Ostracode Analysis for Cores BL96-1 and BL96-2 from Bear Lake, Utah and Idaho

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This report has not been reviewed for stratigraphic nomenclature.

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Introduction

This report summarizes the results of ostracode faunal analyses of two cores, 96-1 and 96-2, located in depth of 50 and 40 m, respectively, from Bear Lake, Utah and Idaho. The lower third of core 96-2 is composed of reddish carbonate-poor fine-grained sediment. This siliciclastic material is overlain by gray carbonate-rich mud (Dean and others, 2005). The deposition rate at the site of core 96-1 was higher than at the site of core 96-2 (Colman and others, 2005), and all of the section sampled by core 96-1 corresponds roughly to the upper half of the carbonate-rich sediments in core 96-2. This report primarily describes the ostracode data and secondarily discusses the stratigraphic structure of the ostracode species profiles. These data contribute to understanding the environmental history of Bear Lake (for example, Schwalb and others, 1995; Smith, 1993; Forester, 1987).

Methods

Samples from core 96-1 were analyzed for ostracodes prior to amino acid analysis (Kaufman, 2003) at Northern Arizona University (NAU). Samples were weighed moist, then disaggregated for several days in deionized water before washing over a 100 mesh (150 μm) sieve to retrieve the ostracode valves. The residues were air dried in the sieves, and whole adult ostracode valves were counted (whole adults that showed minor damage were included in the count). Partial valves were not counted. A total of 1,618 adult valves were counted from 22 core intervals.

Core 96-2 was sampled systematically at intervals of 4 centimeters. The samples were prepared at the U.S. Geological Survey in Denver, Colorado, and reference slides were sent to NAU for ostracode counts. Slide contents were dry sieved at 50 mesh (300 μm) and 100 mesh (150 μm) to separate the adult *Candona* valves from the *Limnocythere* adults. Only whole, adult valves were counted. A total of 5,753 adult valves were counted from 99 core intervals. Representative male and female valves of each species were photographed using a scanning election microscope. Digital versions of these images are in the Appendix.

Results

Ostracodes were abundant and well preserved through core 96-1 and the upper carbonate-rich two thirds of core 96-2 (table 1). With the exception of one taxon found in core 96-1, all of the taxa are undescribed species and, therefore, appear to be endemic to Bear Lake. In contrast, ostracodes collected from the littoral zone of Bear Lake are common species currently found in streams and marshes throughout the Bear Lake valley (Bright, unpublished data). The rich fauna (10 endemic species) in Bear Lake is inconsistent with other large North American lakes. For example, only three ostracode species typify the deep-lake sediments of Lake Huron (Dettman and others, 1995) and Lake Michigan (Forester and others, 1994). This may be due to the young (<12,000 yr) age of these lakes. By comparison, nearly 200 endemic species of ostracodes are known from Lake Tanganyika, Africa, which ranks second in species diversity behind Lake Baikal, Russia (Wells and others, 1999). The high diversity in these lakes probably is related to their longevity (9–12 Ma) and complex habitat structures within the lakes (Wells and others, 1999; Forester, 1991). If so, then the endemic fauna of Bear Lake hints at a lake considerably older or more complex than typical deep North American lakes.

Table 1. Ostracodes found in Bear Lake cores 96-1 and 96-2.
X indicates species is present.
-- indicate species absent

	96-1	**96-2**
Candona **sp. 1**		X
	X	
Candona **sp. 2**	X	X
Candona **sp. 3**	X	X
Candona **sp. 4**	X	X
Candon**a sp. 5**	X	X
Candona **sp. 6**	X	X
Candona **sp. 7**	X	X
Limnocythere **sp. 1**	X	X
Limnocythere **sp. 2**	--	X
unidentified	X	X
Ilyocypris bradyi	X	--

Core 96-1

Core 96-1 contains 10 ostracode species from four genera (table 2). The genus *Candona* is represented by seven species, three of which are common. The genera *Limnocythere* and *Ilyocypris* are each represented by one species, and there is one unidentified species. Ostracode valve data from core 96-1 primarily were intended for amino acid analyses. Only the common taxa were enumerated, and their distributions are shown on figure 1.

Core 96-2

Core 96-2 also contains 10 species from three genera (table 3). *Candona* is represented by seven species, four of which are common. The seven *Candona* species are the same species found in core 96-1. *Limnocythere* is represented by the same species as core 96-1 and by an isolated occurrence of a second species. An unidentified species is present as well. The occurrence of each species is summarized on figure 2.

Table 2. Ostracode concentrations in core 96-1.
Note: The core was cut into 5 sections, A through E. Sample numbers indicate the depth in each section, in centimeters, relative to the top of the core liner for that section. The Depth in the core is the depth relative to the uppermost sediments in section A
.

Sample No.	Depth	*Candona* sp1	*Candona* sp.2	other *Candona*	*Limno*.. sp 1	unident.	**Total**
	(cm)	(valves /g)	(valves /g)	(valves /g)	(valves /g)	(valves /g)	**(valves /g)**
A-7	3	1.9	1.1	1.1	0.0	0.0	**4.1**
A-52	48	4.3	2.2	9.0	11.1	2.9	**29.5**
A-70	66	2.8	1.0	0.0	0.0	0.0	**3.8**
A-81	77	4.1	7.4	2.6	0.0	1.5	**15.6**
A-91	87	2.6	2.6	0.5	0.0	0.0	**5.7**
B-29	126	7.2	33.2	7.2	0.0	0.4	**48.0**
B-49	146	3.9	9.6	7.3	2.2	4.7	**27.7**
B-69	166	1.5	2.5	1.0	1.6	0.1	**6.7**
B-89	186	1.4	0.4	2.2	1.0	0.4	**5.4**
B-99	196	0.3	0.0	1.0	0.0	0.0	**1.3**
C-29	226	0.5	0.1	0.1	0.4	0.1	**1.2**
C-49	246	2.3	4.0	3.1	0.7	1.4	**11.5**
C-69	266	2.9	5.7	1.4	1.3	0.3	**11.6**
C-99	296	3.1	0.4	3.2	0.8	1.1	**8.6**
D-29	327	0.2	0.0	0.1	0.0	0.0	**0.3**
D-49	347	1.3	0.0	2.0	1.2	0.9	**5.4**
D-69	376	0.4	0.0	0.5	0.6	0.1	**1.6**
D-99	397	1.7	0.0	2.3	0.2	0.3	**4.5**
E-29	427	1.7	6.6	1.7	0.4	1.7	**12.1**
E-51	449	2.8	0.3	1.9	0.0	0.1	**5.1**
E-69	467	2.1	5.0	0.8	0.3	0.7	**8.9**
E-99	497	2.8	0.6	2.7	0.0	0.8	**6.9**

Discussion

Because of its greater sampling resolution and longer record, core 96-2 was used to define five ostracode zones (fig. 2). The zones are based solely on the stratigraphic structure of the various species. Because the fauna is largely endemic, the mechanisms responsible for the structure are poorly understood.

Zone 1 (0 to 87 cm) is characterized by the highest total concentrations of ostracode valves in the core. *Candona* sp. 1, sp. 2, and sp. 3 are especially abundant. The unidentified species and *Limnocythere* sp. 1 are at their highest concentrations as well. *Candona* sp. 4 abundances decline upward through this interval.

Zone 2 (87 to 192 cm) is defined by the near absence of *Candona* sp. 2 at 87 and 192 cm. It also encompasses two discrete peaks of increased *Candona* sp. 2 concentrations at 110 and 155 cm. *Candona* sp. 4 concentrations are near their maximum throughout this zone. *Limnocythere* sp. 1 becomes firmly established in this zone, and its concentrations increase upward through the zone.

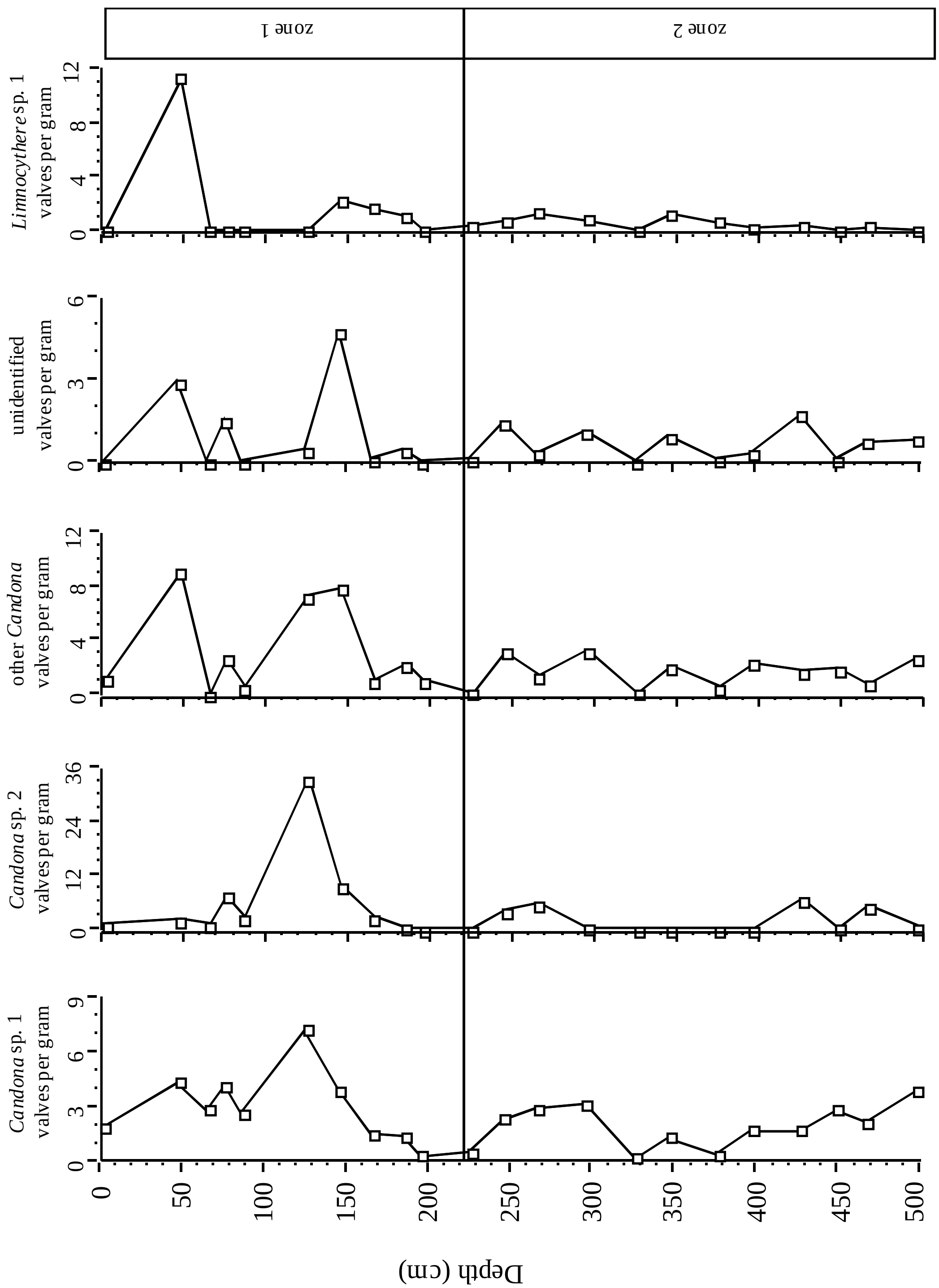

Figure 1. Abundances of common ostracode fauna (valves per gram, vpg) vs. depth for core 96-1. Faunal zones are shown on the right side of the diagram.

Table 3. Ostracode concentrations in core 96-2.
Note: The core was cut into 5 sections, A through E. Sample numbers indicate the depth in each section, in centimeters, relative to the top of the core liner for that section. The Depth in the core is the depth relative to the uppermost sediments in section A.

Sample No.	Depth (cm)	*Candona* sp. 1 (valves/g)	*Candona* sp. 2 (valves/g)	*Candona* sp. 3 (valves/g)	*Candona* sp. 4 (valves/g)	*Candona* sp. 5 (valves/g)	*Candona* sp. 6 (valves/g)	*Candona* sp. 7 (valves/g)	*Limno.* sp. 1 (valves/g)	*Limno.* sp. 2 (valves/g)	unidentified species (valves/g)	**TOTAL (valves/g)**
A-11	1	7.3	60.0	3.6	0.9	1.8	0.9	0.0	0.9	0.0	0.0	**83**
A-16	6	1.0	13.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**15**
A-20	10	8.7	22.7	6.0	0.7	0.7	0.0	0.0	1.3	0.0	0.7	**61**
A-24	14	8.8	30.6	6.3	0.6	1.3	0.0	0.0	1.9	0.0	1.3	**81**
A-28	18	11.2	40.6	1.2	1.2	1.8	0.0	0.0	1.8	0.0	0.0	**98**
A-32	22	20.0	126.3	1.3	0.0	1.3	2.5	1.3	1.3	0.0	0.0	**123**
A-36	26	14.1	50.6	6.8	0.0	1.8	0.0	0.6	2.1	0.0	3.2	**269**
A-40	30	5.7	25.7	5.7	3.3	0.0	0.0	0.0	12.9	0.0	2.4	**117**
A-44	34	7.3	50.9	7.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**72**
A-48	38	8.1	56.9	5.6	0.6	0.0	1.3	0.0	0.0	0.0	0.6	**117**
A-52	42	10.7	95.0	14.3	0.0	0.0	1.4	0.0	0.0	0.0	0.0	**170**
A-56	46	8.6	42.9	9.6	1.8	0.0	2.5	0.4	3.9	0.0	1.4	**199**
A-60	50	5.8	45.8	5.8	0.0	0.0	1.7	0.0	0.0	0.0	0.8	**72**
A-64	54	8.6	69.5	8.6	1.9	0.0	2.4	0.0	2.4	0.0	1.0	**198**
A-68	58	7.5	27.1	5.0	1.8	0.0	1.1	0.0	4.3	0.0	1.8	**136**
A-72	62	8.6	12.3	7.7	5.0	0.0	0.9	0.5	8.6	0.0	2.3	**101**
A-76	66	5.0	7.5	5.5	5.0	0.0	1.5	0.0	4.0	0.0	0.5	**58**
A-80	70	2.0	10.0	4.5	3.5	0.0	1.5	0.0	1.5	0.0	1.0	**48**
A-83	73	2.4	5.2	2.9	1.4	0.0	1.0	0.0	2.4	0.0	0.0	**32**
A-87	77	3.6	5.9	1.8	5.0	0.0	2.3	0.0	1.8	0.0	0.0	**45**
A-91	81	3.2	2.7	1.1	2.2	0.0	0.8	0.5	5.7	1.1	0.8	**67**
A-95	85	1.6	1.6	0.0	0.6	0.0	0.3	0.0	0.9	0.0	0.0	**16**
A-99	89	3.4	6.6	0.9	5.0	0.0	0.0	0.0	2.5	0.0	0.0	**59**
B-3	93	3.5	15.9	0.6	4.7	0.0	0.0	0.0	4.4	0.0	0.6	**101**
B-7	97	8.5	11.5	3.3	4.6	0.0	0.5	0.0	3.8	0.0	0.5	**128**
B-11	101	6.1	25.6	1.1	4.7	0.0	1.7	0.0	1.1	0.0	0.3	**146**
B-15	105	7.7	50.9	0.6	3.4	0.0	2.0	0.0	2.3	0.0	1.7	**240**
B-19	109	6.1	25.3	0.3	7.8	0.0	0.0	0.0	3.6	0.0	2.8	**165**
B-23	113	5.3	13.1	0.3	4.1	0.0	0.0	0.6	3.8	0.0	0.3	**88**
B-27	117	3.9	17.8	0.3	4.7	0.0	0.0	0.3	4.2	0.0	1.9	**119**
B-32	122	5.1	7.1	0.3	4.0	0.0	0.0	0.0	1.1	0.0	0.0	**62**
B-36	126	3.8	11.3	0.0	5.0	0.0	0.0	0.4	3.3	0.0	0.4	**58**
B-40	130	7.9	3.6	0.7	11.8	0.0	0.0	1.1	6.4	0.0	0.0	**88**
B-44	134	4.2	3.6	0.3	3.3	0.0	0.3	0.3	1.2	0.0	0.0	**44**
B-48	138	3.0	5.7	0.9	6.5	0.0	0.0	0.0	0.4	0.0	0.4	**39**
B-52	142	3.2	13.2	5.3	3.7	0.5	0.5	0.0	2.1	0.0	0.0	**54**
B-56	146	3.3	13.3	1.8	2.4	0.6	0.0	0.0	0.6	0.0	0.0	**73**
B-60	150	6.5	51.0	7.5	2.0	0.0	0.0	0.0	0.0	0.0	1.0	**136**
B-64	154	10.7	54.4	3.0	3.0	0.0	0.0	0.0	1.1	0.0	0.4	**196**
B-68	158	5.7	23.2	1.1	0.7	0.0	0.0	0.4	0.0	0.0	0.0	**87**
B-72	162	4.2	28.2	2.4	3.3	1.5	0.3	0.0	0.0	0.0	0.6	**134**
B-76	166	11.1	18.6	2.1	7.9	0.0	1.4	0.0	1.1	0.0	0.0	**118**
B-80	170	10.0	10.0	2.9	5.7	0.0	0.0	0.0	0.0	0.0	0.0	**80**

Table 3 (cont.). Ostracode concentrations in core 96-2. – Continued

Sample No.	depth (cm)	*Candona* sp. 1 (valves/g)	*Candona* sp. 2 (valves/g)	*Candona* sp. 3 (valves/g)	*Candona* sp. 4 (valves/g)	*Candona* sp. 5 (valves/g)	*Candona* sp. 6 (valves/g)	*Candona* sp. 7 (valves/g)	*Limno.* sp. 1 (valves/g)	*Limno.* sp. 2 (valves/g)	unidentified species (valves/g)	**TOTAL (valves/g)**
B-84	174	10.7	13.7	1.3	1.0	0.0	0.0	0.0	0.0	0.0	0.7	**82**
B-88	178	8.4	4.8	0.0	2.9	0.0	0.0	0.3	0.0	0.0	0.0	**51**
B-92	182	10.0	20.4	1.8	1.1	0.4	2.1	0.4	0.0	0.0	0.4	**102**
B-96	186	3.3	14.6	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	**44**
B-100	190	3.8	1.5	0.0	0.3	0.0	0.0	1.5	0.3	0.0	0.3	**30**
C-3	194	5.3	11.1	0.3	0.0	0.0	0.0	0.3	0.0	0.0	0.0	**64**
C-7	198	9.2	3.3	0.3	0.0	0.0	0.0	0.3	0.0	0.0	0.0	**51**
C-11	202	22.7	11.8	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	**77**
C-14	205	18.6	39.1	1.8	0.5	0.0	0.0	2.3	0.0	0.0	0.9	**139**
C-18	209	20.5	34.5	4.1	0.5	0.0	0.0	0.9	0.0	0.0	0.9	**135**
C-22	213	20.8	53.3	2.1	0.0	0.0	0.0	0.8	0.0	0.0	1.7	**189**
C-26	217	4.3	11.4	1.0	0.5	0.0	0.0	0.5	1.0	0.0	0.0	**39**
C-30	221	10.0	16.5	0.0	0.0	0.5	0.0	0.5	1.5	0.0	0.0	**58**
C-34	225	5.9	5.5	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	**29**
C-38	229	9.1	5.9	0.0	0.9	0.0	0.0	0.0	0.5	0.0	0.0	**36**
C-41	232	12.7	4.5	0.0	0.9	0.0	0.0	0.0	1.4	0.0	0.0	**43**
C-45	236	15.7	0.9	0.4	1.3	0.0	0.0	0.0	1.3	0.0	0.0	**45**
C-50	241	3.0	0.4	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.4	**10**
C-54	245	4.3	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**21**
C-58	249	5.7	3.9	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	**25**
C-62	253	5.7	6.1	0.0	0.0	0.0	1.7	0.0	0.0	0.0	0.0	**31**
C-66	257	1.2	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**15**
C-70	261	1.3	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**6**
C-74	265	0.9	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**4**
C-78	269	0.8	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**3**
C-82	273	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**5**
C-86	277	0.8	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**4**
C-90	281	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**1**
C-94	285	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**3**
C-98	289	0.9	1.4	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	**6**
D-0	292	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**2**
D-4	296	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**1**
D-8	299	0.6	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**2**
D-11	303	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**1**
D-16	308	0.5	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**4**
D-20	312	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**1**
D-24	316	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
D-28	320	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
D-32	324	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
D-36	328	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
D-40	332	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
D-44	336	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
D-48	340	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**1**
D-52	344	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
D-56	348	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
D-60	352	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**

Table 3 (cont.). Ostracode concentrations in core 96-2. – Continued

Sample No.	depth (cm)	*Candona* sp. 1 (valves/g)	*Candona* sp. 2 (valves/g)	*Candona* sp. 3 (valves/g)	*Candona* sp. 4 (valves/g)	*Candona* sp. 5 (valves/g)	*Candona* sp. 6 (valves/g)	*Candona* sp. 7 (valves/g)	*Limno.* sp. 1 (valves/g)	*Limno.* sp. 2 (valves/g)	unidentified species (valves/g)	**TOTAL (valves/g)**
D-64	356	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
D-68	360	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
D-72	364	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
D-76	368	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
D-80	372	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
D-84	376	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
D-88	380	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
D-92	384	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
D-96	388	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**
D-100	392	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0**

Zone 3 (192 to 255 cm) is characterized by a large increase in the concentration of *Candona* sp. 1 and contains peaks in the concentrations of *Candona* sp. 2, *Candona* sp. 3, *Candona* sp. 7, and the unidentified species make their first appearances in the core and exhibit minor peaks in their concentrations in this zone. *Candona* sp. 4 occurs in low concentrations. *Limnocythere* sp. 1 has two small, isolated occurrences in this zone.

Zone 4 (255 to 308 cm) contains low concentrations of *Candona* sp. 1 and *Candona* sp. 2.

Zone 5 (308 to 392 cm) contains two isolated occurrences of *Candona* sp. 1; otherwise, it is barren.

Core 96-1 contains only two zones, which are equivalent to Zone 1 and the upper part of Zone 2 defined in core 96-2.

Zone 1 (0 to 221cm) is characterized by the highest ostracode concentrations in the core.

Zone 2 (221 to 500 cm) is defined by overall low ostracode concentrations.

Correlating the minor fluctuations in ostracode assemblages in Zone 1 between the two cores is hampered by the low sample resolution in core 96-1. However, the overall ostracode concentration structure from core 96-1 seems to match well with the concentration structure in the upper ~ 200 cm of core 96-2 (fig. 3). Plotting the total ostracode concentrations by age (based on the age equations of Colman and others, 2005) shows that the overall rise and fall of ostracode concentrations are similar in the two cores (fig. 4). Both cores show a marked increase in ostracode concentrations at ~3300 cal yr BP.

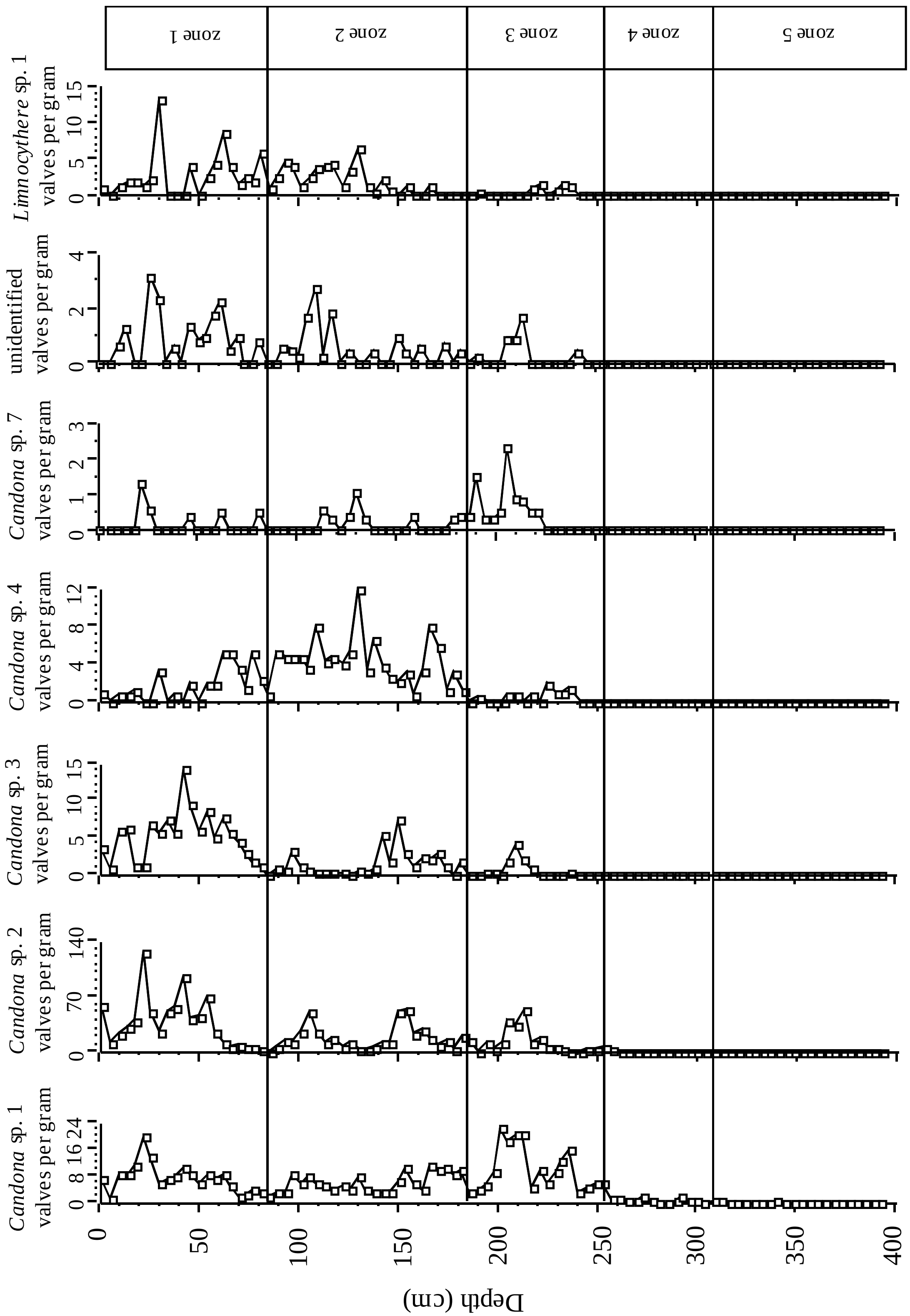

Figure 2. Abundances of common ostracode fauna (valves per gram, vpg) vs. depth for core 96-2. Faunal zones are shown on the right side of the diagram.

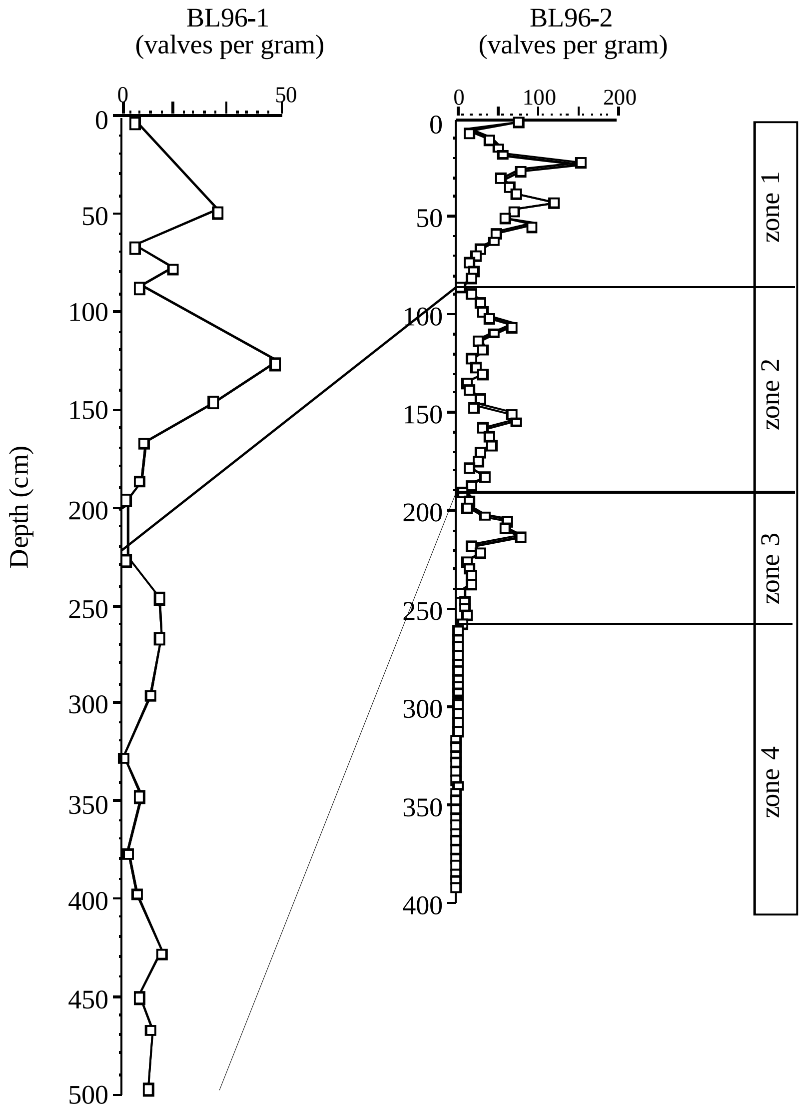

Figure 3. Correlation between ostracode zones vs. depth in cores 96-1 and 96-2, based on total valve concentrations (valves per gram, vpg). Faunal zones are shown on right side of diagram.

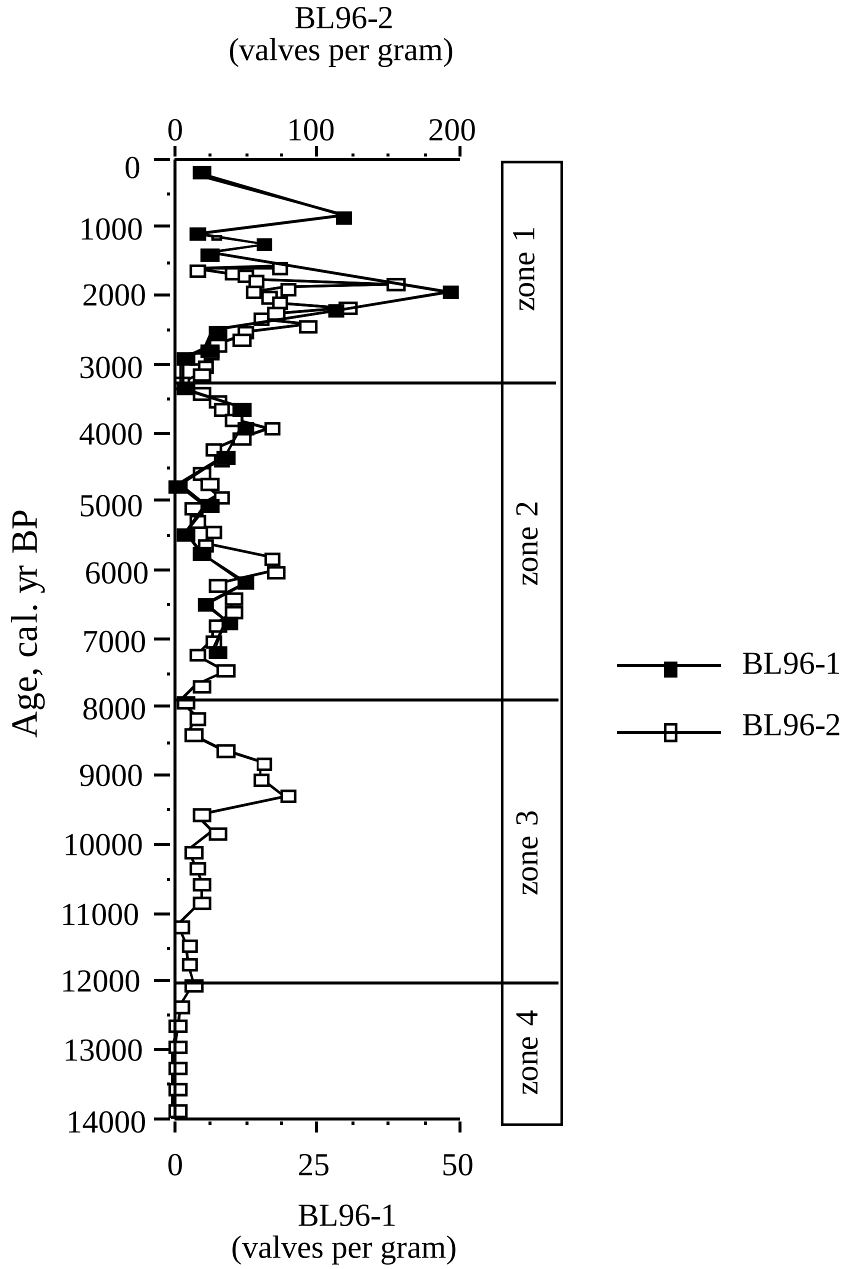

Figure 4. Total concentration of ostracodes (valves per gram, vpg) and faunal zones vs. age. Chronology from Colman and others (2005). Faunal zones are shown on right side of diagram.

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