34.443	133.392
n_half_3_log10	1.889	0.140	13.493	0.0000	77.424	40.916	145.463
n_half_4_log10	1.866	0.154	12.150	0.0000	73.468	36.986	144.526
Model 5h							
t_h_hab0_log10	-1.792	0.237	-7.545	0.0000	0.016	0.006	0.047
t_h_hab1_log10	-1.084	0.064	-16.928	0.0000	0.082	0.062	0.110
a_log10	-0.499	0.054	-9.273	0.0000	0.317	0.247	0.402

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Table 20: All 32 summary tables from *Ischnura elegans* model fits. *(continued)*

Name	Orig. Est.	SE	z	p	Estimate	CI low	CI up
Model 5r							
f_max_hab0_log10	1.448	0.083	17.543	0.0000	28.081	19.614	40.661
f_max_hab1_log10	1.164	0.069	16.839	0.0000	14.578	10.677	19.958
n_half_log10	1.756	0.111	15.797	0.0000	57.000	34.927	92.747
Model 6h							
t_h_hab0_log10	-1.578	0.176	-8.959	0.0000	0.026	0.012	0.058
t_h_hab1_log10	-1.126	0.074	-15.163	0.0000	0.075	0.053	0.103
a_hab0_log10	-0.378	0.092	-4.091	0.0000	0.419	0.276	0.633
a_hab1_log10	-0.561	0.065	-8.607	0.0000	0.275	0.205	0.370
Model 6r							
f_max_hab0_log10	1.578	0.176	8.959	0.0000	37.807	17.169	83.852
f_max_hab1_log10	1.126	0.074	15.163	0.0000	13.361	9.623	18.599
n_half_hab0_log10	1.955	0.250	7.837	0.0000	90.245	29.085	280.100
n_half_hab1_log10	1.687	0.126	13.389	0.0000	48.647	27.711	84.947
Model 7h							
t_h_hab0_log10	-1.639	0.198	-8.274	0.0000	0.023	0.009	0.057
t_h_hab1_log10	-1.107	0.070	-15.876	0.0000	0.078	0.057	0.106
a_intercept_log10	-0.420	0.087	-4.817	0.0000	0.380	0.256	0.559
a_slope	-0.047	0.040	-1.157	0.2471	-0.047	-0.126	0.034
Model 7r							
f_max_hab0_log10	1.563	0.133	11.770	0.0000	36.596	20.055	67.144
f_max_hab1_log10	1.132	0.071	15.910	0.0000	13.563	9.855	18.636
n_half_intercept_log10	1.935	0.185	10.474	0.0000	86.008	37.318	198.091
n_half_slope	-0.094	0.074	-1.272	0.2035	-0.094	-0.238	0.052
Model 8h							
t_h_hab0_log10	-1.578	0.176	-8.959	0.0000	0.026	0.012	0.058
t_h_hab1_log10	-1.133	0.074	-15.380	0.0000	0.074	0.053	0.102
a_0_log10	-0.378	0.092	-4.091	0.0000	0.419	0.274	0.630
a_1_log10	-0.748	0.108	-6.904	0.0000	0.179	0.109	0.292
a_2_log10	-0.468	0.111	-4.201	0.0000	0.341	0.207	0.561
a_3_log10	-0.541	0.104	-5.219	0.0000	0.288	0.179	0.453
a_4_log10	-0.504	0.110	-4.585	0.0000	0.313	0.192	0.516
Model 8r							
f_max_hab0_log10	1.578	0.176	8.959	0.0000	37.807	17.057	83.852
f_max_hab1_log10	1.133	0.074	15.380	0.0000	13.569	9.745	18.752
n_half_0_log10	1.955	0.250	7.837	0.0000	90.243	29.289	279.771
n_half_1_log10	1.880	0.150	12.570	0.0000	75.896	38.332	146.630
n_half_2_log10	1.600	0.156	10.243	0.0000	39.837	19.807	80.009
n_half_3_log10	1.674	0.148	11.291	0.0000	47.174	24.075	91.656
n_half_4_log10	1.637	0.153	10.687	0.0000	43.351	21.575	85.927
Model 9h							
t_h_intercept_log10	-1.528	0.132	-11.571	0.0000	0.030	0.016	0.054
t_h_slope	0.162	0.050	3.261	0.0011	0.162	0.064	0.259
a_log10	-0.495	0.053	-9.382	0.0000	0.320	0.252	0.407
Model 9r							
f_max_intercept_log10	1.402	0.082	17.130	0.0000	25.244	17.389	36.620
f_max_slope	-0.091	0.022	-4.179	0.0000	-0.091	-0.134	-0.048
n_half_log10	1.750	0.110	15.840	0.0000	56.226	34.593	93.320
Model 10h							
t_h_intercept_log10	-1.428	0.120	-11.919	0.0000	0.037	0.022	0.064
t_h_slope	0.096	0.051	1.887	0.0592	0.096	-0.003	0.196
a_hab0_log10	-0.320	0.087	-3.692	0.0002	0.479	0.326	0.710

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Name	Orig. Est.	SE	z	p	Estimate	CI low	CI up
a_hab1_log10	-0.598	0.064	-9.422	0.0000	0.252	0.189	0.339
Model 10r							
f_max_intercept_log10	1.339	0.094	14.301	0.0000	21.827	14.248	33.441
f_max_slope	-0.048	0.041	-1.160	0.2461	-0.048	-0.128	0.031
n_half_hab0_log10	1.622	0.153	10.633	0.0000	41.882	20.872	83.404
n_half_hab1_log10	1.834	0.136	13.524	0.0000	68.270	37.123	127.759
Model 11h							
t_h_intercept_log10	-1.440	0.124	-11.641	0.0000	0.036	0.021	0.065
t_h_slope	0.111	0.052	2.135	0.0327	0.111	0.007	0.215
a_intercept_log10	-0.372	0.084	-4.453	0.0000	0.425	0.291	0.623
a_slope	-0.077	0.039	-2.001	0.0454	-0.077	-0.154	-0.002
Model 11r							
f_max_intercept_log10	1.440	0.124	11.640	0.0000	27.542	15.938	48.023
f_max_slope	-0.111	0.052	-2.136	0.0327	-0.111	-0.212	-0.008
n_half_intercept_log10	1.812	0.184	9.852	0.0000	64.841	28.441	146.797
n_half_slope	-0.034	0.079	-0.430	0.6669	-0.034	-0.188	0.123
Model 12h							
t_h_intercept_log10	-1.476	0.134	-11.024	0.0000	0.033	0.018	0.061
t_h_slope	0.117	0.055	2.132	0.0330	0.117	0.007	0.226
a_0_log10	-0.339	0.088	-3.863	0.0001	0.458	0.308	0.677
a_1_log10	-0.798	0.100	-7.961	0.0000	0.159	0.103	0.250
a_2_log10	-0.533	0.105	-5.093	0.0000	0.293	0.182	0.469
a_3_log10	-0.536	0.107	-5.010	0.0000	0.291	0.179	0.472
a_4_log10	-0.500	0.113	-4.429	0.0000	0.316	0.190	0.525
Model 12r							
f_max_intercept_log10	1.476	0.134	11.024	0.0000	29.898	16.362	54.581
f_max_slope	-0.117	0.055	-2.132	0.0330	-0.117	-0.227	-0.008
n_half_0_log10	1.815	0.200	9.092	0.0000	65.239	26.520	160.135
n_half_1_log10	2.039	0.138	14.746	0.0000	109.348	58.513	204.319
n_half_2_log10	1.774	0.147	12.083	0.0000	59.458	30.348	116.381
n_half_3_log10	1.660	0.164	10.137	0.0000	45.741	21.656	95.974
n_half_4_log10	1.624	0.168	9.686	0.0000	42.029	19.466	89.593
Model 13h							
t_h_0_log10	-1.765	0.224	-7.883	0.0000	0.017	0.006	0.047
t_h_1_log10	-0.944	0.111	-8.513	0.0000	0.114	0.069	0.189
t_h_2_log10	-1.044	0.117	-8.904	0.0000	0.090	0.054	0.153
t_h_3_log10	-1.056	0.126	-8.379	0.0000	0.088	0.050	0.154
t_h_4_log10	-1.203	0.097	-12.358	0.0000	0.063	0.040	0.097
a_log10	-0.488	0.055	-8.902	0.0000	0.325	0.254	0.418
Model 13r							
f_max_0_log10	1.442	0.082	17.509	0.0000	27.663	19.184	40.161
f_max_1_log10	1.056	0.090	11.759	0.0000	11.369	7.610	17.029
f_max_2_log10	1.185	0.088	13.388	0.0000	15.298	10.221	22.918
f_max_3_log10	1.169	0.091	12.886	0.0000	14.750	9.867	22.059
f_max_4_log10	1.213	0.077	15.704	0.0000	16.325	11.483	23.044
n_half_log10	1.745	0.111	15.673	0.0000	55.625	33.327	91.462
Model 14h							
t_h_0_log10	-1.578	0.176	-8.959	0.0000	0.026	0.012	0.060
t_h_1_log10	-0.981	0.119	-8.209	0.0000	0.104	0.061	0.179
t_h_2_log10	-1.079	0.127	-8.508	0.0000	0.083	0.047	0.150
t_h_3_log10	-1.107	0.142	-7.810	0.0000	0.078	0.041	0.149
t_h_4_log10	-1.240	0.109	-11.393	0.0000	0.058	0.035	0.094
a_hab0_log10	-0.378	0.092	-4.091	0.0000	0.419	0.274	0.645

Table 20: All 32 summary tables from *Ischnura elegans* model fits. *(continued)*

Name	Orig. Est.	SE	z	p	Estimate	CI low	CI up
a_hab1_log10	-0.547	0.067	-8.164	0.0000	0.284	0.212	0.385
Model 14r							
f_max_0_log10	1.578	0.176	8.959	0.0000	37.807	17.036	83.146
f_max_1_log10	1.016	0.093	10.869	0.0000	10.364	6.821	15.794
f_max_2_log10	1.143	0.093	12.336	0.0000	13.903	9.289	20.995
f_max_3_log10	1.125	0.095	11.827	0.0000	13.324	8.759	20.248
f_max_4_log10	1.177	0.080	14.628	0.0000	15.038	10.457	21.501
n_half_hab0_log10	1.955	0.250	7.837	0.0000	90.243	29.419	277.665
n_half_hab1_log10	1.672	0.126	13.262	0.0000	46.939	27.047	81.399
Model 15h							
t_h_0_log10	-1.592	0.179	-8.886	0.0000	0.026	0.011	0.058
t_h_1_log10	-0.957	0.113	-8.457	0.0000	0.110	0.066	0.182
t_h_2_log10	-1.057	0.120	-8.806	0.0000	0.088	0.051	0.148
t_h_3_log10	-1.127	0.152	-7.403	0.0000	0.075	0.038	0.150
t_h_4_log10	-1.256	0.117	-10.729	0.0000	0.055	0.033	0.092
a_intercept_log10	-0.389	0.089	-4.357	0.0000	0.409	0.273	0.614
a_slope	-0.060	0.043	-1.411	0.1582	-0.060	-0.144	0.024
Model 15r							
f_max_0_log10	1.526	0.148	10.322	0.0000	33.565	17.282	65.485
f_max_1_log10	1.050	0.090	11.707	0.0000	11.214	7.505	16.640
f_max_2_log10	1.178	0.088	13.332	0.0000	15.083	10.161	22.491
f_max_3_log10	1.120	0.106	10.611	0.0000	13.168	8.170	21.251
f_max_4_log10	1.173	0.089	13.253	0.0000	14.896	9.991	22.163
n_half_intercept_log10	1.878	0.214	8.759	0.0000	75.506	28.657	199.951
n_half_slope	-0.072	0.094	-0.764	0.4447	-0.072	-0.254	0.114
Model 16h							
t_h_0_log10	-1.578	0.176	-8.959	0.0000	0.026	0.012	0.060
t_h_1_log10	-1.145	0.205	-5.593	0.0000	0.072	0.028	0.182
t_h_2_log10	-0.984	0.125	-7.859	0.0000	0.104	0.059	0.182
t_h_3_log10	-1.074	0.167	-6.416	0.0000	0.084	0.040	0.179
t_h_4_log10	-1.266	0.142	-8.913	0.0000	0.054	0.028	0.104
a_0_log10	-0.378	0.092	-4.091	0.0000	0.419	0.276	0.635
a_1_log10	-0.754	0.141	-5.346	0.0000	0.176	0.093	0.328
a_2_log10	-0.377	0.135	-2.790	0.0053	0.420	0.229	0.784
a_3_log10	-0.509	0.138	-3.689	0.0002	0.310	0.166	0.572
a_4_log10	-0.583	0.128	-4.537	0.0000	0.261	0.144	0.472
Model 16r							
f_max_0_log10	1.578	0.176	8.959	0.0000	37.806	17.235	84.753
f_max_1_log10	1.145	0.205	5.593	0.0000	13.955	5.532	34.624
f_max_2_log10	0.984	0.125	7.859	0.0000	9.638	5.467	17.012
f_max_3_log10	1.074	0.167	6.416	0.0000	11.850	5.662	25.198
f_max_4_log10	1.266	0.142	8.913	0.0000	18.439	9.611	34.967
n_half_0_log10	1.955	0.250	7.837	0.0000	90.242	29.048	284.233
n_half_1_log10	1.898	0.319	5.951	0.0000	79.115	18.875	329.834
n_half_2_log10	1.361	0.230	5.906	0.0000	22.968	8.075	64.368
n_half_3_log10	1.582	0.281	5.639	0.0000	38.234	11.072	132.403
n_half_4_log10	1.849	0.248	7.462	0.0000	70.559	22.991	212.855

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Table 21: All 32 summary tables from *Ischnura elegans* model fits.

Name	Orig. Est.	SE	z	p	Estimate	CI low	CI up
Model 1h							
t_h_log10	-1.372	0.020	-67.929	0.0000	0.042	0.039	0.046
a_log10	-0.177	0.028	-6.309	0.0000	0.665	0.585	0.752
Model 1r							
f_max_log10	1.372	0.020	67.929	0.0000	23.560	21.525	25.826
n_half_log10	1.550	0.044	35.545	0.0000	35.447	29.102	43.262
Model 2h							
t_h_log10	-1.397	0.021	-65.700	0.0000	0.040	0.036	0.044
a_hab0_log10	0.180	0.050	3.567	0.0004	1.513	1.206	1.895
a_hab1_log10	-0.308	0.031	-10.011	0.0000	0.493	0.428	0.566
Model 2r							
f_max_log10	1.397	0.021	65.701	0.0000	24.927	22.668	27.427
n_half_hab0_log10	1.217	0.062	19.709	0.0000	16.473	12.408	21.837
n_half_hab1_log10	1.704	0.047	36.543	0.0000	50.605	40.895	62.636
Model 3h							
t_h_log10	-1.398	0.021	-66.503	0.0000	0.040	0.036	0.044
a_intercept_log10	0.185	0.048	3.861	0.0001	1.532	1.231	1.902
a_slope	-0.198	0.019	-10.239	0.0000	-0.199	-0.237	-0.161
Model 3r							
f_max_log10	1.398	0.021	66.503	0.0000	24.980	22.696	27.436
n_half_intercept_log10	1.212	0.060	20.267	0.0000	16.306	12.413	21.361
n_half_slope	0.198	0.019	10.239	0.0000	0.198	0.160	0.236
Model 4h							
t_h_log10	-1.405	0.021	-65.883	0.0000	0.039	0.036	0.043
a_0_log10	0.172	0.050	3.426	0.0006	1.487	1.191	1.859
a_1_log10	-0.329	0.056	-5.873	0.0000	0.469	0.363	0.607
a_2_log10	-0.111	0.050	-2.227	0.0259	0.775	0.621	0.973
a_3_log10	-0.440	0.050	-8.781	0.0000	0.363	0.291	0.455
a_4_log10	-0.404	0.053	-7.639	0.0000	0.395	0.311	0.500
Model 4r							
f_max_log10	1.405	0.021	65.883	0.0000	25.418	23.084	27.963
n_half_0_log10	1.233	0.062	19.975	0.0000	17.098	12.927	22.612
n_half_1_log10	1.734	0.067	25.749	0.0000	54.184	40.206	72.788
n_half_2_log10	1.516	0.060	25.109	0.0000	32.788	24.838	42.871
n_half_3_log10	1.845	0.060	30.740	0.0000	70.047	53.314	92.195
n_half_4_log10	1.809	0.063	28.531	0.0000	64.392	48.241	85.800
Model 5h							
t_h_hab0_log10	-1.616	0.038	-42.110	0.0000	0.024	0.020	0.029
t_h_hab1_log10	-1.291	0.021	-60.565	0.0000	0.051	0.046	0.056
a_log10	-0.162	0.028	-5.689	0.0000	0.689	0.608	0.785
Model 5r							
f_max_hab0_log10	1.543	0.025	61.397	0.0000	34.907	31.212	39.089
f_max_hab1_log10	1.311	0.021	61.828	0.0000	20.471	18.634	22.479
n_half_log10	1.535	0.044	35.142	0.0000	34.239	28.250	41.625
Model 6h							
t_h_hab0_log10	-1.498	0.035	-43.204	0.0000	0.032	0.027	0.037
t_h_hab1_log10	-1.329	0.024	-54.437	0.0000	0.047	0.042	0.052
a_hab0_log10	0.084	0.055	1.510	0.1310	1.212	0.944	1.556
a_hab1_log10	-0.250	0.033	-7.580	0.0000	0.562	0.486	0.653
Model 6r							
f_max_hab0_log10	1.498	0.035	43.204	0.0000	31.487	26.931	36.874

Table 21: All 32 summary tables from *Ischnura elegans* model fits. *(continued)*

Name	Orig. Est.	SE	z	p	Estimate	CI low	CI up
f_max_hab1_log10	1.329	0.024	54.437	0.0000	21.335	19.064	23.824
n_half_hab0_log10	1.414	0.082	17.338	0.0000	25.971	17.927	37.547
n_half_hab1_log10	1.579	0.052	30.513	0.0000	37.942	29.953	47.844
Model 7h							
t_h_hab0_log10	-1.486	0.033	-45.247	0.0000	0.033	0.028	0.038
t_h_hab1_log10	-1.338	0.024	-54.753	0.0000	0.046	0.041	0.051
a_intercept_log10	0.116	0.051	2.273	0.0230	1.307	1.038	1.642
a_slope	-0.153	0.023	-6.625	0.0000	-0.153	-0.198	-0.108
Model 7r							
f_max_hab0_log10	1.464	0.030	49.125	0.0000	29.114	25.404	33.386
f_max_hab1_log10	1.350	0.024	55.297	0.0000	22.380	20.023	24.988
n_half_intercept_log10	1.318	0.069	19.192	0.0000	20.773	15.209	28.292
n_half_slope	0.124	0.031	4.048	0.0001	0.124	0.065	0.184
Model 8h							
t_h_hab0_log10	-1.498	0.035	-43.204	0.0000	0.032	0.027	0.037
t_h_hab1_log10	-1.342	0.025	-53.876	0.0000	0.045	0.041	0.051
a_0_log10	0.084	0.055	1.510	0.1310	1.212	0.945	1.562
a_1_log10	-0.263	0.060	-4.351	0.0000	0.546	0.417	0.721
a_2_log10	-0.063	0.051	-1.224	0.2209	0.865	0.687	1.092
a_3_log10	-0.396	0.053	-7.411	0.0000	0.402	0.317	0.512
a_4_log10	-0.350	0.056	-6.209	0.0000	0.447	0.345	0.576
Model 8r							
f_max_hab0_log10	1.498	0.035	43.204	0.0000	31.487	26.967	36.915
f_max_hab1_log10	1.342	0.025	53.876	0.0000	21.986	19.696	24.622
n_half_0_log10	1.414	0.082	17.338	0.0000	25.971	18.070	37.489
n_half_1_log10	1.605	0.075	21.508	0.0000	40.242	28.741	56.928
n_half_2_log10	1.405	0.064	21.810	0.0000	25.415	19.095	34.188
n_half_3_log10	1.738	0.066	26.357	0.0000	54.714	40.868	73.958
n_half_4_log10	1.692	0.070	24.294	0.0000	49.227	36.190	67.267
Model 9h							
t_h_intercept_log10	-1.607	0.036	-44.903	0.0000	0.025	0.021	0.029
t_h_slope	0.128	0.014	8.866	0.0000	0.127	0.099	0.156
a_log10	-0.157	0.029	-5.486	0.0000	0.697	0.611	0.793
Model 9r							
f_max_intercept_log10	1.542	0.024	62.993	0.0000	34.831	31.239	38.851
f_max_slope	-0.094	0.009	-11.012	0.0000	-0.094	-0.111	-0.077
n_half_log10	1.531	0.044	35.031	0.0000	33.937	27.876	41.368
Model 10h							
t_h_intercept_log10	-1.510	0.033	-45.322	0.0000	0.031	0.027	0.036
t_h_slope	0.076	0.016	4.826	0.0000	0.076	0.045	0.107
a_hab0_log10	0.072	0.054	1.314	0.1887	1.179	0.924	1.513
a_hab1_log10	-0.241	0.033	-7.353	0.0000	0.574	0.495	0.665
Model 10r							
f_max_intercept_log10	1.513	0.031	48.459	0.0000	32.600	28.237	37.488
f_max_slope	-0.078	0.014	-5.425	0.0000	-0.078	-0.105	-0.049
n_half_hab0_log10	1.445	0.076	19.038	0.0000	27.839	19.700	39.194
n_half_hab1_log10	1.562	0.049	31.601	0.0000	36.444	29.067	45.675
Model 11h							
t_h_intercept_log10	-1.488	0.033	-45.420	0.0000	0.033	0.028	0.038
t_h_slope	0.063	0.016	3.856	0.0001	0.063	0.031	0.095
a_intercept_log10	0.102	0.052	1.947	0.0515	1.265	0.999	1.606
a_slope	-0.144	0.024	-5.956	0.0000	-0.144	-0.190	-0.096

Table 21: All 32 summary tables from *Ischnura elegans* model fits.
(continued)

Name	Orig. Est.	SE	z	p	Estimate	CI low	CI up
Model 11r							
f_max_intercept_log10	1.488	0.033	45.420	0.0000	30.745	26.547	35.734
f_max_slope	-0.063	0.016	-3.857	0.0001	-0.062	-0.095	-0.032
n_half_intercept_log10	1.386	0.077	17.998	0.0000	24.304	17.269	34.682
n_half_slope	0.081	0.036	2.225	0.0261	0.081	0.008	0.151
Model 12h							
t_h_intercept_log10	-1.493	0.033	-45.054	0.0000	0.032	0.028	0.037
t_h_slope	0.062	0.017	3.734	0.0002	0.061	0.029	0.094
a_0_log10	0.089	0.054	1.632	0.1026	1.227	0.962	1.570
a_1_log10	-0.291	0.058	-5.054	0.0000	0.511	0.394	0.661
a_2_log10	-0.083	0.050	-1.654	0.0981	0.826	0.662	1.031
a_3_log10	-0.372	0.056	-6.624	0.0000	0.425	0.330	0.550
a_4_log10	-0.321	0.059	-5.402	0.0000	0.477	0.362	0.625
Model 12r							
f_max_intercept_log10	1.493	0.033	45.054	0.0000	31.101	26.795	36.244
f_max_slope	-0.062	0.017	-3.735	0.0002	-0.061	-0.094	-0.029
n_half_0_log10	1.404	0.079	17.776	0.0000	25.342	17.772	36.362
n_half_1_log10	1.661	0.069	24.147	0.0000	45.803	33.626	62.023
n_half_2_log10	1.452	0.060	24.043	0.0000	28.346	21.622	37.486
n_half_3_log10	1.680	0.074	22.813	0.0000	47.842	34.367	66.734
n_half_4_log10	1.629	0.078	20.921	0.0000	42.570	29.906	60.664
Model 13h							
t_h_0_log10	-1.611	0.038	-42.479	0.0000	0.024	0.021	0.029
t_h_1_log10	-1.233	0.038	-32.446	0.0000	0.059	0.050	0.070
t_h_2_log10	-1.435	0.036	-39.612	0.0000	0.037	0.031	0.043
t_h_3_log10	-1.253	0.039	-32.161	0.0000	0.056	0.047	0.066
t_h_4_log10	-1.208	0.039	-31.368	0.0000	0.062	0.052	0.074
a_log10	-0.153	0.029	-5.358	0.0000	0.703	0.619	0.801
Model 13r							
f_max_0_log10	1.541	0.025	61.458	0.0000	34.784	31.000	38.905
f_max_1_log10	1.287	0.030	42.422	0.0000	19.350	16.892	22.182
f_max_2_log10	1.416	0.028	51.411	0.0000	26.070	23.011	29.495
f_max_3_log10	1.264	0.031	40.568	0.0000	18.371	15.930	21.152
f_max_4_log10	1.255	0.031	40.067	0.0000	17.969	15.594	20.703
n_half_log10	1.531	0.044	35.103	0.0000	33.928	27.874	41.177
Model 14h							
t_h_0_log10	-1.498	0.035	-43.204	0.0000	0.032	0.027	0.037
t_h_1_log10	-1.267	0.041	-30.789	0.0000	0.054	0.045	0.065
t_h_2_log10	-1.477	0.041	-35.995	0.0000	0.033	0.028	0.040
t_h_3_log10	-1.292	0.042	-30.706	0.0000	0.051	0.042	0.062
t_h_4_log10	-1.241	0.041	-30.172	0.0000	0.057	0.048	0.069
a_hab0_log10	0.084	0.055	1.510	0.1310	1.212	0.945	1.558
a_hab1_log10	-0.240	0.033	-7.217	0.0000	0.575	0.495	0.668
Model 14r							
f_max_0_log10	1.498	0.035	43.204	0.0000	31.487	27.098	36.760
f_max_1_log10	1.304	0.033	39.997	0.0000	20.122	17.354	23.386
f_max_2_log10	1.433	0.030	47.723	0.0000	27.122	23.744	31.072
f_max_3_log10	1.282	0.033	38.276	0.0000	19.133	16.451	22.231
f_max_4_log10	1.272	0.034	37.905	0.0000	18.699	16.080	21.738
n_half_hab0_log10	1.414	0.082	17.338	0.0000	25.971	18.090	37.663
n_half_hab1_log10	1.574	0.052	30.458	0.0000	37.468	29.683	47.559
Model 15h							
t_h_0_log10	-1.489	0.033	-44.613	0.0000	0.032	0.028	0.038

(continued on next page...)

Table 21: All 32 summary tables from *Ischnura elegans* model fits. *(continued)*

Name	Orig. Est.	SE	z	p	Estimate	CI low	CI up
t_h_1_log10	-1.243	0.039	-32.106	0.0000	0.057	0.048	0.068
t_h_2_log10	-1.448	0.037	-38.812	0.0000	0.036	0.030	0.042
t_h_3_log10	-1.335	0.047	-28.329	0.0000	0.046	0.037	0.057
t_h_4_log10	-1.276	0.045	-28.270	0.0000	0.053	0.043	0.065
a_intercept_log10	0.107	0.053	2.036	0.0418	1.280	1.008	1.637
a_slope	-0.144	0.024	-5.938	0.0000	-0.144	-0.192	-0.096
Model 15r							
f_max_0_log10	1.488	0.033	45.165	0.0000	30.741	26.530	35.805
f_max_1_log10	1.293	0.031	42.179	0.0000	19.646	17.101	22.672
f_max_2_log10	1.423	0.028	50.988	0.0000	26.474	23.357	30.003
f_max_3_log10	1.305	0.037	34.849	0.0000	20.181	17.028	23.858
f_max_4_log10	1.295	0.037	34.622	0.0000	19.703	16.666	23.457
n_half_intercept_log10	1.385	0.077	17.965	0.0000	24.285	17.375	34.666
n_half_slope	0.081	0.037	2.220	0.0264	0.081	0.009	0.150
Model 16h							
t_h_0_log10	-1.498	0.035	-43.204	0.0000	0.032	0.027	0.037
t_h_1_log10	-1.232	0.045	-27.187	0.0000	0.059	0.048	0.072
t_h_2_log10	-1.423	0.041	-34.733	0.0000	0.038	0.031	0.045
t_h_3_log10	-1.406	0.066	-21.145	0.0000	0.039	0.029	0.053
t_h_4_log10	-1.257	0.049	-25.651	0.0000	0.055	0.044	0.069
a_0_log10	0.084	0.055	1.510	0.1310	1.212	0.940	1.551
a_1_log10	-0.151	0.073	-2.063	0.0391	0.707	0.507	0.983
a_2_log10	-0.125	0.057	-2.193	0.0283	0.750	0.578	0.964
a_3_log10	-0.441	0.067	-6.611	0.0000	0.363	0.270	0.491
a_4_log10	-0.279	0.068	-4.102	0.0000	0.526	0.387	0.715
Model 16r							
f_max_0_log10	1.498	0.035	43.204	0.0000	31.487	26.881	36.838
f_max_1_log10	1.232	0.045	27.187	0.0000	17.046	13.958	20.865
f_max_2_log10	1.423	0.041	34.733	0.0000	26.492	22.000	31.916
f_max_3_log10	1.406	0.066	21.146	0.0000	25.453	18.958	34.459
f_max_4_log10	1.257	0.049	25.651	0.0000	18.057	14.495	22.518
n_half_0_log10	1.414	0.082	17.338	0.0000	25.971	17.828	37.629
n_half_1_log10	1.382	0.106	12.994	0.0000	24.113	15.046	38.949
n_half_2_log10	1.548	0.088	17.666	0.0000	35.334	23.550	52.643
n_half_3_log10	1.846	0.123	15.060	0.0000	70.211	40.660	123.627
n_half_4_log10	1.536	0.104	14.724	0.0000	34.349	21.388	54.584

Project Settings

We created the statistics in this report and the report itself using R version 4.4.3 (2025-02-28) - Trophy Case on a x86_64 computer with Linux Mint 22.1 as operating system. Find the loaded and attached packages that we used in table 22.

Table 22: All loaded R packages that we used in this report, including base packages.

Package Name	Version	Is Package Attached?	Is a Base Package?
base	4.4.3	TRUE	TRUE
datasets	4.4.3	TRUE	TRUE
graphics	4.4.3	TRUE	TRUE
grDevices	4.4.3	TRUE	TRUE
methods	4.4.3	TRUE	TRUE
stats	4.4.3	TRUE	TRUE
utils	4.4.3	TRUE	TRUE
compiler	4.4.3	FALSE	TRUE
grid	4.4.3	FALSE	TRUE
parallel	4.4.3	FALSE	TRUE
stats4	4.4.3	FALSE	TRUE
tools	4.4.3	FALSE	TRUE
dplyr	1.1.4	TRUE	FALSE
foreach	1.5.2	TRUE	FALSE
bbmle	1.0.25.1	FALSE	FALSE
bdsmatrix	1.3-7	FALSE	FALSE
bookdown	0.42	FALSE	FALSE
boot	1.3-31	FALSE	FALSE
cli	3.6.3	FALSE	FALSE
coda	0.19-4.1	FALSE	FALSE
codetools	0.2-20	FALSE	FALSE
colorspace	2.1-1	FALSE	FALSE
curl	6.2.0	FALSE	FALSE
digest	0.6.37	FALSE	FALSE
doParallel	1.0.17	FALSE	FALSE
emdbook	1.3.13	FALSE	FALSE
evaluate	1.0.3	FALSE	FALSE
fastmap	1.2.0	FALSE	FALSE
frair	0.5.100	FALSE	FALSE
generics	0.1.3	FALSE	FALSE
gh	1.4.1	FALSE	FALSE
gitcreds	0.1.2	FALSE	FALSE
glue	1.8.0	FALSE	FALSE
here	1.0.1	FALSE	FALSE
htmltools	0.5.8.1	FALSE	FALSE
httr2	1.1.0	FALSE	FALSE
iterators	1.0.14	FALSE	FALSE
jsonlite	1.8.9	FALSE	FALSE
kableExtra	1.4.0	FALSE	FALSE
knitr	1.49	FALSE	FALSE
lamW	2.2.4	FALSE	FALSE
lattice	0.22-5	FALSE	FALSE
lifecycle	1.0.4	FALSE	FALSE
magrittr	2.0.3	FALSE	FALSE
MASS	7.3-65	FALSE	FALSE
Matrix	1.7-3	FALSE	FALSE
munsell	0.5.1	FALSE	FALSE

mvtnorm	1.3-3	FALSE	FALSE
numDeriv	2016.8-1.1	FALSE	FALSE
pillar	1.10.1	FALSE	FALSE
pkgconfig	2.0.3	FALSE	FALSE
plyr	1.8.9	FALSE	FALSE
purrr	1.0.4	FALSE	FALSE
R6	2.5.1	FALSE	FALSE
rappdirs	0.3.3	FALSE	FALSE
Rcpp	1.0.14	FALSE	FALSE
RcppParallel	5.1.10	FALSE	FALSE
rlang	1.1.5	FALSE	FALSE
rmarkdown	2.29	FALSE	FALSE
rprojroot	2.0.4	FALSE	FALSE
rstudioapi	0.17.1	FALSE	FALSE
scales	1.3.0	FALSE	FALSE
sessioninfo	1.2.3	FALSE	FALSE
stringi	1.8.4	FALSE	FALSE
stringr	1.5.1	FALSE	FALSE
supportR	1.4.0	FALSE	FALSE
svglite	2.1.3	FALSE	FALSE
systemfonts	1.2.1	FALSE	FALSE
tibble	3.2.1	FALSE	FALSE
tidyselect	1.2.1	FALSE	FALSE
vctrs	0.6.5	FALSE	FALSE
viridisLite	0.4.2	FALSE	FALSE
withr	3.0.2	FALSE	FALSE
xfun	0.50	FALSE	FALSE
xml2	1.3.6	FALSE	FALSE
yaml	2.3.10	FALSE	FALSE