

1 Regional and global changes during Heinrich Event 1
2 affecting macrobenthic habitat: ichnological evidence of sea-
3 bottom conditions at the Galicia Interior Basin

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13

14 **Abstract**

15 Heinrich events (HEs) are climatic changes, occurring during the Pleistocene, related to
16 massive discharge of freshwater from the Laurentide Ice Sheet, through the Hudson Strait,
17 recognized in the sedimentary record through distinctive layers of ice-rafted detritus (IRD),
18 the so-called Heinrich layers (HLs). Environmental changes during HEs influence
19 significantly in marine biota (i.e. modifications in composition and abundance of
20 assemblages), with ecological and evolutionary consequences. This point has been only
21 partially addressed in particular groups (e.g. microorganisms), whereas interactions with
22 other groups remain understudied. Here, we analyse ichnological features of the Heinrich
23 layer 1, associated to Heinrich Event 1 (HE1), from several gravity cores at the Galicia

24 Interior Basin (NW Iberian Peninsula) to test the influence of this HE1 on environmental
25 parameters, such as bottom and pore-water oxygenation, as well as benthic food availability,
26 conforming the macrobenthic habitat. Freshwater input during the first phase of the HE1
27 caused unfavorable conditions (probably highly dysoxic to anoxic) for tracemakers, as
28 revealed by the absence of both discrete traces and a well-developed mottled background.
29 However, the tracemaker community was reestablished shortly after deposition of the ice-
30 rafted detritus layer (Heinrich layer) of HE1, as reflected by the significant increase in
31 diversity and abundance of traces (*Planolites*, *Thalassinoides*, *Thalassinoides*-like,
32 *Chondrites*, and *Zoophycos*), revealing a major shift to oxic bottom and pore waters and
33 likely benthic food. This global/general pattern, though, is affected by the regional setting and
34 by the associated predominant sedimentation processes, leading to a variable incidence of
35 paleoenvironmental changes associated with HE1. The ecological impact on macrobenthic
36 biota, in term of changes in diversity and abundance of tracemakers, by HE1 soon attenuates,
37 resulting in a negligible evolutionary impact.

38

39 **Keywords:** Heinrich Event 1; Iberian margin; Gravity cores; Ichnology;
40 Palaeoenvironmental conditions; Oxygenation.

41

42 **1. Introduction**

43 Heinrich events (HEs) are climatic occurrences triggered by massive discharge of
44 freshwater from the Laurentide Ice Sheet, through the Hudson Strait into the North Atlantic
45 Ocean, occurring during the Pleistocene, recognized in the sedimentary record through
46 distinctive layers of ice-rafted detritus (IRD), the so-called Heinrich layers (HLs) (Heinrich,

47 1988; Hemming, 2004; Hodell et al., 2008). These events were assumed to cause major
48 disruptions in the Atlantic Meridional Overturning Circulation (AMOC) and North Atlantic
49 Deep Water (NADW) formation. However, in recent years, paleoclimatologists have revealed
50 weaknesses in this relationship, and the initial AMOC reduction could not be caused by the
51 Heinrich events themselves. Thus alternative driving mechanisms have been proposed
52 (Álvares-Solas et al., 2011). Subsequently, these events have been examined intensely
53 (Hemming, 2004), yet some aspects are still poorly understood (Bassis et al., 2017), and the
54 interpretation of paleoenvironmental conditions and changes associated with these events
55 poses a challenge. Ichnology is a tool in paleoenvironmental studies, including
56 paleoceanography and paleoclimatology, which provide data useful for the interpretation of
57 parameters such as hydrodynamic energy, oxygenation, sedimentation rate or nutrient
58 availability (Buatois and Mángano, 2011; Knaust and Bromley, 2012). Nevertheless, few
59 ichnological studies have focused on Heinrich events. Changes in ichnological features
60 associated to Heinrich layers may be related to the effects of the Heinrich events on the
61 macrobenthic tracemaker community, based on the influence of paleoenvironmental
62 conditions on the behavior of producers (i.e., Baas et al., 1997, 1998; Löwemark et al., 2004;
63 Rodríguez-Tovar et al., 2015a,b). Recently, a detailed ichnological analysis, conducted on
64 cores from the IODP Site U1308, located within the ice-rafted detritus belt of the North
65 Atlantic, has revealed the complex relationship between nutrient availability and oxygen
66 conditions during Heinrich Event 1 (Hodell et al., 2017; Rodríguez-Tovar et al., 2019).

67 The Galicia Interior Basin (GIB), is a narrow marginal basin (100 km wide, 2500–
68 3000m deep), located between the western Iberian continental margin and the Galicia Bank at
69 the northwestern Iberian Peninsula (Fig. 1). The GIB serves as a natural laboratory to study
70 paleoceanographic dynamics, given the location near a critical transition between the
71 subtropical (temperate) and subpolar (cold) gyres of the North Atlantic. In 2009, five gravity

72 cores, covering the last 63 ka (Mena, 2014) were retrieved along a latitudinal transect
73 traversing the GIB (Fig. 1). The cores provided conspicuous sedimentary evidence of
74 Heinrich events (HEs), showing significant lateral variation in facies as indicated by the
75 changes registered in the stratigraphic intervals associated with HEs (Mena, 2014; Mena et
76 al., 2015, 2018) (Fig. 2). The data compiled support the characterization of HE1 as the most
77 pronounced cold event recorded in GIB over the last 60 ka.

78 Here, we examine, for the first time, ichnological features of the Heinrich Layer 1
79 from several cores at the Galicia Interior Basin, a setting of special interest for
80 paleoceanographic studies due to the particular location, to assess how global and regional
81 changes related to Heinrich Event 1 exert an impact on the macrobenthic habitat, as well as to
82 improve knowledge of the incidence of HE1 on sea-bottom conditions as bottom and pore-
83 water oxygenation and benthic food availability.

84 **2. Methods**

85 Five gravity cores, FSG09-10 (230 cm thick), FSG09-16 (390 cm thick), FSG09-09
86 (342 cm thick), FSG09-07 (335 cm thick) and FSG09-17 (329 cm thick), collected in the
87 Galicia Interior Basin (GIB) during the ForSaGal 09 (R/V Sarmiento de Gamboa in 2009)
88 research cruises were studied (Mena et al., 2015, 2018). These cores, covering the last 63 ka,
89 traverse an E-W transect of the GIB at depths between 2150 and 2780 m (Mena, 2014; Mena
90 et al., 2015, 2018). In previous studies, cores were subjected to CT-scan and logging
91 procedures which provided sediment radiodensities and allowed a detailed facies analysis
92 (Mena et al., 2015). Moreover, each core was analyzed using an X-ray fluorescence (XRF)
93 core scanner (Avaatech; available through the University of Barcelona) to measure the semi-
94 quantitative abundance of Ca, Fe, and other elements. Following the scanning of the core,
95 high-resolution sediment sampling was performed for the micropaleontological study (Mena,

96 2014). An age model was established based on 18 new AMS-¹⁴C dates (measured at the
97 Center for Applied Isotopes Studies, University of Georgia, USA) determined from
98 monospecific handpicked samples of the planktonic foraminifera *G. bulloides* (Mena et al.,
99 2018). Terrigenous elements (Fe, Ti, K) and Ca/Sr and Zr/Sr ratios were quantified for
100 additional information on facies related to HEs (Mena, 2014; Mena et al., 2015, 2018).

101 We conducted a continuous analysis of the ichnological features, including
102 ichnofabrics, of the stratigraphic interval spanning the HE1 in these five cores. Ichnological
103 research was supported by digital image analysis (Dorador and Rodríguez-Tovar, 2014, 2018;
104 Dorador et al., 2014a,b; Rodríguez-Tovar and Dorador, 2015), applied to the high-resolution
105 images made from the five cores studied (FSG09-10, FSG09-16, FSG09-09, FSG09-07 and
106 FSG09-17). The technique is based on image adjustment modifications to enhance visibility
107 and characterization of ichnological features. Three adjustment modifications (levels,
108 brightness and vibrance) were applied using Adobe Photoshop CS6 software®. The digital
109 treatment of high-resolution images was conducted at the Department of Stratigraphy and
110 Paleontology at the University of Granada (Spain). Digital image analysis enables: a)
111 differentiation between trace fossils (i.e. bioturbational sedimentary structures with sharp
112 outlines and a characteristic recurrent geometry) and biodeformational structures (i.e. with no
113 distinct outlines and no recurrent geometry determining a mottled background); b)
114 ichnotaxonomy; c) relative abundance; d) cross-cutting relationships; e) percentage of
115 bioturbation; and f) characterization of ichnofabrics (Dorador and Rodríguez-Tovar, 2014,
116 2018; Dorador et al., 2014a,b; Rodríguez-Tovar and Dorador, 2015). As usually occurs with
117 core analysis, ichnotaxonomic identification was limited, in most cases, to the ichnogenus
118 level. The sections studied correspond to the uppermost 150 cm of each core, including the
119 ice-rafted detritus layer of HE1, and the sediments directly below and above (Fig. 2).

120 **3. Results**

121 Figure 3 shows the distribution of differentiated ichnogenera through the sections of
122 the cores. Differentiated ichnotaxa are indicated, corresponding to: *Ch*=*Chondrites*,
123 *Pl*=*Planolites*, *Th*=*Thalassinoides*, *Th-l*=*Thalassinoides*-like, and *Zo*=*Zoophycos*, as well as
124 Mottled background. Cross-cutting relationships were indicated when detected. In any of the
125 sections, five intervals were studied for a more detailed ichnological analysis, corresponding
126 to sediments pre-IRD layer of HE1 (intervals 1-2), IRD layer (interval 3), and post-IRD layer
127 (intervals 4-5). Figure 4 shows the intervals studied (1 to 5) in all the cores showing
128 ichnogenera and the corresponding percentage of bioturbated surface by ichnotaxa. Table 1
129 includes, for each interval studied, data of the percentage of bioturbated surface by ichnotaxa,
130 and the total bioturbated surface.

131 Ichnological data reveal a similar general pattern in all the cores studied for the IRD
132 layer as well as for sediments below and above, even with some differences according to the
133 particular cores. In this context, core FSG09-10, to the west of the GIB shows a sparse
134 ichnological record, in sharp contrast to the rest of cores (Fig. 3). As observed in the general
135 stratigraphic distribution through the cores (Fig. 3), and in detailed analysis of selected
136 intervals (Fig. 4 and Table 1), the general pattern is as follows:

137 - Sediments below the IRD layer of HE1 (intervals 1 and 2) show scarcity (interval 1; 8-9%
138 of bioturbated surface) or absence (interval 2; 0%) of discrete trace fossils, but the presence
139 of a relatively well-developed mottled background (Fig. 4, Table 1). In western cores
140 (FSG09-16, FSG09-09), the mottled-background interval is interrupted by the presence of
141 discrete trace fossils, including *Planolites*, *Thalassinoides*, and *Chondrites*, whereas in the
142 eastern cores (FSG09-07, FSG09-17) this mottled-background interval is thicker and
143 continuous (Fig. 3).

144 - Sediments corresponding to the IRD layer (interval 3) show the record of scarce discrete
145 traces (mainly *Planolites*), especially in the east (Fig. 3). The percentage of bioturbated
146 section-surface is low, between 0 and 13% (Table 1).

147 - Sediments above the IRD layer (intervals 4 and 5) show significantly greater diversity and
148 abundance of traces bearing *Planolites*, *Thalassinoides*, *Thalassinoides*-like, *Chondrites*, and
149 *Zoophycos* (Fig. 3). The percentage of bioturbated surface increases from just above the IRD
150 layer (interval 4; between 0 to 17%) to the sediment above (interval 5, between 5 to 25%)
151 (Table 1). This increase is especially marked and rapid in the eastern cores (Fig. 4).

152 In the context of the observed similar pattern in the stratigraphic distribution of
153 ichnological data through the studied cores, lateral changes in ichnological features have been
154 recognized (Figs. 3, 4, Table 1). From the west (FSG09-10) to the east (FSG09-7 and FSG09-
155 17) ichnodiversity and abundance clearly increase in the IRD layer of HE1 as well as in the
156 sediments above (Fig. 3, Table 1). FSG09-10 to the west shows a distinctly different record
157 with respect to the other cores, with the near absence of discrete traces at the IRD layer of
158 HE1 as well as in the sediments above (Fig. 3). In the center of the transect, cores FSG09-16
159 and FSG09-9 are very similar, with the record of several traces in the IRD layer (*Planolites*
160 and *Chondrites*). Then, after the IRD layer, the abundance and diversity gradually and
161 steadily increase with the record of *Planolites*, *Thalassinoides*, *Thalassinoides*-like, and
162 *Chondrites* (Fig. 3). The percentage of bioturbated surface for intervals 3 to 5 is between 16%
163 (FSG09-16) and 24% (FSG09-09) (Table 1). In the east, cores FSG09-07 and FSG09-17 are
164 quite similar, registering the highest values in abundance and diversity (Fig. 3, Table 1). The
165 IRD layer consists of dominant *Planolites*, and then abundance and diversity rapidly changes
166 with the presence of *Planolites*, *Thalassinoides*, and *Chondrites*, as well as *Zoophycos* and
167 *Scolicia*. The percentage of bioturbated surface for intervals 3 to 5 reaches 43% (FSG09-07)
168 and 49% (FSG09-17) (Fig. 3, Table 1).

169 **4. Discussion**

170 *4.1. Heinrich events, paleoenvironmental conditions and macrobenthic tracemaker*
171 *community*

172 Global paleoenvironmental changes appear during Heinrich events, with dramatic
173 reductions in both temperature and salinity being the most commonly reported features,
174 attributable to the amount of ice melting (Hemming, 2004). However, the incidence of other
175 conditions, such as oxygenation or nutrient availability, has not been sufficiently considered.
176 Large freshwater discharges in relation to iceberg surges may have caused a temporary
177 stratification of the water column and then dysaerobic conditions at the sea bottom during
178 Heinrich events (Tamburini et al., 2002). This decrease in bottom-water oxygenation during
179 HEs has been identified by productivity changes during North Atlantic Heinrich events
180 (Hoogakker et al., 2016). As usually interpreted, bottom and pore-water oxygenation as well
181 as benthic food availability constitute major limiting conditions for the tracemaker
182 community living in deep-sea marine environments, making ichnological information a
183 valuable tool to explain changes in these parameters (Rodríguez-Tovar et al., 2015a,b). The
184 influence of bottom-water oxygen conditions and food availability on the macrobenthic
185 tracemaker community has been sometimes previously assessed for HE1. Concentrations of
186 *Chondrites* immediately below Heinrich layers can be used as a proxy for bottom-water
187 stagnation and low-oxic bottom-water conditions during Heinrich events (Baas et al., 1997,
188 1998). The presence of a short interval with *Chondrites*, in coincidence with the occurrence
189 of IRD associated with HE1, was interpreted as possibly caused by a greater influence of
190 oxygen-depleted deep-water masses (Baas et al., 1997, 1998). An increase in freshwater input
191 associated with the HE1 led to diminishing oxygenation in bottom-water conditions and thus
192 to an increase in the abundance of *Chondrites* (Baas et al., 1997; Löwemark et al., 2004).
193 Recently, a detailed ichnofabric analysis throughout the HE1 interval recorded in North

194 Atlantic (Site U1308, close to the mouth of Hudson Strait) revealed differences between the
195 two different stages of HE1 (i.e. HE1.1 and HE1.2) and the interval in between (Rodríguez-
196 Tovar et al., 2019). At the beginning of HE1.1, a dominance of *Chondrites* suggests highly
197 dysoxic conditions. By contrast, above, a greater diversity of trace fossils
198 (*Planolites/Thalassinoides*), and the disappearance of *Chondrites*, reveals oxygen (pore and
199 bottom water) amelioration and more available benthic food content for larger tracemakers.
200 Conditions abruptly changed (between HE1.1 and HE1.2); the absence of bioturbation
201 structures reveals falling oxygen levels to dysoxic/anoxic conditions. Finally, during the
202 development of HE1.2, conditions again improved, as supported the record of *Planolites*.
203 These changes in paleoenvironmental conditions were related to the dynamics of the Atlantic
204 Meridional Overturning Circulation, affecting deep-water circulation (Rodríguez-Tovar et al.,
205 2019).

206 4.2. Ichnological features through HE1 at the Galicia Interior Basin

207 HE1 presents the same configuration in all cores, with high radio-density particles of
208 diverse sizes embedded in a low-density muddy matrix (Mena, 2014; Mena et al., 2015,
209 2018). The base of the IRD layer of HE1 usually has very low radiodensity, diffuse
210 lamination, and profuse bioturbation. The low radiodensity values of the mud matrix are
211 consistent with higher abundance of terrigenous material from the greater continental input
212 during the HE (Wilson and Austin, 2002; Sierro et al., 2009; Mena, 2014).

213 The HE1 signal at the Galicia Interior Basin (GIB; NW Iberian Peninsula) shows a
214 generally similar ichnological pattern before, during, and after the Heinrich Event 1, in all the
215 cores studied (Fig. 5). The near absence of discrete traces, but the presence of a relatively
216 well-developed mottled background immediately below IRD layers may be related to general
217 low oxygenation in bottom and pore water prior to the Heinrich Event 1. Dysoxic conditions
218 probably allow the bioturbation of only the first centimeters of the sediments by micro-

219 tracemakers, but any activity of larger producers is nearly absent (Fig. 3). Later, associated
220 with freshwater input during the first phase of the Heinrich Event 1, oxygen conditions are
221 less favorable, apparently highly dysoxic to anoxic, even leading to the absence of a well-
222 developed mottled background (Fig. 5). These unfavorable conditions start to improve during
223 the final deposition of the IRD layer, as revealed by the meager presence of discrete traces
224 (i.e. *Planolites*). Shortly after deposition of the IRD layer, a major shift to oxic bottom and
225 pore waters is interpreted, probably related to the mixing of bottom water after stagnation and
226 restoration of background paleoclimatic/paleoceanographic conditions, as reflected by the
227 significant surge in diversity and abundance of traces (*Planolites*, *Thalassinoides*,
228 *Thalassinoides*-like, *Chondrites*, and *Zoophycos*) (Fig. 5). Thus, a general trend in oxygen
229 conditions was from dysoxic to highly dysoxic/anoxic and finally oxic, caused a comparable
230 global/general response of the macrobenthic tracemaker community in all the cores studied.

231 4.3. Lateral variability of Heinrich Event 1

232 Within the Galicia Interior Basin, facies associations indicate three spatiotemporal
233 domains with different predominant sedimentation processes during glacial events (Mena,
234 2014; Mena et al., 2015, 2018). These include (from the west): the area close to the Galicia
235 Bank, where the GIB consists of turbidites and hemipelagic sediments; the center of the GIB,
236 where only Pre-Holocene pelagic sediments (PelC) were formed; and the eastern area, near
237 the continental slope where hemipelagic and contouritic facies developed. According to this
238 scheme, the stratigraphic intervals associated with any of the recorded HEs also show
239 significant lateral variation. This lateral facies change was interpreted as having been caused
240 by the development of an oceanographic boundary between surface water masses with
241 different temperatures and salinity parameters or changes in surface currents which may have
242 channeled relatively warmer water into the GIB during the last glacial period (Mena et al.,

243 2018). Our ichnological data from the cores studied also support the idea of this
244 regional/lateral variation in HE1 (Figs. 3, 4, Table 1).

245 The observed increase in ichnodiversity from the west (FSG09-10) to the east
246 (FSG09-07 and FSG09-17), in the IRD layers and in the sediments above, as well as the
247 changes in the rate of recovery, can be related to the particular spatiotemporal domain and to
248 the associated predominant sedimentation processes determining a variable incidence of
249 paleoenvironmental changes associated with HE1 (Fig. 5). The westernmost core FSG09-10
250 is from the east flank of the Galicia Bank, in the so-called Transitional Zone (Vázquez et al.,
251 2008), a dome-like elevation dominated by bottom current activity that generates the abraded
252 surfaces (Ercilla et al., 2011). Cores FSG09-09 and FSG09-16 are located in the central part
253 of the basin, between the Transitional Zone (Ercilla et al., 2011) and the lower slope (Bender
254 et al., 2012), dominated by pelagic and hemipelagic sedimentation. Core FSG09-07 and
255 especially the easternmost core FSG09-17 corresponds mainly to a hemipelagic and
256 contouritic depositional setting that developed on the lower continental slope (Bender et al.,
257 2012). Thus, the near absence of discrete traces in the IRD layer of HE1 as well as in the
258 sediments above in core FSG09-10 reveal the clear influence of the particular depositional
259 setting in an elevated area with density current processes causing an unfavorable habitat for
260 the macrobenthic tracemaker community, superimposed on the global HE1 phenomena (Fig.
261 3). In the central and eastern part of the basin, general conditions are favorable for the
262 development of a multitiered tracemaker community typical of the *Zoophycos* ichnofacies –
263 usually associated with fine-grained pelagic and hemipelagic sediments with abundant
264 organic matter, in low-energy subtidal settings (Rodríguez-Tovar et al., 2015a, b) – especially
265 when hemipelagic and bottom current deposits predominated, presumably could be related to
266 the increase in terrigenous material and organic matter content (Fig. 5).

267 **5. Conclusions**

268 Although the Heinrich Event 1 has been profusely studied, some aspects are still
269 poorly understood. Changes in the ichnological features before, during and after HE1 at the
270 Galicia Interior Basin reveal the impact of this event on the benthic marine habitat at global
271 and regional scales. Firstly, a marked global/general change is recorded during the
272 development of HE1. This is indicated by the near absence of discrete traces, but the presence
273 of a relatively well-developed mottled background, immediately below the IRD layers, the
274 absence of trace fossils and mottled background during most of the IRD layer deposition, the
275 scarce presence of discrete traces (i.e. *Planolites*) at the final deposition of the IRD layer,
276 and the significant increase in diversity and abundance of traces (*Chondrites*, *Planolites*,
277 *Thalassinoides*, *Thalassinoides*-like, and *Zoophycos*) just afterwards, evidencing the
278 influence of the HE1 on the macrobenthic tracemaker community at a global scale. Variations
279 in oxygen conditions from dysoxic to highly dysoxic/anoxic and finally oxic are interpreted
280 as the main factor inducing the response of the biota. Secondly, major ichnological changes
281 registered between the cores studied, with an increase in ichnodiversity from the west
282 (FSG09-10) to the east (FSG09-07 and FSG09-17), demonstrate the lateral variability of the
283 HE1 associated to variations in topography and ocean dynamics at regional scale. Changes in
284 the input of terrigenous material and in the organic matter content at the benthic habitat could
285 affect macrobenthic tracemaker community at a regional scale.

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388

389 **Figure captions**

390 **Figure 1.** Location of the cores taken at the Galicia Interior Basin, with differentiation of the
391 three main domains.

392 **Figure 2.** Synthetic columns of the cores indicating differentiated facies (Mena, 2014; Mena
393 et al., 2015, 2018) and schematic infill of the Galicia Interior Basin with the main
394 sedimentary facies showing IRD-1 layer and position of the cores. Modified from Mena et al.
395 (2018).

396 **Figure 3.** Distribution of ichnotaxa through the cores studied indicating selected intervals 1
397 to 5. Note: Intervals 1 and 2 correspond to pre-IRD-1 layer deposits, interval 3 to IRD-1
398 layer, and intervals 4 and 5 to post-IRD-1 layer deposits.

399 **Figure 4.** Original (left) and treated (right) images of the selected intervals 1 to 5 in the cores
400 studied (see Fig. 3 for location), with differentiation of ichnotaxa. The percentage of
401 bioturbated surface is indicated by both the particular ichnotaxa and the total bioturbated
402 surface.

403 **Figure 5.** Tiering models according to the relationship with IRD layer (pre-IRD, IRD and
404 post-IRD) and the general location respect to the Galicia Interior Basin (from west to east),
405 indicating variations in diversity and abundance of trace fossils.

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407

408 **Tables**

409 **Table 1.** Percentage of bioturbated surface in the selected intervals 1 to 5 for every ichnotaxa
 410 (Ich) and total bioturbated surface (BS). Note: *Ch* = *Chondrites*, *Ph* = *Phycosiphon*, *Pl* =
 411 *Planolites*, *Th* = *Thalassinoides*, *Th-1* = *Thalassinoides*-like, *Zo* = *Zoophycos*.

412

	FSG09-10		FSG09-16		FSG09-09		FSG09-07		FSG09-17	
	Ich	BS	Ich	BS	Ich	BS	Ich	BS	Ich	BS
5	<i>Pl</i> 5.2%	~5%	<i>Pl</i> 0.6%	~1%	<i>Pl</i> 4.9% <i>Ch</i> 0.1%	~5%	<i>Pl</i> 2.6% <i>Th</i> 3.6% <i>Th-1</i> 10.2% <i>Ch</i> 1.2% <i>Zo</i> 5.9%	~24%	<i>Th</i> 12.5% <i>Ch</i> 0.7% <i>Zo</i> 12.1%	~25%
4		0%	<i>Ph</i> 0.8% <i>Th</i> 9.4%	~10%	<i>Pl</i> 0.4% <i>Th</i> 9.9% <i>Th-1</i> 16.6% <i>Ch</i> 0.3%	~17%	<i>Pl</i> 0.9% <i>Th</i> 8.1% <i>Ch</i> 0.5% <i>Zo</i> 5.0%	~15%	<i>Pl</i> 2.0% <i>Th</i> 1.2% <i>Zo</i> 7.8%	~11%
3		0%	<i>Pl</i> 2.0% <i>Th</i> 1.7% <i>Ch</i> 1.7%	~5%	<i>Pl</i> 1.6%	~2%	<i>Pl</i> 3.3% <i>Th</i> 1.1%	~4%	<i>Pl</i> 3.7% <i>Zo</i> 8.8%	~13%
2		0%		0%		0%		0%		0%
1		0%	<i>Pl</i> 4.7% <i>Th</i> 4.6%	~9%	<i>Pl</i> 4.4% <i>Th</i> 2.3% <i>Ch</i> 0.8%	~8%		0%		0%

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