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Jurassic Taxa Ranges and Correlation Charts
for the Circum Pacific

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5. North America



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Preface

This is part of a series of papers dealing with the Jurassic fossil record of the Circum-Pacific area. The principal parts are:

1. Soviet Union
2. China (People's Rep.)
3. South America and Antarctic Peninsula
4. Japan and South-East Asia
5. North America
6. Australasia

Parts 1 to 4 have been published previously in this Journal (Vol. 19, 1 & 2 : 1-130, 1988, Vol. 21, 2 : 75-147, 1990 and Vol. 24, 1/2 : 81-108, 1991).

This publication is one of the outcomes of the research undertaken under the IGCP Project # 171: Circum-Pacific Jurassic. The Project began in 1980 and has attempted to integrate investigations of all aspects bearing on the correlation of the Circum-Pacific Jurassic, with the aim to provide a more detailed documentation of fossil ranges than is usually available in the literature.

The idea embodied in the range charts is to provide a data source for a variety of uses, especially for constructing sound biostratigraphic zones and correlations for the Jurassic of the entire Circum-Pacific area. Subsequently, these correlations may be used for accurate dating of magmatic, tectonic and evolutionary events and for paleogeographic and biogeographic reconstruction.

We intended to include, as far as possible, all fossil taxa. However, given the variety of contributors and the differences in the state of knowledge of the taxa in each area, the levels of coverage and consistency vary greatly.

In order to provide useful and objective data, we decided to select those taxa and ranges which have been documented and illustrated in published records. Contributors were asked to document the fossil ranges for the taxa and areas they were most familiar with. These records were to be correlated as precisely as possible with the European standard Jurassic scale, i. e. the standard zones. It is evident, however, that some fossil groups, especially those of continental sequences, require a scale of lower accuracy. More details of the methodology are given below.

The editors wish to thank all contributors for the time and effort devoted to this project.

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Methods and Symbols

Each paper of this series is organized in a similar pattern: a brief introduction (with map); discussions of the regional fossil assemblages and of the biozones if known (with correlation chart); brief comments on the taxa in each biostratigraphic unit (with range charts); and bibliographic references.

A general correlation chart includes the regional fossil assemblages and biozones. Both are numbered as in the range charts and correlated with other regional zones, and with the standard chronostratigraphic scale, with the best precision possible. Lithostratigraphic units may also be included. The range charts are prepared for each fossil group with the appropriate degree of accuracy and using the symbols shown in Fig. A. The standard forms for the charts, provided by the editors, include only (A) the stages and substages, scaled according to the averaged subzone method (WESTERMANN 1984, Episodes 7, 2: 26-28). Addition of the European standard zones for greater accuracy is optional. (B) Taxa names are followed by numbers shown in brackets, referring to the numbered reference(s) in the bibliography. (C) Vertical range and, if applicable, relative abundance of species are indicated by symbols as shown in Fig. A, including also notations for guide fossils and biogeographic distribution. Stage and substage boundaries are indicated according to their regional precision. (D) Informal numbers at the bottom of each table, alone or together with the abbreviated names of regional zones, are the same as in the correlation chart.

In the text, biozones are in lower case and italics; standard zones in upper case and normal script.

SERIES TAXA	STAGE	AAL.	BAJOCIAN	BATHONIAN			
			Lower	Upper			
1 <i>Chonetes dotoformis</i> (5)				—			
2			—	—			
3 <i>Grossouvreia</i> sp. (8)			—	+	(single specimen)		
4			—	—	(single level / age)		
5			—	—	(level / age uncertain — generally omit)		
6			—	—	(endemic to area discussed)		
7			—	—	(local — single locality < 10 km.)		
8			—	—	(stage boundary certain)		
9			—	—	(substage boundary uncertain -- as is)		
			—	—	(uncertain)		
			—	—	primary marker taxon -- lower and upper limits defined		
			—	—	supplementary marker taxon -- upper limit defined		
			—	—	same -- no limit defined		
REGIONAL ZONATION		1	2a. 2b. 2a. 2b.				
		?	Z.2				
Northern Fossilland							
H. Smith							
E							

Fig. A. Symbols used in the range tables.

5. North America

5.1 Lower Jurassic

by P. L. SMITH, J. M. BEYERS, E. S. CARTER, G. K. JAKOBS, J. PÁLFY, E. PESSAGNO,
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with 1 figure and 19 charts

Introduction

Lower Jurassic rocks are known along the Pacific margin of North America from Mexico to Alaska (WESTERMANN 1992). This report deals with fossils from the allochthonous terranes and the western margin of the craton; excluded are faunas from the geographically adjacent areas of northern Alaska (e.g. IMLAY 1981), northern Yukon (e.g. POULTON 1991) and eastern Mexico (e.g. ERBEN 1956).

Fossiliferous Lower Jurassic rocks of California are separated from the platformal rocks of western Nevada by the Sierra Nevada batholith where roof pendants yield rare and poorly preserved fossils (JONES & MOORE 1973). In Oregon, limited breaches in the extensive Tertiary volcanic cover have revealed marine Lower Jurassic rocks in the east-central and northeastern parts of the State. The allochthonous terranes of western Canada and southern Alaska were the sites of deposition of great thicknesses of marine Lower Jurassic rocks derived from volcanic activity and the weathering of volcanic rocks. By contrast, correlative marine sequences on the western margin of the craton in what is now western Alberta and northeastern British Columbia, are thin and composed entirely of cratonal sediments. Terrestrial rocks are restricted to the Colorado Plateau in the United States where the Glen Canyon Group has yielded an important vertebrate fauna.

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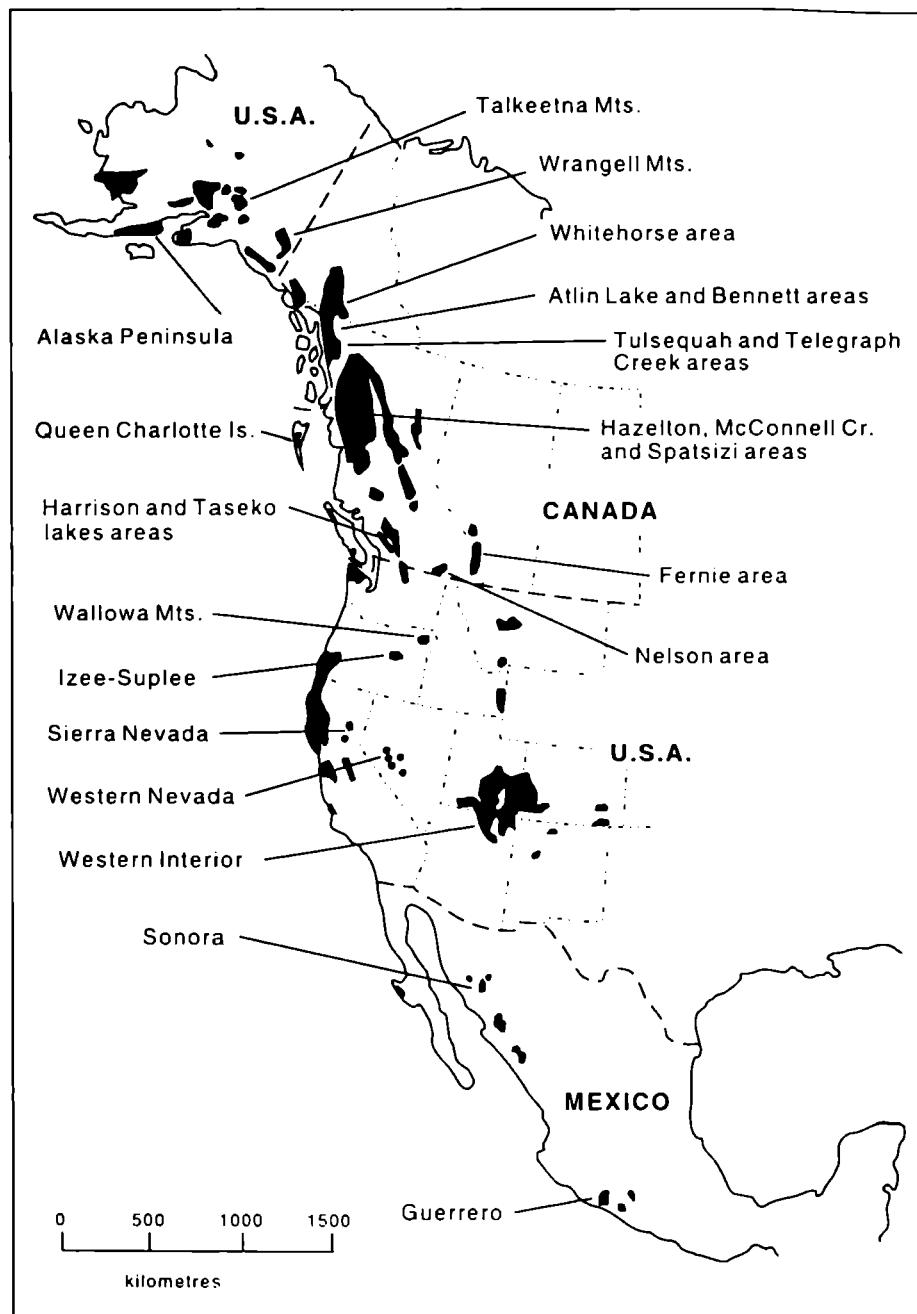


Fig. 1. Index map of Jurassic outcrops and important Lower Jurassic localities in western North America.

Early Jurassic organisms of western North America therefore inhabited a diverse suite of tectonic and sedimentary environments spanning a considerable paleolatitude. The region became more strongly convergent in the Early Jurassic as Pangaea fragmented and North America began its northwestward drift (OLDOW et al. 1984, MAY & BUTLER 1986). This introduces the possibility of an Early Jurassic seaway, the Hispanic Corridor, linking the western Tethyan Ocean and the eastern Pacific, a link that would have significant biogeographic ramifications in both terrestrial and marine environments (SMITH & TIPPER 1986, SMITH 1988).

Ammonites and to a much lesser extent bivalves, have the longest history of study in North America in that they have provided age constraints for geological mapping which is still going on in remote parts of the continent. The relatively recent discovery of stratabound precious metal deposits and potential oil source rocks in Lower Jurassic sequences of western Canada has given impetus to the study of these rocks and emphasized the importance of refining biostratigraphic control. The application of radiolarians is becoming increasingly more important since they are widespread, can be readily used in the subsurface, and often occur in otherwise unfossiliferous rocks, particularly in mélange terranes. The study of most of the other groups of organisms dealt with below has barely begun. We have chosen to base the range charts on taxa that are illustrated in the literature and to leave untouched the extensive lists of undescribed fossils that exist in geological reports and paleontological compilations.

Comments to Correlation Chart (Chart 1)

The only formally described ammonite zones for the Lower Jurassic of North America are the Canadensis Zone* of FREBOLD (1967) and the Pliensbachian zones established by SMITH et al. (1988). The present compilation represents a progress report on the synthesis of ammonite biostratigraphy for the rest of the North American Lower Jurassic where work on the Hettangian and Sinemurian of western Nevada and the entire Lower Jurassic of the Queen Charlotte Islands is proving to be critical. It has led to the recognition of the informal assemblages used herein which represent a first step towards a formal zonation (TIPPER & GUEX in press, JAKOBs et al. in press, PALFY et al. in press). The following sequence of ammonite zones and assemblages is distinguished, in ascending order:

A – *Psiloceras* Assemblage – TIPPER & GUEX (in press). Poorly represented in the Queen Charlotte Islands, the *Psiloceras* fauna is best known from Nevada.

B – *Euphyllites* Assemblage – TIPPER & GUEX (in press). Euphyllitids occur with species of *Discamphiceras* and *Fergusonites striatus*.

C – *Franziceras* Assemblage – TIPPER & GUEX (in press). *Saxoceras* and schlotheimiids are abundant in the lower beds; the rest of the assemblage contains the last known *Pleuroacanthites* and species of *Caloceras*.

* Editor's Note: Exceptionally in this series of papers, the names of standard zones are in upper case and normal script (not in italics).

Chart 1

STAGE		NORTH AMERICAN AMMONITE ZONES		NORTHWEST EUROPEAN AMMONITE ZONES	NORTH AMERICAN RADIOLARIAN ZONES		
		↓ Code for range charts			SUPERZONE	ZONE	SUBZONE
TOARCIAN	U	U Assemblage 6		Levenquei	1	1A (pt.)	1A2
		T Assemblage 5		Thouarsense			
		S Assemblage 4		Variabilis			
	M	R Assemblage 3		Bifrons			
	L	Q Assemblage 2		Falciferum			01B
		P Assemblage 1		Tenuicostatum			01A
PLIENSBACHIAN	U	O Carlottense Zone		Spinatum	01		
		N Kunae Zone		Margaritatus			
		M Freboldi Zone		Davoci			
	L	L Whiteavesi Zone		Ibex		02	
		K Imlayi Zone		Jamesoni			
SINEMURIAN	U	J Tetraspidoceras Assemblage		Raricostatum	02		
		I Pleschioceras? hubbledownense Assemblage		Oxynotum		03	
		H Asteroceras cf. varians Assemblage		Ohlusum			
	L	G Arnioceras arnouldi Assemblage		Turritum		04	
		F Coroniceras Assemblage		Semicostatum			
		E Canadensis Zone		Bucklandi			
HETTANGIAN	D	Pseudactatomoceras doetzkirchneri Assemblage		Angulata	05		
		C Franziceras Assemblage		Liasicus			
		B Euphyllites Assemblage		Planorbis			
	A Psiloceras Assemblage						

D – *Pseudactatomoceras doetzkirchneri* Assemblage – TIPPER & GUEX (in press). The index species characterizes the beds immediately below the Canadensis Zone. Species of *Eolytoceras*, *Ectocentrites* and *Badouxia* are abundant.

E – Canadensis-Zone – FREBOLD (1967). In the type area of Taseko Lakes species of *Badouxia*, *Eolytoceras*, *Sunrisites*, *Vermiceras* and *Metophioceras* along with schlotheimids and phylloceratids characterize the zone. In the Queen Charlotte Islands the same taxa occur.

F – *Coroniceras* Assemblage – PÁLFY et al. (in press). The poorly preserved fauna consists of species of *Coroniceras?*, *Angulaticeras*, *Metophioceras*, *Arnioceras* and *Juraphyllites*.

G – *Arnioceras arnouldi* Assemblage – PÁLFY et al. (in press). Several species of *Arnioceras* accompanied by rare lytoceratids comprise the assemblage.

H – *Asteroceras cf. varians* Assemblage – PÁLFY et al. (in press). Asteroceratids accompanied, in lower strata, by long-ranging arnioceratids. Also important are *Epophioceras* aff. *carinatum* and *Hypasteroceras?* sp.

I – *Pleschioceras?* *hubbledownense* Assemblage- PÁLFY et al. (in press). Characterized by the first appearance of oxynoticeratids and echioceratids, near the base the assemblage also has species of *Tetraspidoceras*.

J – *Tetraspidoceras* Assemblage – PÁLFY et al. (in press). Signal taxa include eoderoceratids, *Juraphyllites* and the bivalve *Posidonotis semiplicata*. Rare oxynoticeratids and a new species of *Tetraspidoceras* occur only at the top of the assemblage zone.

K – Imlayi-Zone – SMITH et al. (1988). Characterizing taxa include *Metaderoceras* of the *evolutum* group and, in the upper parts of the zone, early species of *Tropidoceras*. The reference section through the black shales of the Ghost Creek Formation is exposed in Fannin Bay, Queen Charlotte Islands, B.C.

L – Whiteavesi Zone – SMITH et al. (1988). Stratotype in the Ghost Creek and Fannin (Rennell Junction Member) formations exposed in Fannin Bay, Queen Charlotte Islands, B.C. The zone is characterized by species of *Tropidoceras*, *Acanthopleuroceras*, early *Dubariceras* and *Metaderoceras*.

M – Freboldi Zone – SMITH et al. (1988). Stratotype in the Fannin Formation exposed in Fannin Bay, Queen Charlotte Islands with reference sections designated in the Spatsizi area, B.C. (THOMSON & SMITH 1992), and the Wallowa Mountains, Oregon. The zone is characterized by species of *Dubariceras*, *Reynesococloceras* and *Metaderoceras*, particularly coarsely ornamented species.

N – Kunae Zone – SMITH et al. (1988). Stratotype in the Fannin Formation exposed in Fannin Bay, Queen Charlotte Islands. Characterized by numerous species of hildoceratids, *Fanninoceras*, and, less commonly, dactylioceratids and *Amaltheus*. The Lower-Upper Pliensbachian boundary in North America does not precisely coincide with the boundary in Europe in that the base of the Kunae Zone is defined by the incoming of species of *Fanninoceras* which usually precede the incoming of the much less common amaltheids.

O – Carlottense Zone – SMITH et al. (1988). Reference sections in the Takwahoni Formation of the Tulsequah area, B.C.; Fannin Bay and Whiteaves Bay in the Queen Charlotte Islands, B.C.; and the Sunrise Formation exposed in the Clan Alpine Mountains, Nevada. Characterized by species of *Fanninoceras*, *Lioceratoides*, *Tiltoniceras*, *Protogrammoceras* and *Amaltheus*.

P – Assemblage 1 – JAKOBS et al. (in press). An interval above the range of *Amaltheus* and *Fanninoceras* that is characterized by species of *Dactylioceras*, *Tiltoniceras*, and *Protogrammoceras* with rare occurrences of *Taffertia*. The upper and lower limits of this assemblage are poorly constrained.

Q – Assemblage 2 – JAKOBS et al. (in press). Characterized by species of *Harpoceras* and *Hildaites* with poorly preserved *Dactylioceras* occurrences.

R – Assemblage 3 – JAKOBS et al. (in press). A diverse assemblage of Tethyan aspect primarily consisting of species of *Peronoceras*, *Leukadiella*, *Piromiceras*, *Rarenodia*, and *Phymatoceras*.

S – Assemblage 4 – JAKOBS et al. (in press). This assemblage, which occurs above the last occurrence of *Rarenodia planulata*, is also Tethyan in aspect being characterized by species of *Phymatoceras*, *Mercaticeras*, *Pseudomercaticeras*, *Brodicia* and *Denckmannia*.

T – Assemblage 5 – JAKOBS et al. (in press). The lower limit of this assemblage zone is marked by the appearance of *Grammoceras thouarsense* and *Phymatoceras* n.sp. above the last occurrence of *Peronoceras* and *Phymatoceras crassicosta*. The fauna is low in diversity and characterized by species of *Phymatoceras*, *Podagrosites* and *Grammoceras*. The Assemblage 5a fauna of JAKOBS et al. (in press) is now included within Assemblage 6.

U – Assemblage 6 – JAKOBS et al. (in press). A highly endemic and diverse assemblage, incoming forms include *Hammatoceras speciosum*, *Pleydellia aalensis*, *Pleydellia* n.sp. and a new genus of Phymatoceratinæ previously assigned to *Haugia*. These disappear near the top of the assemblage zone. Other forms such as *Sphaerocoeloceras brochiiforme*, *Dumortieria?* n.sp., and *Pseudolioceras compactile* are restricted to the middle of the assemblage zone.

A preliminary Lower Jurassic zonation for North American radiolarians has been described in detail by PESSAGNO et al. (1987). Radiolarian data from the Queen Charlotte Islands (CARTER et al. 1988) which were included in this compilation can now be correlated more accurately with the North American ammonite zonation (JAKOBS 1992; JAKOBS et al. in press) as follows:

The upper part of Subzone 01A (North American Radiolarian Zonation) which includes Queen Charlotte Island radiolarian zone 1 of CARTER et al. (1988) correlates with the North American Carlottense Ammonite Zone.

The uppermost part of Subzone 01B and lowermost part of Subzone 1A₂ (North American Radiolarian Zonation) which includes Queen Charlotte Island radiolarian zone 2 of CARTER et al. (1988) correlate with the upper part of ammonite Assemblage 3 and lower part of Assemblage 4 of JAKOBS (1992).

The upper part of Subzone 1A₂ (North American Radiolarian Zonation) which includes Queen Charlotte Island radiolarian zones 3, 4 and 5 of CARTER et al. (1988) correlates with ammonite Assemblage 6 of JAKOBS (1992).

Comments to Range Charts

Ammonoids (charts 2–6)

1. GUEX (1980) and TOZER (1982) determined that FREBOLD's (1967 a) specimen is not a *Psiloceras* but probably a Triassic *Rhacophyllites*.
9. Imlay suggests an Early Hettangian age whereas occurrences at Kennecott Point and in Nevada suggest a mid-Hettangian age.
28. Formerly *Alsatisoides coronoides* as discussed by GUEX (1989) and TIPPER & GUEX (in press). *Franziceras* sp. in TIPPER et al. (1991) may be the same form.
32. The forms in these three publications probably represent different schlotheimiid species.
38. Originally *Psiloceras occidentale*, which is now considered a *Badouxia*.
39. BLOOS (1988) proposed that all Late Hettangian-Early Sinemurian schlotheimiids assigned to *Sulciferites*SPATH and *Charmasseiceras*SPATH be assigned to *Angulaticeras*; this was accepted by TIPPER & GUEX (in press) but PÁLFY et al. (in press) assigned *Charmasseiceras* to *Sulciferites* following DONOVAN & FORSEY (1973).
40. Originally *Paracaloceras rursicostatum*. *Metophioceras* is accepted by PÁLFY et al. (in press) following GUÉRIN-FRANIATTE (1966) for forms closely allied with *Coroniceras*. Hence *Metophioceras rursicostatum* is preferred.
42. Includes *Schlotheimia* cf. *acuticosta* illustrated in FREBOLD (1964 b), synonymized by him (1967 a) with *Psiloceras columbiae* and placed in *Badouxia* by GUEX & TAYLOR (1976).
43. Probably not *Discampficeras*. Associated with *Paracaloceras* which at Last Creek is usually but not always in the upper part of the Canadensis Zone. If this is correct then an earliest Sinemurian age is indicated. It is higher than any *Discampficeras* in Nevada or at Kennecott Point.
44. Considerable confusion exists about this species. FREBOLD (1967 a) originally described some of these specimens as *Vermiceras scylla* (FREBOLD 1951; 1964 b). The stratigraphic position needs clarification.

Chart 2

LOWER JURASSIC	HETT.	SINEMURIAN		PLIENSBACHIAN		TOARCIAN															
AMMONOIDS		LOWER	UPPER	LOWER	UPPER	LOWER	MIDDLE	UPPER													
1 Psiloceras cf. planorbis (19,38,65)	?																				
2 Psiloceras pacificum (29)	—																				
3 Laqueoceras cf. sublaqueus (38)	—																				
4 Psiloceras erugatus (43)	|																				
5 Psiloceras calliphyllum (63,65)	—																				
6 Nevadaphyllites compressus (29,65)	—																				
7 Psiloceras polymorphum (29)	|																				
8 Transipsiloceras transiens (29)	|																				
9 Franziceras cf. ruidum (38,65)	?																				
10 Discamphiceras antiquum (29)	—																				
11 Fergusonites striatus (29,62,65)	—																				
12 Discamphiceras silberlingi (29,65)	—																				
13 Discamphiceras sp. (38,62)	.....																			
14 Kammerkarites praecoronoides (29,31)	|																				
15 Discamphiceras kammerkaroides (26)	|																				
16 Kammerkarites rectiradiatus (29)	|																				
17 Phylloceras spp. (37,59,62)	+			+	.....															
18 Kammerkarites frigga (30)	—																				
19 Kammerkarites haplotychus (30)	—																				
20 Pleuroacanthites mulleri (29,30)	—																				
21 Discamphiceras cf. toxophorum (38)	—																				
22 Kammerkarites? sp. (62)	...																				
23 Wachneroceras cf. tenerum (38)	—																				
24 Wachneroceras cf. portlocki (38,65)	—																				
25 Euphyllites occidentalis (29)	|																				
26 Kammerkarites diplotychoides (29)	|																				
27 Franziceras aff. ruidum (31)	|																				
28 Franziceras coronoides (29,31,65)	—																				
REGIONAL ZONATION	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U

Chart 3

LOWER JURASSIC	HETT.	SINEMURIAN								
		LOWER	UPPER							
AMMONOIDS										
29 <i>Mullerites pleuroacanthoides</i> (29,65)	|	-	-							
30 <i>Sunrisites sunrisense</i> (29,65)	—	-	-							
31 <i>Eolytoceras tasekoi</i> (19)	—	-	-							
32 <i>Schlotheimia</i> spp. (13,38,62,65)	—	-	-							
33 <i>Paradiscamphiceras dickinsoni</i> (56)	-	-	-							
34 <i>Badouxia canadensis</i> (13,17,38,48,62,65)	—	-	-							
35 <i>Paradiscamphiceras athabascaense</i> (56)	|	-	-							
36 <i>Eolytoceras</i> sp. (19)	|	-	-							
37 <i>Paracaloceras subsalinarium</i> (58)	-	-	-							
38 <i>Badouxia occidentalis</i> (19)	—	-	-							
39 <i>Sulciferites marmoreus</i> (19,38,48)	—	-	-							
40 <i>Metophioceras rursicostatum</i> (19,65)	—	-	-							
41 <i>Paracaloceras</i> cf. <i>grunowi</i> (58)	-	-	-							
42 <i>Badouxia columbiæ</i> (13,19,38)	—	-	-							
43 <i>Discamphiceras?</i> <i>tipperi</i> (19)	||	-	-							
44 <i>Paracaloceras</i> cf. <i>coregonense</i> (13,17,19)	?	-	-							
45 <i>Paracaloceras multicostatum</i> (19)	?	-	-							
46 <i>Vermiceras crossmani</i> (5)	?	-	-							
47 <i>Vermiceras</i> sp. (62)	?	-	-							
48 <i>Charmasseiceras</i> sp. (38)	...	-	-							
49 <i>Arietites</i> cf. <i>bucklandi</i> (38)	...	-	-							
50 <i>Coroniceras bisulcatum</i> (13,17)	—	-	-							
51 <i>Coroniceras</i> spp. (38)	.....	-	-						
52 <i>Vermiceras latisulcatum</i> (13,17)	?	-	-							
53 <i>Paracoroniceras</i> cf. <i>gmundense</i> (17)	...	-	-							
54 <i>Paracoroniceras</i> sp. (38)	...	-	-							
55 <i>Arnioceras begbiei</i> (6)	.....	-	-						
56 <i>Arnioceras humboldti</i> (36, 43)	.....	-	-						
57 <i>Arnioceras kwakiutlanus</i> (6,17,24)	.....	-	-						
58 <i>Arnioceras nevadanus</i> (27)	.....	-	-						
59 <i>Arnioceras telferi</i> (64)	.....	-	-						
60 <i>Arnioceras vancouverensis</i> (68)	.....	-	-						
61 <i>Arnioceras</i> spp. (15,17,38,50)	—	-	-							
62 <i>Arnioceras arnouldi</i> (48,62,65)	—	-	-							
63 <i>Agassiceras</i> cf. <i>scipionianum</i> (13)	..	-	-							
64 <i>Arnioceras</i> cf. <i>densicosta</i> (38)	—	-	-							
65 <i>Asteroceras</i> cf. <i>stellare</i> (13,33,65)	↑...	-	-							
66 <i>Asteroceras</i> spp. (50,62)	—	↑...	-							
67 <i>Asteroceras</i> cf. <i>variana</i> (48)	—	—	-							
68 <i>Epophioceras</i> cf. <i>breoni</i> (33,65)	—	+	-							
69 <i>Arcoasteroceras jeletzkyi</i> (38,65)	—	?	-							
70 <i>Plesiochiloceras?</i> <i>harbledownense</i> (6, 38,48,62,65)	—	—	—							
71 <i>Euechioceras exoletum</i> (9)	—	—	?							
REGIONAL ZONATION	A	B	C	D	E	F	G	H	I	J

46. CRICKMAY's (1925) figure is closely similar to *Metophioceras rursicostatum* (FREBOLD).
50. This species was assigned to *Arietites* by GUÉRIN-FRANIATTE (1966).
55. Originally *Arniotites begbiei*. The type shows affinity to *Arnioceras ceratitoides* group but due to its poor preservation the name should fall into disuse.
56. Probably a junior synonym of *Arnioceras ceratitoides*.
57. Originally *Arniotites kwakiutlanus*. Probably a junior synonym of *Arnioceras arnouldi*, although the type material is incomplete and poorly preserved.
60. Probably a juvenile *Arnioceras*.
70. The species *harbledownense* is the type for the monospecific genus *Melanhippites* which is now considered to be an echioceratid, possibly *Plesioechioceras*. *Arnioceras* (*Melanhippites*) sp. indet. from the Salmo area (FREBOLD 1959) is probably also an echioceratid.
- 75, 76. These taxa are probably also present in the Salmo map area originally described as *Perisphinctes*? s.l.sp. indet. (FREBOLD & LITTLE 1962, TIPPER 1984).
81. Includes *Crucilobiceras pacificum* (FREBOLD 1970, IMLAY 1981).
85. Probably a *Metaderoceras*.
- 86–87. 86 Includes *Gleviceras* sp. indet. of FREBOLD (1969) and *Oxynoticeras* sensu lato sp. indet. of FREBOLD (1970). 87 Includes *Eoderoceras* sp. indet., E? sp. indet., and *Crucilobiceras*? sp. indet. of FREBOLD (1969); *Crucilobiceras*? sp. indet. was later revised to *Coeloceras* sp. indet. (FREBOLD (1970). This fauna was thought to indicate a Late Sinemurian or Early Pliensbachian age but the latter seems more likely particularly as *Phricodoceras* is reported from the same general locality (FREBOLD 1970).
89. Includes *Crucilobiceras* cf. *submuticum* of IMLAY (1981).
90. *Crucilobiceras* cf. *muticum* described from Alaska by IMLAY (1981) constitutes the type material. Included here for the present is the related form *M. aff. talkeetnaense* of THOMSON & SMITH (1992).
96. A problematic form possibly belonging to *Oistoceras*.
97. THOMSON & SMITH (1992) present the most recent synonymy for this biostratigraphically important, east Pacific species.
102. WIEDENMAYER (1977, 1980) suggests that this form and species 106, 126 and 137 can be accommodated in the Tethyan genera *Reynesocoeloceras* and *Aveyroniceras*.
105. Includes *Prodactylioceras davoei* of FREBOLD (1964 a) as discussed by WIEDENMAYER (1980).
106. See 102.
108. WIEDENMAYER (1980) considered this assignable, in part, to the genus *Oregonites*.
112. *Oregonites imlayi* of WIEDENMAYER (1980).
116. Includes some material assigned to *Arieticeras ruthenense* (WIEDENMAYER 1980, THOMSON & SMITH 1992).
- 117–119. Assigned to *Oregonites* by WIEDENMAYER (1980).
126. See 102.
131. Placed in *Leptaleoceras* by BRAGA (1983).
133. The form figured by IMLAY (1968) is probably a *Protogrammoceras*? sp. indet. of Pliensbachian age. The form figured by FREBOLD (1976) is a *Harpoceras*? sp. indet. of the Early Toarcian (Assemblage 2).

Chart 4

LOWER JURASSIC		PLIENSBACHIAN			
AMMONOIDS		LOWER	UPPER		
72 Cruciloboceras cf. crucilobatum	(38,65)				
73 Tetraspidoceras sp.	(48)	-			
74 Juraphyllites? aff. nardii	(48)	+			
75 Miltoceras sp.	(59)	—			
76 Gemmellaroceras sp.	(53,54)	—			
77 Tropidoceras cf. erythraeum	(54)	—			
78 Pseudosirocceras imrayi	(53,54,62,65)	—			
79 Tropidoceras flandriini	(59,62)	—			
80 Tropidoceras actaeon	(22,38,65)	—			
81 Metaderoceras evolutum	(22,38,53,54,59)	—			
82 Phricodoceras cf. taylori	(22,53,54,62)	—			
83 Acanthopleuroceras whiteavesi	(54,59,62,65)	—			
84 Tropidoceras masseanum	(62)	—			
85 Acanthopleuroceras sutherlandbrownii	(22)	?			
86 Oxynoticeratidae spp.	(21,22)	?			
87 Reynesocoeloceras? spp.	(21,22)	?			
88 Acanthopleuroceras aff. stahli	(59)	—			
89 Dubariceras silviesi	(34,38,53,54,59)	—			
90 Metaderoceras talkeetnaense	(38,54,59)	—			
91 Gemmellaroceras aenigmaticum	(62)	—			
92 Ligaroceras (Bech.) cf. bechei	(16,17,37)	—	+		
93 Metaderoceras mouterdei	(22,24,38,53,54,59,65)	—			
94 Polymorphites? sp.	(59)	+			
95 Dayiceras sp.	(59)	-			
96 Uptonia? sp.	(38,59,65)	—			
97 Dubariceras freboldi	(22,38,51,53,54,59,62,65)	—			
REGIONAL ZONATION		J	K	L	M

LOWER JURASSIC		PLIENSBACHIAN			
AMMONOIDS		LOWER	UPPER		
98 Metaderoceras beirensis	(54)				
99 Reynesocoeloceras cf. baconicum	(54)				
100 Reynesocoeloceras cf. incertum	(59)				
101 Aveyroniceras spp.	(33,59)			....	....
102 Prodactylioceras cf. italicum	(37,38)			..	..
103 Prodactylioceras aff. davoei	(54)			||	
104 Aveyroniceras colubriforme	(52,53,54,65)			+	
105 Aveyroniceras cf. inaequiornatum	(16,17,54)			..	
106 Prodactylioceras cf. meneghini	(37)			..	
107 Fanninoceras fannini	(12,20,45,53,54,62)			+	
108 Arieticeras cf. domarense	(37,38)			....
109 Arieticeras cf. gerardi	(16,17)			..	....
110 Arieticeras lipheri	(37)			..	....
111 Canavaria cf. excellens	(37)			..	....
112 Canavaria? cf. morosa	(37)			..	....
113 Fanninoceras bodguae	(37,45)			..	....
114 Fanninoceras dolmagii	(20,45)			..	....
115 Fanninoceras lowrii	(45)			..	....
116 Fuciniceras cf. acutidorsatum	(37)			..	....
117 Fuciniceras cf. capellini	(37)			..	....
118 Fuciniceras cf. inclytum	(37)			..	....
119 Fuciniceras cf. laviniatum	(37)			..	....
120 Fuciniceras spp.	(37,59)			..	....
121 Holcophylloceras sp.	(37)			..	....
122 Leptaleoceras dickinsoni	(37)			..	....
123 Leptaleoceras cf. leptum	(37)			..	....
124 Leptaleoceras? morganense	(37)			..	....
REGIONAL ZONATION		K	L	M	N

134. *Protogrammoceras kurrianum* according to HOWARTH (1992).
137. See 102.
139. Includes *Harpoceras* spp. of FREBOLD (1959).
141. Includes *Amaltheus* sp. indet. aff. *gibbosus* of FREBOLD (1969) and *Amaltheus* sp. indet of FREBOLD (1969, 1970).
146. Includes forms previously assigned to *Leptaleoceras pseudoradians* as discussed by THOMSON & SMITH (1992).
147. The Oregon material is assigned to *Fontanelliceras perspiratum* by BRAGA (1983) although WIEDENMAYER (1980) assigned it tentatively to *Oregonites*.
149. WIEDENMAYER (1980) considered this assignable, in part, to the genus *Oregonites*.
- 158, 159. Probably includes species of *Lioceratoides*.
163. According to WIEDENMAYER (1981) the *Dactylioceras* (O.) cf. *kanense* of IMLAY (1968) is an *Aveyroniceras striatum* (DEL CAMPANA) of Pliensbachian age.
165. Probably a *Harpoceras*? sp. indet.
166. Many of the species figured by FREBOLD (1964 a) belong to *Protogrammoceras* sp. indet.
168. The form figured by IMLAY (1981) belongs to *Hammatoceras* sp. indet. of the latest Toarcian (Assemblage 6). The form figured by ARTHUR et al. (1993) belongs to *Hildaites* cf. *H. propeserpentinum* (BUCKMAN) of the Early Toarcian (Assemblage 2).
169. This form is *Harpoceras* cf. *chrysanthemum* (YOKOYAMA).
175. These forms belong to *Dactylioceras* cf. *athleticum* (SIMPSON).
176. This form belongs to *Polyplectus* cf. *subplanatus* (OPPEL).
177. This form may belong to *Dactylioceras* cf. *athleticum* (SIMPSON).
179. Probably a *Hildaites* sp. indet.
181. The form figured by FREBOLD (1976) is a *Peronoceras* cf. *verticosum* (BUCKMAN).
185. This form is *Phymatoceras* cf. *P. pseudoerbaense* (GABILLY).
188. Although similar to *Phymatoceras copiapense*, this is probably a new endemic species.
190. TAYLOR (1988) re-identified this form as *Asthenoceras boreale* (WHITEAVES) of Bajocian age.
191. This form is an indeterminate harpoceratid, probably from the Middle Jurassic.
192. This group includes a variety of forms which need study. The forms illustrated by IMLAY (1968) may belong to *Pleydellia* cf. *P. fluitans* (DUMORTIER).
193. Probably a *Pseudolioceras*? sp. indet.
195. This form belongs to *Pleydellia* sp. indet.
196. This form belongs to a new genus of Phymatoceratinae.
197. This form is a new species of *Pleydellia*.
198. The forms figured by HALL (1987) include species of *Pleydellia* as well as a new Phymatoceratinae genus.
199. A new species of *Pleydellia*.
200. These specimens do not belong to *Haugia*, but in fact to a new species of *Pleydellia* as well as *Pleydellia* sp. indet.
201. This form is a new species of *Pleydellia*.
202. These specimens do not belong to *Haugia* but to two genera, a new genus of Phymatoceratinae and a new species of *Pleydellia*.
203. This form belongs to a new genus of Phymatoceratinae.

Chart 5

LOWER JURASSIC	PLIENSBACHIAN			TOARCIAN							
	AMMONOIDS	LOWER	UPPER	LOWER	MIDDLE	UPPER					
125 Metacymbites cf. centriglobus (37)		+ . . .		|		|					
126 Prodactylioceras? cf. mortilleti (37)		. . . .		|		|				
127 Protagrammoceras cf. borelli (37)		. . . .		|		|				
128 Protagrammoceras cf. mariannii (37)		. . . .		|		|				
129 Protagrammoceras cf. meneghini (37)		. . . .		|		|				
130 Protagrammoceras cf. nipponicum (37)		. . . .		|		|				
131 Protagrammoceras? ochocoensis (37)		. . . .		|		|				
132 Protagrammoceras? cf. pseudofieldingi (37)		. . . .		|		|				
133 Whityceras? sp. (23,37)		?		|		|					
134 Protagrammoceras argutum (22,37,38)		. . . . .		|		|				
135 Protagrammoceras paltum (22,38)		. . . . .		|		|				
136 Canavaria? spp. (37,59)		?		|		|					
137 Dactylioceras s.l. (22,37)		?		|		|					
138 Pleuroceras? sp. (22)		?		|		|					
139 Protagrammoceras spp. (15,33,59,65)		. . . . .		|		|				
140 Amaltheus stokesi (16,17,18,22,33,38,52,53,65)		—		|		|					
141 Amaltheus spp. (21,22)		. . . . .		|		|				
142 Fanninoceras crassum (45,53,54,62)		—		|		|					
143 Fanninoceras kunaee 20,37,45,53,54,65)		—		|		|					
144 Reynesoceras ragazzonii (37,53,54,62,65)		—		|		|					
145 Arieticeras cf. ruthenense (59)		—		|		|					
146 Leptaleoceras aff. accuratum (16,17,22,38,54,59,62,65)		—		|		|					
147 Fontanelliceras cf. fontanellense (37,38)		—		|		|					
148 Fuciniceras cf. intumescentis (37,54)		—		|		|					
149 Arieticeras cf. algovianum (16,17,22,37,38,52,54)		—		|		|					
150 Fanninoceras latum (45,59)		—		|		|					
151 Leptaleoceras guerrense (11)		| |		|		|					
152 Tragophylloceras sp. (37)		| +		|		|					
153 Reynesoceras cf. aegrum (37)		| +		|		|					
154 Protagrammoceras pectinatum (54,62)		| —		|		|					
155 Amauroceras? sp. indet. (33)		....		|		|				
156 Lioceratoides? spp. (37,54)		....		|		|				
157 Fanninoceras carlotense (17,20,37,38,45,52,53,54,62,65,68)		—		|		|					
158 Harpoceras s.l. maurelli (45)		... ?		|		|					
159 Harpoceras s.l. allifordense (17,45)		... .		|		|				
160 Tiltoniceras propinquum (15,42,50,59,63,65)		—		|		|					
161 Aptychi (16,24,33,59)		—		|		|					
162 Amaltheus viligaeense (53,54)		|		|		|					
REGIONAL ZONATION	K	L	M	N	O	P	Q	R	S	T	U

Chart 6

LOWER JURASSIC		TOARCIAN					LOWER JURASSIC		TOARCIAN					
AMMONOIDS		LOWER	MIDDLE	UPPER				AMMONOIDS	LOWER	MIDDLE	UPPER			
163	Dactylioceras kanense (17,37,38,40,45,62,65)	—					189	Grammoceras thouarsense (62)			—			
164	Dactylioceras spp. (1,16,24)	—	—				190	Grammoceras? boreale (17,69)		?	►			
165	Brodieia? sp. indet. (23)	· · · · ·	· ·				191	Grammoceras aff. fallaciosum (17)		?	►			
166	Harpoceras cf. exaratum (14,17,24,40,62)	—	—	—			192	Grammoceras? sp. indet. (17,26,37,38)		· · ·				
167	Harpoceras sp. indet. (1,15,17)	—	—	—			193	Hildocerataceae (24)		· · ·				
168	Phymatoceras? spp. (1,38)	+	—	—	+		194	Pseudolioceras sp. (38)		· · ·				
169	Hildaites cf. chrysanthemum (62,65)	—	—	—			195	Brodieia cf. tenuicostata nodosa (38)		—				
170	Harpoceras cf. falciferum (14,23,33,65)	· · ·	—				196	Phlyseogrammoceras aff. dispensiforme (26)		—				
171	Harpoceratoidea sp. (33,37)	· · ·	—				197	Phlyseogrammoceras? sp. (62)		—				
172	Hildaites cf. serpentiniformis (23,33,65)	· · ·	—				198	Grammoceratinae spp. (33)		—				
173	Polyplectus cf. subplanatus (33,37,65)	· · ·	—				199	Haugia cf. compressa (38,65)		—				
174	Dactylioceras cf. athleticum (33,65)	· ·	—				200	Haugia cf. grandis (38)		—				
175	Dactylioceras (Orthodactylites) spp. (23)	· ·	—				201	Haugia aff. illustris (23)		—				
176	Harpoceras exaratum (23)	· ·	—				202	Haugia aff. navis (23)		—				
177	Dactylioceras aff. commune (14)	· ·	—				203	Haugia cf. variabilis (37)		—				
178	Dactylioceras cf. commune (38,65)	· ·	—				204	Haugia spp. (23,37,65)		—				
179	Hildaites sp. nov.? (23)	· ·	—				205	Catulloceras cf. dumortieri (37)		—				
180	Peronoceras cf. subarmatum (14,17,65)	· · · · ·	—				206	Catulloceras? (16,17)		—				
181	Peronoceras sp. indet. (16,23)	· · · · ·	—				207	Dumortieria cf. insignisimilis (1)		—				
182	Rarenodia planulata (40)	—	—				208	Dumortieria cf. levesquei (1)		—				
183	Leukadiella ionica (40)	—	—				209	Dumortieria? cf. pusilla (37,65)		—				
184	Paroniceras sternale (62)	—	+				210	Hildoceratinae? indet. (33)		—				
185	Phymatoceras sp. indet. (21)	· · · · ·	—				211	Hammatoceras speciosum (62,65)		—				
186	Phymatoceras crassicosta (40)	—	—	—			212	Hammatocratidae? indet. (33)		—				
187	Podagrosites latescens (40)	—	—	—			213	Sphaerocoeloceras brochiiforme (40,62,65)		—				
188	Phymatoceras copiapense (40,62)	—	—	—			REGIONAL ZONATION		P	Q	R	S	T	U
REGIONAL ZONATION		P	Q	R	S	T	U							

204. *Haugia* does not occur in North America and forms assigned to this genus belong to several different genera. The specimens figured by FREBOLD (1976) belong to a new species of *Pleydellia*. The specimens figured by IMLAY (1968) belong to *Hammatoceras* sp. indet. The specimens figures by IMLAY (1981) belong to *Pleydellia?* sp. indet.
210. Probably a new species of *Dumortieria*.
212. These forms belong to the genus *Sphaerocoeloceras*.

Bivalves (Charts 7-8)

No attempt has been made to include the taxa illustrated by WHITEAVES (1876, 1884, 1889 a, b). This fauna was originally assigned to the Triassic and Cretaceous but it contains Jurassic forms some of which may be from the Lower Jurassic.

1. Includes *Parapecten praecursor* and *P. acutiplicatus* from the Lilac and Hardgrave formations in California (CRICKMAY 1933 b, MULLER & FERGUSON 1939, DAMBORENEA & MANCENIDO 1979).
2. Includes *Trigonia* aff. *costatula* of LEES (1934) and FREBOLD (1964); refigured from LEES (1934).
17. Originally *Pecten* cf. *acutiplicatus* in SANBORN (1960).
21. Originally *Entolium balteatum* CRICKMAY (PÁLFY et al. in press).
26. Originally (JAWORSKI 1929) *Neithe mexicana*; included in *Weyla* by DAMBORENEA & MANCENIDO (1979).
- 29-31. Supposed Sinemurian occurrences in Nevada are now interpreted to be Lower Pliensbachian.
35. Includes *Weyla* aff. *bodenbenderi* of FREBOLD & TIPPER (1969).
47. *Plicatostylus* (LUPHER & PACKARD 1930) is considered a junior synonym of *Lithiotis* (NAUSS & SMITH 1988 and references therein).
53. The bivalve figured by HALL (1987; Pl. 3, fig. M) is referred to *Inoceramus* on p. 1690 but listed in the figure caption as an unidentified bivalve.

Brachiopods (Chart 9)

No attempt has been made to include the taxa illustrated by WHITEAVES (1876, 1884, 1889 a, b). This fauna was originally assigned to the Triassic and Cretaceous but it contains Jurassic forms some of which may be from the Lower Jurassic.

3. Obtusum Zone.
- 4, 5. Whiteavesi and Freboldi zones.

Cephalopods (excluding ammonoids) (Chart 9)

2. Probably Falcifer Zone (HALL 1987).

Gastropods (Chart 9)

1. Varians Assemblage of PÁLFY et al. (in press).

Chart 7

LOWER JURASSIC BIVALVES	HETT.	SINEMURIAN		PLIENSBACHIAN		TOARCIAN		
		LOWER	UPPER	LOWER	UPPER	LOWER	MIDDLE	UPPER
1 Weyla alata (3,24,25)				
2 Lima columbiæ (27)						
3 Frenguelliella spp. (8,16,23)					?	
4 Gervillia? cf. inflata (16)						
5 Modiola mandannaensc (8,16)						
6 Modiola aff. scalpra (16)						
7 Oxytoma cygnipes (6,8,9)		—	—					
8 Pholadomya donacina (8,16)						
9 Pleuromya (Myacites) cf. gregaria (8,16)						
10 Pleuromya yukonensc (16)		—	—					
11 Cardinia aff. regularis (7,8)						
12 Chlamys? fernensis (27)						
13 Entolium meeki (3,24)		?				
14 Gryphaea rockymontana (6,8,27)						
15 Lima aff. compressa (7)						
16 Trigonia littlei (7,8)						
17 Weyla acutiplicata (18,24)						
18 Pleuromyid? indet. (13)			—					
19 Ostrea ammonites (4)			—	—				
20 Vaugonia aff. oregonensis (23)							
21 Posidonotis semiplicata (1,2)				—				
22 Astarte cf. antipodum (15)						
23 Lima nodulosa (15)						
24 Myoconcha cf. valenciennesi (15)						
25 Plagiostoma cf. exaltata (15)						
26 Frenguelliella cf. inexpectata (15)						

Chart 8

LOWER JURASSIC BIVALVES	HETT.	SINEMURIAN		PLIENSBACHIAN		TOARCIAN		
		LOWER	UPPER	LOWER	UPPER	LOWER	MIDDLE	UPPER
27 <i>Weyla mexicana</i> (15)						
28 <i>Pinna expansa</i> (3)						
29 <i>Jaworskiella siemonmulleri</i> (23)						
30 <i>Trigonia</i> aff. <i>hemisphaerica</i> (23)						
31 <i>Vaugonia vancouverensis</i> (22,23)						
32 <i>Campstonectes</i> (<i>Camptochlamys</i>) sp. (26)				—	—			
33 <i>Cardinia</i> sp. (26)				—	—			
34 <i>Jaworskiella suplicensis</i> (23,26)				—			
35 <i>Weyla bodenbenderi</i> (11,26)				—	—	?		
36 <i>Pleuromya</i> aff. <i>liaxina</i> (10)				?				
37 <i>Gresslyia</i> cf. <i>rotundata</i> (10)				?				
38 <i>Oxytoma inequivale</i> (10)				?				
39 <i>Gervillaria?</i> sp. (26)				—	—			
40 <i>Modiolus</i> sp. (26)				—	—			
41 <i>Oxytoma</i> sp. (26)				—	—			
42 <i>Pholadomya</i> sp. (26)				—	—			
43 <i>Pleuromya</i> sp. (26)				—	—			
44 <i>Vaugonia jeletzkyi</i> (22,26)				—			
45 <i>Psilotrigonia canadensis</i> (22)				—			
46 <i>Trigonia</i> sp. (22)				—			
47 <i>Lithiotis problematica</i> (17,20)				—	—			
48 <i>Luperella boechiformis</i> (14)				—	—			
49 <i>Lima</i> (<i>Plagiostoma?</i>) sp. (11)				?				
50 <i>Vaugonia oregonensis</i> (23)				—	—			
51 <i>Vaugonia coatesi</i> (22)				—	—
52 Bivalves indet. (13)				—	—	—	—	—
53 <i>Inoceramus</i> sp. (13)				—	—	—	—	—

Chart 9

LOWER JURASSIC TAXA	HETT.	SINEMURIAN		PLIENSBACHIAN		TOARCIAN		
		LOWER	UPPER	LOWER	UPPER	LOWER	MIDDLE	UPPER
ANNELIDS								
1 <i>Serpula</i> sp. (1)				—				
ARTHROPODS								
1 [?] <i>Eryma</i> ollerenshawi (1)				+				
2 <i>Kinkelina</i> sp. (2)							
BRACHIOPODS								
1 <i>Furciflychia striata</i> (1,3)		—						
2 <i>Tetrarhynchia dunrobinensis</i> (1,3)	—	—						
3 <i>Anarhynchia</i> aff. <i>gabbi</i> (3)							
4 <i>Sulcirostra parva</i> (3)							
5 <i>Quadratirhynchia</i> aff. <i>quadrata</i> (3)							
6 <i>Brachiopoda</i> indet. (2)		—						
7 <i>Lobothyris</i> subpunktata (4)				—				
8 <i>Zeilleria</i> (<i>Cincta</i>) <i>numiamelis</i> (4)				—				
BRYOZOANS								
1 <i>Heteropora</i> tipperi (1)			1		1	....	1	1
COELENTERATES								
1 <i>Epimilipora</i> ? cf. <i>densaserrae</i> (1)				1	+			
2 <i>Actinastera minima</i> (1)				1	+	1		
CEPHALOPODS (EXCLUDING AMMONOIDS)								
1 <i>Ceroceras</i> sp. (4)				—				
2 <i>Teudopsis cadomunensis</i> (2)				1				
3 <i>Paraplicostechia hastata</i> (1)				1		+		
4 <i>Conodicocites</i> aff. <i>meyratii</i> (3)				?			
5 ? <i>Pseudodiscocites</i> sp. indet. A (3)							
6 ? <i>Dicoelites</i> sp. indet. A (3)							
7 <i>Conodicocites</i> aff. <i>keeuwensis</i> (3)						—		
ECHINODERMATA								
1 <i>Scirocrinus</i> subangularis (1)			1		1	+	1	1
GASTROPODS								
1 Gastropod indet. (2)		—						
2 <i>Nerinea thompsonensis</i> (1)		1			.....		1	1
MARINE VERTEBRATES								
1 <i>Ichthyosaurus</i> sp. (1,2)	—	1		1				
2 <i>Plesiosauridae</i> indet. (4)	+			1				
3 <i>Ichthyolitus</i> (5)								
4 <i>Acidorynchus</i> cf. <i>acutus</i> (3)		1		1		+	1	1
PALYNOMORPHS								
1 <i>Leiosphaeridia langenianensis</i> (1)	1		1				
2 <i>Micrhystridium polyedricum</i> (1)	1		1				
3 <i>Dictyotidium castendense</i> (1)	1	.....	1	.....	1	.....	1

Non-marine Vertebrates and Trace Fossils (Chart 10)

All terrestrial vertebrate fossils from western North America that might be Early Jurassic in age originate from the Glen Canyon Group in the United States. A few collections have been made in Colorado and Utah but the majority of fossils come from northern Arizona. The Glen Canyon Group is unconformably overlain by the San Rafael Group of Bajocian age and unconformably underlain by the Upper Triassic Chinle Formation. Discussions of the age of the Glen Canyon Group formations are given by COLBERT (1986), CLARK & FASTOVSKY (1986), OLSEN & SUES (1986) and SUES (1986) who recognize four locally interdigitating for-

Chart 10

LOWER JURASSIC NON-MARINE VERTEBRATES AND TRACE FOSSILS	HETT.	SINEMURIAN	PLIENSBACHIAN	TOARCIAN
1 Batrachopus sp. (21)				
2 Dilophosauripus williamsi (9,30)				
3 Dilophosaurus wetherelli (28,29)				
4 Hopiichthys shringi (9,30)				
5 Kayentapus hoppii (9,30)				
6 Oligokyphus sp. (17,27)				
7 Protosuchus sp. (12)				
8 Scutellosaurus lawleri (8)				
9 Protosuchus richardsoni (3,4,6,11,12)			?	
10 Dinnebitodon amarali (26)				
11 Dinnetherium nezorum (17)				
12 Eopneumatosuchus colberti (12)				
13 Kyantatherium wellesi (18,27)				
14 Kayentachelys aprix (14)				
15 Lepidotes walcotti (13)				
16 Massospondylus sp. (1)				
17 Morganucodon sp. (17)				
18 Rhamphinion jenkinsi (23)				
19 Rhamphorhynchoid indet. (23)				
20 Semionotus cf. gigas (16)				
21 Semionotus kanabensis (25)				
22 Syntarsus kayentakatae (24)				
23 Ammosaurus cf. major (1,15)				
24 Navahopus falcipollex (2)				
25 Segisaurus halli (5)				
FORMATIONS		MOENAVE	KAYENTA	NAVAJO

mations named in ascending order the Wingate, Moenave, Kayenta and Navajo of which all but the lower Wingate are probably of Early Jurassic age. The range chart indicates the formation from which the fossil originated; no stratigraphic position within the formation is implied. The correlation of these terrestrial formations with marine equivalents and hence the standard time scale has proved contentious. Assignment to stages is based only on: (a) unpublished reports of latest Sinemurian-early Pliensbachian pollen in one member of the Moenave Formation and (b) broad comparisons of vertebrate faunas with faunas of known age elsewhere in the world.

1. Crocodylomorph trace fossil.
2. Saurischian trace fossil.
3. Therapod (Saurischia).
- 4, 5. Saurischian trace fossils.
6. Tritylodontid.
7. Protosuchid crocodilian.
8. Ornithischian.
9. According to CLARK & FASTOVSKY (1986) the *Protosuchus richardsoni* from the Kayenta Formation is not complete enough to be confidently identified.
10. Tritylodontid.
11. Mammal.
12. Protosuchid crocodilian.
13. Tritylodontid.
14. The oldest cryptodire turtle.
15. Semionotid fish.
16. Prosauropod (Saurischia).
17. Mammal.
- 18, 19. Pterosaurs.
- 20, 21. Semionotid fish.
22. Therapod (Saurischia).
23. Prosauropod (Saurischia): *Ammosaurus* may be a synonym of *Massospondylus* according to CLARK & FASTOVSKY (1986).
24. Prosauropod trace fossil.
25. Therapod (Saurischia).

Palynomorphs (Chart 9)

- 1–3. Nordegg Formation of the Fernie Group occurrence.
- 1, 2. Floral Zone J1³.
3. Floral Zone J1³ to J2² (?Bathonian).

Radiolaria (Charts 11–18)

Generic ranges cited by CARTER (CARTER 1992, TIPPER et al. 1991) include stratigraphically useful taxa but they have been omitted pending further work. Also omitted are Early Jurassic Radiolaria recovered from Bridge River and other rocks in British Columbia by CORDEY who

discussed them as part of a doctoral thesis (CORDEY 1988). Species with alphanumerical designations have commonly been grouped as "spp." but the resultant combined range does not always coincide with the total known range of the genus. A taxon's age range does not include data from outside the study area.

41, 49, 51–53, 97. PESSAGNO & WHALEN (1982) extended the range of these species into the lower Toarcian on the basis of the provisional identification of an ammonite now assigned to *Tiltoniceras propinquum*, a species characteristic of the uppermost Pliensbachian and lowermost Toarcian in North America (SMITH et al. 1988). All the Radiolaria occur in the Carlotense Zone and possibly the lowermost Toarcian except for *Canutus bainaensis* which is known only from the Pliensbachian. The range of *Canoptum anulatum* was extended in CARTER et al. (1988).

220, 254, 265, 268, 271, 272 & 297. Corrected spelling in accordance with Article 32d (ii) of the International Code of Zoological Nomenclature (1985).

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Chart 11

LOWER JURASSIC	HETT.	SINEMURIAN		PLIENSBACHIAN		TOARCIAN		
RADIOLARIA		LOWER	UPPER	LOWER	UPPER	LOWER	MIDDLE	UPPER
1 Relanus aff. striatus (1)								
2 Archaeocenosphaera laseekensis (1,8)								
3 Archaeocenosphaera sp. (1)								
4 Paracanoptum merum (1,9,13)								
5 Paracanoptum praeanulatum (9)	|							
6 Pantanellium kluense (1,6)								
7 Pantanellium aff. kluense (6)								
8 Pantanellium tanuense (1,6)		...						
9 Pantanellium aff. tanuense (12)								
10 Relanus reefensis (1,9,12)								
11 Canoptium unicum (1,9,12)								
12 Gorgansium spp. (6,12)								
13 Drotius hecatensis (1,9)								
14 Orbiculiforma spp. (1,2,14)								
15 Pseudoheliodiscus spp. (1,12,14)								
16 Spongotorchus sp. (1)								→
17 Pantanellium spp. (6,12,14)								
18 Stauroloncho? spp. (1,2)								→
19 Bipedis sp. (1)								
20 Prachexasaturnalis tetraradiatus (1)								
21 Paronaella spp. (1,2)								→
22 Paleosaturnalis sp. (1,12)		..						
23 Relanus? sp. (12)								
24 Pantanellium browni (6,12)	|							
25 Pantanellium talunkwaense (6)								
26 Pantanellium danaense (6)								
27 Katroma spp. (1,13,14)								
SUPERZONE	This interval not assigned to a superzone.						1	
ZONE	05	04	03	02	01		1A (pt.)	
SUBZONE	This interval not subdivided into subzones.						01A	01B
								1A2

Chart 12

LOWER JURASSIC RADIOLARIA	HETT.	SINEMURIAN		PLIENSBACHIAN		TOARCIAN		
		LOWER	UPPER	LOWER	UPPER	LOWER	MIDDLE	UPPER
28 Eucyrtis? sp. (12)	?							
29 Pantanellium kungaense (6)		—						
30 Bagotum erraticum (9)				—				
31 Bagotum? helmetense (9)			—					
32 Broctus kuensis (9)		—	—					
33 Broctus selwynensis (9)		—	—					
34 Canoptum dixoni (9)		—	—					
35 Drotius laeekensis (9)		—	—					
36 Drotius lyellensis (9)			—					
37 Napora? graybayensis (10)			—					
38 Pantanellium skedansense (6)			—					
39 Wrangellium thurstonense (9)		—	—					
40 Pantanellium haidaense (6)			—	—				
41 Canutus rockfishensis (9)		—				?		
42 Bagotum aff. erraticum (9)		—		—	—			
43 Hsuum mulleri (9)		—		—	—			
44 Jacus? sandspitensis (10)		—		—	—			
45 Noritus lillihornensis (9,13)		—						
46 Pantanellium aff. haidaense (6)		—		—				
47 Wrangellium sp. (9)		—		—	—			
48 Canutus giganteus (2,9)				—	—			
49 Canutus hainaensis (2,9,13)				—	—			
50 Canutus tipperi (2,9)				—	—			
51 Bagotum maudense (9)		—				?		
52 Canoptum rugosum (9)		—		?	?			
53 Canutus biomei (9)		—			?			
54 Noritus spp. (9,14)		—		—	—			
SUPERZONE	This interval not assigned to a superzone.						1	
ZONE	05	04	03	02	01	01A	01B	1A (pt)
SUBZONE	This interval not subdivided into subzones.							1A2

Chart 13

LOWER JURASSIC		PLIENSBACHIAN		TOARCIAN		
RADIOLARIA		LOWER	UPPER	LOWER	MIDDLE	UPPER
55	Paracanoptum anulatum (2,9,14)					
56	Hsuum spp. (2,9,14)		.....		
57	Luperium spp. (2,9,14)					→
58	Pantanellium cumshewaense (6)			.....	.....	→
59	Zartus mostleri (6)	—	—			
60	Jacus? aff. sandspitensis (10)	||				
61	Pantanellium sanrafaelense (6)	—	—			
62	Broctus ruesti (14)	—	—			
63	Broctus spp. (14)	—	—			
64	Drulanta pulchra (14)	—	—			
65	Farcus multidorsus (14)	—	—			
66	Katroma bifurca (14)	—	—			
67	Katroma clara (14)	||	—			
68	Noritus cf. lillihomensis (14)	—	—			
69	Pseudocrucella beata (14)	—	—			
70	Pseudocrucella jurassica (14)	—	—			
71	Sontonaella concinna (14)	—	—			
72	Bagotum modestum (9)	—	—			
73	Bagotum aff. modestum (9)	—	—			
74	Bipedis fannini (2,12)	—	—			
75	Cantalum sp. (14)	—	—			
76	Canutus spp. (2,9,14)	—	—			
77	Drotlus cf. lyellensis (2)	—	—			
78	Fantus indormitus (9,14)	—	—			
79	Farcus asperoensis (10)	—	—			
80	Farcus graylockensis (10,14)	—	—			
81	Farcus kozuri (14)	—	—			
82	Gorgansium morganense (6,14)	—	—			
83	Hagiastrum spp. (2,14)	—	—			
84	Jacus reiferensis (10)	—	—			
85	Katroma ninstintsi (2,12,14)	—	—			
86	Napora morganensis (10,14)	—	—			
87	Orbiculiforma kwunaensis (2)	—	—			
88	Orbiculiforma trispinula (2)	—	—			
89	Pantanellium cf. haidaense (2)	—	—			
90	Praeconocaryomma whiteavesi (2,12)	—	—			
91	Rolumbus gastili (10)	—	—			
92	Rolumbus halseyensis (10)	—	—			
93	Rolumbus hamiltoni (10)	—	—			
SUPERZONE		This interval not assigned to a superzone			1	
ZONE		02	01		1A (pt.)	
SUBZONE			01A	01B	1A2	

Chart 14

LOWER JURASSIC RADIOLARIA	PLIENSBACHIAN		TOARCIAN		
	LOWER	UPPER	LOWER	MIDDLE	UPPER
94 Sontonaella fera (14)					
95 Stephanastrum? magnum (2)		1			
96 Trillus aff. elkhornensis (14)					
97 Canutus izeensis (2,9,14)			?		
98 Canutus nitidus (2,14)					
99 Crubus chengi (14)					
100 Hsuurn validum (14)					
101 Orbiculiforma? trispina (14)					
102 Parasaturalis spp. (14)					
103 Acanthocircus spp. (14)					
104 Bagotum aff. maudense (9,14)					
105 Bistarkum bifurcum (14)					
106 Bistarkum rigidum (14)					
107 Crubus spp. (14)					
108 Drulanta spp. (14)					
109 Fantus spp. (14)					
110 Farcus spp. (14)					
111 Katroma angusta (14)					
112 Lantus sixi (14)					
113 Napora cerromesaensis (10,14)			.....	
114 Napora spp. (14)					
115 Neowrangellium spp. (14)					
116 Noritus pauxillus (14)					
117 Noritus tenuis (14)					
118 Orbiculiforma callosa (14)					
119 Parasaturalis vigrassi (14)					
120 Poulpus lipheri (14)					
121 Poulpus spp. (2,14)					
122 Praeconocaryomma parvimmamma (14)					
123 Protoperispyridium oregonense (14)					
124 Pseudocrucella pecta (14)					
125 Pseudopantanellium spp. (14)					
126 Pseudopoulpus spp. (14)					
127 Rolumbus laetus (14)					
128 Sontonaella bona (14)					
129 Tetratrabs spp. (14)					
130 Jacus magnificus (2)			.....	
131 Praeconocaryomma aff. media (2)			.....	
132 Trillus spp. (14)					
SUPERZONE	This interval not assigned to a superzone			1	
ZONE	02		01		1A (pt.)
SUBZONE		01A		01B	1A2

Chart 15

LOWER JURASSIC RADIOLARIA	PLIENSBACHIAN		TOARCIAN		
	LOWER	UPPER	LOWER	MIDDLE	UPPER
133 Wrangellium oregonense (2,14)					
134 Xiphostylus spp. (14)					
135 Zartus spp. (14)					
136 Napora insolita (10,14)					
137 Rolumbus venustus (10,14)					
138 Crucella angulosa (2,12)					
139 Acaeniotyle? spp. (2)		|			|
140 Canoptum cf. dixoni (2)					
141 Crucella aff. squama (2)					
142 Napora aff. turgida (2)					
143 Parahsuum edenshawi (2,12)					
144 Praeconocaryomma? immodica (2)					
145 Pseudocrucella spp. (2,14)					
146 Hagiastrum cf. egregium (2)				|	→
147 Higumastra spp. (2,14)				· · · · ·	→
148 Paronaella variabilis (2)					→
149 Praeconocaryomma? fasciata (2)					
150 Tripocyclia spp. (2,14)				· · · ·	→
151 Trillus elkhornensis (6,14)	|				→
152 Farcus cf. lepidus (14)	|				
153 Hsuum? unicum (14)	|				
154 Canoptum artum (14)	|				
155 Pleesus aptus (14)	|				
156 Praeconocaryomma decora (14)	|				
157 Turanta spp. (2,14)	|			· · · · ·	
158 Canoptum aff. artum (14)	|				
159 Canoptum cf. poissoni (14)	|				
160 Canoptum spinosum (14)				—	
161 Canutus baumgartneri (14)	|				
162 Canutus fusus (14)	|				
163 Drulanta cf. bella (14)	|				
164 Drulanta formosa (14)	|			—	
165 Drulanta mostleri (14)	|				
166 Fantus aff. schoolhouseensis (14)	|			|	
167 Farcus lepidus (14)	|			—	
168 Gorgansium yangi (14)	|			|	
169 Higumastra laxa (14)	|			|	
170 Higumastra splendida (14)	|			—	
171 Homeoparonaella hydensis (14)	|			|	
SUPERZONE	This interval not assigned to a superzone			1	
ZONE	02	01		1A (pt.)	
SUBZONE		01A	01B	1A2	

Chart 16

LOWER JURASSIC		TOARCIAN		
RADIOLARIA		LOWER	MIDDLE	UPPER
172 Hsuum acutum (14)				|
173 Hsuum gratum (14)	|			|
174 Hsuum? lucidum (14)	→	|		
175 Hsuum parvulum (14)	→			|
176 Hsuum cf. robustum (14)	|			|
177 Hsuum cf. rosebudense (14)	|			|
178 Katroma cf. bifurca (14)	|			|
179 Katroma inflata (14)	|			|
180 Napora cf. bona (14)	|			|
181 Napora proba (14)	|			|
182 Napora propria (14)	→	|		|
183 Neowrangellium pessagnoi (14)	→			|
184 Noritus cf. pauxillus (14)	|			|
185 Pseudopantanellium floridum (14)	→			|
186 Pseudopoulpus pessagnoi (14)	→			|
187 Pseudoristola aff. faceta (14)	|	|		|
188 Pseudoristola cf. megaglobosa (14)	|			|
189 Rolumbus beatus (14)	→			|
190 Saitoum smithi (14)	→			|
191 Sontonaella cf. concinna (14)	|			|
192 Turanta fida (14)	→			|
193 Wrangellium izeense (14)	|			|
194 Xiphostylus simplus (14)	→	|		|
195 Bistarkum cf. bifurcum (14)	→			|
196 Canoptum poissoni (14)	→			|
197 Combusta munda (14)	→			|
198 Combusta spp. (14)	→			|
199 Crubus firmus (14)	→			|
SUPERZONE				1
ZONE		01 (pt.)	1A (pt.)	
SUBZONE		01B	1A2	

LOWER JURASSIC		TOARCIAN		
RADIOLARIA		LOWER	MIDDLE	UPPER
200 Crubus? robustus (14)				
201 Drulanta bella (14)				
202 Drulanta mirifica (14)				
203 Fantus schoolhousensis (14)				
204 Higumastra lipheri (14)				
205 Higumastra oregonensis (14)				|
206 Napora mitrata (10)		|		|
207 Napora relicta (14)				|
208 Pantanellium wui (14)				|
209 Poulpus haekeli (14)				|
210 Praeconocaryo cf. parviammina (14)				|
211 Pseudocrucella hilara (14)				|
212 Pseudoristola faceta (14)				|
213 Pseudoristola obesa (14)	|			|
214 Rolumbus hilarus (14)				|
215 Rolumbus mirus (10,14)				|
216 Saitoum thayeri (14)				|
217 Sontonaella snowshoensis (14)				|
218 Tetratrabs izeensis (14)				|
219 Rolumbus spp. (14)				→
220 Protoperispyridium hippense (2,14)				→
221 Trilus cf. seidersi (14)				→
222 Drulanta sporta (14)	|			|
223 Wrangellium cf. thurstonense (14)	|			|
224 Bistarkum saginatum (14)	→			|
225 Fantus exiguis (14)	|			|
226 Farcus cf. graylockensis (14)	|	|		|
227 Hsuum cf. lipheri (14)	|	|		|
SUPERZONE				1
ZONE		01 (pt.)	1A (pt.)	
SUBZONE		01B	1A2	

Chart 17

LOWER JURASSIC		TOARCIAN		
RADIOLARIA		LOWER	MIDDLE	UPPER
228	<i>Napora aperta</i> (14)	—		
229	<i>Napora cf. cerromesaensis</i> (14)	|	|	
230	<i>Napora cf. fructuosa</i> (14)	|	|	|
231	<i>Napora aff. relicta</i> (14)	|	|	
232	<i>Perispyridium?</i> sp. (14)	—	—	|
233	<i>Praeconocaryomma splendida</i> (14)	—	|	
234	<i>Pseudopoulpus deweveri</i> (14)	|	|	
235	<i>Pseudopoulpus aff. pessagnoi</i> (14)	|	|	
236	<i>Pseudoristola megaglobosa</i> (14)	|	|	
237	<i>Saitoum dickinsoni</i> (14)	|	|	
238	<i>Sontonaella spongiosa</i> (14)	|	|	
239	<i>Tetratrabs imlayi</i> (14)	|	|	
240	<i>Zartus cf. imlayi</i> (14)	|	|	
241	<i>Perispyridium</i> spp. (14)	—	|	
242	<i>Hsuum cf. rosebudense</i> (2)	|	|	
243	<i>Jacus</i> sp. (2)	|	|	
244	<i>Parvingula</i> spp. (2)	—	—	→
245	<i>Paronaella cf. mulleri</i> (2)	|	|	
246	<i>Homeoparonaella reciproca</i> (2,12)	—	—	
247	<i>Perispyridium?</i> sp. (2)	—	|	
248	<i>Canoptium?</i> sp. (2)	—	|	
249	<i>Emiluvia?</i> <i>moresbyensis</i> (2)	—	|	
250	<i>Emiluvia</i> spp. (2)	|	—	→
251	<i>Praeconocaryo. aff. mammillaria</i> (2)	—	|	
252	<i>Protounuma paulsmithi</i> (2,12)	|	|	→
253	<i>Crubus wilsonensis</i> (2)	|	|	
254	<i>Hsuum optimum</i> (2,12)	—	—	→
SUPERZONE			1	
ZONE		01 (pt.)	1A (pt.)	
SUBZONE		01B	1A2	

LOWER JURASSIC		TOARCIAN		
RADIOLARIA		LOWER	MIDDLE	UPPER
255	<i>Paronaella skowkonaensis</i> (2)	—	—	→
256	<i>Parvingula aculeata</i> (2)	—	—	→
257	<i>Parvingula boesii</i> group (2)	—	—	→
258	<i>Parvingula aff. burnensis</i> (2)	—	—	→
259	<i>Parvingula aff. media</i> (2)	—	—	→
260	<i>Perispyridium turnarackense</i> (7,11,14)	—	—	→
261	<i>Staurolonche eilsi</i> (2)	—	—	→
262	<i>Stichocapsa cf. convexa</i> (2)	—	—	→
263	<i>Tricolocapsa cf. rusti</i> (2)	—	—	→
264	<i>Caltrop nodosum</i> (2)	—	—	→
265	<i>Maudia yakounensis</i> (2)	—	—	→
266	<i>Napora aff. cosmica</i> (2)	—	—	→
267	? <i>Paronaella handyi</i> (2)	—	—	→
268	<i>Rolumbus kiustaensis</i> (2,12)	—	—	→
269	<i>Spongistoma</i> sp. (2)	—	—	→
270	<i>Acaeniotyle?</i> <i>ghostensis</i> (2)	—	—	→
271	<i>Alievium?</i> <i>juskatlaense</i> (2)	—	—	→
272	<i>Amphibrachium?</i> <i>phantomense</i> (2)	—	—	→
273	? <i>Heliodiscus inchoatus</i> (2)	—	—	→
274	<i>Paronaella porosa</i> (2)	—	—	→
275	<i>Spongistoma saccideon</i> (2,12)	—	—	→
276	<i>Spongostaurus cruciformis</i> (2)	—	—	→
277	<i>Spongotorchus tanaensis</i> (2)	—	—	→
278	<i>Tetratrabs aff. gratiosa</i> (2)	—	—	→
279	<i>Tympanoides charlottensis</i> (2,12)	—	—	→
280	<i>Eolidium cameroni</i> (2,12)	—	—	→
281	<i>Eolidium nadenensis</i> (2)	—	—	→
SUPERZONE			1	
ZONE		01 (pt.)	1A (pt.)	
SUBZONE		01B	1A2	

Chart 18

LOWER JURASSIC		TOARCIAN		
RADIOLARIA		LOWER	MIDDLE	UPPER
282	<i>Homeoparonaella</i> aff. <i>argolidensis</i> (2)			—
283	<i>Homeoparonaella</i> aff. <i>elegans</i> (2)			→
284	<i>Mesosaturnalis hexagonus</i> (2,12)			→
285	? <i>Paronaella denudata</i> (2)			→
286	<i>Paronaella grahamensis</i> (2)			→
287	<i>Paronaella</i> aff. <i>grahamensis</i> (2)			→
288	<i>Paronaella tiellensis</i> (2)			→
289	<i>Pseudocrucella sanfilippoae</i> (2)			→
290	<i>Spongotorpus incomptus</i> (2)			→
291	<i>Spongotorchus (Stylospongidium)</i> aff. <i>echinodiscus</i> (2)			→
292	? <i>Staurosphaera amplissima</i> (2)			→
293	<i>Turanta morinae</i> (2,7)			→
294	<i>Turanta nodosa</i> (2,7)			—
295	<i>Lithomelissa</i> sp. (2)			—
296	<i>Praeonocaryo</i> aff. <i>parvimmamma</i> (2)			—
297	<i>Tripocyclia rosespitensis</i> (2,12,14)			—
298	<i>Perispyridium darwini</i> (5)			→
299	<i>Perispyridium dobzhanskyi</i> (5)			→
300	<i>Perispyridium elegans</i> (5)			→
301	<i>Perispyridium gouldi</i> (5)			→
302	<i>Perispyridium mayri</i> (5)			→
303	<i>Perispyridium robustum</i> (5)			→
304	<i>Perispyridium schopfi</i> (5)			→
305	<i>Perispyridium simpsoni</i> (5)			→
306	<i>Perispyridium slaughteri</i> (5)			→
307	<i>Perispyridium triangulatum</i> (5)			→
308	<i>Spongostaurus pugunculus</i> (2)			—
SUPERZONE				1
ZONE		01 (pt.)	1A (pt.)	
SUBZONE		01B	1A2	

Chart 19

LOWER JURASSIC	PLIENSBACHIAN		TOARCIAN		
FORAMINIFERA Note: all taxa are from (1)	LOWER	UPPER	LOWER	MIDDLE	UPPER
1 Marginulina prima	|				
2 Paralingulina tenera tenuistriata	|				
3 Paralingulina L. pupa	?	|			
4 Ichthyolaria bicostata bicostata	?	|			
5 Ichthyolaria b. mesoliassica	?	|			
6 Mesodentalina hausieri	?	|			
7 Mesodentalina tenuistriata	?	|			
8 Paralingulina sp.	?	|			
9 Paralingulina tenera subprismaticata	|	|			
10 Paralingulina t. subsp. A	|	|			
11 Bigenerina? sp.	|				
12 Ichthyolaria? pygmaea		|			
13 Lingulonodosaria sp.		|			
14 Neobulimina? sp.		|			
15 Marginulina burgundiae		|			
16 Citharina saggittiformis			|		
17 Lenticulina spp				|	
18 Falsopalmula varians				
19 Lenticulina d'orbignyi				
20 Pseudonodosaria pygmaea				
21 Reinholdella cf. macfadyeni				
22 Lenticulina gottingensis					
23 Lenticulina prima					
24 Vaginulina listi					
25 Citharina cf. longuemari					
26 Falsopalmula juvensis					

References

Introduction

- ERBEN, H. K. (1956): El Jurásico inferior de México y sus ammonitas. – XX Congr. Geol. Int., 393 pp.
- IMLAY, R. W. (1981): Early Jurassic Ammonites from Alaska. – U.S. Geol. Surv. Prof. Pap. 1148: 49 pp., 12 pls.
- JONES, D. L. & J. G. MOORE (1973): Lower Jurassic ammonite from the south-central Sierra Nevada, California. – U.S. Geol. Surv. J. Res. 1: 453–458.
- MAY, S. R. & R. F. BUTLER (1986): North American Jurassic apparent polar wander; implications for plate motion, paleogeography, and Cordilleran tectonics. – J. Geophys. B 91: 11,519–11,544.
- OLDOW, J. S., H. G. AVÉ LALLEMAND & W. J. SCHMIDT (1984): Kinematics of plate convergence deduced from Mesozoic structures in the Western Cordillera. – In: Correlation between plate motions and Cordilleran tectonics. – Tectonics 3: 201–227.
- POULTON, T. P. (1991): Hettangian through Aalenian (Jurassic) guide fossils and biostratigraphy, northern Yukon and adjacent Northwest Territories. – Geol. Surv. Can. Bull. 410: 1–95.
- SMITH, P. L. (1988): Paleobiogeography and plate tectonics. – Geosci. Can. 15: 261–279.
- SMITH, P. L. & H. W. TIPPER (1986): Plate tectonics and paleobiogeography: Early Jurassic (Pliensbachian) endemism and diversity. – Palaios 1: 399–412.
- WESTERMANN, G. E. G., Ed. (1992): The Jurassic of the Circum-Pacific. – Cambridge University Press, 676 p.

Correlation Chart

- CARTER, E. S., B. E. B. CAMERON & P. L. SMITH (1988): Lower and Middle Jurassic radiolarian biostratigraphy and systematic paleontology, Queen Charlotte Islands, British Columbia. – Geol. Surv. Can. Bull. 386: 1–104.
- CARTER, E. S. (in press): Evolutionary trends in latest Norian and Hettangian radiolaria from the Queen Charlotte Islands, British Columbia. – Geobios.
- FREBOLD, H. (1967): Hettangian ammonite faunas of the Taseko Lakes area British Columbia. – Geol. Surv. Can. Bull. 158: 1–35.
- JAKOBS, G. K. (1992): Toarcian (Lower Jurassic) ammonite biostratigraphy and ammonite fauna of North America. – Unpublished Ph. D. thesis, University of British Columbia, 682 pp.
- JAKOBS, G. K., P. L. SMITH & H. W. TIPPER (in press): Towards an ammonite zonation for the Toarcian of North America. – Geobios.
- PÁLFY, J., P. L. SMITH & H. W. TIPPER (in press): Sinemurian (Lower Jurassic) ammonite biostratigraphy of the Queen Charlotte Islands, British Columbia. – Geobios..
- PESSAGNO, E., C. D. BLOME, E. S. CARTER, N. MACLEOD, P. A. WHALEN & K.-Y. YEH (1987): Preliminary radiolarian zonation for the Jurassic of North America. – In: Studies of North American Jurassic Radiolaria, Part. 2. Cushman Found. Foraminiferal Res. Spec. Publ. 23: 1–18.
- SMITH, P. L., H. W. TIPPER, D. G. TAYLOR & J. GUEX (1988): An ammonite zonation for the Lower Jurassic of Canada and the United States: the Pliensbachian. – Can. J. Earth Sci. 25: 1503–1523.
- TIPPER, H. W. & J. GUEX (in press): Preliminary remarks on the Hettangian ammonite succession in Queen Charlotte Islands, British Columbia. – Geobios.

Ammonites

- ARTHUR, A., P. L. SMITH, J. W. MONGER & H. W. TIPPER (1993): Mesozoic stratigraphy and Jurassic paleontology west of Harrison Lake, southwestern British Columbia. – Geol. Surv. Can. Bull. 441: 1–62.
- BLOOS, G. (1979): The zone of *Schlotheimia marmorea* (Lower Lias)-Hettangian or Sinemurian? – Newslett. Stratigr. 12: 123–131.

3. (1988): *Ammonites marmoreus* OPPEL (Schlotheimiidae) im unteren Lias (Angulata-Zone) von Württemberg (Südwestdeutschland). – Stuttg. Beitr. Naturkd. **B-141**: 1–47.
4. BRAGA, J. (1983): Ammonites del domerense de la zona Subbética (Cordilleras Béticas, sur de España). – Ph. D. thesis, University of Granada, 410 pp., 16 pls.
5. CRICKMAY, C. H. (1925): A note on two of Hyatt's Liassic ammonites. – Proc. Cal. Acad. Sci. 4. Ser. **14**: 77–81.
6. – (1928): The stratigraphy of Parson Bay, British Columbia. – Univ. Cal. Publ. Geol. Sci. **18**: 51–70.
7. – (1932): A new Jurassic ammonite from the Coast Ranges of California. – Am. Midl. Nat. **13**: 1–7, pls. 1, 2.
8. – (1932–1933): Some of Alpheus Hyatt's unfigured types from the Jurassic of California. – U.S. Geol. Surv. Prof. Pap. **175-B**: 51–64, pls. 14–18.
9. – (1933): Mount Jura investigation. – Geol. Soc. Am. Bull. **44**: 895–926, pls. 23–34.
10. DONOVAN, D. T. & G. F. FORSEY (1973): Systematics of Lower Liassic Ammonitina. – Univ. Kans. Paleontol. Contrib. Pap. **64**: 1–18.
11. ERBEN, H. K. (1954): Dos ammonitas nuevos y su importancia para la estratigrafía del Jurásico de México. – Paleontol. Mex. **1**: 4–17.
12. – (1956): El Jurásico inferior de México y sus ammonitas. – XX Congr. Geol. Int., 393 pp.
13. FREBOLD, H. (1951): Ammonite fauna and stratigraphy of the Lower Lias in Tyaughton Lake map area, British Columbia. – In: Contributions to the Palaeontology and Stratigraphy of the Jurassic System in Canada. – Geol. Surv. Can. Bull. **18**: 1–14, pls. I–XIV.
14. – (1957): The Jurassic Fernie Group in the Canadian Rocky Mountains and Foothills. – Geol. Surv. Can. Mem. **287**: 1–197, 44 pls.
15. – (1959): Marine Jurassic rocks in Nelson and Salmo areas southern British Columbia. – Geol. Surv. Can. Bull. **49**: 31 pp., 5 pls.
16. – (1964 a): Lower Jurassic and Bajocian ammonoid faunas of northwestern British Columbia and southern Yukon. – Geol. Surv. Can. Bull. **116**: 31 pp., 8 pls.
17. – (1964 b): Illustrations of Canadian fossils, Jurassic of western and arctic Canada. – Geol. Surv. Can. Pap. **63-4**: 1–107, pls. 1–51.
18. – (1966): Upper Pliensbachian beds in the Fernie Group of Alberta. – Geol. Surv. Can. Pap. **66-27**: 1–7, 1 pl.
19. – (1967 a): Hettangian ammonite faunas of the Taseko Lakes area British Columbia. – Geol. Surv. Can. Bull. **158**: 1–35, pls. 1–9.
20. – (1967 b): Position of the Lower Jurassic genus *Fanninoceras* McLEARN and the age of the Maude Formation on Queen Charlotte Islands. – Can. J. Earth Sci., **4**: 1145–1149.
21. – (1969): Subdivision and facies of Lower Jurassic rocks in the southern Canadian Rocky Mountains and Foothills. – Proc. Geol. Assoc. Can. **20**: 76–89, 2 pls.
22. – (1970): Pliensbachian ammonoids from British Columbia and southern Yukon. – Can. J. Earth Sci., **7**: 435–452, pls. 1–4.
23. – (1976): The Toarcian and Lower Middle Bajocian beds and ammonites in the Fernie Group of southeastern British Columbia and parts of Alberta. – Geol. Surv. Can. Pap. **75-39**: 20 pp., 9 pls.
24. FREBOLD, H. & H. W. LITTLE (1962): Palaeontology, stratigraphy and structure of the Jurassic rocks in Salmo map-area, British Columbia. – Geol. Surv. Can. Bull. **81**: 31 pp., 5 pls.
25. FREBOLD, H. & H. W. TIPPER (1969): Lower Jurassic rocks and fauna near Ashcroft, British Columbia and their relation to some granitic plutons (92-I). – Geol. Surv. Can. Pap. **69-23**: 20 pp., 1 pl.
26. FREBOLD, H., H. W. TIPPER & J. A. COATES (1969): Toarcian and Bajocian rocks and guide ammonites from southwestern British Columbia. – Geol. Surv. Can. Pap. **67-10**: 55 pp., 6 pls.
27. GABB, W. M. (1869): Descriptions of some secondary fossils from the Pacific Coast States. – Am. J. Conchol. **5**: 5–18, pl. 3.
28. GUÉRIN-FRANIATTE, S. (1966): Ammonites du Lias inférieur de France. Psilocerataceae: Arietitidae. – Centre National de la Recherche Scientifique, Paris, 445 pp.
29. GUEX, J. (1980): Remarques préliminaires sur la distribution stratigraphique des ammonites hettangiennes du New York Canyon (Gabbs Valley Range, Nevada). – Bull. Lausanne **250**: 127–140.

30. – (1981): Quelques cas de dimorphisme chez les ammonoides du Lias inférieur. – Bull. Géol. Lausanne **258**: 239–248.
31. – (1989): Note sur le genre *Franziceras* BUCKMAN (Ammonoidea, Cephalopoda). – Bull. Géol. Lausanne **305**: 347–354.
32. GUEX, J. & D. G. TAYLOR (1976): La limite Hettangien-Sinémurien, des Préalpes romandes au Névada. – Eclogae Geol. Helv. **69**: 521–526.
33. HALL, R. L. (1987): New Lower Jurassic ammonite fauna from the Fernie Formation, southern Canadian Rocky Mountains. – Can. J. Earth Sci. **24**: 1688–1704, 5 pls.
34. HERTLEIN, L. G. (1925): New species of marine fossil mollusca from western North America. – Bull. South. Cal. Acad. Sci. **24**: 39–46, pls. 3, 4.
35. HOWARTH, M. K. (1992): The ammonite family Hildoceratidae in the Lower Jurassic of Britain. – Monogr. Palaeontograph. Soc. London, No. 586, Vol. 145, Pt. 1: 1–106, pls. 1–16.
36. HYATT, A. (1889): Genesis of the Arietidae. – Smiths. Contrib. Knowl. **26**: 1–250.
37. IMLAY, R. W. (1968): Lower Jurassic (Pliensbachian and Toarcian) Ammonites from eastern Oregon and California. – U.S. Geol. Surv. Prof. Pap. **593-C**: 51 pp., 9 pls.
38. – (1981): Early Jurassic Ammonites from Alaska. – U.S. Geol. Surv. Prof. Pap. **1148**: 49 pp., 12 pls.
39. JAKOBS, G. K. (1992): Toarcian (Lower Jurassic) ammonite biostratigraphy and ammonite fauna of North America. – Unpublished Ph. D. thesis, University of British Columbia, 682 pp.
40. JAKOBS, G. K., P. L. SMITH & H. W. TIPPER (in press): Towards an ammonite zonation for the Toarcian of North America. – Geobios.
41. JAWORSKI, E. (1929): Eine Lias-Fauna aus Nordwest-Mexico. – Abh. Schweiz. Palaeontol. Ges. **48**: 1–12.
42. JONES, D. L. & J. G. MOORE (1973): Lower Jurassic ammonite from the south-central Sierra Nevada, California. – U.S. Geol. Surv. J. Res. **1**: 453–458.
43. LEES, E. J. (1934): Geology of the Laberge area, Yukon. – Trans. R. Inst. Can. **20**: 1–48.
44. MCLEARN, F. H. (1930): Notes on some Canadian Mesozoic faunas. – Trans. R. Soc. Can., Ser. 3 **24**: 1–7, 2 pls.
45. – (1932): Contributions to the stratigraphy and palaeontology of Skidegate Inlet, Queen Charlotte Islands British Columbia. – Trans. R. Soc. Can., Ser. 3 **26**: 51–80, 10 pls.
46. MOORE, J. G. (1960): Mesozoic age of roof pendants in west-central Nevada. – U.S. Geol. Surv. Prof. Pap. **400-B**: 285–289.
47. PÁLFY, J. (1991): Uppermost Hettangian to lowermost Pliensbachian (Lower Jurassic) biostratigraphy and ammonoid fauna of the Queen Charlotte Islands, British Columbia. – Unpublished M. Sc. thesis, University of British Columbia, Vancouver, 243 pp.
48. PÁLFY, J., P. L. SMITH & H. W. TIPPER (in press): Sinemurian (Lower Jurassic) ammonite biostratigraphy of the Queen Charlotte Islands, British Columbia. – Geobios..
49. POULTON, T. P. & D. J. TEMPELMAN-KLUIT (1982): Recent discoveries of Jurassic fossils in the Lower Schist Division of Central Yukon. – Geol. Surv. Can. Pap. **82-1C**: 91–94.
50. SANBORN, A. F. (1960): Geology and paleontology of the southwest quarter of the Big Bend quadrangle. – Calif. Div. Mines Geol. Spec. Rep. **63**: 3–26.
51. SMITH, P. L. (1983): The Pliensbachian ammonite *Dayiceras dayiceroides* and Early Jurassic paleogeography. – Can. J. Earth Sci. **20**: 86–91.
52. SMITH, P. L. & H. W. TIPPER (1986): Plate tectonics and paleobiogeography: Early Jurassic (Pliensbachian) endemism and diversity. – Palaios **1**: 399–412.
53. – – (1988): Biochronology, stratigraphy and tectonic setting of the Pliensbachian of Canada and the United States. – In: ROCHA, R. B. & A. F. SOARES (eds.): 2nd International Symposium on Jurassic Stratigraphy, Lisbon **1**: 119–138.
54. SMITH, P. L., H. W. TIPPER, D. G. TAYLOR & J. GUEX (1988): An ammonite zonation for the Lower Jurassic of Canada and the United States: the Pliensbachian. – Can. J. Earth Sci. **25**: 1503–1523.
55. TAYLOR, D. G. (1986): The Hettangian-Sinemurian boundary (Early Jurassic): reply to Bloos 1983. – Newsr. Stratigr. **16**: 57–67.
56. – (1988 a): *Paradiscamp hiceras*, a new Lower Liassic ammonite genus. – Bull. Géol. Lausanne **298**: 117–122.

57. (1988 b): Middle Jurassic (late Aalenian and early Bajocian) ammonite biochronology of the Snowshoe Formation, Oregon. – Oreg. Geol. 50: 123–138.
58. – (1990): Two species of *Paracaloceras* from the Canadense Zone (Hettangian-Sinemurian) in Nevada (U.S.A.). – Bull. Géol. Lausanne 309: 211–219.
59. THOMSON, R. C. & P. L. SMITH (1992): Pliensbachian (Lower Jurassic) biostratigraphy and ammonite fauna of the Spatsizi area, north-central British Columbia. – Geol. Surv. Can. Bull. 437: 1–85.
60. TIPPER, H. W. (1984): The age of the Jurassic Rossland Group of southeastern British Columbia. – In: Current Research, Part A, Geol. Surv. Can. Pap. 84-1A: 631, 632.
61. TIPPER, H. W. & J. GUEX (in press): Preliminary remarks on the Hettangian ammonite succession in Queen Charlotte Islands, British Columbia. – Geobios.
62. TIPPER, H. W., P. L. SMITH, B. E. B. CAMERON, E. S. CARTER, G. K. JAKOBS & M. J. JOHNS (1991): Biostratigraphy of the Lower Jurassic formations of the Queen Charlotte Islands, British Columbia. – In: WOODSWORTH, G. J. (ed.): Evolution and Hydrocarbon Potential of the Queen Charlotte Basin, British Columbia. – Geol. Surv. Can. Pap. 90-10: 203–235.
63. TOZER, E. T. (1982): Late Triassic (upper Norian) and earliest Jurassic (Hettangian) rocks and ammonoid faunas, Halfway River and Pine Pass map areas, British Columbia. – In: Current Research, Part A, Geol. Surv. Can. Pap. 82-1A: 385–391.
64. WARREN, P. S. (1931): A Lower Jurassic fauna from Fernie, B.C. – Trans. R. Soc. Can., Ser. 3 25: 105–111, 1 pl.
65. WESTERMANN, G. E. G., Ed. (1992): The Jurassic of the Circum-Pacific. – Cambridge University Press, 676 p.
66. WHITEAVES, J. F. (1876): On some invertebrates from the coal-bearing rocks of the Queen Charlotte Islands. – Geol. Nat. Hist. Surv. Can., Mesozoic Fossils, Vol. 1, Pt. 1: 1–92.
67. – (1884): On the fossils of the coal-bearing deposits of the Queen Charlotte Islands collected by Dr. G. M. Dawson in 1878. – Geol. Nat. Hist. Surv. Can., Mesozoic Fossils, Vol. 1, Pt. 3: 1–261, 14 pls.
68. – (1889 a): Contributions to Canadian Palaeontology, Vol. 1, Pt. 2, Sect. 3: On some fossils from the Triassic of British Columbia. – Geol. Nat. Hist. Surv. Can.: 144–148, pl. xix.
69. – (1889 b): Contributions to Canadian Palaeontology, Vol. 1, Pt. 2, Sect. 4: On some Cretaceous fossils from British Columbia, the North West Territory and Manitoba. – Geol. Nat. Hist. Surv. Can.: 149–159, pls. xx, xi.
70. WIEDENMAYER, F. (1977): Die Ammoniten des Besazio-Kalks (Pliensbachian, Südtessin). – Schweiz. Paläontol. Abh. 98: 1–169, 19 pls.
71. – (1980): Die Ammoniten der mediterranen Provinz im Pliensbachian und unteren Toarcian aufgrund neuer Untersuchungen im Generoso-Becken (Lombardischen Alpen): Denkschr. Schweiz. Naturforsch. Ges. 93: 1–261, 34 pls.

Annelids

1. THOMSON, R. C. & P. L. SMITH (1992): Pliensbachian (Lower Jurassic) biostratigraphy and ammonite fauna of the Spatsizi area, north-central British Columbia. – Geol. Surv. Can. Bull. 437: 1–85.

Arthropods

1. FELDMANN, R. M. & M. J. COPELAND (1988): A new species of erymid lobster from Lower Jurassic strata (Sinemurian/Pliensbachian), Fernie Formation, southwestern Alberta. – Contributions to Canadian Paleontology, Geol. Surv. Can. Bull. 379: 93–101.
2. TIPPER, H. W., P. L. SMITH, B. E. B. CAMERON, E. S. CARTER, G. K. JAKOBS & M. J. JOHNS (1991): Biostratigraphy of the Lower Jurassic formations of the Queen Charlotte Islands, British Columbia. – In: WOODSWORTH, G. J. (ed.): Evolution and Hydrocarbon Potential of the Queen Charlotte Basin, British Columbia. – Geol. Surv. Can. Pap. 90-10: 203–235.

Bivalves

1. CRICKMAY, C. H. (1928): The stratigraphy of Parson Bay, British Columbia. – Univ. Cal. Publ. Geol. Sci. **18**: 51–70.
2. – (1932–1933 a): Some of Alpheus Hyatt's unfigured types from the Jurassic of California. – U.S. Geol. Surv. Prof. Pap. **175-B**: 51–64.
3. – (1933 b): Mount Jura investigation. – Geol. Soc. Am. Bull. **44**: 895–926.
4. – (1964): Ghost fossils. – Can. Soc. Petr. Geol. Bull. **12**: 153–159.
5. DAMBORENEA, S. E. & M. O. MANCEÑIDO (1979): On the palaeogeographical distribution of the pectinid genus *Weylu* (Bivalvia, Lower Jurassic). – Palaeogeogr. Palaeoclimatol. Palaeoecol. **27**: 85–102.
6. FREBOLD, H. (1957): The Jurassic Fernie Group in the Canadian Rocky Mountains and Foothills. – Geol. Surv. Can. Mem. **287**:
7. – (1959): Marine Jurassic rocks in Nelson and Salmo areas southern British Columbia. – Geol. Surv. Can. Bull. **49**.
8. – (1964): Illustrations of Canadian fossils-Jurassic of western and Arctic Canada. – Geol. Surv. Can. Pap. **63-4**.
9. – (1966): Upper Pliensbachian beds in the Fernie Group of Alberta. – Geol. Surv. Can. Pap. **66-27**.
10. – (1969): Subdivision and facies of Lower Jurassic rocks in the southern Canadian Rocky Mountains and Foothills. – Proc. Geol. Assoc. Can. **20**: 76–89, 2 pls.
11. FREBOLD, H. & H. W. TIPPER (1969): Lower Jurassic rocks and fauna near Ashcroft, British Columbia and their relation to some granitic plutons (92-I). – Geol. Surv. Can. Pap. **69-23**.
12. HALL, R. L. (1984): Lithostratigraphy and biostratigraphy of the Fernie Formation (Jurassic) in the southern Canadian Rocky Mountains. – In: STOTT, D. F. & D. J. GLASS (eds.): The Mesozoic of Middle North America. – Can. Soc. Pet. Geol. Mem. **9**: 233–247.
13. – (1987): New Lower Jurassic ammonite faunas from the Fernie Formation, southern Canadian Rocky Mountains. – Can. J. Earth Sci. **24**: 1688–1704.
14. IMLAY, R. W. (1967): The Mesozoic pelecypods *Otapiria* MARWICK and *Luperella* IMLAY, new genus, in the United States. – U.S. Geol. Surv. Prof. Pap. **573-B**.
15. JAWORSKI, E. (1929): Eine Lias-Fauna aus Nordwest-Mexiko. – Abh. Schweiz. Palaeontol. Ges. **48**: 1–12.
16. LEES, E. J. (1934): Geology of the Laberge area, Yukon. – Trans. R. Inst. Can. **20**: 1–48.
17. LUPHER, R. L. & E. L. PACKARD (1930): The Jurassic and Cretaceous rudists of Oregon. – Univ. Oreg. Publ. **1**: 203–212.
18. MEEK, F. B. (1864): Description of the Jurassic fossils. – Geol. Surv. California, Paleontology of California **1**: 37–53.
19. MULLER, S. W. & H. G. FERGUSON (1939): Mesozoic stratigraphy of the Hawthorne and Tonopah quadrangles, Nevada. – Geol. Soc. Am. Bull. **50**: 1573–1624.
20. NAUSS, A. L. & P. L. SMITH (1988): *Lithiotis* (Bivalvia) bioherms in the Lower Jurassic of east central Oregon, U.S.A. – Palaeogeogr. Palaeoclimatol. Palaeoecol. **65**: 253–268.
21. PÁLFY, J., P. L. SMITH & H. W. TIPPER (in press): Sinemurian (Lower Jurassic) ammonoid biostratigraphy of the Queen Charlotte Islands, western Canada. – Geobios.
22. POULTON, T. P. (1976): Some Lower Jurassic trigoniid bivalves from southwestern British Columbia. – Contributions to Canadian Paleontology, Geol. Surv. Can. Bull. **256**: 41–53.
23. – (1979): Jurassic trigoniid bivalves from Canada and western United States of America. – Geol. Surv. Can. Bull. **282**.
24. SANBORN, A. F. (1960): Geology and paleontology of the southwest quarter of the Big Bend quadrangle. – Calif. Div. Mines Geol. Spec. Rep. **63**: 3–26.
25. SMITH, P. L. & H. W. TIPPER (1986): Plate tectonics and paleobiogeography: Early Jurassic (Pliensbachian) endemism and diversity. – Palaios **1**: 399–412.
26. THOMSON, R. C. & P. L. SMITH (1992): Pliensbachian (Lower Jurassic) biostratigraphy and ammonite fauna of the Spatsizi area, north-central British Columbia. – Geol. Surv. Can. Bull. **437**: 1–85.
27. WARREN, P. S. (1931): A Lower Jurassic fauna from Fernie, B.C. – Trans. R. Soc. Can., Ser. 3, **25**: 105–111.

28. WHITEAVES, J. F. (1876): On some invertebrates from the coal-bearing rocks of the Queen Charlotte Islands. – Geol. Nat. Hist. Surv. Can., Mesozoic Fossils, Vol. 1, Pt. 1: 1–92.
29. – (1884): On the fossils of the coal-bearing deposits of the Queen Charlotte Islands collected by Dr. G. M. Dawson in 1878. – Geol. Nat. Hist. Surv. Can., Mesozoic Fossils, Vol. 1, Pt. 3: 1–261, 14 pls.
30. – (1889 a): Contributions to Canadian Palaeontology, Vol. 1, Pt. 2, Sect. 3: On some fossils from the Triassic of British Columbia. – Geol. Nat. Hist. Surv. Can.: 144–148, pl. xix.
31. – (1889 b): Contributions to Canadian Palaeontology, Vol. 1, Pt. 2, Sect. 4: On some Cretaceous fossils from British Columbia, the North West Territory and Manitoba. – Geol. Nat. Hist. Surv. Can.: 149–159, pls. xx, xi.

Brachiopods

1. AGER, D. V. & G. E. G. WESTERMANN (1963): New Mesozoic brachiopods from Canada. – J. Paleontol. 37: 595–610.
2. HALL, R. L. (1987): New Lower Jurassic ammonite faunas from the Fernie Formation, southern Canadian Rocky Mountains. – Can. J. Earth Sci. 24: 1688–1704.
3. MACEÑIDO, M. O. & DAGYS, A. S. (1992) Brachiopods of the circum-Pacific region. – In: WESTERMANN, G. E. G. (ed.): The Jurassic of the Circum-Pacific. – Cambridge University Press, 676 p.
4. THOMSON, R. C. & P. L. SMITH (1992): Pliensbachian (Lower Jurassic) biostratigraphy and ammonite fauna of the Spatsizi area, north-central British Columbia. – Geol. Surv. Can. Bull. 437: 1–85.

Bryozoans

1. HENDERSON, C. M. & D. G. PERRY (1981): A Lower Jurassic heteroporid bryozoan and associated biota, Turnagain Lake, British Columbia. – Can. J. Earth Sci. 18: 457–468.

Cephalopods (excluding ammonoids)

1. HALL, R. L. (1985): *Paraplesioteuthis hastata* (Münster), the first teuthid squid recorded from the Jurassic of North America. – J. Paleontol. 59: 870–874.
2. HALL, R. L. & A. G. NEUMAN (1989): *Teudopsis cadominensis*, a new teuthid squid from the Toarcian (Lower Jurassic) of Alberta. – J. Paleontol. 63: 324–327.
3. JELETZKY, J. A. (1980): Dicoelitid belemnites from the Toarcian-Middle Bajocian of western and Arctic Canada. – Geol. Surv. Can. Bull. 338.
4. THOMSON, R. C. & P. L. SMITH (1992): Pliensbachian (Lower Jurassic) biostratigraphy and ammonite fauna of the Spatsizi area, north-central British Columbia. – Geol. Surv. Can. Bull. 437: 1–85.

Coelenterates

1. BEAUVAIS, L. (1982): Etude de quelques coelenterés de la base du Mésozoïque du Canada occidental. – Can. J. Earth Sci. 19: 1963–1973.
2. POULTON, T. P. (1988): A Lower Jurassic coral reef. – In: GELDSETZER, H., N. P. JAMES & G. E. TEBBUTT (eds.): Reefs, Canada and adjacent areas. – Can. Soc. Pet. Geol. Mem. 13: 754–757.

Echinodermata

1. HALL, R. L. (1991): *Seirocrinus subangularis* (MILLER, 1821), a Pliensbachian (Lower Jurassic) crinoid from the Fernie Formation, Alberta, Canada. – J. Paleontol. 65: 300–307.

Foraminifera

1. TIPPER, H. W., P. L. SMITH, B. E. B. CAMERON, E. S. CARTER, G. K. JAKOBS & M. J. JOHNS (1991): Biostratigraphy of the Lower Jurassic formations of the Queen Charlotte Islands, British Columbia. – In: WOODSWORTH, G. J. (ed.): Evolution and Hydrocarbon Potential of the Queen Charlotte Basin, British Columbia. – Geol. Surv. Can. Pap. 90-10: 203–235.

Gastropoda

1. CRICKMAY, C. H. (1933): Mount Jura investigation. – Geol. Soc. Am. Bull. 44: 895–926.
2. HALL, R. L. (1987): New Lower Jurassic ammonite faunas from the Fernie Formation, southern Canadian Rocky Mountains. – Can. J. Earth Sci. 24: 1688–1704.

Marine Vertebrates

1. DENNISON, S. S., P. L. SMITH & H. W. TIPPER (1990): An Early Jurassic ichthyosaur from the Sandilands Formation, Queen Charlotte Islands, British Columbia. – J. Paleontol. 64: 850–853.
2. McGOWAN, C. (1978): Further evidence for the wide geographical distribution of ichthyosaur taxa (Reptilia: Ichthyosauria). – J. Paleontol. 52: 1155–1162.
3. NEUMAN, A. G. & M. V. H. WILSON (1985): A fossil fish of the family Saurichthyidae from the Lower Jurassic of western Alberta, Canada. – Can. J. Earth Sci. 22: 1158–1162.
4. TIPPER, H. W., P. L. SMITH, B. E. B. CAMERON, E. S. CARTER, G. K. JAKOBS & M. J. JOHNS (1991): Biostratigraphy of the Lower Jurassic formations of the Queen Charlotte Islands, British Columbia. – In: WOODSWORTH, G. J. (ed.): Evolution and Hydrocarbon Potential of the Queen Charlotte Basin, British Columbia. – Geol. Surv. Can. Pap. 90-10: 203–235.

Non-marine Vertebrates and Trace Fossils

1. ATTRIDGE, J., A. W. CROMPTON & F. A. JENKINS Jr. (1985): The southern African Liassic prosauropod *Massospondylus* discovered in North America. – J. Vertebr. Paleontol. 5: 128–132.
2. BAIRD, D. (1980): A prosauropod dinosaur trackway from the Navajo sandstone (Lower Jurassic) of Arizona. – In: Jacobs, L. L. (ed.): Aspects of Vertebrate History. – Museum of Northern Arizona Press, 219–230.
3. BROWN, B. B. (1933): An ancestral crocodile. – Am. Mus. Nat. Hist. Novit. 683: 1–4.
4. – (1934): A change of names. – Science 79: 80.
5. CAMP, C. L. (1936): A new type of small bipedal dinosaur from the Navajo sandstone of Arizona. – Univ. Cal. Publ. Geol. Sci. 24: 39–56.
6. CLARK, J. M. & D. E. FASTOVSKY (1986): Vertebrate biostratigraphy of the Glen Canyon Group in Northern Arizona. – In: Padian, K. (ed.): The Beginning of the Age of the Dinosaurs. – Cambridge University Press, New York: 285–301.
7. CLEMENS, W. A. (1984): Jurassic mammals of North America. – IGCP 171, Spec. Pap. 4: 5–10.
8. COLBERT, E. H. (1981): A primitive ornithischian dinosaur from the Kayenta Formation of Arizona. – Mus. North. Ariz. Bull. 53, 61 p.
9. – (1984): The Jurassic Dinosaurs of North America. – IGCP 171, Spec. Pap. 4: 1–4.
10. – (1986): Historical aspects of the Triassic-Jurassic boundary problem. – In: Padian, K. (ed.): The Beginning of the Age of the Dinosaurs. – Cambridge Univ. Press, New York: 9–19.
11. COLBERT, E. H. & C. C. MOOK (1951): The ancestral crocodilian *Protosuchus*. – Bull. Am. Mus. Nat. Hist. 97: 147–182.
12. CROMPTON, A. W. & K. K. SMITH (1980): A new genus and species of crocodilian from the Kayenta Formation (Late Triassic?) of northern Arizona. – In: JACOBS, L. L. (ed.): Aspects of Vertebrate History. – Museum of Northern Arizona press: 193–217.

13. EASTMAN, C. R. (1917): Fossil fishes in the collections of the United States National Museum. – Proc. U.S. Nat. Mus. **52**: 235–304.
14. GAFFNEY, E. S., J. H. HUTCHISON, F. A. JENKINS & L. J. MEEKER (1987): Modern turtle origins: the oldest known cryptodire. – Science **237**: 289–291.
15. GALTON, P. M. (1976): Prosauropod dinosaurs (Reptilia: Saurischia) of North America. – Peabody Museum, Yale University, Postilla **169**: 1–98.
16. HESSE, C. J. (1935): *Semionotus cf. gigas* from the Triassic of Zion Park, Utah. – Am. J. Sci. **29**: 526–531.
17. JENKINS, F. A., A. W. CROMPTON & W. R. DOWNS (1983): Mesozoic mammals from Arizona: new evidence on mammalian evolution. – Science, **222**: 1233–1235.
18. KERMACK, D. M. (1982): A new tritylodontid from the Kayenta Formation of Arizona. – Zool. J. Linn. Soc. **76**: 1–17.
19. LEWIS, G. E. (1958): American Triassic mammal-like vertebrates. – Geol. Soc. Am. Bull. **69**: 1735.
20. OLSEN, P. E. & P. M. GALTON (1977): Triassic–Jurassic tetrapod extinctions: are they real? – Science **197**: 986–989.
21. OLSEN, P. E. & K. PADIAN (1986): Earliest records of *Batrachopus* from the southwestern United States, and a revision of some Early Mesozoic crocodylomorph ichnogenera. – In: PADIAN, K. (ed.): The Beginning of the Age of the Dinosaurs. – Cambridge University Press, New York: 259–273.
22. OLSEN, P. E. & H. D. SUES (1986): Correlation of continental Late Triassic and Early Jurassic sediments, and patterns of the Triassic–Jurassic tetrapod transition. – In: PADIAN, K. (ed.): The Beginning of the Age of the Dinosaurs. – Cambridge University Press, New York: 321–351.
23. PADIAN, K. (1984): Pterosaur remains from the Kayenta Formation (?Early Jurassic) of Arizona. – Palaeontology, **27**: 407–413.
24. ROWE, T. (1989): A new species of the theropod dinosaur *Syntarsus* from the Early Jurassic Kayenta Formation of Arizona. – J. Vertebr. Paleontol. **9**: 125–136.
25. SCHAEFFER, B. & D. DUNKLE (1950): A semionotid fish from the Chinle Formation, with consideration of its relationships. – Am. Mus. Nat. Hist. Novit. **1457**: 1–29.
26. SUES, H. (1986 a): *Dinnebitodon amarali*, a new tritylodontid (Synapsida) from the Lower Jurassic of western North America. – J. Paleontol. **60**: 758–762.
27. – (1986 b): Relationships and biostratigraphic significance of the Tritylodontidae (Synapsida) from the Kayenta Formation of northeastern Arizona. – In: PADIAN, K. (ed.): The Beginning of the Age of the Dinosaurs. – Cambridge University Press, New York: 279–284.
28. WELLES, S. P. (1954): New Jurassic dinosaur from the Kayenta Formation of Arizona. – Geol. Soc. Am. Bull. **65**: 591–598.
29. – (1970): *Dilophosaurus* (Reptilia: Saurischia), a new name for a dinosaur. – J. Paleontol. **44**: 989.
30. – (1971): Dinosaur footprints from the Kayenta Formation of northern Arizona. – Plateau **44**: 27–38.

Palynomorphs

1. POCOCK, S. A. J. (1972): Palynology of the Jurassic sediments of western Canada, Part 2: marine species. – Palaeontographica B **137**: 85–153, pls. 22–29.

Radiolaria

1. CARTER, E. S. (in press): Evolutionary trends in latest Norian and Hettangian radiolaria from the Queen Charlotte Islands, British Columbia. – Geobios.
2. CARTER, E. S., B. E. B. CAMERON & P. L. SMITH (1988): Lower and Middle Jurassic radiolarian biostratigraphy and systematic paleontology. Queen Charlotte Islands, British Columbia. – Geol. Surv. Can. Bull. **386**: 1–104.
3. CORDEY, F. (1988): Etude des radiolaires permiens, triassiques et jurassiques des complexes ophiolitiques de Cache Creek, Bridge River et Hozameen (Colombie-Britannique, Canada): implications paléogéographiques et structurales. Mém. Sci. Terre, Univ. Pierre et Marie Curie, Paris, **88-17**: 374 pp.
4. ICBN (International Code of Zoological Nomenclature) (1985). – International Trust for Zoological Nomenclature, London, i–xx + 338 pp. (third edition).

5. MACLEOD, N. (1988): Lower and Middle Jurassic *Perispyridium* (Radiolaria) from the Snowshoe Formation, east-central Oregon. – *Micropaleontology* **34**: 289–315.
6. PESSAGNO, E. A. JR. & C. D. BLOME (1980): Upper Triassic and Jurassic Pantanelliinae from California, Oregon and British Columbia. – *Micropaleontology* **26**: 225–273.
7. – – (1982): Bizarre Nassellariina (Radiolaria) from the Middle and Upper Jurassic of North America. – *Micropaleontology* **28**: 289–318.
8. PESSAGNO, E. A. JR., W. M SIX & Q. YANG (1989): The Xiphosylidae Haeckel and Parvivaccidae, n. fam., (Radiolaria) from the North American Jurassic. – *Micropaleontology* **35**: 193–255.
9. PESSAGNO, E. A. JR., P. A. WHALEN (1982): Lower and Middle Jurassic Radiolaria (multicyrtid Nassellariina) from California, east-central Oregon and the Queen Charlotte Islands, B.C. – *Micropaleontology* **28**: 111–169.
10. PESSAGNO, E. A. JR., P. A. WHALEN & K.-Y. YEH (1986): Jurassic Nassellariina (Radiolaria) from North American geologic terranes. – *Bull. Am. Paleontol.* **91** (326).
11. PESSAGNO, E. A. JR., C. D. BLOME, E. S. CARTER, N. MACLEOD, P. A. WHALEN & K.-Y. YEH (1987): Preliminary radiolarian zonation for the Jurassic of North America. – In: *Studies of North American Jurassic Radiolaria, Part 2*. Cushman Found. Foraminiferal Res. Spec. Publ. **23**: 1–18.
12. TIPPER, H. W., P. L. SMITH, B. E. B. CAMERON, E. S. CARTER, G. K. JAKOBS & M. J. JOHNS (1991): Biostratigraphy of the Lower Jurassic formations of the Queen Charlotte Islands, British Columbia. – In: WOODSWORTH, G. J. (ed.): *Evolution and Hydrocarbon Potential of the Queen Charlotte Basin, British Columbia*. – *Geol. Surv. Can. Pap.* **90-10**: 203–235.
13. WESTERMANN, G. E. G., Ed. (1992): *The Jurassic of the Circum-Pacific*. – Cambridge University Press, 676 p.
14. YEH, K.-Y. (1987): Taxonomic studies of Lower Jurassic Radiolaria from east-central Oregon. – *Nat. Mus. Nat. Sci., Taichung, Taiwan, Rep. China, Spec. Publ.* **2**.

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