

Supplementary Material

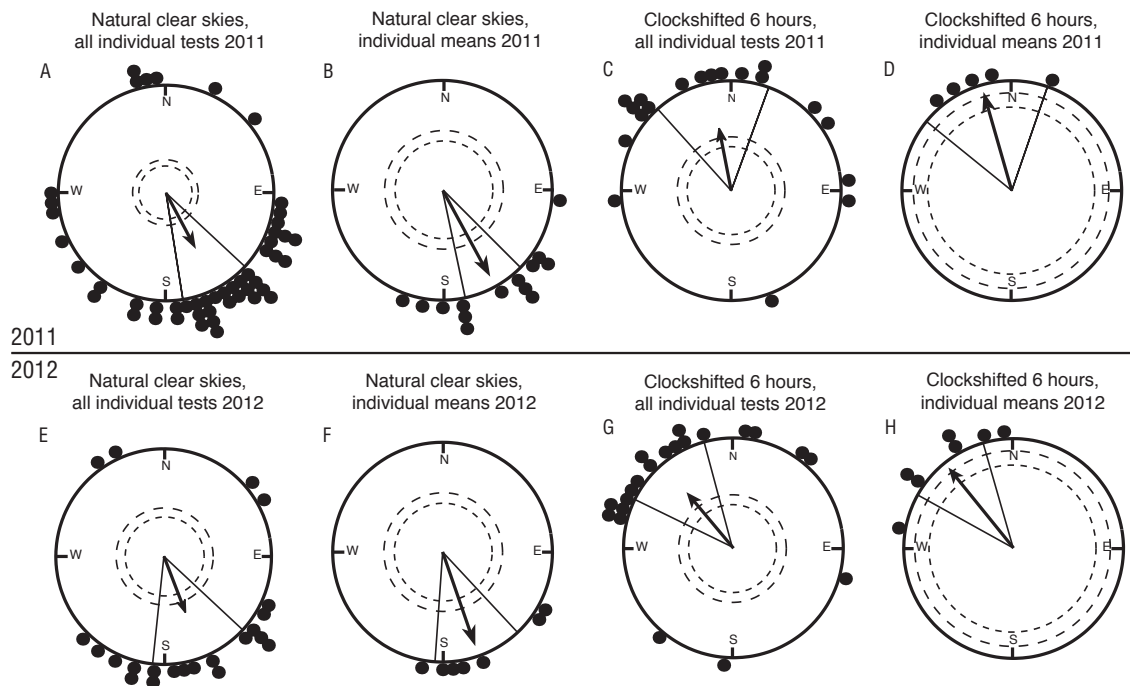


Figure S1. Inter- and intra-individual variation in orientation is similar in our settling stage *Ostorhinchus doederleini*. A: Forty-nine single tests under natural sunny skies with 14 just-settled *O. doederleini* tested in 2011 showed a clear orientation towards SSE, both when all the individual tests were considered (A: mean direction: 162° , $r=0.56$, $n=49$, $p<0.001$) and when only the second order means of each of the tested individuals were considered (B: mean direction: 162° , $r=0.88$, $n=14$, $p<0.001$). When five fish were clock-shifted 6 hours backwards, they turned their orientation by ca. 180° (C: all individual tests, mean direction: 359° , $r=0.58$, $n=19$, $p<0.001$; D: individual second order means, mean direction: 354° , $r=0.94$, $n=5$, $p<0.01$). Twenty-two single tests under natural sunny skies with 7 pre-settlement *O. doederleini* tested in 2012 also showed a clear orientation towards SSE, both when all the individual tests were considered (E: mean direction: 169° , $r=0.57$, $n=22$, $p<0.001$) and when only the second order means of each of the tested individuals were considered (F: mean direction: 171° , $r=0.91$, $n=7$, $p<0.001$). When all 7 fish were clock-shifted 6 hours backwards, they turned their orientation by ca. 180° (G: all individual tests, mean direction: 330° , $r=0.62$, $n=21$, $p<0.001$; H: individual second order means, mean direction: 331° , $r=0.92$, $n=7$, $p<0.001$). Notice that the 95% confidence intervals (lines flanking the group mean vector) in our experiments remained almost identical regardless whether all tests or individual means are depicted (compare Fig. S1A with S1B, S1C with S1D, S1E with S1F, and S1G with S1H). This is only to be expected if the intra- and inter-individual variation in orientation is very similar for our fish. Each dot at the circle periphery indicates the mean orientations observed in each of the individual tests done under the given condition (A, C, E, G) or the mean orientation chosen by each individual fish based on the second order average of all tests of the given fish in the given condition (B, D, F, H). Arrows indicate the group mean vectors. Inner and outer dashed circles indicate the radius of the group mean vector needed for significance according to the Rayleigh Test ($p<0.05$ and $p<0.01$, respectively).

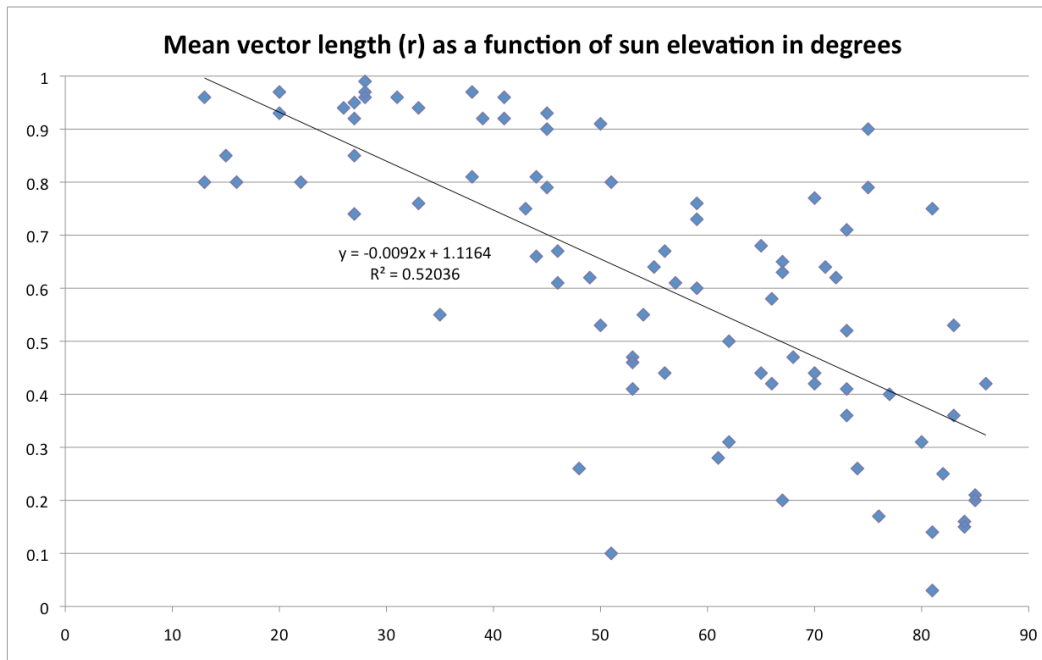


Figure S2. The lower the sun elevation, the better the fish were able to keep their chosen heading. The y-axis indicates the r-value for each individual test (the length of the mean vector of the 40 recorded single direction in a given single test). The x-axis indicates the sun elevation in degrees. There is a highly significant negative correlation between the r-value and the sun elevation, which means that the higher the sun elevation is, the poorer the fish are able to keep a chosen direction.

Orientation of the non-clock-shifted fish relative to the observer

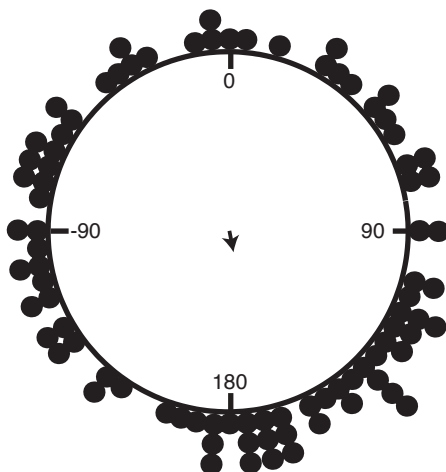


Figure S3. Evidence for no significant observer bias. The observer's position is defined as 0 degrees and the orientation of each individual fish in the non-clock-shifted condition is indicated by the dots at the circle periphery (2011 and 2012 fish combined). Thus, a point in 0 degrees would mean that the fish oriented towards the observer and a point in 180 degrees would mean that the fish oriented away from the observer. The distribution is random (mean direction 169° , $r=0.12$, $n=87$, n.s.). For description of the circular diagram, see legend to Figure S1.

Table S1. Orientation results for non-clock-shifted larvae. “Time tested” indicates the start of the given 20 minute test. “r” is the length of the mean vector calculated from the 40 individual directions recorded during the individual test. “p” is the p-value resulting from a Rayleigh Test. However, since each individually recorded direction is unlikely to be completely independent, to be conservative, we demanded a $p < 0.001$ for inclusion of the direction in the circular diagrams (Figure 1A-D and Figure S1).

| Table S1. | | | | | | | | | |
|-----------|---------------------|-------------|---|---|------|-------|-------------------------------------|------------------------|---|
| Fish ID | Date tested (D.M.Y) | Time tested | Orientation relative to magnetic North in degrees | Orientation relative to geographic North in degrees | r | "p" | Sun height above horizon in degrees | Sun azimuth in degrees | Comment (NS = considered non-significant) |
| HM4 | 20.1.2011 | 10:17 | 119 | 109 | 0.63 | 0.001 | 67 | 86 | |
| HM5 | 20.1.2011 | 12:00 | 187 | 177 | 0.42 | 0.001 | 86 | 331 | |
| HM2 | 20.1.2011 | 13:07 | 169 | 159 | 0.79 | 0.001 | 75 | 279 | |
| HM1 | 20.1.2011 | 15:34 | 154 | 144 | 0.96 | 0.001 | 41 | 263 | |
| HM3 | 20.1.2011 | 16:34 | 180 | 170 | 0.99 | 0.001 | 28 | 259 | |
| HM4 | 21.1.2011 | 08:51 | 132 | 122 | 0.67 | 0.001 | 46 | 95 | |
| HM2 | 21.1.2011 | 09:22 | 3 | 353 | 0.47 | 0.001 | 53 | 93 | |
| HM5 | 21.1.2011 | 12:36 | 256 | 246 | 0.75 | 0.001 | 81 | 293 | |
| HM1 | 21.1.2011 | 13:10 | 201 | 191 | 0.26 | 0.07 | 74 | 279 | NS |
| HM3 | 21.1.2011 | 15:03 | 29 | 19 | 0.26 | 0.06 | 48 | 266 | NS |
| HM3 | 22.1.2011 | 8:44 | 107 | 97 | 0.81 | 0.001 | 44 | 95 | |
| HM1 | 22.1.2011 | 9:17 | 326 | 316 | 0.10 | 0.68 | 51 | 93 | NS |
| HM5 | 22.1.2011 | 9:48 | 128 | 118 | 0.60 | 0.001 | 59 | 90 | |
| HM2 | 22.1.2011 | 10:52 | 149 | 139 | 0.71 | 0.001 | 73 | 81 | |
| HM4 | 22.1.2011 | 13:48 | 270 | 260 | 0.68 | 0.001 | 65 | 274 | |
| HM3 | 22.1.2011 | 15:49 | 273 | 263 | 0.81 | 0.001 | 38 | 263 | |
| HM1 | 22.1.2011 | 16:38 | 147 | 137 | 0.85 | 0.001 | 27 | 259 | |
| HM1 | 23.1.2011 | 8:42 | 147 | 137 | 0.75 | 0.001 | 43 | 95 | |
| HM10 | 24.1.2011 | 10:43 | 129 | 119 | 0.64 | 0.001 | 71 | 81 | |
| HM11 | 24.1.2011 | 11:11 | 121 | 111 | 0.40 | 0.001 | 77 | 74 | |
| HM12 | 24.1.2011 | 11:39 | 201 | 191 | 0.36 | 0.01 | 83 | 55 | NS |
| HM13 | 24.1.2011 | 14:04 | 268 | 258 | 0.31 | 0.02 | 62 | 273 | NS |
| HM9 | 24.1.2011 | 14:43 | 203 | 193 | 0.46 | 0.001 | 53 | 269 | |
| HM12 | 25.1.2011 | 14:39 | 117 | 107 | 0.55 | 0.001 | 54 | 270 | |
| HM13 | 25.1.2011 | 15:11 | 281 | 271 | 0.61 | 0.001 | 46 | 267 | |
| HM9 | 25.1.2011 | 15:50 | 355 | 345 | 0.97 | 0.001 | 38 | 263 | |
| HM10 | 25.1.2011 | 16:17 | 174 | 164 | 0.96 | 0.001 | 31 | 261 | |
| HM11 | 25.1.2011 | 16:43 | 357 | 347 | 0.94 | 0.001 | 26 | 259 | |
| HM10 | 26.1.2011 | 10:24 | 37 | 27 | 0.42 | 0.001 | 66 | 84 | |
| HM12 | 26.1.2011 | 10:52 | 61 | 51 | 0.36 | 0.001 | 73 | 78 | |
| HM13 | 26.1.2011 | 11:33 | 338 | 328 | 0.14 | 0.44 | 81 | 59 | NS |
| HM11 | 26.1.2011 | 12:00 | 258 | 248 | 0.21 | 0.18 | 85 | 12 | NS |
| HM9 | 26.1.2011 | 12:26 | 224 | 214 | 0.53 | 0.001 | 83 | 311 | |
| HM11 | 26.1.2011 | 15:33 | 359 | 349 | 0.92 | 0.001 | 41 | 265 | |
| HM13 | 26.1.2011 | 16:02 | 160/340 | - | 0.55 | 0.001 | 35 | 263 | bimodal |
| HM9 | 26.1.2011 | 16:36 | 186 | 176 | 0.92 | 0.001 | 27 | 260 | |
| HM12 | 26.1.2011 | 17:30 | 163 | 153 | 0.85 | 0.001 | 15 | 256 | |
| HM9 | 27.1.2011 | 11:08 | 317 | 307 | 0.17 | 0.3 | 76 | 72 | NS |
| HM12 | 27.1.2011 | 11:35 | 188 | 178 | 0.25 | 0.09 | 82 | 56 | NS |
| HM10 | 27.1.2011 | 12:02 | 165 | 155 | 0.20 | 0.19 | 85 | 6 | NS |
| HM10 | 27.1.2011 | 16:34 | 161 | 151 | 0.97 | 0.001 | 28 | 261 | |

| | | | | | | | | | |
|-------|-----------|-------|-----|-----|------|-------|----|-----|----|
| HM13 | 28.1.2011 | 16:30 | 171 | 161 | 0.96 | 0.001 | 28 | 261 | |
| HM20 | 28.1.2011 | 16:58 | 207 | 197 | 0.80 | 0.001 | 22 | 259 | |
| HM19 | 28.1.2011 | 17:26 | 171 | 161 | 0.80 | 0.001 | 16 | 257 | |
| HM19 | 29.1.2011 | 11:31 | 193 | 183 | 0.31 | 0.02 | 80 | 57 | NS |
| HM20 | 29.1.2011 | 11:55 | 97 | 87 | 0.15 | 0.42 | 84 | 23 | NS |
| HM13 | 29.1.2011 | 12:18 | 307 | 297 | 0.16 | 0.37 | 84 | 330 | NS |
| HM19 | 29.1.2011 | 13:16 | 224 | 214 | 0.52 | 0.001 | 73 | 285 | |
| HM20 | 29.1.2011 | 13:45 | 241 | 231 | 0.58 | 0.001 | 66 | 278 | |
| HM9 | 29.1.2011 | 14:55 | 194 | 184 | 0.91 | 0.001 | 50 | 270 | |
| HM11 | 29.1.2011 | 15:18 | 174 | 164 | 0.93 | 0.001 | 45 | 268 | |
| HM12 | 30.1.2011 | 9:12 | 160 | 150 | 0.62 | 0.001 | 49 | 90 | |
| HM19 | 30.1.2011 | 9:45 | 147 | 137 | 0.61 | 0.001 | 57 | 87 | |
| HM13 | 30.1.2011 | 10:33 | 124 | 114 | 0.47 | 0.001 | 68 | 80 | |
| HM22 | 31.1.2011 | 11:56 | 18 | 8 | 0.03 | 0.96 | 81 | 50 | NS |
| HM21 | 31.1.2011 | 13:11 | 169 | 159 | 0.41 | 0.001 | 73 | 288 | |
| HM20 | 31.1.2011 | 13:40 | 121 | 111 | 0.20 | 0.22 | 67 | 281 | NS |
| HM22 | 31.1.2011 | 14:28 | 177 | 167 | 0.67 | 0.001 | 56 | 273 | |
| HM12 | 31.1.2011 | 14:51 | 147 | 137 | 0.80 | 0.001 | 51 | 271 | |
| HM20 | 31.1.2011 | 15:22 | 153 | 143 | 0.66 | 0.001 | 44 | 268 | |
| HM11 | 1.2.2011 | 8:55 | 148 | 138 | 0.90 | 0.001 | 45 | 91 | |
| HM22 | 1.2.2011 | 9:54 | 152 | 142 | 0.73 | 0.001 | 59 | 85 | |
| HM21 | 1.2.2011 | 14:02 | 109 | 99 | 0.50 | 0.001 | 62 | 278 | |
| HM22 | 1.2.2011 | 14:32 | 121 | 111 | 0.64 | 0.001 | 55 | 273 | |
| HM21 | 1.2.2011 | 15:15 | 195 | 185 | 0.79 | 0.001 | 45 | 269 | |
| OTI20 | 20.1.2012 | 10:37 | 193 | 183 | 0.77 | 0.001 | 70 | 85 | |
| OTI21 | 20.1.2012 | 11:01 | 138 | 128 | 0.90 | 0.001 | 75 | 80 | |
| OTI22 | 20.1.2012 | 13:17 | 203 | 193 | 0.62 | 0.001 | 72 | 277 | |
| OTI23 | 20.1.2012 | 13:42 | 333 | 323 | 0.65 | 0.001 | 67 | 273 | |
| OTI24 | 20.1.2012 | 14:05 | 180 | 170 | 0.28 | 0.04 | 61 | 271 | NS |
| OTI20 | 20.1.2012 | 14:30 | 71 | 61 | 0.44 | 0.001 | 56 | 268 | |
| OTI21 | 20.1.2012 | 14:53 | 180 | 170 | 0.53 | 0.001 | 50 | 266 | |
| OTI22 | 20.1.2012 | 15:18 | 194 | 184 | 0.79 | 0.001 | 45 | 264 | |
| OTI23 | 20.1.2012 | 15:42 | 213 | 203 | 0.92 | 0.001 | 39 | 262 | |
| OTI24 | 20.1.2012 | 16:08 | 142 | 132 | 0.94 | 0.001 | 33 | 261 | |
| OTI20 | 20.1.2012 | 16:08 | 129 | 119 | 0.76 | 0.001 | 33 | 261 | |
| OTI21 | 20.1.2012 | 16:37 | 237 | 227 | 0.95 | 0.001 | 27 | 258 | |
| OTI22 | 20.1.2012 | 16:37 | 60 | 50 | 0.74 | 0.001 | 27 | 258 | |
| OTI24 | 20.1.2012 | 17:09 | 126 | 116 | 0.93 | 0.001 | 20 | 256 | |
| OTI23 | 20.1.2012 | 17:09 | 173 | 163 | 0.97 | 0.001 | 20 | 256 | |
| OTI23 | 20.1.2012 | 17:38 | 147 | 137 | 0.80 | 0.001 | 13 | 254 | |
| OTI24 | 20.1.2012 | 17:38 | 138 | 128 | 0.96 | 0.001 | 13 | 254 | |
| OTI26 | 21.1.2012 | 9:23 | 166 | 156 | 0.47 | 0.001 | 53 | 93 | |
| OTI25 | 21.1.2012 | 9:23 | 164 | 154 | 0.41 | 0.001 | 53 | 93 | |
| OTI26 | 21.1.2012 | 9:50 | 206 | 196 | 0.76 | 0.001 | 59 | 90 | |
| OTI25 | 21.1.2012 | 10:14 | 184 | 174 | 0.44 | 0.001 | 65 | 88 | |
| OTI26 | 21.1.2012 | 10:38 | 225 | 215 | 0.42 | 0.001 | 70 | 84 | |
| OTI25 | 21.1.2012 | 10:38 | 346 | 336 | 0.44 | 0.001 | 70 | 84 | |

Table S2. Mean vector lengths (r) in individual orientation tests performed in different time of day intervals for the non-clock-shifted larvae tested in 2011. Data originates from Table S1 (column 6). The mean time for any given 20 min test (i.e. “Time tested” + 10 min) decided in which time interval the test was considered. The third column in this table gives the mean r-value for each individual fish that was tested in a given time interval, and these values were used in the calculations of the means and standard deviations as indicated on Figure 1F and for the subsequent ANOVA.

| Table S2 | | |
|--------------------|-------------------------|---------------------------------|
| Fish ID | r-value in single tests | Mean r-value used for Figure 1F |
| 8:00-9:45 | | |
| HM1 | 0.10 | 0.43 |
| | 0.75 | |
| HM2 | 0.47 | 0.47 |
| HM3 | 0.81 | 0.81 |
| HM4 | 0.67 | 0.67 |
| HM11 | 0.90 | 0.90 |
| HM12 | 0.62 | 0.62 |
| 9:45-11:15 | | |
| HM2 | 0.71 | 0.71 |
| HM4 | 0.63 | 0.63 |
| HM5 | 0.60 | 0.60 |
| HM10 | 0.64 | 0.53 |
| | 0.42 | |
| HM12 | 0.36 | 0.36 |
| HM13 | 0.47 | 0.47 |
| HM19 | 0.61 | 0.61 |
| HM22 | 0.73 | 0.73 |
| 11:15-12:45 | | |
| HM5 | 0.42 | 0.42 |
| HM9 | 0.53 | 0.35 |
| | 0.17 | |
| HM10 | 0.20 | 0.20 |
| HM11 | 0.40 | 0.31 |
| | 0.21 | |
| HM12 | 0.36 | 0.30 |
| | 0.25 | |
| HM13 | 0.14 | 0.15 |
| | 0.16 | |
| HM19 | 0.31 | 0.31 |
| HM20 | 0.15 | 0.15 |
| HM22 | 0.03 | 0.03 |

| Table S2 (continued) | | |
|-----------------------------|------|------|
| 12:45-14:15 | | |
| HM1 | 0.26 | 0.26 |
| HM2 | 0.79 | 0.79 |
| HM4 | 0.68 | 0.68 |
| HM5 | 0.75 | 0.75 |
| HM13 | 0.31 | 0.31 |
| HM19 | 0.52 | 0.52 |
| HM20 | 0.58 | 0.39 |
| | 0.2 | |
| HM21 | 0.41 | 0.46 |
| | 0.5 | |
| 14:15-15:45 | | |
| HM3 | 0.26 | 0.26 |
| HM9 | 0.46 | 0.68 |
| | 0.91 | |
| HM11 | 0.92 | 0.93 |
| | 0.93 | |
| HM12 | 0.55 | 0.67 |
| | 0.80 | |
| HM13 | 0.61 | 0.61 |
| HM20 | 0.66 | 0.66 |
| HM21 | 0.79 | 0.79 |
| HM22 | 0.67 | 0.66 |
| | 0.64 | |
| after 15:45 | | |
| HM1 | 0.96 | 0.90 |
| | 0.85 | |
| HM3 | 0.99 | 0.90 |
| | 0.81 | |
| HM9 | 0.97 | 0.94 |
| | 0.92 | |
| HM10 | 0.96 | 0.97 |
| | 0.97 | |
| HM11 | 0.94 | 0.94 |
| HM12 | 0.85 | 0.85 |
| HM13 | 0.55 | 0.75 |
| | 0.96 | |
| HM19 | 0.80 | 0.80 |
| HM20 | 0.80 | 0.80 |

Table S3. Orientation results for clock-shifted larvae. “Time tested” indicates the start of the given 20 minute test. “r” is the length of the mean vector calculated from the 40 individual directions recorded during the individual test. “p” is the p-value resulting from a Rayleigh Test. However, since each individually recorded direction is unlikely to be completely independent, to be conservative, we demanded a $p < 0.001$ for inclusion of the direction in the circular diagrams (Figure 1A-D and Figure S1).

| Table S3. | | | | | | | | | | | | |
|------------|-------------|-------------|---|---|------|-------|-------------------------------------|------------------------|--------------------------------------|--------------------------------------|---------|--|
| Fish ID | Date tested | Time tested | Orientation relative to magnetic North in degrees | Orientation relative to geographic North in degrees | r | "p" | Sun height above horizon in degrees | Sun azimuth in degrees | Sun azimuth 6 hours later in degrees | Predicted clockwise shift in degrees | Comment | |
| HM1 (cs) | 29.1.2011 | 8:19 | 5 | 355 | 0.50 | 0.001 | 37 | 95 | 276 | 179 | | |
| HM3 (cs) | 29.1.2011 | 8:48 | 318 | 308 | 0.56 | 0.001 | 44 | 93 | 270 | 183 | | |
| HM4 (cs) | 29.1.2011 | 9:17 | 168 | 158 | 0.43 | 0.001 | 51 | 90 | 268 | 182 | | |
| HM5 (cs) | 29.1.2011 | 9:50 | 106 | 96 | 0.57 | 0.001 | 58 | 87 | 265 | 182 | | |
| HM4 (cs) | 29.1.2011 | 10:26 | 26 | 16 | 0.91 | 0.001 | 66 | 81 | 262 | 179 | | |
| HM5 (cs) | 30.1.2011 | 8:24 | 23 | 13 | 0.75 | 0.001 | 38 | 95 | 273 | 182 | | |
| HM4 (cs) | 30.1.2011 | 8:51 | 93 | 83 | 0.11 | 0.61 | 45 | 92 | 270 | 182 | NS | |
| HM3 (cs) | 30.1.2011 | 11:02 | 17 | 7 | 0.55 | 0.001 | 74 | 72 | 259 | 173 | | |
| HM1 (cs) | 31.1.2011 | 9:39 | 64 | 54 | 0.54 | 0.001 | 55 | 87 | 268 | 179 | | |
| HM4 (cs) | 31.1.2011 | 10:03 | 323 | 313 | 0.44 | 0.001 | 61 | 84 | 264 | 180 | | |
| HM5 (cs) | 31.1.2011 | 10:28 | 325 | 315 | 0.84 | 0.001 | 67 | 80 | 262 | 178 | | |
| HM3 (cs) | 31.1.2011 | 10:52 | 93 | 83 | 0.43 | 0.001 | 72 | 74 | 260 | 174 | | |
| HM4 (cs) | 1.2.2011 | 6:45 | 306 | 296 | 0.66 | 0.001 | 16 | 102 | 302 | 160 | | |
| HM1 (cs) | 1.2.2011 | 7:09 | 1 | 351 | 0.90 | 0.001 | 21 | 100 | 290 | 170 | | |
| HM5 (cs) | 1.2.2011 | 7:34 | 277 | 267 | 0.66 | 0.001 | 27 | 98 | 283 | 175 | | |
| HM3 (cs) | 1.2.2011 | 8:04 | 319 | 309 | 0.60 | 0.001 | 34 | 96 | 277 | 179 | | |
| HM10 (cs) | 1.2.2011 | 8:30 | 353 | 343 | 0.83 | 0.001 | 40 | 94 | 274 | 180 | | |
| HM10 (cs) | 1.2.2011 | 9:19 | 347 | 337 | 0.62 | 0.001 | 51 | 89 | 269 | 180 | | |
| HM10 (cs) | 1.2.2011 | 10:17 | 318 | 308 | 0.50 | 0.001 | 64 | 81 | 263 | 178 | | |
| HM1 (cs) | 1.2.2011 | 10:43 | 55 | 45 | 0.72 | 0.001 | 70 | 76 | 261 | 175 | | |
| OTI20 (cs) | 25.1.2012 | 10:25 | 324 | 314 | 0.56 | 0.001 | 67 | 84 | 261 | 183 | | |
| OTI21 (cs) | 25.1.2012 | 10:25 | 299 | 289 | 0.57 | 0.001 | 67 | 84 | 261 | 183 | | |
| OTI22 (cs) | 25.1.2012 | 10:50 | 195 | 185 | 0.46 | 0.001 | 72 | 79 | 259 | 180 | | |
| OTI23 (cs) | 25.1.2012 | 10:50 | 325 | 315 | 0.57 | 0.001 | 72 | 79 | 259 | 180 | | |
| OTI24 (cs) | 26.1.2012 | 7:16 | 303 | 293 | 0.90 | 0.001 | 24 | 101 | 282 | 179 | | |
| OTI20 (cs) | 26.1.2012 | 7:16 | 49 | 39 | 0.94 | 0.001 | 24 | 101 | 282 | 179 | | |
| OTI21 (cs) | 26.1.2012 | 7:43 | 298 | 288 | 0.95 | 0.001 | 30 | 99 | 277 | 182 | | |
| OTI22 (cs) | 26.1.2012 | 7:43 | 344 | 334 | 0.71 | 0.001 | 30 | 99 | 277 | 182 | | |
| OTI23 (cs) | 26.1.2012 | 8:11 | 309 | 299 | 0.95 | 0.001 | 36 | 97 | 273 | 184 | | |
| OTI24 (cs) | 26.1.2012 | 8:11 | 17 | 7 | 0.91 | 0.001 | 36 | 97 | 273 | 184 | | |
| OTI20 (cs) | 26.1.2012 | 8:37 | 239 | 229 | 0.19 | 0.24 | 42 | 95 | 270 | 185 | NS | |
| OTI21 (cs) | 26.1.2012 | 8:37 | 353 | 343 | 0.65 | 0.001 | 42 | 95 | 270 | 185 | | |
| OTI23 (cs) | 26.1.2012 | 9:04 | 232 | 222 | 0.79 | 0.001 | 48 | 93 | 268 | 185 | | |
| OTI22 (cs) | 26.1.2012 | 9:04 | 335 | 325 | 0.96 | 0.001 | 48 | 93 | 268 | 185 | | |
| OTI20 (cs) | 26.1.2012 | 9:35 | 297 | 287 | 0.88 | 0.001 | 55 | 90 | 265 | 185 | | |
| OTI24 (cs) | 26.1.2012 | 9:35 | 44 | 34 | 0.91 | 0.001 | 55 | 90 | 265 | 185 | | |
| OTI25 (cs) | 26.1.2012 | 10:00 | 115 | 105 | 0.54 | 0.001 | 61 | 87 | 263 | 184 | | |
| OTI26 (cs) | 26.1.2012 | 10:00 | 297 | 287 | 0.78 | 0.001 | 61 | 87 | 263 | 184 | | |
| OTI26 (cs) | 26.1.2012 | 10:26 | 22 | 12 | 0.67 | 0.001 | 67 | 83 | 261 | 182 | | |
| OTI25 (cs) | 26.1.2012 | 10:26 | 342 | 332 | 0.56 | 0.001 | 67 | 83 | 261 | 182 | | |
| OTI26 (cs) | 27.1.2012 | 8:05 | 344 | 334 | 0.89 | 0.001 | 34 | 97 | 274 | 183 | | |

| | | | | | | | | | | | |
|------------|-----------|-------|-----|-----|------|-------|----|----|-----|-----|------------------------------------|
| OTI25 (cs) | 27.1.2012 | 8:05 | 314 | 304 | 0.78 | 0.001 | 34 | 97 | 274 | 183 | |
| OTI25 (cs) | 27.1.2012 | 10:05 | 354 | 344 | 0.71 | 0.001 | 62 | 86 | 263 | 183 | |
| OTI26 (cs) | 27.1.2012 | 10:05 | 339 | 329 | 0.77 | 0.001 | 62 | 86 | 263 | 183 | |
| | | | | | | | | | | | Mean 180, r=1.00(!), P<0.001 |

Table S4: Summary table for calculations of individual mean orientation before and after clock-shift. The individual mean directions were calculated by vector addition of unit vectors in each of the mean directions shown in the individual tests of the given individual (Batchelet 1981).

| Table S4. | | | | | | |
|-----------|---|---|---------------------------------|--|---|--|
| Fish ID | Means orientation of individual non-clock-shifted tests | Mean orientation of the individual in the non-clock-shifted tests | Clock-shifted from date (D.M.Y) | Mean orientation of individual clock-shifted tests | Mean orientation of the individual in the clock-shifted tests | Clockwise deviation in the clock-shifted condition compared to the orientation of the same individual in the non-clock-shifted condition |
| HM1 | 144, 137, 137 | 139 | 23.1.2011 | 355, 54, 351, 45 | 21 | 200 |
| HM2 | 159, 353, 139 | 128 | 22.1.2011 | Died during clock-shifting | - | - |
| HM3 | 170, 97, 263 | 172 | 22.1.2011 | 308, 7, 83, 309 | 349 | 177 |
| HM4 | 109, 122, 260 | 142 | 22.1.2011 | 158, 16, 313, 296 | 320 | 178 |
| HM5 | 177, 246, 118 | 179 | 22.1.2011 | 96, 13, 315, 267 | 342 | 163 |
| HM9 | 193, 345, 214, 176, 184 | 200 | - | Not clock-shifted | - | - |
| HM10 | 119, 164, 27, 151 | 124 | 27.1.2011 | 343, 337, 308 | 329 | 205 |
| HM11 | 111, 347, 349, 164, 138 | 94 | - | Not clock-shifted | - | - |
| HM12 | 107, 51, 153, 150, 137 | 123 | - | Not clock-shifted | - | - |
| HM13 | 271, 161, 114 | 170 | - | Not clock-shifted | - | - |
| HM19 | 161, 214, 137 | 170 | - | Not clock-shifted | - | - |
| HM20 | 197, 231, 143 | 191 | - | Not clock-shifted | - | - |
| HM21 | 159, 99, 185 | 149 | - | Not clock-shifted | - | - |
| HM22 | 167, 142, 111 | 140 | - | Not clock-shifted | - | - |
| OTI20 | 183, 61, 119 | 120 | 21.1.2012 | 314, 39, 287 | 329 | 209 |
| OTI21 | 128, 170, 227 | 174 | 21.1.2012 | 289, 288, 343 | 306 | 132 |
| OTI22 | 193, 184, 50 | 160 | 21.1.2012 | 185, 334, 325 | 303 | 143 |
| OTI23 | 323, 203, 163, 137 | 181 | 21.1.2012 | 315, 299, 222 | 281 | 100 |
| OTI24 | 132, 116, 128 | 125 | 21.1.2012 | 293, 7, 34 | 354 | 229 |
| OTI25 | 154, 174, 336 | 172 | 21.1.2012 | 105, 332, 304, 344 | 344 | 172 |
| OTI26 | 156, 196, 215 | 189 | 21.1.2012 | 287, 12, 334, 329 | 331 | 142 |

Batchelet (1981). Circular Statistics in Biology. London: Academic Press.