Sandeel data used

Three treatments

- Control (*C*)
- Food (*F*)
- Olfactory (*O*)

For 492 individuals the time between the events “head up” and “swim”/”bury” is available, *C*: 46, *F*: 240, *O*: 206. In the following, “time” always refers to this time.

In the treatments *F* and *O* these times seem to differ between the containers. For my analyses I removed container D6 [2 values for *C* (1 s, 1 s), 1 value for *F* (2041 s), 1 value for *O* (624)], and 3 extreme values from *O* (1368 s, 2148 s, 3190 s).

The resulting ranges of times for the three treatments are

- *C*: 2 s - 783 s (*N*=44)
- *F*: 0 s - 866 s (*N*=239)
- *O*: 0 s - 868 s (*N*=202)

The times for ***C*** can be explained by a geometric distribution (with parameter p=0.0061).

Fig. 1a

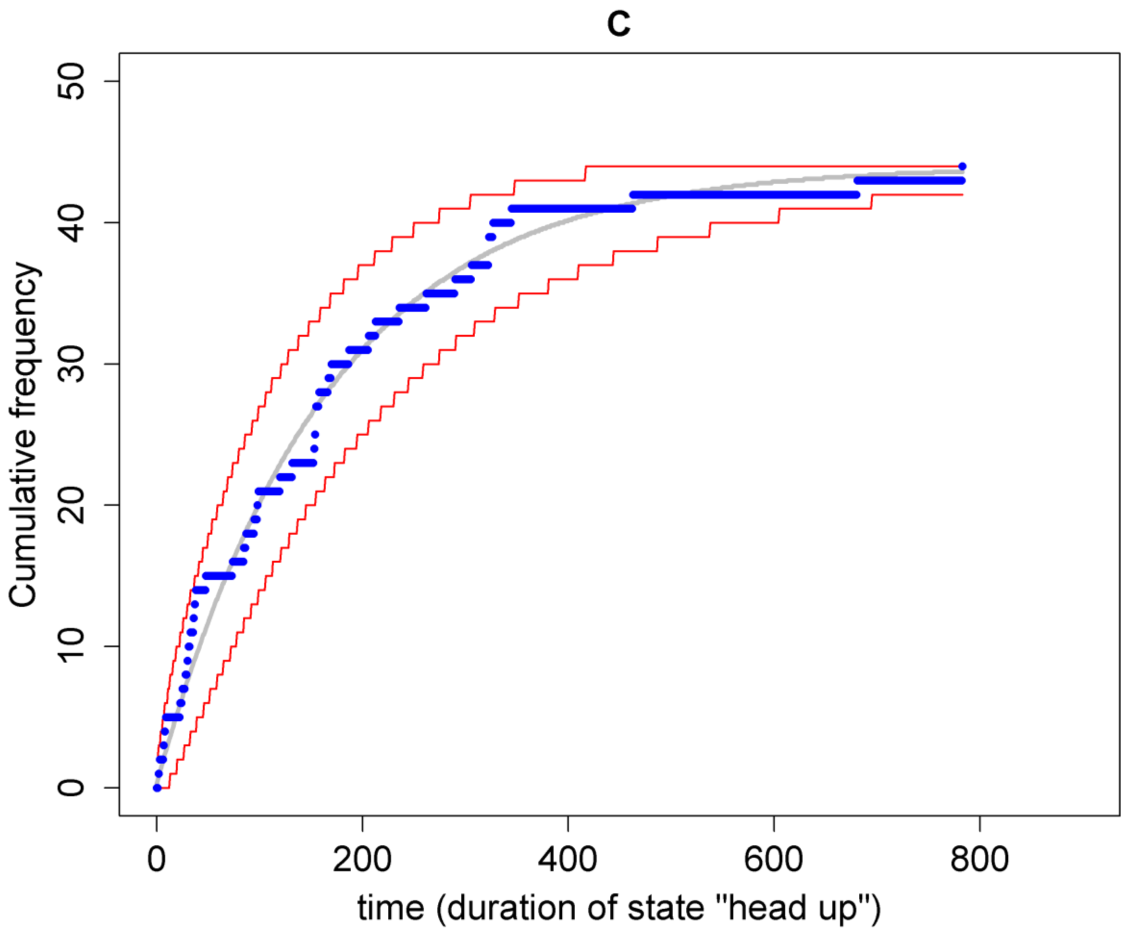
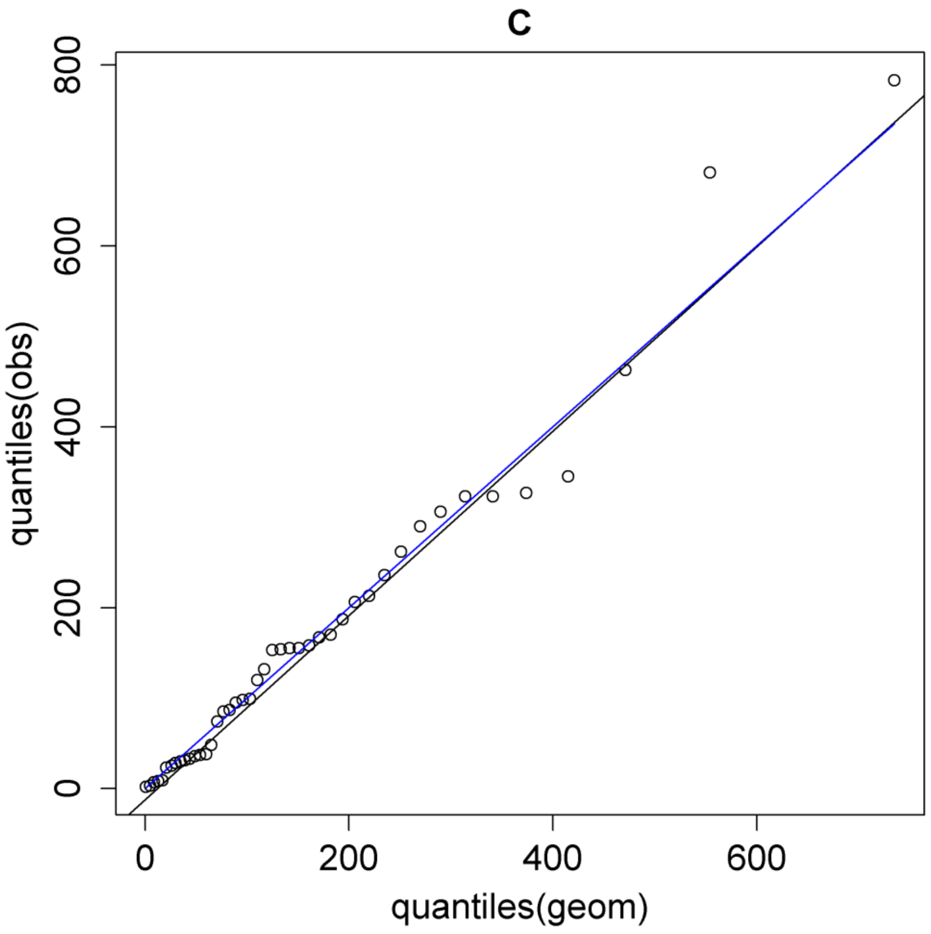


Fig. 1b QQ-plot



blue: cumulative frequency distribution of the observed N times
grey: fitted geometric distribution
red: 95% range of the fitted distribution, if N values are drawn

blue: expected line
black: qq line (1^{st} and 3^{rd} quartile)

The times for ***F*** cannot be explained by a geometric distribution. Might be a combination of two distributions, a geometric distr. and a second one that explains the short times.

Fig. 1c

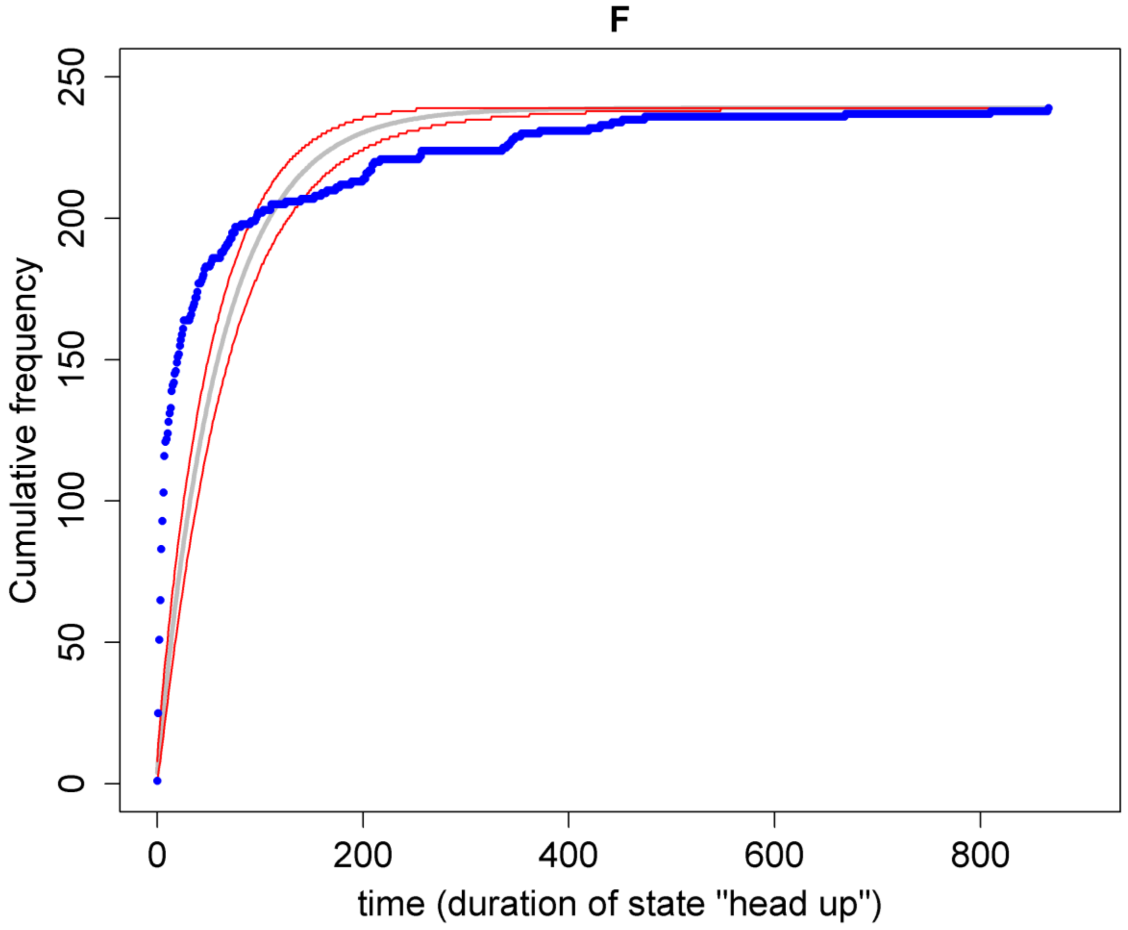
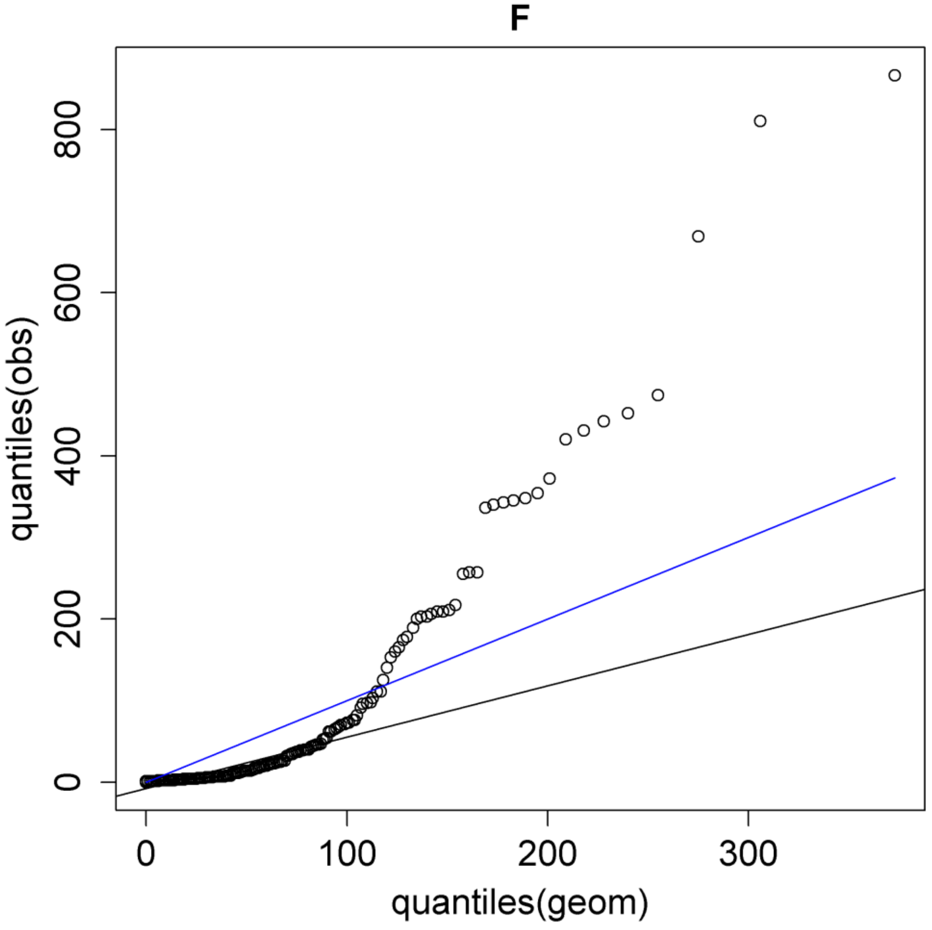


Fig. 1d QQ-plot



blue: cumulative frequency distribution of the observed *N* times
grey: fitted geometric distribution
red: 95% range of the fitted distribution, if *N* values are drawn

blue: expected line
black: qq line (1st and 3rd quartile)

The times for ***O*** cannot be explained by a geometric distribution. Deviation similar to *F*.

Fig. 1e

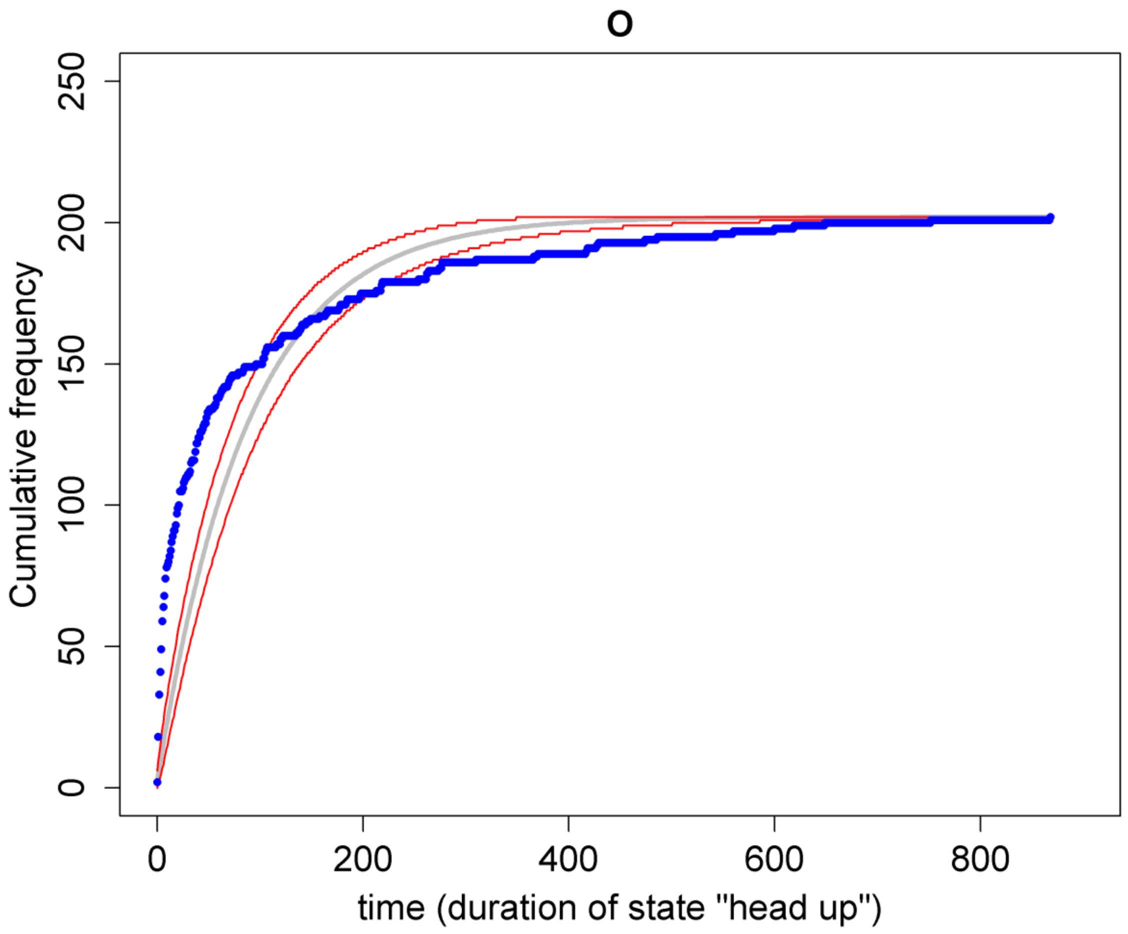
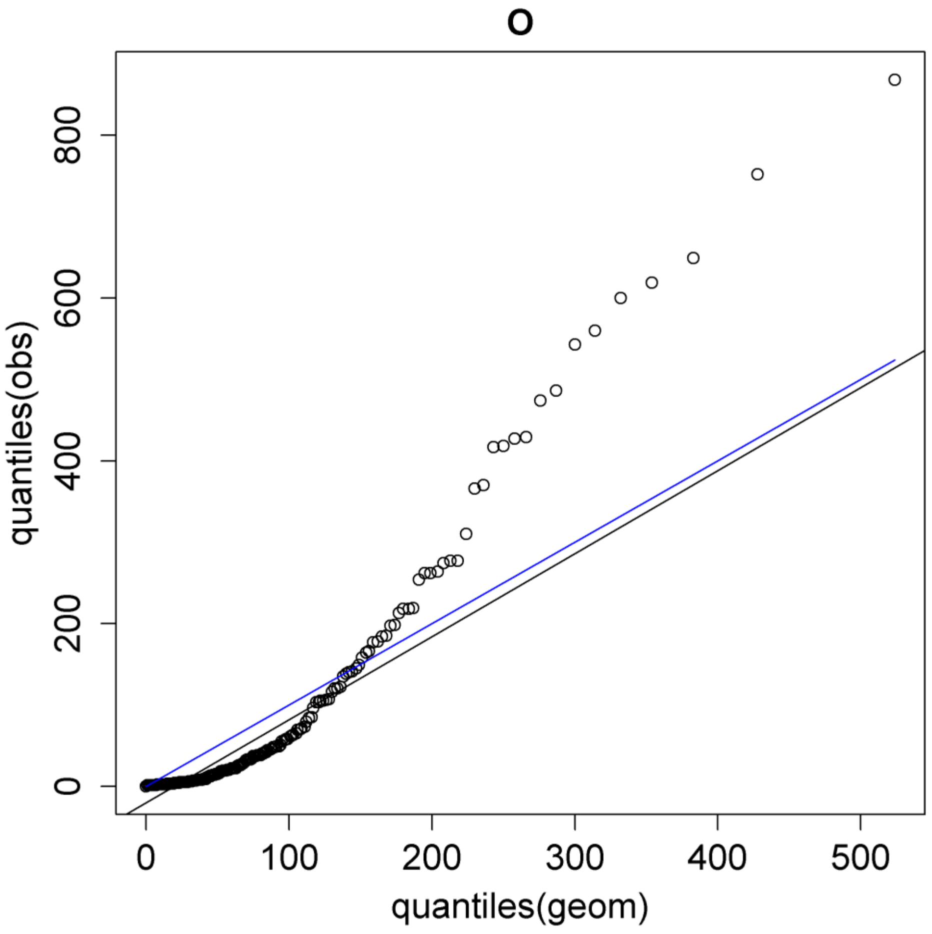


Fig. 1f QQ-plot



blue: cumulative frequency distribution of the observed *N* times
grey: fitted geometric distribution
red: 95% range of the fitted distribution, if *N* values are drawn

blue: expected line
black: qq line (1st and 3rd quartile)

If only those cases are taken into account, where the second event is “bury”, the times in each treatment can be explained by a geometric distribution with almost the same parameter value (*p* in the range 0.0053 – 0.0058). For the second event “swim” this is different. Here, only *C* follows a geom. distribution.

Fig. 2a

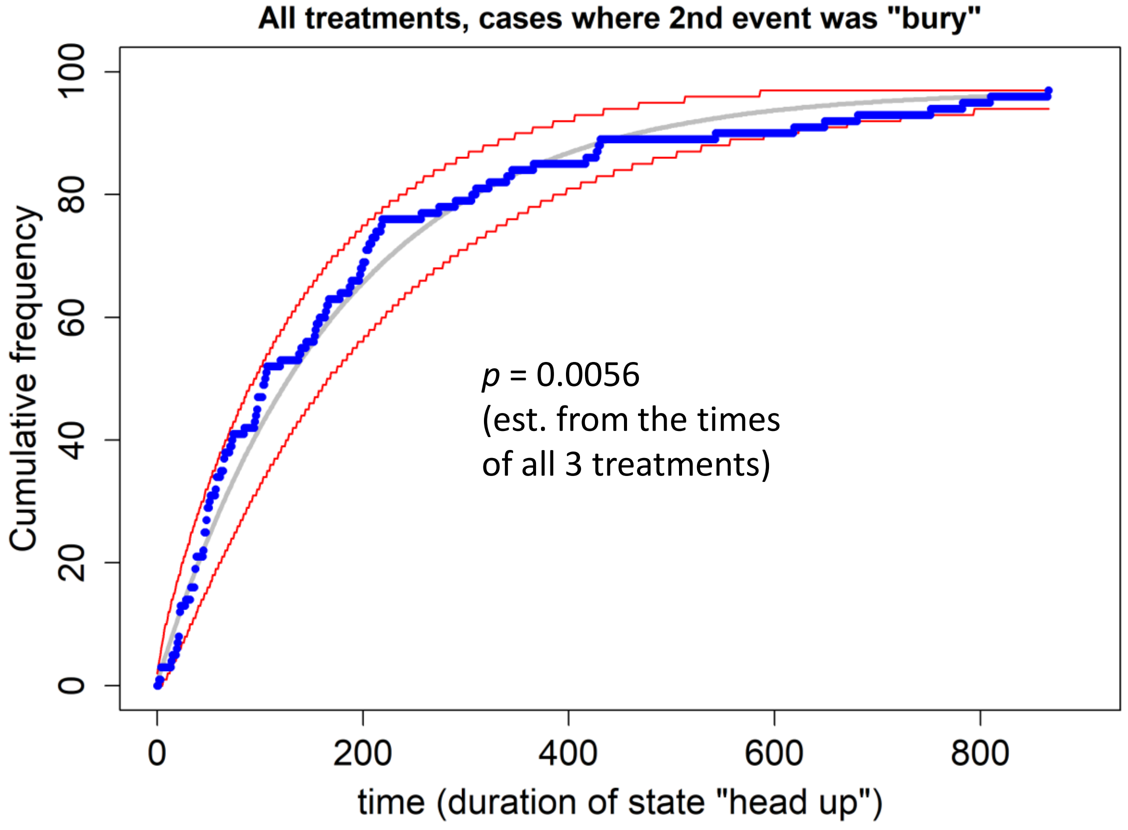
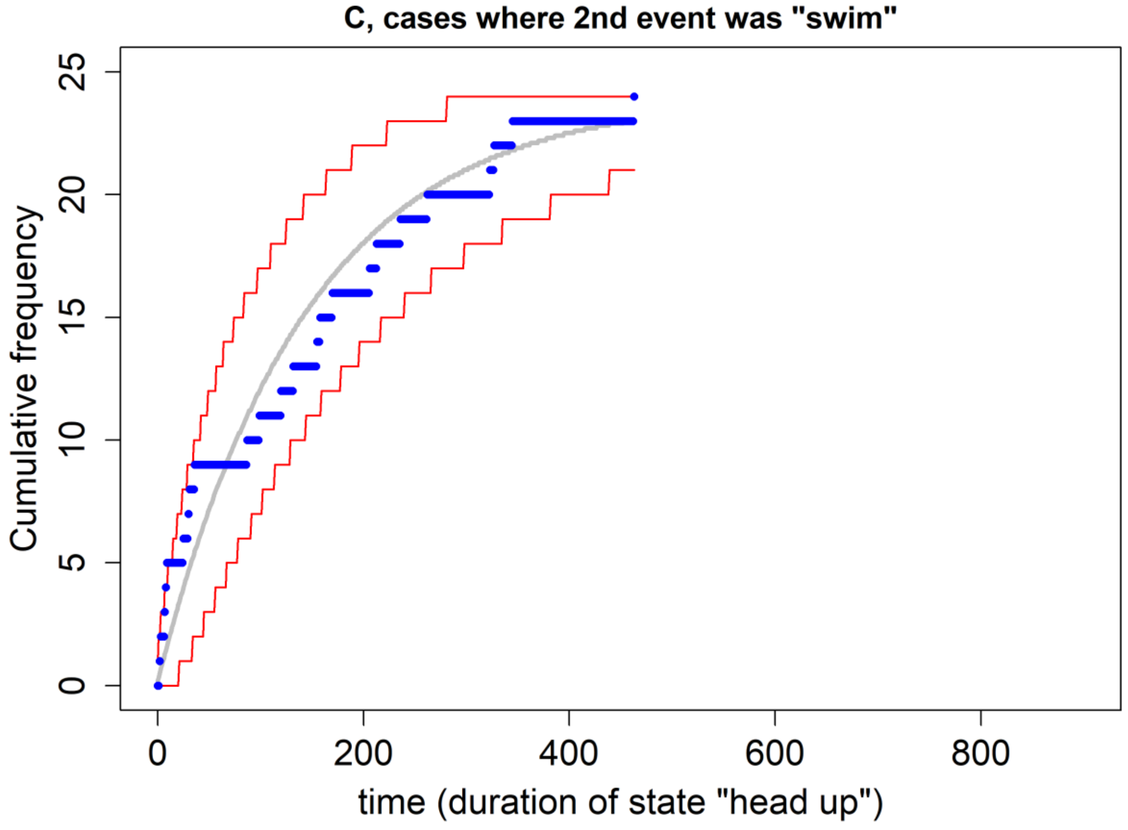


Fig. 2b



blue: cumulative frequency distribution of the observed *N* times
grey: fitted geometric distribution
red: 95% range of the fitted distribution, if *N* values are drawn

For the cases, where the second event was “swim”, the times in neither of the treatments *F* and *O* followed a geometric distribution.

Fig. 2c

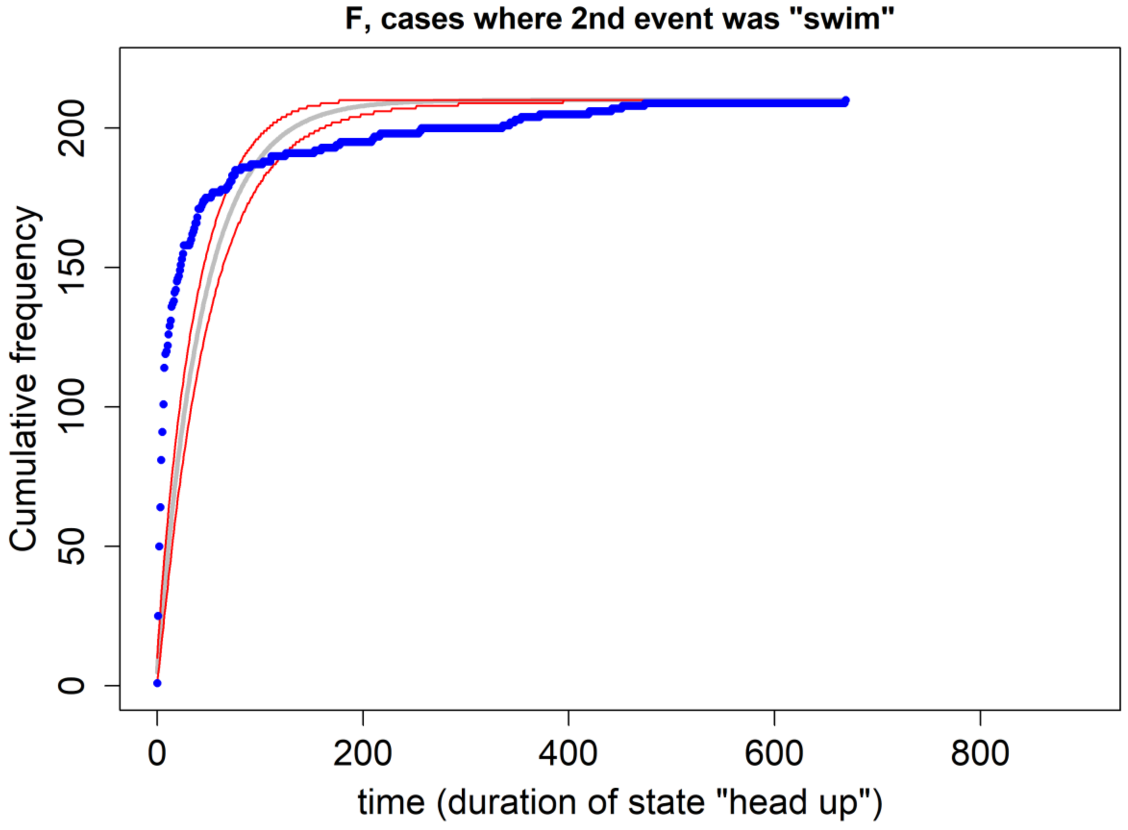
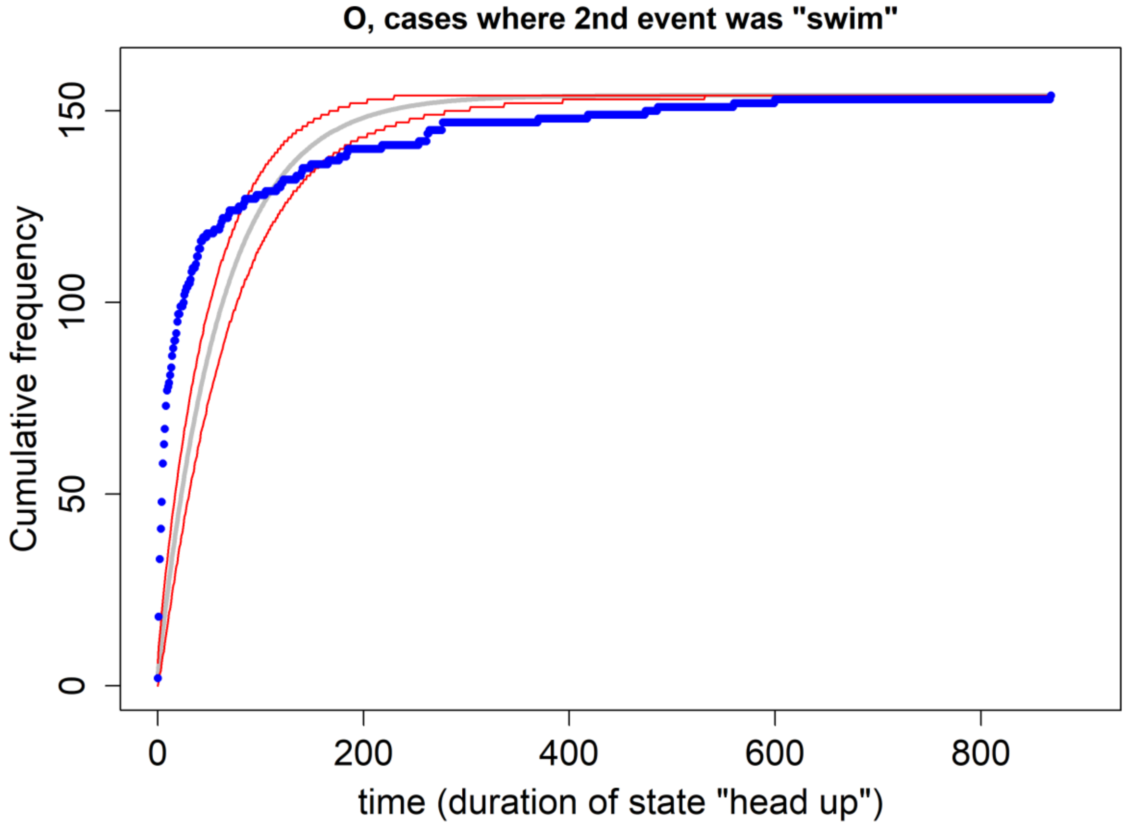


Fig. 2d

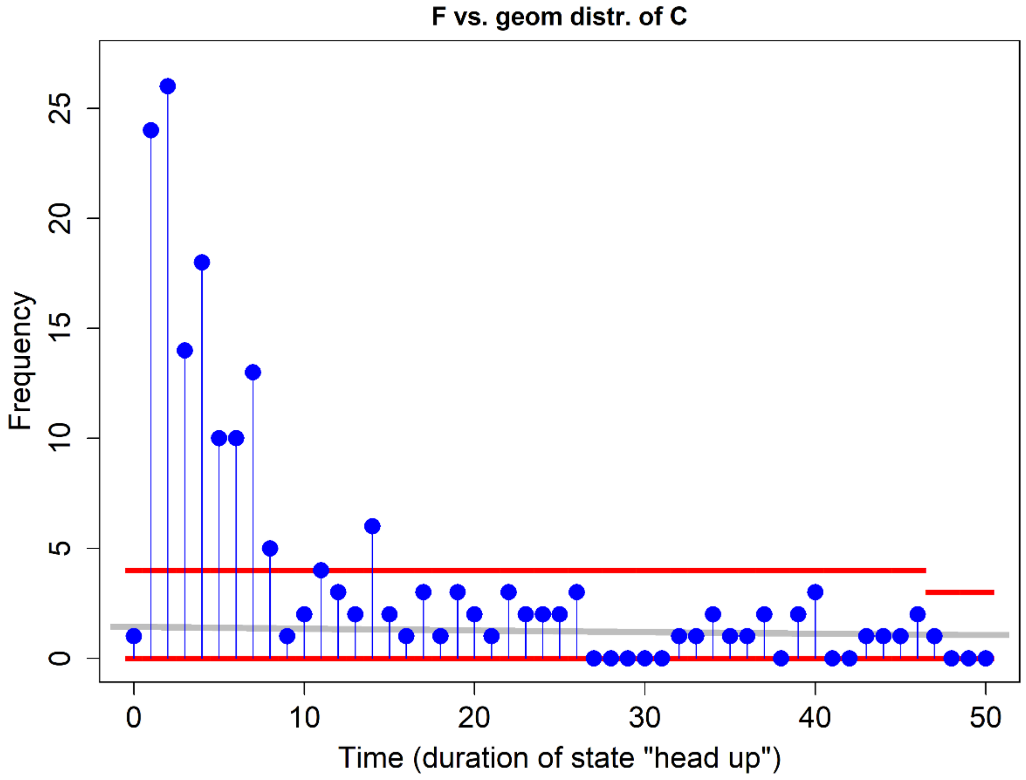


blue: cumulative frequency distribution of the observed *N* times
grey: fitted geometric distribution
red: 95% range of the fitted distribution, if *N* values are drawn

These results suggest that the distributions for *F* and *O* can be explained by a combination of a geometric distribution D_1 and an additional distribution D_2, where some individuals follow D_1 (e.g. the not so hungry/motivated ones) and the others D_2 (e.g. the hungry/motivated ones).

To separate these distributions, I made the assumption that D_1 is the distribution observed in the control treatment. I extracted the times "belonging" to D_2 from *F* and *O*, respectively, in the following way:

Fig. 3



From the frequency distribution of all times ≤ 50 s I repeatedly subtracted 1 from the most unlikely value, given the geom. distr. of *C* with parameter value p_C.

The process stopped, when the estimated value of *p* of the remaining set of times for this treatment (including the times > 50 s) was $\leq p_C$.

The removed times then formed the set of times belonging to D_2.

No information about the second event was used by this procedure.

blue: Frequency distribution of the observed *N* times, grey: fitted distribution of C (geometric, p=0.0061)
red: 95% range of the fitted distribution, if *N* values are drawn

After removing the specified times in the interval 0 s – 50 s from *F* and *O*, respectively, the times of both *F* and *O* followed the geometric distribution estimated from *C*.

Fig. 4a

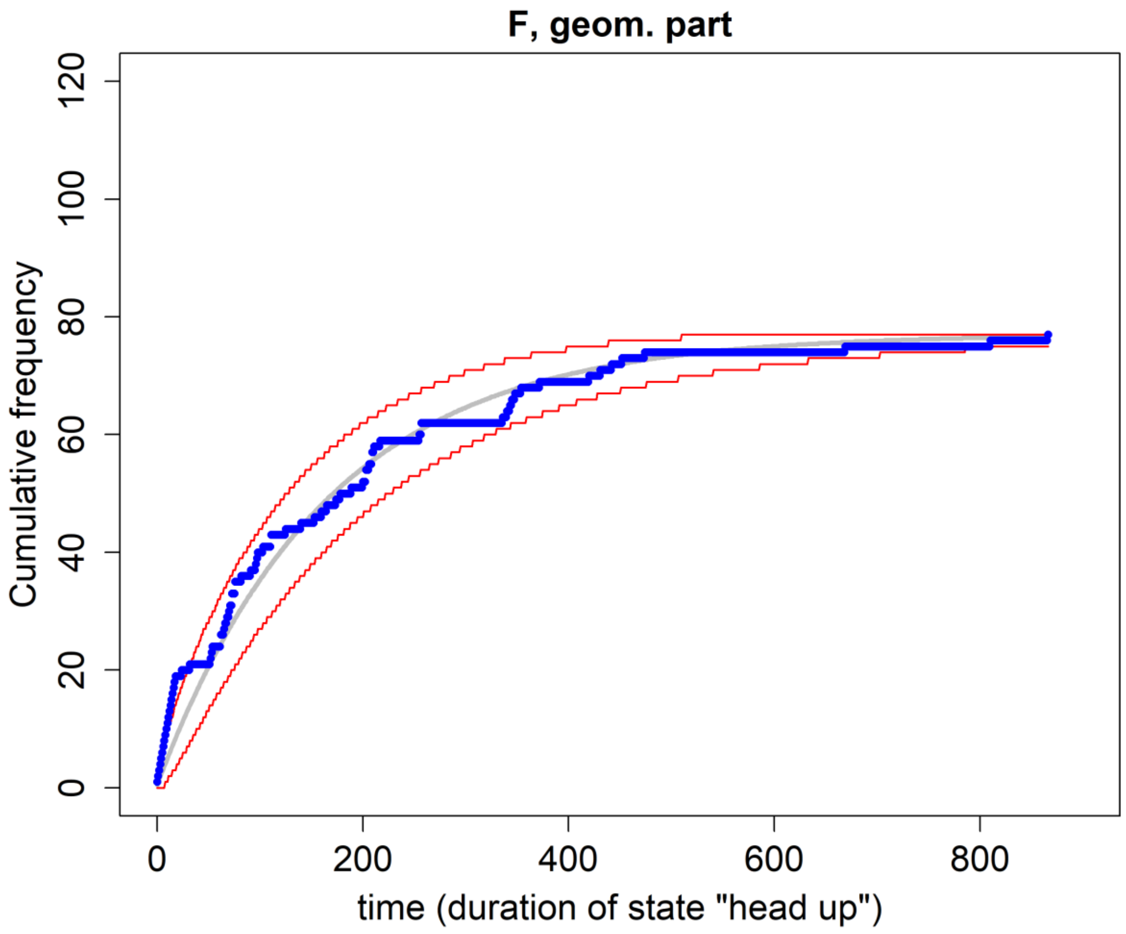
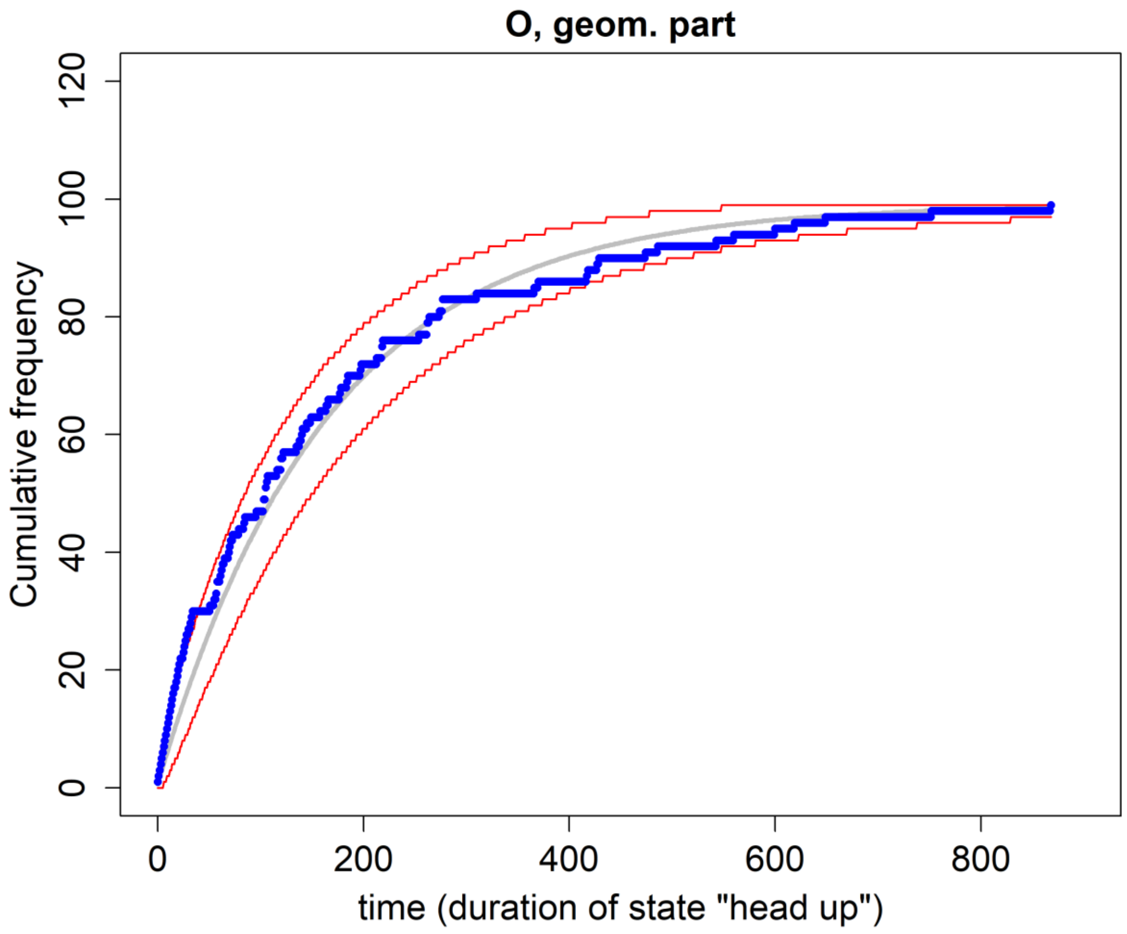


Fig. 4b



blue: cumulative frequency distribution of the observed *N* times minus the extracted times

grey: fitted geometric distribution with *p* est. from *C*

red: 95% range of the fitted distribution, if *N* values are drawn

The resulting distributions of extracted times look roughly lognormal with similar parameters (*F*: *meanlog* = 1.70, *sdlog* = 1.16; *O*: *meanlog* = 1.81 *sdlog* = 1.32). This means, in these cases the state “head up” seems to have a “typical” duration.
(The local maxima between the x values 3 and 4 are probably an artefact of the split procedure.)

Fig. 5a

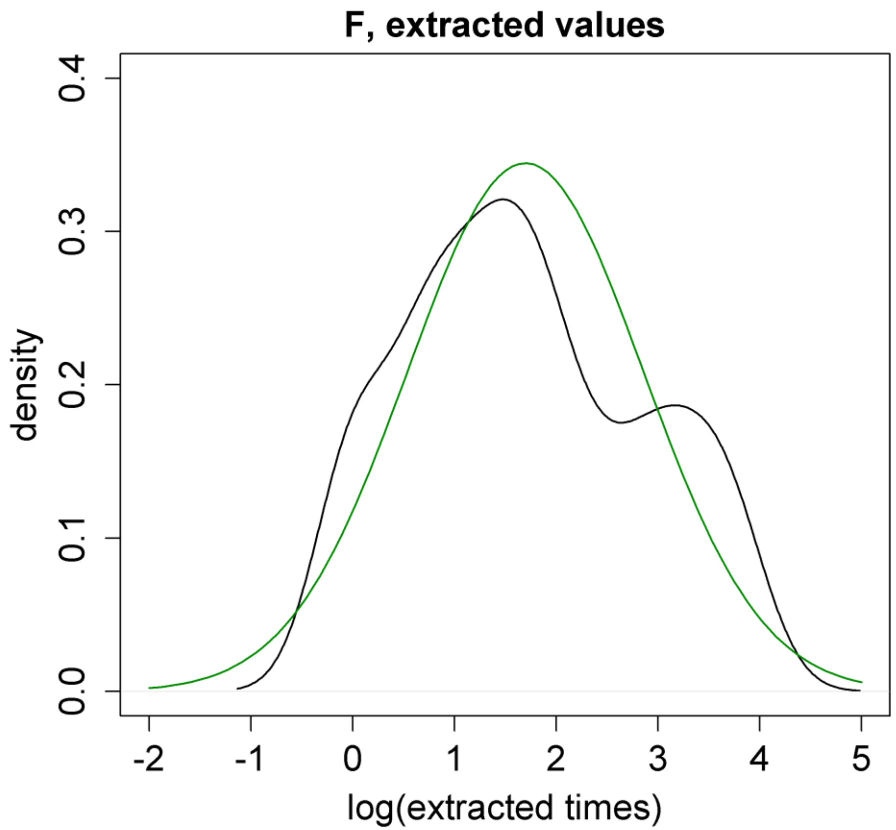
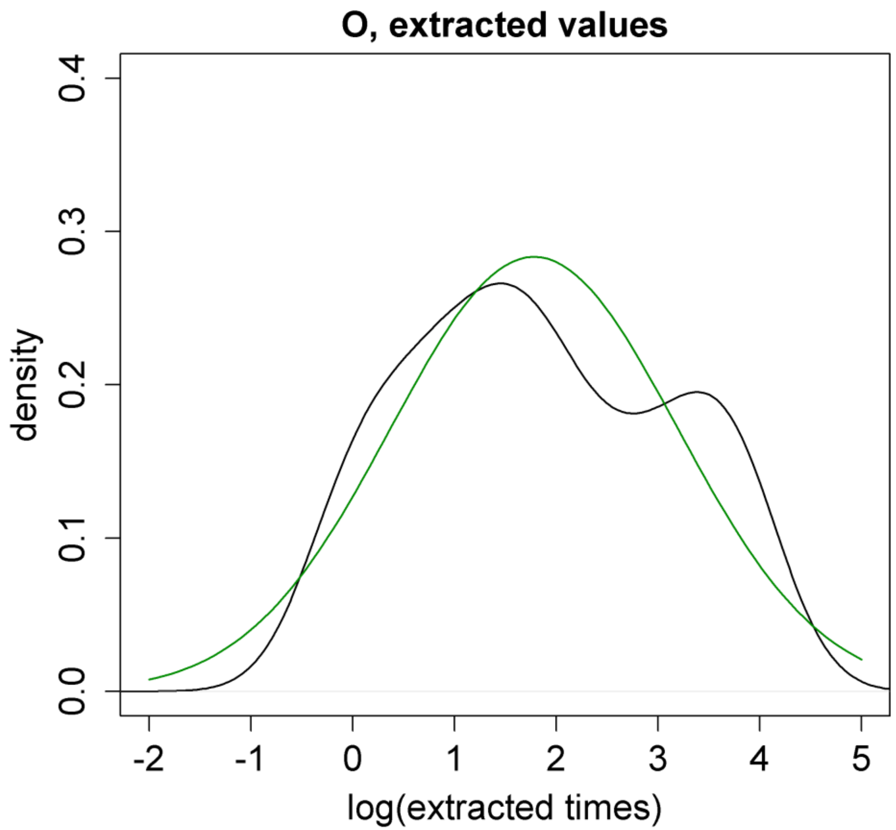


Fig. 5b



black: kernel density estimate of log values
green: fitted (log)normal distribution

By combining the distributions D_1 (geom. with param. *p* estimated from *C*) and D_2 (lognorm with param. *meanlog* and *sdlog* estimated from the combined extracted times of *F* and *O*), the distributions of times of the treatments F and O can be explained. The only values specific to *F* and *O*, respectively, are the numbers of individuals following each of the two distributions, which are different for the two treatments (determined by the extraction procedure).

Fig. 6a

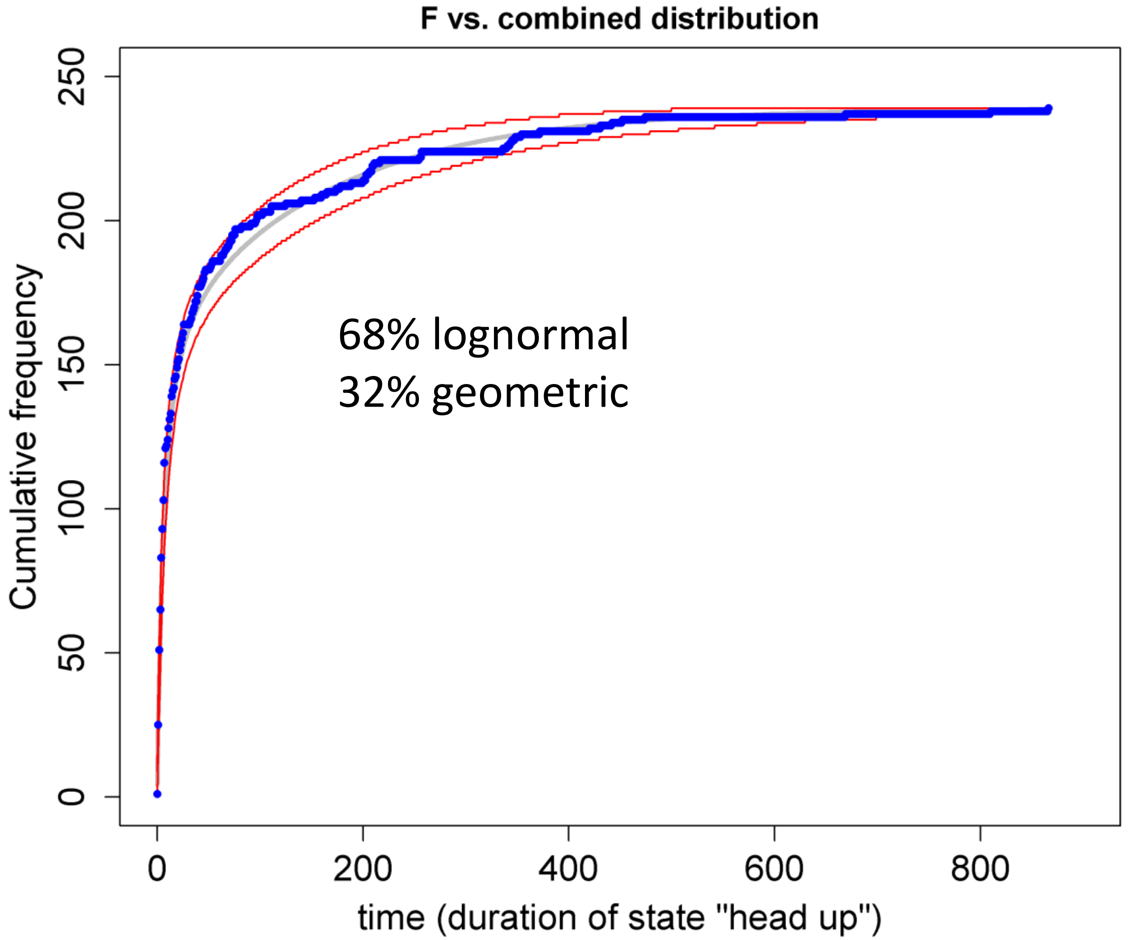
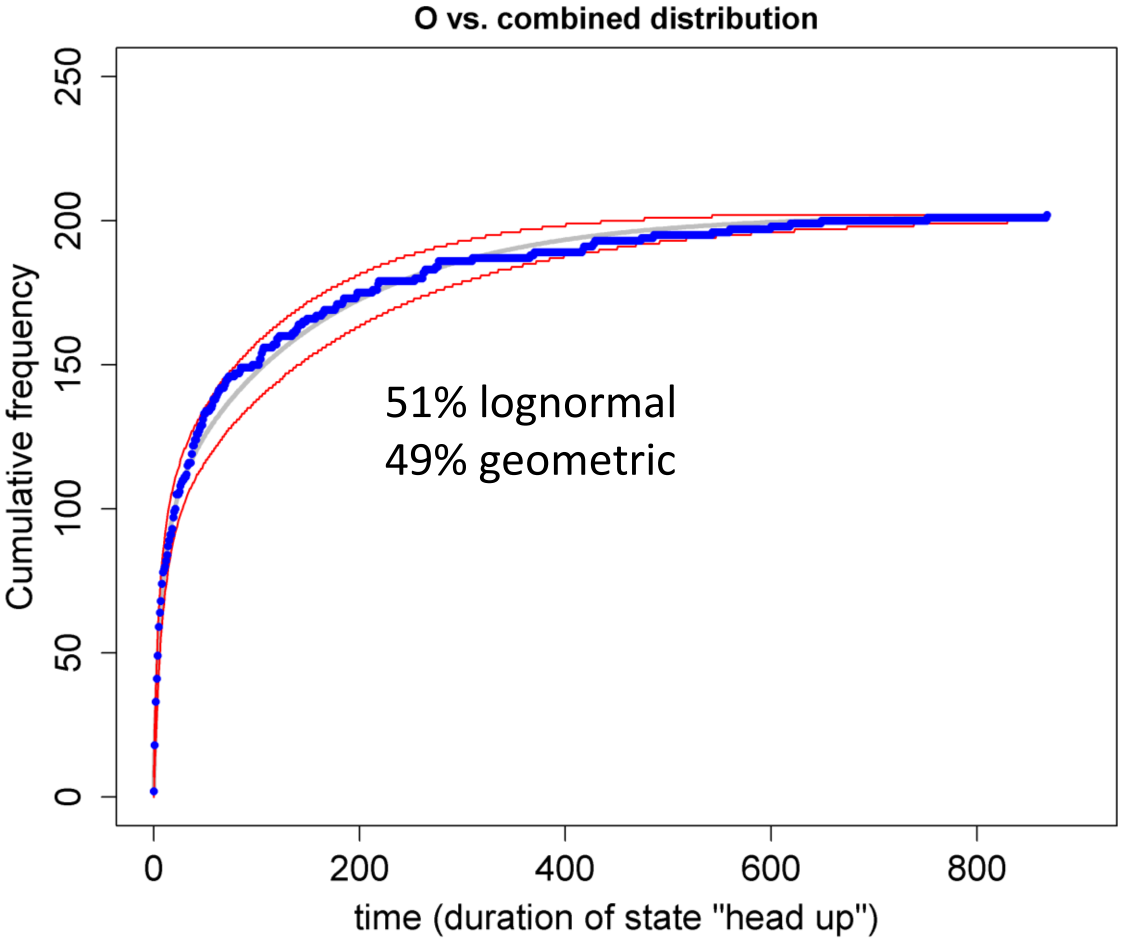


Fig. 6b

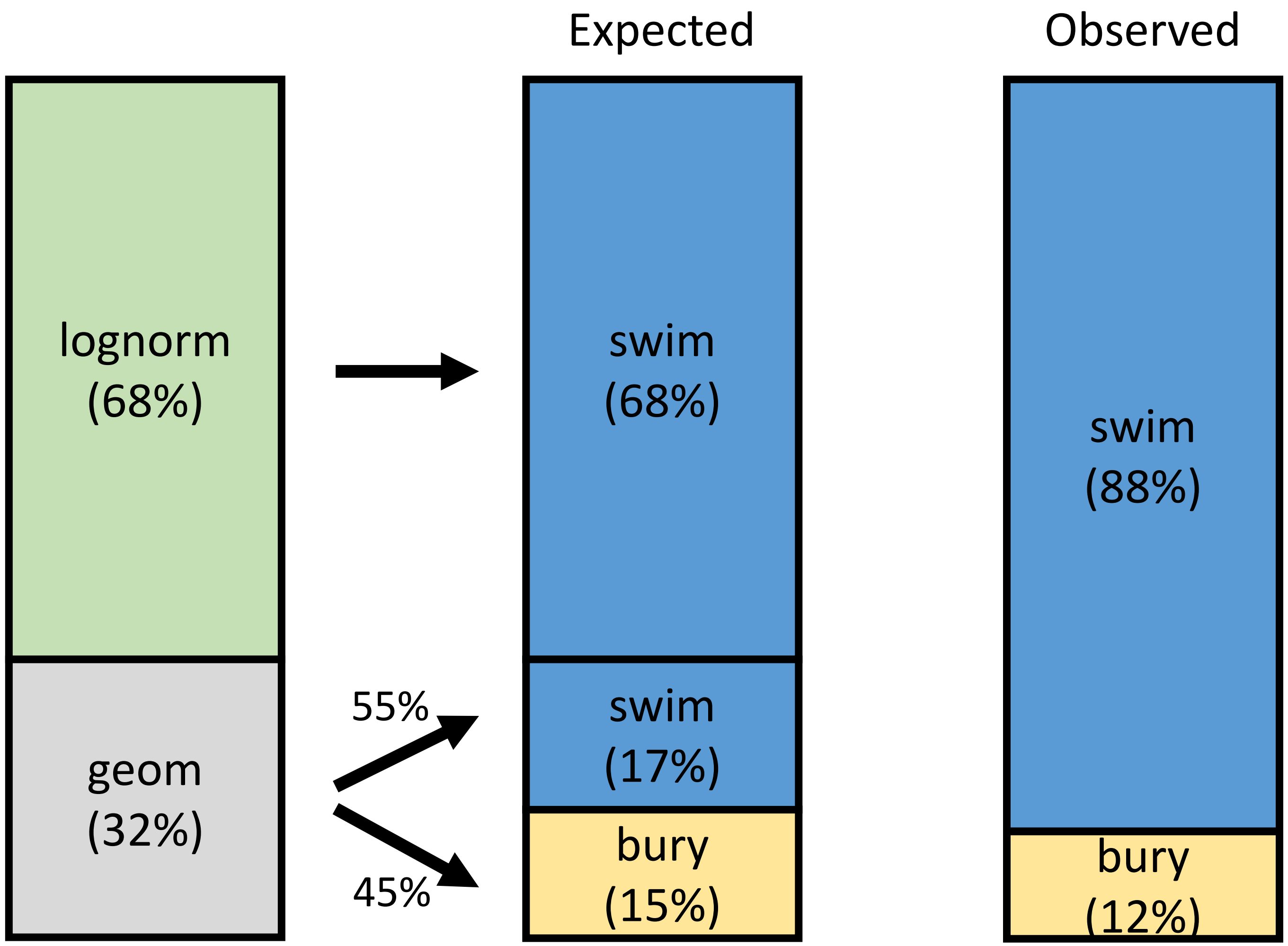


blue: cumulative frequency distribution of the observed *N* times, grey: fitted distribution (geometric + lognorm)

red: 95% range of the fitted distribution, if *N* values are drawn

Fig. 7a. Prediction of the percentages of “bury” and “swim” events based on the percentages of individuals following each of the two distributions.

Food treatment

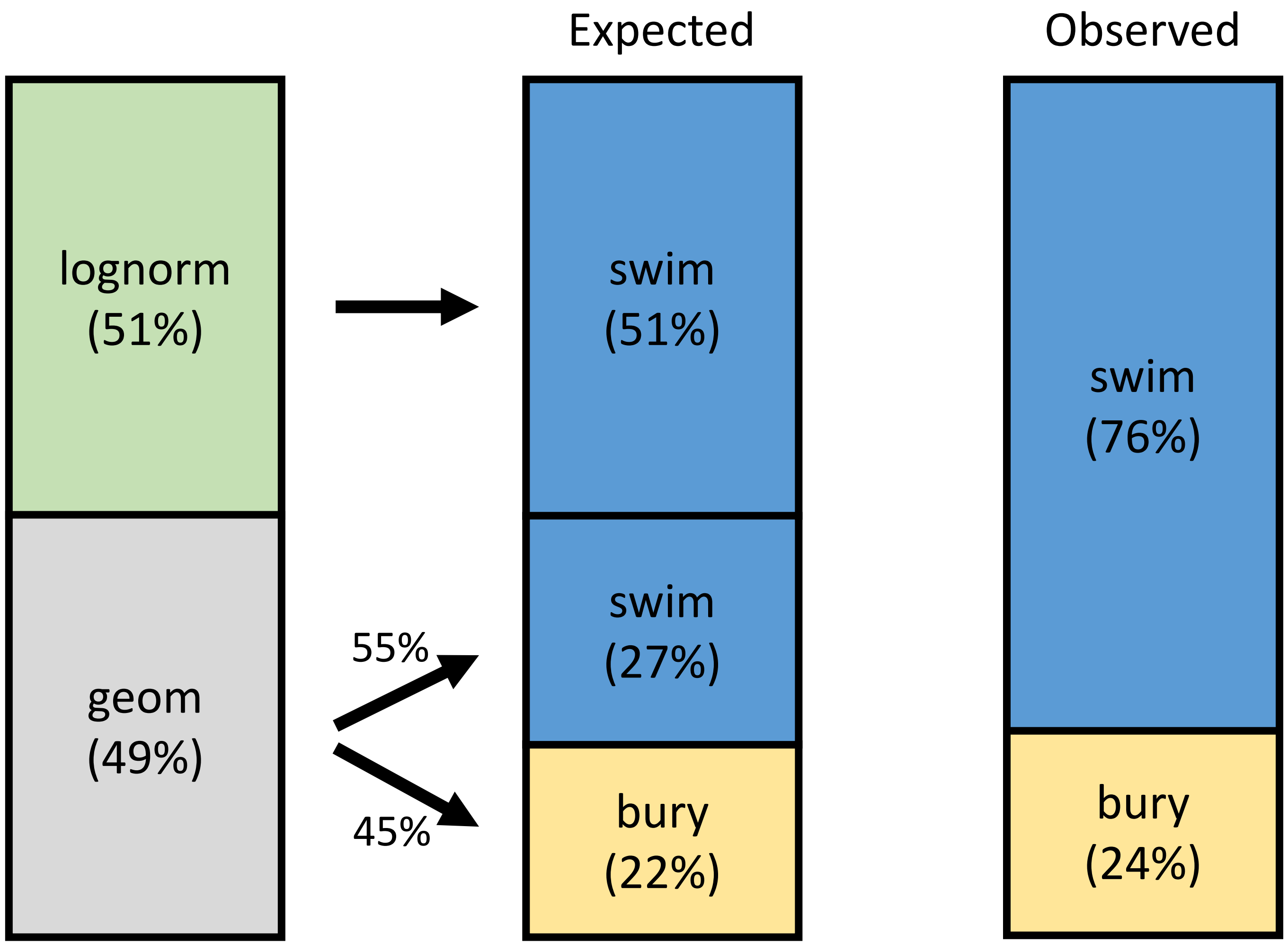


Expectation based on:

- individuals following lognorm will “swim”
- individuals following geom. decide exactly like individuals in the control treatment, i.e. 55% “swim”, 45% “bury”.

Fig. 7b. Prediction of the percentages of “bury” and “swim” events based on the percentages of individuals following each of the two distributions.

Olfactory treatment



Expectation based on:

- individuals following lognorm will “swim”
- individuals following geom. decide exactly like individuals in the control treatment, i.e. 55% “swim”, 45% “bury”.