

**GEOLOGICAL
SURVEY
OF
CANADA**

**DEPARTMENT OF ENERGY,
MINES AND RESOURCES**

BULLETIN 158

**HETTANGIAN AMMONITE FAUNAS OF THE
TASEKO LAKES AREA
BRITISH COLUMBIA**

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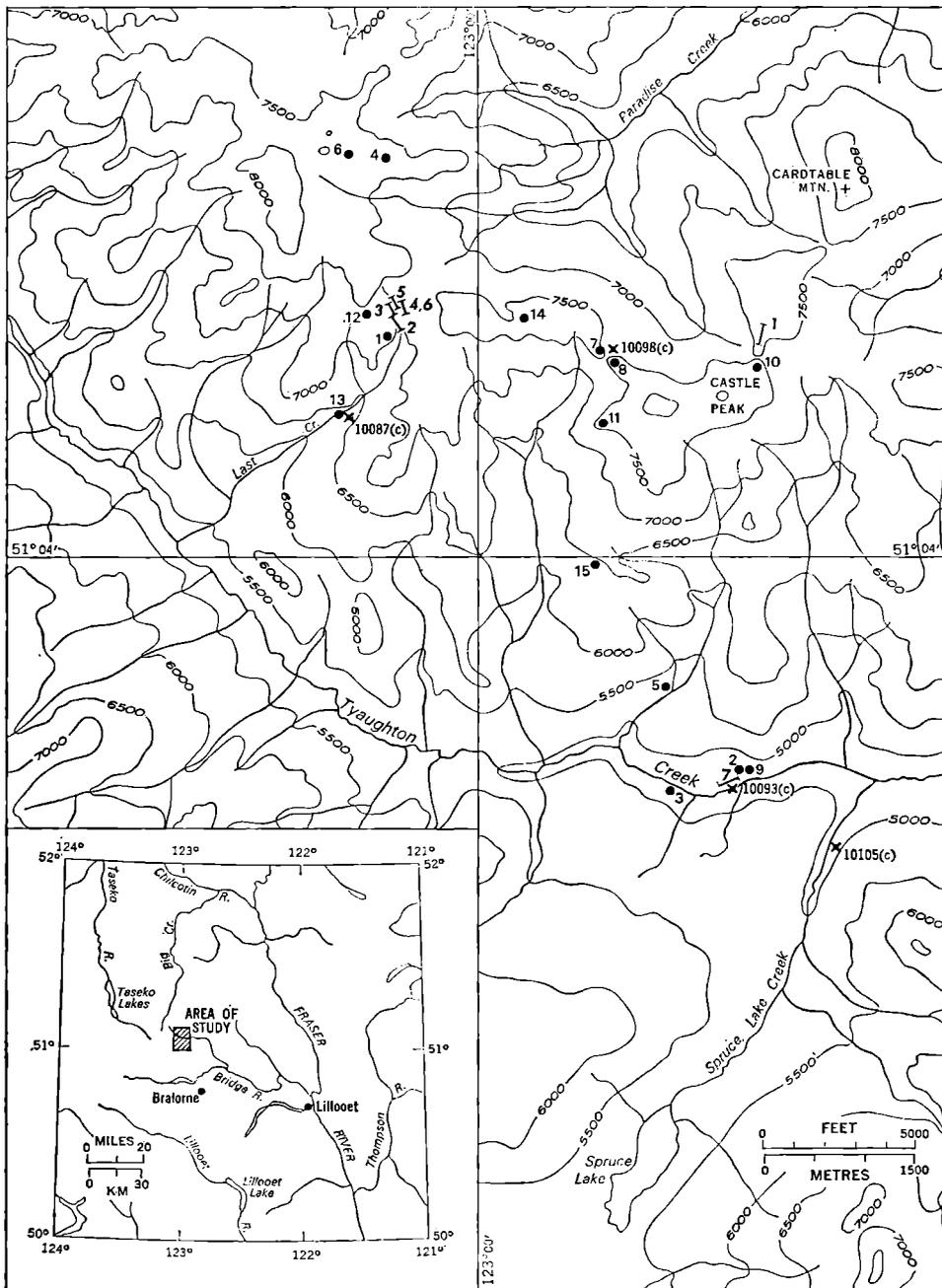
INTRODUCTION

The presence of Lower Jurassic beds in the Tyaughton Lake area, which forms part of the Taseko Lakes area, was demonstrated by C. E. Cairnes and C. H. Crickmay in 1937 and 1939 respectively, and a number of ammonite genera that had been determined in the field were mentioned in the report published by C. E. Cairnes (1943). A later study of these ammonites by the author (Frebald, 1951) revealed the presence of several ammonite zones of the Hettangian and Sinemurian stages, however, some doubts about the succession of the various ammonites remained. During their field work in the Taseko Lakes area in 1963 and 1964, H. W. Tipper and E. T. Tozer, both of the Geological Survey, collected a rather abundant ammonite fauna that was obtained from beds in situ. In addition to ammonites previously known from this area, new forms were found which made a new study desirable.

This report describes only the Hettangian ammonites. Further reports describing the younger Jurassic faunas are in preparation.

The author wishes to thank Dr. Tipper and Dr. Tozer for the details of the various stratigraphic sections and localities, and for the discussion of problems arising during the study of the various faunas. Sincere thanks are also extended to Professor Siemon W. Muller, Stanford University, who showed his very interesting Hettangian ammonite material from Nevada to the author.

MS. received October 1965.



GSC

- Sections measured by H.W. Tipper and E.T. Tozer, respectively 7
- Other localities: 8 ●
- Localities, C.H. Crickmay, 1939 10093(c) ×
- Contours, interval 500 feet 6000

FIGURE 1. Index map showing Hettangian fossil localities southeast of Taseko Lakes.

DESCRIPTION OF LOCALITIES

The seven sections and fifteen other localities that are described below are indicated on Figure 1 by the same numbers as used in the text.

The description of sections 1-5 including the lithology is by H. W. Tipper, that of sections 6 and 7 by E. T. Tozer. The fossil identifications are by the author of this report. Numbers in brackets after GSC locality numbers are collectors' field numbers.

Section 1. Approximately 1½ miles northeast of Castle Mountain

GSC loc. 62345 (U-107aTD). Part of collections is from talus.

Psiloceras canadense Frebold.

GSC loc. 62499 (U-107bTD). 10 feet below GSC loc. 62345.

Psiloceras canadense Frebold, *P. occidentale* n. sp., *Eolytoceras tasekoi* n. sp., *Eolytoceras* sp. indet. 2, 3, *P. rursicostatum*.

GSC loc. 62362 (U-107cTD). About 10 feet below GSC loc. 62499.

Psiloceras canadense Frebold, *Paracaloceras rursicostatum* n. sp., *Charmasseiceras marmoreum* (Oppel), *Eolytoceras* cf. *E. tasekoi* n. sp., *Eolytoceras* sp. indet. 1.

According to Dr. Tipper (pers. com.), 15 feet below GSC loc. 62362 there are conglomerates several hundred feet thick, the top of which contain *Psiloceras canadense* Frebold only.

Section 2. South side of Last Creek

Unit	GSC locality	Thick-ness	Accumu- lated thickness	Description
15	62479 (2f-222TD)	8"	37' 7"	Brown weathering, grey greywacke with wood fragments, <i>Psiloceras canadense</i> Frebold, <i>P. (Curviceras) columbiae</i> n. sp.
14	62494 (2e-222TD)	8"	36' 11"	Grey-green crumbly greywacke. <i>P. (Curviceras) columbiae</i> n. sp.
13		7"	36' 3"	Concretionary greywacke
12		11"	35' 8"	Crumbly dark green greywacke
11	62466 (2d-222TD)	1'	34' 9"	Concretionary greywacke, weathers grey, grey-green on fresh surface. <i>P. (Curviceras) columbiae</i> n. sp.
10		5' 3"	33' 9"	Crumbly greywacke, rusty, shattered
9		1' 2"	28' 6"	Massive green greywacke, no bedding, silty

Section 2. (conc'd) South side of Last Creek

Unit	GSC locality	Thick-ness	Accumu-lated thickness	Description
8		1'	27' 4"	Crumbly greywacke, soft, grey-green
7	62490 (2c-222TD)	1' 6"	26' 4"	Concretionary limy greywacke, grey-green. <i>Psiloceras</i> (? <i>Curviceras</i>) sp. indet.
6	62491 (2b-222TD)	1' 6"	24' 10"	Greywacke, green, with layers of concretions with pelecypods and wood, limy green 4" thick irregular concretionary bands. <i>P. canadense</i> Frebold
5	62487 (2a-222TD)	1' 4"	23' 4"	Pebble-conglomerate and greywacke, mainly brown weathering. Fragments of pelecypods at base. <i>P. canadense</i> Frebold
4		7'	22'	Massive greenish greywacke, grey weathering
3		5' 6"	15'	Green pebble-conglomerate and greywacke. Weathers brown. Conglomeratic bands 4" thick
2		3' 6"	9' 6"	Green greywacke, massive beds 8" thick, no fine bedding, slightly sheared 2"-6" red greywacke
1		6'	6'	Green conglomerate, fine grit, coarse sand, few pebble lenses

Section 3. Head of Last Creek

Southwest side of creek above second fault (opposite section 5)

Unit	GSC locality	Thick-ness	Accumu-lated thickness	Description
	62405 (3i-222TD)	1' +		Argillite, limy. End of section. Sinemurian
		60'		Shales, black, soft, sheared (fault zone)
20	62403 (3h-222TD)	1'	102' 3"	Greywacke blue-grey, hard, weathers brown. <i>P. (Curviceras) columbiae</i> n. sp., <i>Paracaloceras</i> sp. indet.
19		14' 9"	101' 3"	Greywacke, dark grey, shaly
18	62431 (3g-222TD)	7' 6"	86' 6"	Greywacke, dark grey, buff weathering. Large chunk of wood. <i>P. (Curviceras) columbiae</i> n. sp., Ammonite gen. et sp. indet. 1
17		9'	79'	Greywacke, dark grey, crumbly
16		1'	70'	Greywacke, greenish, with small concretions at top, buff weathering
15		3'	69'	Greywacke, dark grey, similar to unit 14
4				

Section 3. (conc'd) Head of Last Creek

Unit	GSC locality	Thick-ness	Accumu- lated thickness	Description
14	62411 (3f-222TD)	5' 6"	66'	Greywacke, dark grey, at top with fossils. <i>Psiloceras</i> sp. indet.
13		18"	60' 6"	Greywacke, greenish, with small concretions
12		14'	59'	Greywacke, grey, crumbly
11	62430 (3e-222TD)	6"	45'	Greywacke, concretionary. <i>P. (Curviceras) columbiae</i> n. sp.
10		8'	44' 6"	Greywacke, greenish brown
9	62402 (3d-222TD)	6"	36' 6"	Greywacke, hard, limy. <i>P. (Curviceras) columbiae</i> n. sp.
8		10'	36'	Greywacke, drab green, crumbly.
7		8"	26'	Greywacke, concretionary, wood fragments
6		7'	25' 4"	Greywacke, dull grey-green, crumbly
5	62406 (3c-222TD)	6"	18' 4"	Greywacke, concretionary, limy. <i>P. (Curviceras) columbiae</i> n. sp.
4		4'	17'10"	Greywacke, dull grey-green, soft, crumbly
3	62432 (3b-222TD)	4"	13'10"	Greywacke, concretionary, limy. <i>P. (Curviceras) columbiae</i> n. sp.
2		10' 6"	13' 6"	Greywacke, dark rusty greenish grey, rubbly
1	62404 (3a-222TD)	3'	3'	Greywacke, concretionary. <i>Psiloceras canadense</i> Frebold

Section 4. Head of Last Creek

(This section corresponds in part to section 6)

Unit	GSC locality	Thick-ness	Accumu- lated thickness	Description
14	62366 (4-222gTD)	1'	62'	Siltstone, light green-grey, very calcareous, very fine grained, bedding undulating, slightly concretionary, weathers light brown, resistant, fossiliferous. <i>P. (Curviceras) columbiae</i> n. sp.
13		11'	61'	Greywacke, light to dark green-grey, very fine grained, very slightly calcareous in places, recessive, bedding $\frac{1}{2}$ -1", weathers in small $\frac{1}{2}$ - $\frac{1}{2}$ " fragments, weathers dark green-grey, few calcareous siltstone concretions in places, very small, averaging approximately 2"-3"
12		$\frac{1}{2}$ '	50'	Few large, up to 1' irregular concretions, not continuous but scattered approximately 10'-20' apart, sometimes in groups, slightly calcareous, weathering brown

Section 4. (conc'd) Head of Last Creek

Unit	GSC locality	Thickness	Accumulated thickness	Description
11		4'	49½'	Greywacke, shaly, with few small (1"-2") concretions
10	62387 (4-222fTD)	½'	45½'	Siltstone, light green-grey, very fine grained, calcareous, bedding undulating, weathers light brown, resistant. <i>P. (Curviceras) columbiae</i> n. sp.
9		5½'	45'	Greywacke as in unit 6, shaly, bedding ½-1", weathers in very small angular (½-1") fragments
8		2'	39½'	Greywacke, dark green-grey, very fine grained, slightly siliceous calcareous, more resistant than other greywackes, weathers in 1"-2" fragments
7	62502 (4-222eTD)	3'	37½'	Limestone, concretionary as in unit 5, slightly silty, concretions (up to 1½' long, 6" wide). Fossils in and close to concretions. <i>P. (Curviceras) columbiae</i> n. sp.
6		16'	34½'	Greywacke as in unit 4, few small 1"-3" concretions
5	62354 (4-222d)	1'	18½'	Limestone, dark blue-grey, very fine grained, slightly silty, very hard, concretionary (2'-3' long, ½-1½' wide, also small concretions). Bed varies in thickness, not fully continuous laterally. Weathers light brown, in sharp contact with greywacke, resistant. <i>Charmasseiceras marmoreum</i> (Oppel), <i>Psiloceras (Curviceras) columbiae</i> n. sp.
4	62358 (4-222c)	5'	17½'	Greywacke, medium to dark green, very fine grained, shaly, non-calcareous, slightly siliceous, recessive, similar to unit 2, few small elongated 1"-4" concretions. Lower contact with siltstone bed, rather sharp. Weathers dark green-brown. <i>P. (Curviceras) columbiae</i> n. sp.
3	62467 (4-222b)	1'	12½'	Siltstone, light grey, very fine grained, calcareous, nodular and concretionary in places, bedding surface undulates slightly. Seems to grade into greywacke above and below, resistant, weathers brown. <i>P. (Curviceras) columbiae</i> n. sp.
2		8½'	11½'	Greywacke, green-brown, very fine grained, slightly siliceous, generally uncalcareous, very finely bedded, recessive, weathers dark green-grey with almost purplish tinge in small ½-1" angular fragments
1	62503 (4-222a)	3'	3'	Siltstone, light green-grey, very fine grained, calcareous, bedding ½-1', resistant, weathers brown grey. <i>Psiloceras (Curviceras) columbiae</i> n. sp. This unit is equivalent to unit 6 in section 6

According to Dr. Tipper (pers. com.), unit 1 is underlain by sandstones and conglomerates, equivalents of units 1-5 in section 6, that contain *Psiloceras canadense* only.

Section 5. Head of Last Creek, northeast side (opposite section 3)

Unit	GSC locality	Thickness	Accumulated thickness	Description
18		5'	100' 2"	Talus
17	62351 (5h-222TD)	2'	95' 2"	Greywacke, grey, blocky. <i>Paracaloceras</i> sp.
16		10'	93' 2"	Greywacke, talus-covered
15	62407 (5g-222TD)	3'	83' 2"	Greywacke, weathering reddish brown, limy, with thin coquina beds. <i>P. canadense</i> Frebold, <i>P. (Curviceras) columbiae</i> n. sp., Ammonite gen. et sp. indet.
14		9'	80' 2"	Greywacke, greenish, talus-covered
13	62333 (5f-222TD)	6"	71' 2"	Greywacke, mauve weathering. <i>Psiloceras (Curviceras?)</i> sp. indet.
12		25'	70' 8"	Talus-covered
11	62410 (5e-222TD)	8"	45' 8"	Greywacke, blue-grey, hard, coquina of small shells. No determinable ammonites
10		2'	45'	Talus-covered
9	62328 (5d-222TD)	1'	43'	Greywacke, blue-grey, hard. <i>P. (Curviceras) columbiae</i> n. sp., Ammonite gen. et sp. indet. 4
8		1'	42'	Talus-covered
7		4'	41'	Greywacke, mainly sandy
6	62409 (5c-222TD)	1'	37'	Greywacke, slightly resistant. <i>Nautilus</i> sp., <i>P. canadense</i> Frebold, <i>P. (Curviceras) columbiae</i> n. sp.
5		9'	36'	Talus-covered
4	62352 (5b-222TD)	1'	27'	Greywacke, blue-green, hard. <i>Psiloceras canadense</i> Frebold, <i>P. (Curviceras) columbiae</i> n. sp.
3		15'	26'	Talus-covered greywacke
2	62331 (5a-222TD)	1'	11'	Greywacke, blue-green, hard. <i>Psiloceras canadense</i> Frebold, <i>P. (Curviceras) columbiae</i> n. sp.
1		10'	10'	Talus-covered greywacke

Unit 1 is, according to Dr. Tipper (pers. com.), underlain by about 50 feet of conglomerates that seem to be equivalent to the basal parts of sections 1, 2, 3, 4, and 6.

Section 6. Near head of Last Creek
(Measured by E. T. Tozer, equivalent in part to section 4)

Unit	GSC locality	Thick-ness	Accumu-lated thickness	Description
6	56416 (TD322A-63)	1'	232'	Sandstone, brown weathering. <i>Psiloceras</i> (<i>Curviceras</i>) <i>columbiae</i> n. sp., <i>Paracaloceras rursicostatum</i> n. sp., wood and pelecypods
5		10'	231'	Covered
4	56417 (TE322B-63)	1'	221'	Sandstone, brown. Pelecypods
3	56419 (TE323A-63)	20'	220'	Sandstone, green, recessive, some hard concretionary masses. <i>Psiloceras?</i> sp. indet. in lower part
2		about 130'	200'	Green sandstone and conglomerate, intermittent exposures Gastropods
1		70'	70'	Mainly covered, small outcrops of conglomerate

Comment by E. T. Tozer: "Units 1 and 2 are possibly the beds in which the Jurassic-Triassic boundary occurs. They resemble the *Choristoceras* bed of Tyaughton Creek. *Psiloceras* ex aff. *planorbis* (Sowerby) (GSC loc. 62357) may be from beds equivalent to this unit."

Section 7. North side of Tyaughton Creek

4,500 feet above Spruce Lake Creek (measured by E. T. Tozer) measuring from east to west.
Beds are vertical.

Unit	GSC locality	Thickness	Description
8		10'	Sandstone, green. Bed at contact with unit 7 has pebbles up to about 4 inches in diameter of green volcanic rock. No limestone pebbles seen
7	56393 (TE-305a-63)	2' 5"	Sandstone, greenish, partly crossbedded. Crossbedding suggests top is to west, i.e., that unit 7 is above unit 8. Abundant fossils in westernmost 6 inches. Unit 7 forms resistant bed. <i>Psiloceras canadense</i> Frebold, <i>Charmasseiceras</i> sp. indet., pelecypods, belemnoids
6	56394 (TE-305b-63)	25'	Sandstone, greenish, mainly recessive and thin-bedded with sandstone nodules and hard bands. <i>Psiloceras canadense</i> Frebold at western limit of outcrop
5		85'	Covered interval; fault?

Section 7. (conc'd) North side of Tyaughton Creek

Unit	GSC locality	Thick-ness	Accumu-lated thickness	Description
4	(TE-306A-63)	27'		Sandstone green. Some pebbles of volcanic rock up to 3 inches in diameter. Contains according to Tozer: <i>Choristoceras</i> cf. <i>C. marshi</i> Hauer, <i>Meleagrinella</i> , and others. At base <i>Myophoria suttonensis</i> and <i>Modiola</i> cf. <i>strigillata</i> . (Rhaetian)
3		2' 6"		Sandstone, as unit 4, but thin-bedded and recessive. Pelecypods at base
2		25'		Covered interval
1		45'		Sandstone and siltstone, green, brown weathering, has concretionary masses, commonly coquinoïd. According to Tozer: <i>Cassianella</i> fauna (Upper Norian)

Interpretation by E. T. Tozer: "Originally I thought that this section showed the relationship between the Rhaetian *Choristoceras* beds (TE-306A) and the Hettangian strata (TE-305a). Later work, a mile or so to the north, showed that the *Cassianella* beds are followed by a substantial thickness of green conglomeratic sandstone. This, and also the crossbedding observed in unit 7, cast doubt on this section as an unfaulted sequence. Unit 6 strikes 010 East (vertical); unit 4 strikes 165 East (vertical). Probably there is a fault in the covered interval (unit 4), and bed 6 overlies bed 7. I am reasonably confident that bed 4 (with *Choristoceras*) overlies bed 1 (with *Cassianella*); this relationship between *Cassianella* and *Choristoceras* beds was also observed immediately below the mouth of Spruce Lake Creek."

Other Localities

- GSC loc. 62478 (U-114-1TD). Upper Green Conglomerate Unit.
½ mile west of limestone mass, ½ mile east of Last Creek.
Psiloceras (Curviceras) columbiae n. sp., Ammonite gen. et sp. indet. 3
- GSC loc. 62504 (U-113-2a). Upper Green Conglomerate Unit.
Small knob, a mile west of Spruce Lake Creek.
Psiloceras canadense Frebold
- GSC loc. 62390 (U-104-8TD). Tyaughton Creek.
About a mile west of Spruce Lake Creek.
Phylloceras sensu lato sp.
Paracaloceras cf. *P. coregonense* (Sowerby),
P. multicostatum n. sp., Ammonite gen. et sp. indet. 5
- GSC loc. 62357 (U-115-15TD). Upper Green Conglomerate Unit.
3½ miles northwest of limestone knob.
Psiloceras ex aff. *P. planorbis* (Sowerby)

5. GSC loc. 62346 (U-111-5TD). Approximately 5 miles south Castle Mountain, in creek at junction of two creeks.
Ammonite gen. et sp. indet. 2, 5
6. GSC loc. 62443 (U-115-13TD). On ridge to northeast (about 3½ miles) of limestone knob.
Psiloceras canadense Frebold, *Paracaloceras* cf. *P. coregonense* (Sowerby)
7. GSC loc. 62448 (U-102-5TD). Upper Green Conglomerate Unit.
Saddle about a mile west of Castle Mountain.
Psiloceras canadense Frebold
8. GSC loc. 62447 (U-102-6TD). Upper Green Conglomerate Unit.
Saddle on ridge about a mile west of Castle Mountain.
Psiloceras canadense Frebold, *P. (Curviceras) columbiae* n. sp.,
Paracaloceras sp. indet., *Charmasseiceras marmoreum* (Oppel) sp. iuven.
9. GSC loc. 62477 (U-113-TD). Small knob, a mile west of Spruce Lake Creek.
Discamphiceras (?) *tipperi* n. sp., *Paracaloceras* sp.
10. GSC loc. 62365 (U-107-1-TD). Upper Green Conglomerate Unit.
About ¼ mile northeast of Castle Mountain.
Ridge leading to saddle.
Psiloceras canadense Frebold, *Paracaloceras*(?) sp. indet.
11. GSC loc. 62445 (U-103-6bTD). Ridge southwest of Castle Mountain.
Psiloceras canadense Frebold
12. GSC loc. 62367 (U-114-7TD). Upper Green Conglomerate Unit.
Approximately 2 miles west of limestone knob, on small ridge, beneath porphyry mass.
P. (Curviceras) columbiae n. sp.
13. GSC loc. 62359 (U-116-1TD). Last Creek, at second stream on east side, from Tyaughton Creek.
Psiloceras cf. *P. canadense* Frebold
14. GSC loc. 62389 (U-100-10TD). Upper Green Conglomerate Unit.
On ridge, about 2½ miles west of Castle Mountain.
Psiloceras canadense Frebold
15. GSC loc. 62485 (U-112-4TD). Upper Green Conglomerate Unit.
4 miles southwest of Castle Mountain ridge.
Psiloceras canadense Frebold

SYSTEMATIC DESCRIPTIONS

The Hettangian ammonite fauna of the Taseko Lakes area described in this report is assigned as follows:

Suborder PHYLLOCERATINA Arkell

Superfamily PHYLLOCERATACEAE Zittel

Family PHYLLOCERATIDAE Zittel

Subfamily PHYLLOCERATINAE Zittel

Phylloceras sensu lato sp.

Suborder LYTOCERATINA Hyatt

Superfamily LYTOCERATACEAE Neumayr

Genus *Eolytoceras* n. gen.

Eolytoceras tasekoi n. sp.

Eolytoceras cf. *E. tasekoi* n. sp.

Eolytoceras spp. indet.

Suborder AMMONITINA Hyatt

Superfamily PSILOCERATACEAE Hyatt

Family PSILOCERATIDAE Hyatt

Subfamily PSILOCERATINAE Hyatt

Genus *Psiloceras* Hyatt

Psiloceras ex aff. *P. planorbis* (Sowerby)

Psiloceras canadense Frebold

Psiloceras occidentale n. sp.

Subgenus *Curviceras* Blind

P. (Curviceras) columbiae n. sp.

Genus *Discamphiceras* Spath

Discamphiceras(?) *tiperi* n. sp.

Subfamily ALSATITINAE Spath

Genus *Paracaloceras* Spath

Paracaloceras cf. *P. coregonense* (Sowerby)

Paracaloceras multicoatum n. sp.

Paracaloceras rursicostatum n. sp.

Family SCHLOTHEIMIIDAE Spath
 Genus *Charmasseiceras* Spath
Charmasseiceras marmoreum (Oppel)

Ammonites incertae sedis

Suborder PHYLLOCERATINA Arkell, 1950
 Superfamily PHYLLOCERATACEA Zittel, 1884
 Family PHYLLOCERATIDAE Zittel, 1884
 Subfamily PHYLLOCERATINAE Zittel, 1884

Phylloceras sensu lato sp.

Plate V, figures 4a, b

Material. One specimen, GSC No. 19929, from GSC locality 62390.

Description. Measurements (in mm) are as follows:

Diameter	Whorl height	Whorl thickness	Umbilical width
65 (100)	38 (0.58)	23 (0.35)	5 (0.07)

The specimen has a narrow umbilicus. The flanks are flat and parallel to each other except in the anterior part of the whorl where they are very slightly convex. The transition to the fairly broad rounded venter is gradual. Except for very fine striae, there is no sculpture. The specimen is septate to the end of the last whorl. Details of the suture line cannot be traced. The ventral lobe is much shorter than the first lateral, which is comparatively wide. Its outer and centre branches are apparently stronger than the inner branch, thus giving almost the picture of a bipartite lobe. The second lateral could not be traced and the auxiliaries are only poorly visible. The first lateral saddle is narrower than the first lateral lobe.

In its general outline and suture line the specimen is similar to the genus *Hantkeniceras* Kovacs. Because of the incompleteness of the suture line of the Taseko Lakes specimen, no detailed comparison or assignment can be made.

Occurrence. At locality 62390 *Phylloceras* sensu lato sp. is associated with *Discamphiceras* (?) *tipperti* n. sp., *Paracaloceras* cf. *P. coregonense* (Sowerby), and *P. multicostatum* n. sp.

Suborder LYTOCERATINA Hyatt, 1889
 Superfamily LYTOCERATACEAE Neumayr, 1875

At one locality Lytocerataceae were found in two beds of the same section. They are forms with the general appearance of some Lytoceratidae such as *Lytoceras* s. str. but are distinguished by a different suture line, particularly the presence of tripartite lobes, in all stages of growth. The specimens are in part fairly well preserved, but there are also a number of fragments whose relationship to one another and to the better preserved specimens could not be established with confidence. Accordingly, each specimen is described separately, although some of them may belong to one and the same species.

The assignment of the specimens that are described as *Eolytoceras* n. gen. to one or another family of the Lytocerataceae is postponed until a richer material has been collected. In their suture line they are similar to *Analytoceras articulatum* (Sowerby). Suture lines of this species figured by Waehner (1894, on Pls. VII, VIII, IX) agree very well with those observed on *Eolytoceras* in the shortness of the ventral lobe, the two tripartite lateral lobes and the incisions of the lateral saddles. Also the general outline of the shell in both genera is similar but the significant deep constrictions of the inner whorls of *Analytoceras*, its parabolic lines and parabolic nodes, sigmoid flares and ventrolateral spines are not observed in *Eolytoceras*. Consequently, an assignment to the Analytoceratinae Spath is not justifiable.

Other Hettangian Lytocerataceae are placed by Spath (1926) in the family Ectocentritidae that comprise "astonishingly diverse" genera. Some of the previously described *Ectocentritidae* (see also Bonarelli, 1900 and Pompeckj, 1893, pp. 175-178) have tripartite lateral lobes at least at younger stages of growth. In *Fucinites* Gugenberger a tripartite lateral lobe seems to be retained at a larger stage of growth (see Gugenberger, 1936, p. 175, pl. 3, fig. 1d), but in other aspects they are clearly distinguished from the Canadian *Eolytoceras*. The genus *Ectocentrites* Canavari (1888, p. 126) has well-pronounced ribs, whereas the Canadian specimens have only very weak ribbing. The genera *Lytotropites* Spath (1924, p. 200) and *Fucinites* Gugenberger (1936, p. 175) have a ventral keel that is absent in our specimens, *Holcolytoceras* Spath (1924, p. 189) has ventrolateral bullae, and *Peltolytoceras* Spath (1924, p. 194) has large, strong ribs which are absent in the Canadian specimens.

Eolytoceras n. gen.

Evolute forms with elliptical to rectangular cross-section. Several constrictions, generally very fine sculpture that is not visible in less well preserved specimens. Only one specimen with more pronounced ribs on inner whorls. Suture line with ventral lobe shorter than first lateral lobe. Both lateral lobes tripartite, saddle endings more or less phylloid.

Type species: Eolytoceras tasekoi n. sp. Age: Hettangian.

Eolytoceras tasekoi n. sp.

Plate VIII, figures 1a, b, c; 2a, b, c; Text-figure 2

Material. Two specimens, GSC Nos. 20059 (holotype) and 20060 (paratype), from GSC locality 62499.

Description. Very evolute, cross-section oval, moderately convex flanks, narrow, rounded venter, no indication of a keel. Several narrow, shallow constrictions. Sculpture fairly well preserved on holotype consisting of fine ribs and growth lines that are slightly inclined forward. Some of the ribs cross the venter.

The suture line is best displayed on the paratype. The ventral lobe is shorter than the first lateral lobe. Both first and second lateral lobes are tripartite, saddles more or less bifid, saddle endings phylloid.

The measurements in millimetres are:

Type	Diameter	Whorl height	Whorl thickness	Umbilical width
Holotype, GSC 20059	52 (100)	21 (0.40)	15 (0.29)	20 (0.38)
Paratype, GSC 20060	52 (100)	19 (0.37)	15 (0.29)	20 (0.38)



Figure 2. Part of suture line of *Eolytoceras tasekoi* n. gen. n. sp. at whorl height 18 mm of paratype GSC 20060. Enlarged about x3. See Pl. VIII, figs. 1a-c.

Comparison. In its general outline the species somewhat resembles *Lytoceras fimbriatum* (Sowerby) from the Pliensbachian, but the suture line is different, the lateral lobes of *L. fimbriatum* being bipartite (see d'Orbigny, 1842-49, pl. 98, fig. 3). Furthermore, *L. fimbriatum* has a more rounded cross-section and its constrictions are more pronounced.

Occurrence. At locality 62499 *Eolytoceras tasekoi* n. sp. is associated with *Psiloceras canadense* Frebold, *P. occidentale* n. sp., *Paracaloceras rursicostatum* n. sp., and *Eolytoceras* sp. indet. 2, 3. Ten feet below (at loc. 62362) *P. canadense*, *Paracaloceras rursicostatum*, *Charmasseiceras marmoreum* (Oppel) are associated with *Eolytoceras* cf. *E. tasekoi* n. sp. and *Eolytoceras* sp. indet. 1. The age of these two faunas is Hettangian.

Eolytoceras cf. *E. tasekoi* n. sp.

Plate VI, figures 1a-c

Material. One specimen, GSC No. 20063 (holotype), from locality 62362.

Description. Very evolute, with slightly convex flanks and rounded venter (not visible at end of last whorl in figure 1b). No indication of keel. On last whorl five to six rather shallow and not very distinct constrictions. Some similar constrictions on penultimate whorl. Inner whorls not visible. Very fine ribs only recognizable on parts of the venter where the shell is preserved.

Only parts of the suture line are visible. It is strongly incised. The ventral lobe is much shorter than the tripartite first lateral. The last whorl is septate almost to its end.

The measurements in millimetres taken at two different diameters are as follows:

Diameter	Whorl height	Whorl thickness	Umbilical width
138 (100)	47 (0.34)	37 (0.27)	58 (0.42)
66 (100)	26 (0.39)	19 (0.29)	29 (0.44)

Comparison. This specimen is apparently related to *Eolytoceras tasekoi* n. sp., but unfortunately no detailed comparison can be made as stages of growth equal to those of the two *tasekoi* specimens are not visible. These circumstances also prevent comparisons with some fragments of smaller specimens described below.

Occurrence. At locality 62362 *Eolytoceras* cf. *E. tasekoi* is associated with *Eolytoceras* sp. indet. 1, *Psiloceras canadense* Frebold, *Paracaloceras rursicostatum* n. sp., *Charmasseiceras marmoreum* (Oppel). The age is Hettangian.

Eolytoceras sp. indet. 1

Plate VIII, figures 3, 4

Material. Two specimens, GSC Nos. 20064, 20065, from GSC locality 62362.

Description. Specimen 20064 is corroded on one side. It is very evolute, the cross-section of the last whorl is almost rectangular with rounded venter and slightly convex flanks. There are about five constrictions on the last whorl; the one close to the end is more pronounced than the others. Some indistinct mostly straight ribs are recognizable on the flanks, some of them faintly crossing the venter. There is no ventral keel. Suture line is poorly preserved, the first lateral lobe is tripartite, longer than the ventral lobe.

The measurements in millimetres at the maximal diameter are as follows:

Diameter	Whorl height	Whorl thickness	Umbilical width
52 (100)	18 (0.35)	14 (0.27)	23 (0.45)

The specimen 20065 is very similar, and belongs to the same species as the described one.

Comparison. The two specimens are distinguished from *Eolytoceras tasekoi* n. sp. mainly by greater evolution.

Occurrence. At locality 62362 *Eolytoceras* sp. indet. 1 is associated with *Psiloceras canadense* Frebold, *Paracaloceras rursicostatum* n. sp., *Charmasseiceras marmoreum* (Oppel), and *Eolytoceras* cf. *E. tasekoi* n. sp. The age is Hettangian.

Eolytoceras sp. indet. 2

Plate VI, figures 2a-c

Material. One fragment, GSC No. 20061, from GSC locality 62499.

Description. The last whorl of this fragment has an elliptic cross-section with slightly convex flanks and rounded venter. The umbilical wall is comparatively high and rather steep. This whorl is almost entirely smooth. The visible parts of the preceding whorl have blunt, straight forward inclined ribs, and the imprint of a still younger whorl is also ribbed.

Indistinct parts of the suture line are visible at the younger part of the last whorl.

Occurrence. At locality 62499 this indeterminable *Eolytoceras* is associated with *Eolytoceras tasekoi* n. sp., *E. sp. indet. 3*, *Psiloceras canadense* Frebold, *P. occidentale* n. sp., and *Paracaloceras rursicostatum* n. sp. The age is Hettangian.

Eolytoceras sp. indet. 3

Plate VI, figure 3

Material. One whorl fragment, GSC No. 20062, from GSC loc. 62499.

Description. The whorl fragment has an elliptic cross-section, three constrictions of which the middle one is more distinct than the others, and very fine forward inclined lines. The entire fragment is septate, the sutures closely following one

another. The sutures are deeply incised, the ventral lobe is much shorter than the tripartite first lateral lobe, the saddle endings are phylloid.

Comparison. The indeterminable fragment may belong to *Eolytoceras* cf. *E. tasekoi*, which has apparently very similar sutures and a similar whorl at the same ontogenetic stage as the whorl fragment.

Occurrence. At locality 62499 *Eolytoceras* sp. indet. 3 is associated with *Eolytoceras tasekoi* n. sp., *E.* sp. indet. 2, *Psiloceras canadense* Frebold, *P. occidentale* n. sp., and *Paracaloceras rursicostatum* n. sp. The age is Hettangian.

Suborder AMMONITINA Hyatt, 1889
Superfamily PSILOCERATACEAE Hyatt, 1867
Family PSILOCERATIDAE Hyatt, 1867
Subfamily PSILOCERATINAE Hyatt, 1867

Lange (1941, 1951) distinguished two genera, *Psiloceras* Hyatt and *Storthoceras* Lange which were subdivided into a number of subgenera. *Psiloceras* included the subgenera *Paraphylloceras* Salfeld (= *Parapsiloceras* Hyatt), *Waehneroceras* Hyatt, *Teneroceras* Lange, and *Caloceras* Hyatt, whereas *Storthoceras* Lange contained *Storthoceras* s. str., *Megastomoceras* Lange, and *Discamphiceras* Spath.

Arkell (1957) distinguished among others the following genera: *Psiloceras* Hyatt, *Caloceras* Hyatt, *Discamphiceras* Spath, *Laqueoceras* Lange, *Parapsiloceras* Hyatt (= *Paraphylloceras* Salfeld); *Waehneroceras* with *Teneroceras* (*Tenoceras*) Lange, *Storthoceras* Lange, and *Megastomoceras* Lange were considered to be synonyms of *Waehneroceras* and were placed into the family Schlotheimiidae Spath.

Blind (1963, p. 48) considers the type of the genus *Waehneroceras* Hyatt, i.e., *Aegoceras tenerum* Neumayr, as belonging to *Psiloceras* s. str. and hence abolishes Hyatt's genus. The group of *Ammonites subangularis* Oppel that had previously been placed by Lange in a subgenus *Waehneroceras* s. str. is assigned to a subgenus of *Psiloceras*, i.e., *Curviceras* Blind. The author follows Blind in this, but follows Arkell (1957) in considering *Discamphiceras* Spath as a genus, and not as a subgenus of *Psiloceras* as proposed by Blind.

Genus *Psiloceras* Hyatt, 1867

Type species: *Psiloceras planorbis* (Sowerby), 1824

Psiloceras ex aff. *P. planorbis* (Sowerby)

Plate I, figures 6, 7, 8a, b

Material. Three small specimens: GSC Nos. 20051, 20053, and 20054. All three specimens are from GSC locality 62357.

Description. The measurements in millimetres of GSC No. 20051 and GSC No. 20053 are as follows:

Type	Diameter	Whorl height	Whorl thickness	Umbilical width
GSC 20051	30 (100)	11 (0.37)	8 (0.27)	11 (0.37)
GSC 20053	30 (100)	10 (0.33)	9 (0.30)	12 (0.40)

The general outline of these specimens and of the fragment GSC No. 20054 is evolute with very slightly convex flanks that grade into the rounded, fairly narrow venter. Transition to umbilicus is rather abrupt with more or less steep but low umbilical slope. Cross-section oval.

Very faint straight blunt ribs are present on the penultimate whorl of GSC No. 20054 (not visible in the illustration, Pl. I, fig. 8a) and faint waves on the venter of the last whorl of the same specimen. The two other specimens seem to be entirely smooth.

Part of the suture line is visible on the last whorl of GSC No. 20051, Plate I, figure 7, but unfortunately details are not well preserved. The ventral lobe is shorter than the lateral. The second lateral saddle is very slightly higher than the first.

Comparisons. In general appearance the Canadian specimens are similar to *Psiloceras planorbis* (Sowerby) and *Psiloceras psilonotum* (Quenstedt) that are closely related to each other. A specimen of the latter species from Nellingen, Suabia (GSC No. 20055, Pl. I, fig. 9) shows the similarity to our specimens. It has also a very faint sculpture at about the same diameter as the Canadian specimen GSC No. 20054. Unsatisfactory preservation does not permit a direct identification with any known species of the *planorbis* group.

Occurrence and age. The Canadian form was not found associated with other ammonites. Because of its similarity to *P. planorbis* (Sowerby), which occurs in Europe at the base of the Hettangian, it is considered to be the oldest Jurassic ammonite hitherto found in the Taseko Lakes area.

Psiloceras canadense Frebold

Plate I, figures 1a, b; 2a, b; 3a-c; Text-figure 3

Psiloceras canadense Frebold, 1951, p. 3, pl. 1, figs. 1-6; pl. 2, fig. 1; pl. 3, fig. 1.
Psiloceras canadense Frebold, 1964, p. 6, pl. 1, figs. 1-5.

A rich new collection additional to that made by Cairnes and Crickmay and previously described (Frebold, 1951) was found by Drs. Tipper and Tozer in the sections and at other localities in the Taseko Lakes area. The new material includes also some larger specimens, one of which is illustrated in figure 1, Plate I. One single smaller specimen, illustrated on Plate I, figure 3, differs from the others in so far as

fine secondary ribs are present on the venter with the point of division of the primary ribs lying above the half height of the flanks. In all other respects, this specimen agrees with typical specimens of *P. canadense*. The previously described suture line is illustrated in Text-figure 3.

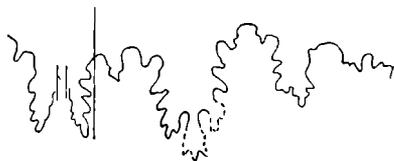


Figure 3. Suture line of *Psiloceras canadense* Frebold at whorl height 11 mm of hypotype GSC 20049. Enlarged about x3.

Occurrence. It is now an established fact that *P. canadense* is associated with many other species, as for instance *P. occidentale* n. sp., *P. (Curviceras) columbiae* n. sp., *Discamphiceras* (?) *tipperi* n. sp., *Paracaloceras* cf. *P. coregonense* (Sowerby), *P. rursicostatum* n. sp., *Charmasseiceras marmoreum* (Oppel), *Eolytoceras tasekoi* n. sp., *E.* cf. *E. tasekoi*, and *E.* spp. indet. However, below the beds containing this assemblage there is another bed that apparently contains only *P. canadense*.

Psiloceras occidentale n. sp.

Plate I, figures 4a, b; 5; Text-figure 4

Material. Two specimens, GSC Nos. 20067 (holotype) and 20068 (paratype), from GSC locality 62499.

Description. The measurements (mm) of the two specimens are as follows:

Type	Diameter	Whorl height	Whorl thickness	Umbilical width
Holotype, GSC 20067	58	24 (0.41)	20 (0.34)	20 (0.34)
Paratype, GSC 20068	51	20 (0.39)	—	17 (0.33)

The two specimens are moderately evolute, the last whorl embraces about half of the preceding one. The flanks are almost flat, very slightly convex; they grade gently into the rounded venter. The umbilical wall is moderately high on the last whorl and near the end of the penultimate one, much lower on the preceding whorls. The transition from the flanks of the last whorl to the umbilical slope is fairly abrupt but rounded.

The preserved part of the living chamber of the holotype is about half a whorl and seems to be entirely smooth. Very faint forwardly inclined undivided ribs are visible on the remaining part of the last whorl, particularly of the paratype (*see* Pl. I, fig. 5). The visible parts of the inner whorls are fairly strongly ribbed.

The suture line (*see* Text-fig. 4), visible in part on the holotype, is asymmetrical and very moderately incised. The first lateral lobe is longer than the ventral lobe.

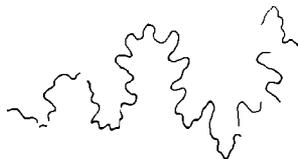


Figure 4. Part of suture line of *Psiloceras occidentale* n. sp. at whorl height 15 mm of holotype GSC 20067. Enlarged about $\times 3$.

Comparisons. In its general outline, cross-section, and suture line the species resembles *Psiloceras canadense* Frebold, which, however, is more evolute and has a less high umbilical wall. The main difference between the two species is that *Psiloceras canadense* at medium and larger sizes has still clearly developed ribs whereas *P. occidentale* n. sp. is already smooth or almost smooth at diameters of 50 mm and less. *Psiloceras* ex aff. *P. planorbis* (Sowerby) from the Taseko Lakes area and *P. psilonotum* (Quenstedt) illustrated on Plate I, figure 9 have almost smooth inner whorls and are laterally more compressed.

Occurrence and age. *Psiloceras occidentale* n. sp. was found only at one locality (62499) where it is associated with *P. canadense* Frebold, *Paracaloceras rursicostatum* n. sp., *Eolytoceras tasekoi* n. sp., and *Eolytoceras* sp. indet. 2, 3. Age: Hettangian.

Subgenus *Curviceras* Blind, 1963

Psiloceras (Curviceras) columbiae n. sp.

Plate I, figures 10 a-c; Plate II, figures 1a, b; 2a, b; 3; 4a, b; 5a, b, c; Plate III, figures 2a, b, c; Text-figure 5

Schlotheimia (Scannoceras) cf. *S. acuticosta* Frebold (non Buckman), 1951, p. 6, Pl. 4, fig. 1.
Schlotheimia (?) sp. indet. Frebold, 1951, p. 7, figs. 2-4.

Material. Numerous specimens, mostly medium-sized, from various localities in the Last Creek area.

Description. The holotype is GSC No. 19925. The only specimen in the collection that reaches a considerably larger size than all the others is the paratype, GSC No. 19948.

Measurements (in mm) of the holotype and four paratypes are as follows:

Type	Diameter	Whorl height	Whorl thickness	Umbilical width
Paratype, GSC 19919	60 (100)	25 (0.42)	18 (0.30)	20 (0.33)
Holotype, GSC 19925	61 (100)	24 (0.39)	20 (0.33)	22 (0.34)
Paratype, GSC 19920	55 (100)	23 (0.42)	17 (0.31)	18 (0.33)
Paratype, GSC 19921	52 (100)	19 (0.37)	17 (0.33)	18 (0.35)
Paratype, GSC 19922 (inner whorls)	9 (100)	4 (0.44)	4 (0.44)	3 (0.33)

The general outline is moderately evolute, the cross-section is almost circle-round at a whorl height of about 3 mm, but becomes oval in the course of the ontogenetic development and is much higher than thick at about 57 mm diameter. The flanks are moderately convex and grade into the rounded venter. There is a moderately high and rather steep umbilical wall. Transition to the flanks is rounded.

Ribs are already present at early stages of growth. They are undivided, forwardly inclined, and bent forward on the outer part of the flank. They are sometimes very slightly S-shaped. In some specimens the ribs cross the venter clearly though somewhat weakened in a curve, in other specimens they seem to be interrupted. Continuation of the ribs on the venter is visible in some of the young whorls (whorl height about 3 mm). In a number of instances ventral rib crossings and interruptions are present in the same specimen at various stages of growth. Lines of growth following the trend of the ribs are visible on the venter of many specimens. The number of ribs changes with the size. GSC No. 19919 has at a diameter of 60 mm about thirty-five ribs on the last whorl; very small specimens have considerably less. The large specimen GSC No. 19948 has a smooth ultimate whorl, except for its beginning where some faint folds are present.

The suture line (*see* Text-fig. 5) of the holotype shows the ventral lobe somewhat shorter than the lateral and the very moderately incised lateral saddles of equal

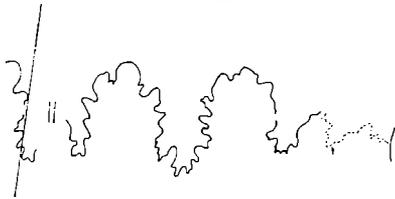


Figure 5. Suture line of *Psiloceras (Curvicer) columbiae* n. sp. at whorl height 15 mm of holotype GSC 19925. Enlarged about x3.

height. The last suture line of paratype 19948 (Pl. II, fig. 1a) differs in so far as the ventral lobe is about the same length as the lateral, whereas the second lateral saddle is higher than the first. The suture line is asymmetrical. The size of the body chamber and the shape of the mouth are unknown.

Comparisons. This species is distinguished from *Psiloceras (Curvicer) curvicorn* (Lange) (*see* Lange, 1952, p. 110, Pl. 13, figs. 8-10, and Blind, 1963, p. 49, Pl. 1, figs. 24, 24a) by a smaller umbilicus, higher whorls, and less S-shaped ribs. *Psiloceras (Curvicer) columbiae* n. sp. is also similar to *Psiloceras canadense* Frebold, but is clearly distinguished from the latter species by reaching an oval and higher cross-section at an earlier stage of growth and by the ribs that in *canadense* fade out on the outer part of the flanks and, with one exception, never cross the venter.

Occurrence. In the Taseko Lakes area *P. (Curvicer) columbiae* n. sp. was found associated with *P. canadense* Frebold, *Charmasseiceras marmoreum* (Oppel), and species of *Discamphiceras* (?) and *Paracaloceras*.

Genus *Discamphiceras* Spath, 1923a

The genus *Discamphiceras* Spath (type species *D. kammerkarensis* (Gümbel)) includes involute Psiloceratinae. Lange (1941, 1952) considers this group as a subgenus of the genus *Storthoceras* Lange of the subfamily Psiloceratinae. Arkell (1957) places *Discamphiceras* as a genus into the subfamily Psiloceratinae, whereas Blind (1963) considers it as a subgenus of the genus *Psiloceras*. The subgenus *Megastomoceras* Lange is, according to Blind, a synonym of *Discamphiceras*. In this report *Discamphiceras* is considered to be a genus of the Psiloceratinae.

The assignment to this genus of the two specimens described in the following as *Discamphiceras*(?) is only tentative. More material has to be studied before an accurate determination can be made.

Discamphiceras(?) *tipperi* n. sp.

Plate V, figures 1a, b; Text-figure 6

Material. One specimen, GSC No. 19926, the holotype, from GSC locality 62477. This species is named for Dr. H. W. Tipper.

Description. Measurements (in mm) of the holotype (GSC No. 19926) are as follows:

Diameter	Whorl height	Whorl thickness	Umbilical width
63 (100)	31 (0.49)	17 (0.27)	10 (0.16)

The holotype is involute with a narrow umbilicus that opens up towards the end of the last whorl. High oval cross-section, rounded venter, almost flat flanks. There are about twelve broad, blunt, rather indistinct folds on the flanks that are accompanied by lines of growth. The last ones and the folds are more distinct on the venter of the body chamber that occupies about two thirds of the last whorl.

The suture line (*see* Text-fig. 6) is well incised, the saddle endings are phylloid. The ventral lobe is shorter than the first lateral. The second lateral saddle is somewhat higher than the first. The suture line is symmetric.



Figure 6. Suture line of *Discamphiceras* (?) *tipperi* n. sp. at whorl height 17 mm of holotype GSC 19926. Enlarged about x2.

Comparison. This species bears some resemblance to some of the species described by Wähler (1884) from the northeastern Alps but there are some differences and it cannot be specifically identified with any of them. The young specimens of the

type species *D. kammerkarensis* (Gümbel) illustrated by Wähner (1884, Pl. 24, figs. 3a-e, 4a-d) have a stronger sculpture and are less involute. *D. atanatense* (Wähner) (1884, Pl. 26, figs. 1 a-c) and *D. n.f. indet.* (Wähner) (loc. cit., Pl. 26, figs. 2a-b) have a similar sculpture but a narrower venter than the Canadian species; this also applies to *D. mesogenos* (Wähner) (loc. cit., Pl. 26, figs. 3a-c). The suture line of the alpine species is asymmetric.

Specimen GSC No. 19927 (Pl. V, figs. 2a-c) is only tentatively referred to this species. Most of the umbilical region of its last whorl is broken away exhibiting an inner whorl. The imprint of the ammonite shows the increase of the umbilical width. The body chamber is secondarily compressed laterally. Sculpture in form of blunt folds and lines of growth are present on the last whorl. Compared with the holotype of the species, the saddle endings of the suture line appear to be more rounded.

Occurrence. At GSC locality 62477 the two specimens are associated with *Paracaloceras*.

Subfamily ALSATITINAE Spath, 1924

In assigning the Alsatitinae to the family Psiloceratidae Hyatt the writer follows both Donovan (1952, p. 643) and Arkell (1957, p. 234). Arkell (loc. cit.) considers the Proarrietitinae Lange (Lange, 1941, p. 46) as a synonym of Alsatitinae Spath. Blind (1963) does not retain the Alsatitinae as a subfamily of the Psiloceratidae; he places this group into the family Arietitidae.

The Alsatitinae comprise evolute forms with whorls slowly increasing in height, with keel and in some forms with furrows on the venter. They are subdivided in a number of genera, of which only one, i.e., *Paracaloceras* Spath seems to be represented in the Taseko Lakes area.

Genus *Paracaloceras* Spath, 1923b

Type species: *Paracaloceras coregonense* (Sowerby, 1831).

The genus *Paracaloceras* Spath (1923b, p. 77) includes Alsatitinae that in the course of their ontogeny develop a carinate-bisulcate venter. Among the specimens of the type species figured by Wähner (1887, pp. 311-318, Pl. 21, figs. 1-3; Pl. 22, figs. 1-4; Pl. 23, figs. 1-4; Pl. 24, figs. 1-6) are forms that have a broad blunt venter when young and others with much narrower venter. The specimens from the Taseko Lakes area have a narrow venter when young.

Blind (1963, p. 101) describes *Paracaloceras coregonense* as *Arietites* (*Alsatites*) *coregonensis* (Sowerby).

The *Paracaloceras* found in the Taseko Lakes area belong to the group of *P. coregonense* (Sowerby). Three forms can be distinguished: (a) those with more or less straight, forward bent ribs, (b) those with more numerous and finer ribs, and

(c) those with strong rursiradiate ribs. Among the specimens of *P. coregonense* (Sowerby) described and illustrated by Wähner (loc. cit.) are forms with the same differences in the shape of the ribs and consequently the Canadian representatives could be described as belonging to one and the same species. However, as the Canadian specimens are not too well preserved and as no gradual transitions from one form to the others could be proved, the various forms are described as different species. A more numerous and better preserved material may show that the three different forms are actually varieties of one and the same species.

Paracaloceras cf. *P. coregonense* (Sowerby)

Plate VII, figures 3; 4a, b; 5a, b; 6a, b; 7a, b

Vermiceras scylla Frebold (non Reynès), 1951, p. 7, pl. 5, figs. 1-6; pl. 6, fig. 1.

Material. Many small and a few medium-sized crushed specimens from GSC locality 62443, some small specimens from GSC locality 62390, and the fragment of an adult specimen from locality 56593.

Description. Evolute, wide umbilicate; cross-section of the young specimens as high as wide with rounded flanks and slightly rounded almost flat venter. At a diameter of less than 8 mm no keel is visible. A faint keel with flat zones on its sides is present at 15 mm diameter in specimen 19937. In specimen 19938 (Pl. VII, figs. 5a, b) a keel but no furrows is clearly visible on the entire last whorl at a diameter of 28 mm. Shallow furrows are visible at the beginning of the last whorl of specimen 19935 (Pl. VII, figs. 4a, b), they are still shallow at a diameter of 45 mm. Adult specimens have deep ventral furrows.

Ribs are present from a very early stage of growth. In early stages of growth they are straight, rather sharp, and slightly inclined forward. At the ventral border they swell slightly and bend forward crossing the venter and keel in an angle as shown in specimen 19938 (Pl. VII, figs. 5a, b). Fine lines of growth follow the trend of the ribs. These fine lines of growth were not seen on less well preserved specimens. As soon as the ventral furrow appears the ribs are extinguished at the ventro-lateral border. The number of ribs at various diameters is 45 at dm. 39 mm, 45 at dm. 28 mm, 32 at dm. 8 mm. The ribs of the best preserved medium-sized specimen 19943 (Pl. VII, fig. 3) are almost straight and fairly widely spaced on the last whorl.

The measurements (in mm) of some of the specimens are as follows:

Type	Diameter	Whorl height	Whorl thickness	Umbilical width
GSC 19935	44 (100)	10 (0.23)	10 (0.23)	27 (0.61)
GSC 19938	28 (100)	8 (0.29)	8 (0.29)	17 (0.61)

Comparison. Some of the specimens found in the same area and described as *Vermiceras scylla* Reynès (Frebold, 1951, p. 7, Pl. 5, figs. 1-6; Pl. 6, fig. 1) belong

to the same species as the forms described here. The closely related *Paracaloceras multicostatum* n. sp. and *P. rursicostatum* n. sp. are distinguished by more numerous or rursicostate ribs respectively.

As already said in the discussion of the genus, the Canadian specimens do not resemble those of Wähler's specimens of *Paracaloceras coregonense* with broad venter. Wähler's specimens (loc. cit., Pl. 23, figs. 2, 3) are similar in the development of the venter, but they have fewer ribs.

Occurrence. At locality 62443 *Paracaloceras* cf. *P. coregonense* (Sowerby) is associated with *Psiloceras canadense* Frebold; at locality 62390 with *Paracaloceras multicostatum* n. sp., *Phylloceras* sensu lato sp., Ammonite gen. et sp. indet. 5; and at locality 56593 with *Psiloceras canadense* Frebold.

Paracaloceras multicostatum n. sp.

Plate VII, figures 8a, b; 9, 10; Plate VIII, figure 5

Material. Some small and medium-sized specimens from GSC localities 62390, 36221, and 10080. Holotype is GSC No. 19939; paratypes GSC Nos. 19940, 19941, 19942.

Description. The holotype (Pl. VII, fig. 10), as most of the other medium-sized and small specimens, is laterally compressed and the true whorl thickness cannot be measured. The species is wide umbilicate, evolute with very slightly convex flanks and numerous undivided ribs that are bent forward on the outer part of the flanks. There are about 57 ribs on the last whorl of the holotype. The venter can only be seen near the end of the last whorl. There is a median keel with furrows on both sides.

Paratype 19942 (Pl. VII, fig. 9), at a diameter of 32 mm, has 57 rather fine ribs on the last whorl. In general outline the specimen agrees very well with the holotype, but the shape of the venter cannot be determined due to secondary compression.

Paratype 19940 (Pl. VII, figs. 8a, b) is not compressed. At a diameter of 17 mm it has 52 ribs. The cross-section at this stage of growth is almost circle-round, and on the venter a faint keel is indicated. There are no furrows.

Measurements (in mm) of some of the specimens are as follows:

Type	Diameter	Whorl height	Whorl thickness	Umbilical width
Holotype, GSC 19939	64 (100)	14 (0.22)	—	39 (0.61)
Paratype, GSC 19942	32 (100)	9 (0.28)	—	18 (0.56)
Paratype, GSC 19940	17 (100)	6 (0.35)	5 (0.29)	9 (0.53)

Comparison. The species is distinguished from *Paracaloceras* cf. *P. coregonense* (Sowerby) by more numerous and finer ribs.

Occurrence. At locality 62390 *Paracaloceras multicostratum* is associated with *P.* cf. *P. coregonense* (Sowerby), *Phylloceras* sensu lato sp., and Ammonite gen. et sp. indet. 5.

Paracaloceras rursicostatum n. sp.

Plate VII, figures 1a-c; 2a, b; Plate IX, figure 1

Material. Fragments of one small and two large specimens from locality 62362, imprints of one small and one large specimen from locality 56416 (the latter with parts of the last and penultimate whorls preserved), one fragment of a large specimen from locality 62499. Holotype is specimen 19944 (Pl. VII, figs. 1a-c; Pl. IX, fig. 1), paratype is specimen 19946 (Pl. VII, figs. 2a, b).

Description. Evolute, wide umbilicate, whorls slowly increasing in height, last preserved whorl of holotype with rectangular cross-section, preceding whorl quadratic, slightly convex flanks and fairly high median keel, deep furrows and keels at the ventro-lateral border. Ribs strong, more or less concave and bent backwards to a higher or lesser degree. In the holotype the backward bend of the ribs is already present on the younger whorls, but in the whorl fragments of paratype 19946 the backward bend is much less expressed. Apparently the degree of the backward bending of the ribs is subject to variation.

Comparison. This species is very similar to some of the specimens of *P. coregonense* described and illustrated by Wähler (1887), but in none of Wähler's illustrated specimens is the backward bend so strong as in the holotype of the new species, *P. rursicostatum*. Wähler's figures show that there is a gradual transition from forms with rursiradiate ribs to others with more rectiradiate ribs. There is a possibility that such transitional forms also exist between the Canadian *P. rursicostatum* n. sp. and *P.* cf. *P. coregonense* (Sowerby), and that both "species" may be united, but the material is not adequate to prove this assumption.

Occurrence. At locality 62362 *P. rursicostatum* n. sp. is associated with *Psiloceras canadense* Frebold, *Charmasseiceras marmoreum* (Oppel), *Eolytoceras* cf. *E. tasekoi*, and *E.* sp. indet. 1.

At locality 56416 the species is associated with *Psiloceras* (*Curviceras*) *columnbiae* n. sp.

Family SCHLOTHEIMIIDAE Spath, 1923b

Genus *Charmasseiceras* Spath, 1924

Type species. *Charmasseiceras charmassei* (d'Orbigny)

The genus *Charmasseiceras* Spath includes involute Schlotheimiidae with bifurcating ribs and complex suture lines. A description of the main characteristics of this group was given by Donovan (1952, p. 652). This group is also recognized as a genus by Arkell (1957, p. L237) and Dean, Donovan, Howarth (1961, p. 446), whereas Blind (1963, p. 80) and others place species of *Charmasseiceras* Spath in the genus *Schlotheimia* Bayle.

The writer follows Spath, Donovan, and Arkell retaining *Charmasseiceras* as a genus of the family Schlotheimiidae.

Representatives of this well-defined group were found at two of Tipper's localities in the Taseko Lakes area. Only one species seems to be present.

Charmasseiceras marmoreum (Oppel)

Plate III, figures 1a-d; 4a, b; Plate IV, figures 1, 2a-c

Ammonites marmoreus Oppel, 1862, p. 130.

Aegoceras marmoreum Wähner, 1886, p. 180, pl. 22, figs. 1-5.

Charmasseiceras marmoreum Donovan, 1952, p. 653.

Schlotheimia marmorea Blind, 1963, p. 80, pl. 2, fig. 5.

Material. The species was found at GSC localities 62447, 62354, and 62362. The specimens are fragmentary. Both young and adult forms are present.

Descriptions. The specimen GSC No. 20056, Pl. III, figs. 1a-d, is fairly well preserved and shows the development at a younger and more adult stage of growth. It is septate to the end of the last whorl.

Last whorl: Laterally compressed with slightly convex flanks, greatest width between half height of the flanks and the umbilical margin. Venter narrow, almost sharp. The height at the end of the whorl is 90 mm, the width 44 mm. Umbilical slope gentle. The ribs begin somewhat above the umbilical margin, they are slightly bent forward and blunt. The primaries bifurcate at about half the height of the flanks, in one case two primaries join each other between the half height of the flank and the umbilical margin. Intervals between primaries slightly larger than ribs. The narrow venter forms a smooth zone, there is no furrow. The ribs alternate at both sides of the venter.

Preceding whorl: The inner part with the umbilical margin is missing, the venter is less sharp than on the last whorl, the ribs are slightly sharper than on the adult whorl and most of them are bifurcated. The point of division is apparently somewhat below the half height of the flanks. Some of the ribs can be traced on the venter.

The increase in whorl height between the penultimate and the last whorl is considerable.

The specimen GSC No. 20057, Pl. IV, fig. 1, is the largest example of this species hitherto collected in the Taseko Lakes area. It is septate almost to the very end of the last whorl, which has a height of 129 mm and a width of 51 mm. The general outline is identical with that of the specimen described above, but the ribs of the last whorl though corroded to a certain degree seem to be weaker.

Also, this specimen demonstrates the rapid increase in the heights of the whorls from younger to adult stages.

The suture line is very deeply incised and resembles the figures given by Wöhner (loc. cit.).

Fragments of younger whorls (GSC Nos. 20050 and 20052) from GSC localities 62362 and 62447 respectively (Pl. IV, figs. 2b, c; and Pl. III, figs. 4a, b) show the presence of a ventral furrow in these stages of growth; this furrow disappears in larger specimens.

Comparison. The specimens resemble closely *Charmasseiceras marmoreum* (Oppel) as illustrated by Wöhner (loc. cit.) and Blind (loc. cit.), however, the umbilical width of the Canadian specimens seems to be somewhat larger than that of the European specimens.

Occurrence and age. At GSC locality 62362 the species is associated with *Psiloceras canadense* Frebold, *Paracaloceras rursicostatum* n. sp., *Eolytoceras* cf. *E. tasekoi*, and *Eolytoceras* sp. indet. 1; at GSC locality 62354, with fragments of *Psiloceras* (*Curvicerias*) *columbiae* n. sp.; and at locality 62447 with *P. canadense* Frebold, *P. (Curvicerias) columbiae* n. sp., and *Paracaloceras* sp. indet.

The species is of Hettangian age.

In the Alps, *Charmasseiceras marmoreum* occurs, according to Blind (1963, p. 90), in zone m of Alpha 2, according to Wöhner (*see* Spath, 1924, p. 198) in the Marmoreum Zone, that is considered to be a valid zone for the east Alpine area (*see* Dean, Donovan, Howarth, 1961, p. 446). In England, the Marmoreum Zone is a synonym of the Angulata Zone (Dean, Donovan, Howarth, 1961, loc. cit.).

Ammonites incertae sedis

In order to give a complete review of the Hettangian ammonites found in the Taseko Lakes area, the description or mention of a number of mostly fragmentary or otherwise unsatisfactorily preserved specimens is included. Their identification is postponed until better material has been collected.

Ammonite gen. et sp. indet. 1 (Pl. V, figs. 5a, b). One specimen, GSC No. 19930, from GSC locality 62431. The diameter is 82 mm, the height at end of the last whorl 46 mm. The first half of the last whorl is badly crushed and part of the umbilicus destroyed. The younger half of the last whorl has a rather steep umbilical wall with rounded transition into the very slightly convex flanks. The venter is broad and slightly rounded, cross-section higher than wide with greatest thickness between venter and outer half of the flanks. On the younger half of the ultimate whorl are fairly strong, blunt, slightly S-shaped undivided ribs. They cross the venter almost transversely, or are very slightly bent forward. The specimen is associated with *Psiloceras* (*Curvicerias*) *columbiae* n. sp.

Ammonite gen. et sp. indet. 2 (Pl. V, fig. 6). One specimen, GSC No. 19931, from GSC locality 62346. The diameter of this narrow umbilicate specimen is 43 mm. It is characterized by the presence of ribs in the upper part of the flanks and

on the venter that is crossed transversely. Suture line with phylloid saddle endings.

Ammonite gen. et sp. indet. 3 (Pl. V, figs. 8a, b). One specimen, GSC No. 19933, from GSC locality 62478. The measurements (in mm) of this fragment are as follows:

Diameter	Whorl height	Whorl thickness	Umbilical width
49 (100)	23 (0.47)	12 (0.24)	11 (0.22)

The cross-section is lancet shaped. The venter is fairly narrow and grades into the slightly convex flanks that reach their greatest thickness below half their height. Transition to the umbilical wall abrupt but rounded. No ribs present or preserved; suture line not discernible. The specimen may be compared with *Discamphiceras mesogenos* Wöhner (1884, p. 119, Pl. 26, figs. 3a, b) but is distinguished from that species by a less thick cross-section.

The specimen is associated with *Psiloceras (Curviceras) columbiae* n. sp.

Ammonite gen. et sp. indet. 4 (Pl. V, fig. 9). The fragment 19934 is from GSC locality 62328. The last and the two preceding whorls are smooth, the venter is comparatively broad and grades into the slightly convex flanks. Transition to the fairly steep umbilical slope rounded. Remnants of suture line on last whorl show phylloid saddle endings.

Ammonite gen. et sp. indet. 5 (Pl. V, figs. 3, 7a, b). Two specimens, GSC No. 19928 from GSC locality 62390, and GSC No. 19932 from GSC locality 62346. Both specimens are narrow umbilicate and smooth. The flanks are very slightly convex and converge towards the fairly narrow rounded venter.

AGE OF THE FAUNA

All ammonites were collected in situ to eliminate possible errors in the stratigraphical succession of the various genera and species. As far as sections are concerned, the ammonites were collected at various intervals. The results of these field studies were confirmed in a number of cases by the presence of several genera and species in the same piece of rock. Initial hope of establishing a fine zonation of the ammonites has not been fulfilled; it can now be stated that a number of species that had been expected to be restricted to different stratigraphic levels actually are associated with one another.

At present two "zones" can be distinguished. The older is characterized by *Psiloceras* ex aff. *P. planorbis* (Sowerby) that was found at one locality. This species is apparently not associated with other ammonites. According to Tipper, these beds are different from the lowest beds of the overlying Canadense Zone, i.e., they are mainly sandstones and siltstones. The younger zone is characterized by *Psiloceras canadense* Frebold, *P. occidentale* n. sp., *P. (Curviceras) columbiae* n. sp., *Discamphiceras(?) tipperi* n. sp., *Paracaloceras* cf. *P. coregonense* (Sowerby), *P. multicosatum* n. sp., *P. rursicostatum* n. sp., *Charmasseiceras marmoreum* (Oppel), *Eolytoceras tasekoi* n. sp., *E. cf. E. tasekoi*, *E. spp. indet.*, *Phylloceras sensu lato* sp., Ammonites gen. et sp. indet.

This association of many genera and species in the younger of the two zones has not been established at any one locality. The faunal associations change from outcrop to outcrop; species that are missing at one locality may be present at another (*see* description of sections and other localities). The above list of ammonites is the total of assemblages found at different localities. The possibility that some of the species may have been derived from an older reworked stratigraphical level and mixed with species of slightly younger age has been considered and discussed with Drs. Tipper and Tozer, who have studied the beds concerned in the field. Apparently there is no convincing evidence in favour of such an assumption, and it is probable that all species that are found associated with one another are of the same age.

There is evidence of a bed in the lower part of the Canadense Zone that is characterized by *Psiloceras canadense* only.

As to the age of the two zones in the Taseko Lakes area of British Columbia, the lower one that contains *Psiloceras* ex aff. *P. planorbis* (Sowerby) is considered to be early Hettangian because of this species' close affinities with early Hettangian species of the genus *Psiloceras sensu stricto*.

Regarding the age of the upper zone with *Psiloceras canadense* Frebold and its

many associates, a comparison with classical sections and faunas in the northeastern Alps recently restudied by Blind (1963) is made difficult by the fact that some genera or species present in the Alps have not been found in British Columbia and vice versa. For instance, none of the fairly frequent species of the Canadian *Eolytoceras* has been described from the Alps. Furthermore, only in one case, i.e. *Charmasseiceras marmoreum* (Oppel), could a specific identity be established. Regarding the genera common to both British Columbia and the northeastern Alps, it can be stated that *Discamphiceras* and *Curviceras* occur in the Alps in the upper part of Alpha 1 (Blind, 1963), while *Paracaloceras* (= *Alsatites* of Blind) and *Charmasseiceras* (= *Schlotheimia* of Blind) are found in the Alps in Alpha 2. *Charmasseiceras marmoreum* (Oppel), the only species common to the Alps and British Columbia, is restricted in the Alps to the top of Alpha 2 (Blind, 1963). Thus in the northeastern Alps the genera that are also represented in British Columbia occur at different stratigraphic levels, whereas in British Columbia they are associated with one another. There is no evidence for the correctness of the hypothetical assumption that part of the associated genera comes from a slightly older bed. Consequently, at present, it can only be stated that the upper zone in the Taseko Lakes area is equivalent in age to part of Alpha 2 and the upper part of Alpha 1 in the northeastern Alps.

An attempt to correlate the Taseko Lakes area sequence with northwestern Europe gives the following results. The beds containing *Psiloceras* ex aff. *P. planorbis* (Sowerby) may be correlated with the zone of *Psiloceras planorbis*. The younger zone of the Taseko Lakes area containing *P. canadense*, *P. (Curviceras) columbiae*, *Discamphiceras*(?), *Paracaloceras*, *Eolytoceras*, and *Charmasseiceras marmoreum* (Oppel) is tentatively assigned to parts of the *Alsatites liasicus* zone, particularly to the subzone of "*Waehneroceras*" *portlocki* and part of the zone of *Schlotheimia angulata*. However, due to the almost complete absence of the same species in the two regions no accurate correlation can be made.

Hettangian beds with *Psiloceras canadense* Frebold are also found in the Telegraph Creek area of northwestern British Columbia where they apparently are not associated with other ammonites.

The Hettangian in Nevada has been studied in detail by Muller and Ferguson (1939). They mention *Psiloceras* (several species), *Euphyllites*, *Waehneroceras*, *Schlotheimia*, *Phylloceras*, and *Pecten* aff. *P. textorius* Quenstedt. Two species names are included in their stratigraphic chart, i.e., *Psiloceras psilonotum* and *Euphyllites struckmanni*. As Professor S. W. Muller has continued to collect material from the beds concerned, no descriptions and figures of the fossils have yet been given.

A. Hallam (1965, pp. 1485, 1486) who has seen Professor Muller's collections says about the Hettangian ammonite fauna from Nevada as follows: "The genus *Psiloceras* (subgenera *Psiloceras*, *Caloceras*, *Franciceras*, and *Waehneroceras*) is especially well represented and many specimens attain large size. Species seem not readily distinguishable from such common European forms as *Psiloceras planorbis* (Sowerby), *P. (Caloceras) johnstoni* (Sowerby), and *P. (Waehneroceras) megastoma* (Gümbel). *Schlotheimia*, with species of the *extranodosa* and *angulata* groups, signifies the upper part of the Hettangian. Less common genera include

Kammerkaroceras and *Gyrophioceras*; *Paracaloceras*, and *Juraphyllites*, and *Phylloceras* are not uncommon.”

Regarding a comparison of the Hettangian ammonites from the Taseko Lakes area, British Columbia, with those from Nevada, the writer has reached the following conclusions. With the possible exclusion of the *Psiloceras planorbis* group (unfortunately the Taseko Lakes area specimens are too poorly preserved to permit a detailed comparison) none of the species seems to be common to the two compared areas. This difference is also expressed in the distribution of some genera as for instance *Kammerkaroceras*, *Gyrophioceras*, *Juraphyllites*, *Euphyllites* that are present in Nevada but have not been found in the Taseko Lakes area, whereas *Charmasseiceras* and *Eolytoceras*, two genera that are well represented in the latter area, were not seen in the Nevada collections. The possible reason for these faunal differences may be slight age differences, but discussion of this and other possibilities is not attempted before completion of the description of the Nevada fauna.

The lower part of the Hettangian of Peru (see Tilman, 1917), which contains *Psiloceras planorbis* (Sowerby) and other *Psiloceratinae*, is probably equivalent to the zone with *Psiloceras* ex aff. *P. planorbis* in British Columbia. The beds in Peru that contain representatives of the genus *Schlotheimia* belong to a younger part of the Hettangian and may be equivalent in part to the Canadense Zone in British Columbia. However, most of the genera found in this zone in British Columbia have not been recorded from Peru.

The opinions offered in this chapter are summarized in Table I.

TABLE I
 Tentative Subdivision and Correlation of the Hettangian Beds
 in the Taseko Lakes Area, British Columbia

Taseko Lakes area, British Columbia Zones	Ammonite Fauna	Northwestern British Columbia	Nevada	Peru	Alps	Northwestern Europe
Psiloceras canadense	<i>Psiloceras canadense</i> , <i>P. occidentale</i> , <i>P. (Cur-</i> <i>vicerias) columbiae</i> , <i>Dis-</i> <i>camphiceras(?) tipperi</i> , <i>Paracaloceras</i> cf. <i>P.</i> <i>coregonense</i> , <i>P. multi-</i> <i>costatum</i> , <i>P. rursicost-</i> <i>atum</i> , <i>Charmasseiceras</i> <i>marmoreum</i> , <i>Eolyto-</i> <i>ceras tasekoi</i> , <i>E. cf. E.</i> <i>tasekoi</i> , <i>E. spp. indet.</i> <i>Phylloceras</i> s.l. sp., <i>Am-</i> <i>monites</i> gen. et sp. indet.	<i>Psiloceras</i> <i>canadense</i>	<i>Schlotheimia</i> sp. (possibly younger than the <i>Psiloceras</i> <i>canadense</i> Zone) Various genera and species large- ly different from those of the <i>Psilo-</i> <i>ceras canadense</i> Zone in British Columbia	<i>Schlotheimia</i> <i>angulata</i> (possibly younger than the <i>Psiloceras</i> <i>canadense</i> Zone)	Part of Alpha 2 and upper part of Alpha 1	<i>Schlotheimia angulata</i> (possibly younger than the <i>Psiloceras canadense</i> Zone) <i>Alsatites liasicus</i> (possibly represented in part in the <i>P. cana-</i> <i>dense</i> Zone)
Psiloceras ex aff. <i>P.</i> <i>planorbis</i>	<i>Psiloceras</i> ex aff. <i>P.</i> <i>planorbis</i>	Unknown	<i>Psiloceras</i> <i>psilonotum</i> , <i>Psiloceras</i> spp. <i>Euphyllites</i> <i>struckmanni</i>	<i>Psiloceras</i> <i>planorbis</i> , <i>Psiloceras</i> cf. <i>P.</i> <i>plicatulum</i> , <i>Psiloceras john-</i> <i>stoni</i> , and other Psiloceratinae	Lower part of Alpha 1	<i>Psiloceras planorbis</i>

REFERENCES

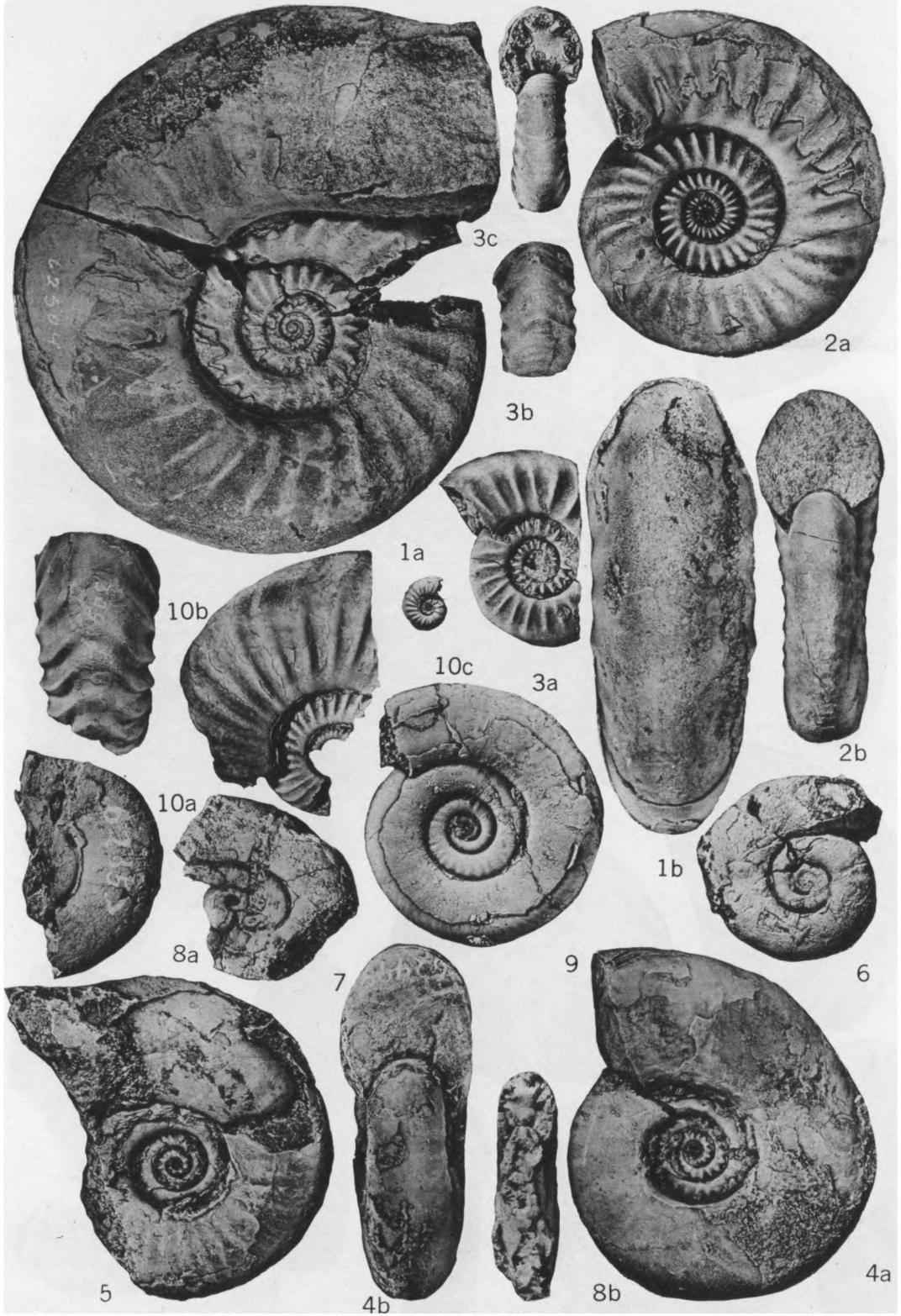
- Arkell, W. J.
1956: Jurassic geology of the World; Edinburgh and London, Oliver and Boyd Limited.
1957: Treatise on Invertebrate Paleontology, Part L, Mollusca 4, Cephalopoda, Ammonoidea; *Geol. Soc. Amer. and Univ. Kansas Press*.
- Blind, W.
1963: Die Ammoniten des Lias Alpha aus Schwaben, vom Fonsjoch und Breitenberg (Alpen) und ihre Entwicklung; *Palaeontographica*, Abt. A, vol. 121.
- Bonarelli, G.
1900: Cefalopodi Sinemuriani dell' Apenino Centrale; *Palaeontographica Italica*, vol. 5, 1899.
- Cairnes, C. E.
1943: Geology and mineral deposits of Tyaughton Lake map-area, B.C.; *Geol. Surv. Can.*, Paper 43-15.
- Canavari, M.
1888: Contribuzione alla Fauna del Lias Inferiore di Spezia; Memorie per servire alla Descrizione della Carta Geologica d'Italia, vol. 3, pt. 2.
- Dean, W. T., Donovan, D. T., and Howarth, M. K.
1961: The Liassic ammonite zones and subzones of the north-west European Province; *Bull. Brit. Mus. (Nat. Hist.)*, *Geology*, vol. 4.
- Donovan, D. T.
1952: The ammonites of the Blue Lias of the Bristol district, Part 1. Psiloceratidae and Schlotheimiidae; *Ann. Mag. Nat. Hist.*, vol. 5.
1954: Synoptic supplement to T. Wright's "Monograph on the Lias Ammonites of the British Islands" (1878-86); *London Palaeontographical Soc.*
- Frebald, Hans
1951: Contributions to the palaeontology and stratigraphy of the Jurassic System in Canada; *Geol. Surv. Can. Bull.* 18.
1964: Lower Jurassic and Bajocian ammonoid faunas of northwestern British Columbia and southern Yukon; *Geol. Surv. Can.*, Bull. 116.
- Gugenberger, O.
1936: Cefalopodi del Lias Inferiore della Montagna del Casale in Provincia di Palermo (Sicilia); *Palaeontographica Italica*, vol. 36.
- Hallam, A.
1965: Observations on marine Lower Jurassic stratigraphy of North America, with special reference to United States; *Bull. Am. Assoc. Petrol. Geol.*, vol. 49, No. 9.

- Hyatt, A.
1889: Genesis of the Arietidae; *Smithsonian Contrib. Knowledge*. No. 673.
- Lange, W.
1924: Über die Pylonotenstufe und die Ammonitenfauna des untersten Lias Nord-Deutschlands; *Jahrb. Preuss. Geol. Landesanstalt*, vol. 44.
1941: Die Ammonitenfauna der Psiloceras-Stufe Norddeutschlands; *Palaeontographica*, Abt. A, vol. 93.
1951: Die Schlotheimiinae aus dem Lias Alpha Norddeutschlands; *Palaeontographica*, Abt. A, vol. 100.
1952: Der untere Lias am Fonsjoch (östliches Karwendelgebirge) and seine Ammonitenfauna; *Palaeontographica*, Abt. A, vol. 102.
- Lees, E. J.
1934: Geology of the Laberge area, Yukon; *Trans. Roy. Can. Inst.*, vol. 20.
- Muller, S. Wm., and Ferguson, H. G.
1939: Mesozoic stratigraphy of the Hawthorne and Tonopah Quadrangles, Nevada; *Bull. Geol. Soc. Amer.*, vol. 50.
- Orbigny, A. d'
1842-1851:
Paléontologie Française, Terrains Jurassiques, I. Céphalopodes; Paris.
- Pompeckj, J. F.
1893: Beiträge zu einer revision der ammoniten des schwäbischen Jura; Stuttgart.
- Quenstedt, F.A.
1883-1885:
Die Ammoniten des schwäbischen Jura, vol. I; Stuttgart.
- Sowerby, J.
1814: Mineral Conchology of Great Britain; London.
- Spath, L. F.
1923a: On ammonites from New Zealand; *Quart. J. Geol. Soc.*, vol. 79.
1923b: Shales with 'Beef', Part II, Palaeontology; *Quart. J. Geol. Soc.*, vol. 79.
1924: The ammonites of the Blue Lias; *Proc. Geol. Assoc.*, vol. 35.
1925-1926:
Notes on Yorkshire ammonites; *The Naturalist*.
- Tilman, H.
1917: Die Fauna des unteren und mittleren Lias in Nord- und Mittel-Peru; *Neues Jahrb. Min. Beil.*, Bd. 41.
- Wähner, F.
1882-1890:
Beiträge zur Kenntnis der tiefern Zonen des unteren Lias in den nordöstlichen Alpen; *Beitr. Pal. Geol. Oester. – Ungarns u. des Orients*, vols. II-VIII.
- Wright, Th.
1878: Monograph on the Lias ammonites of the British Islands; London.

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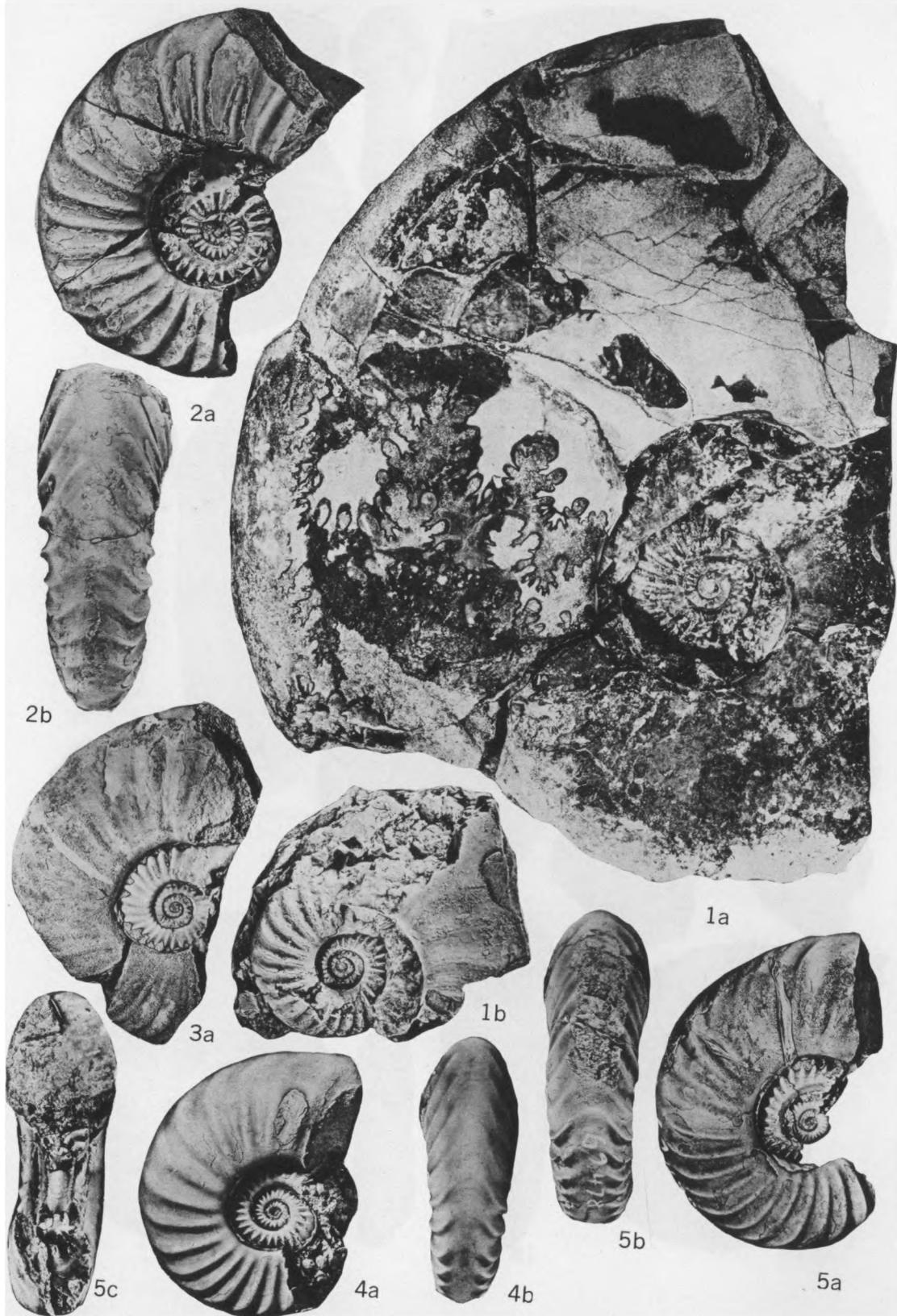
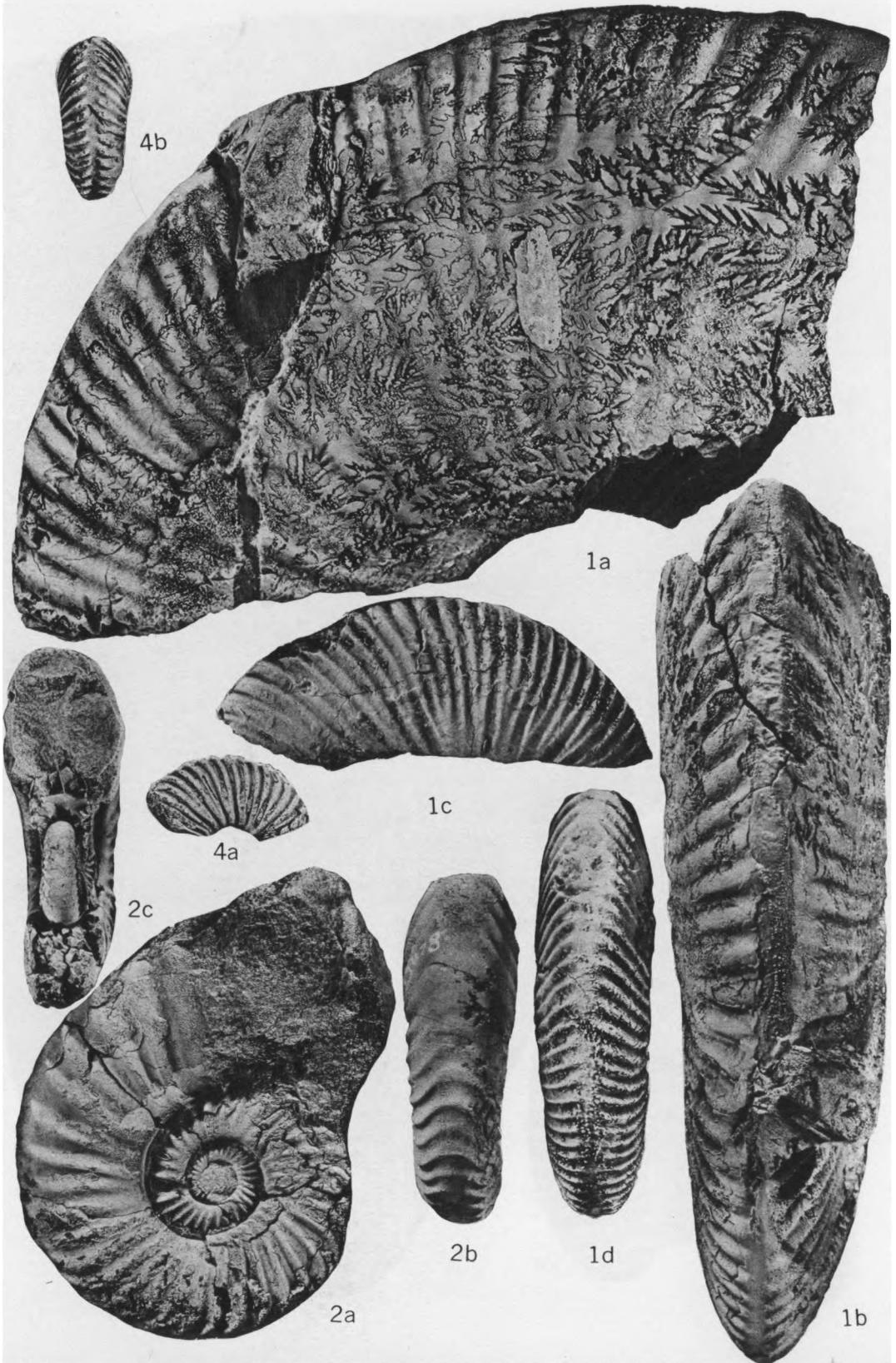


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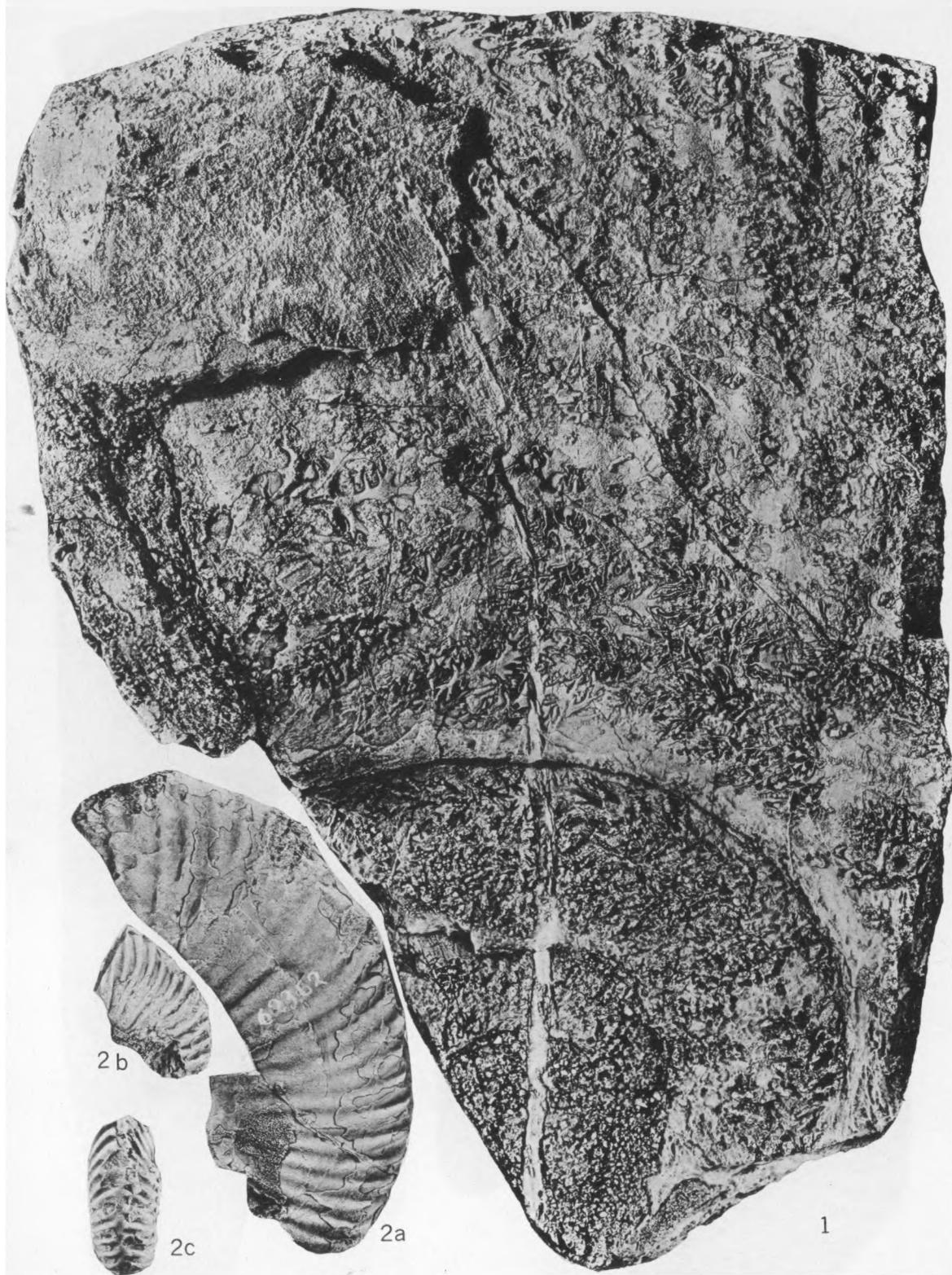


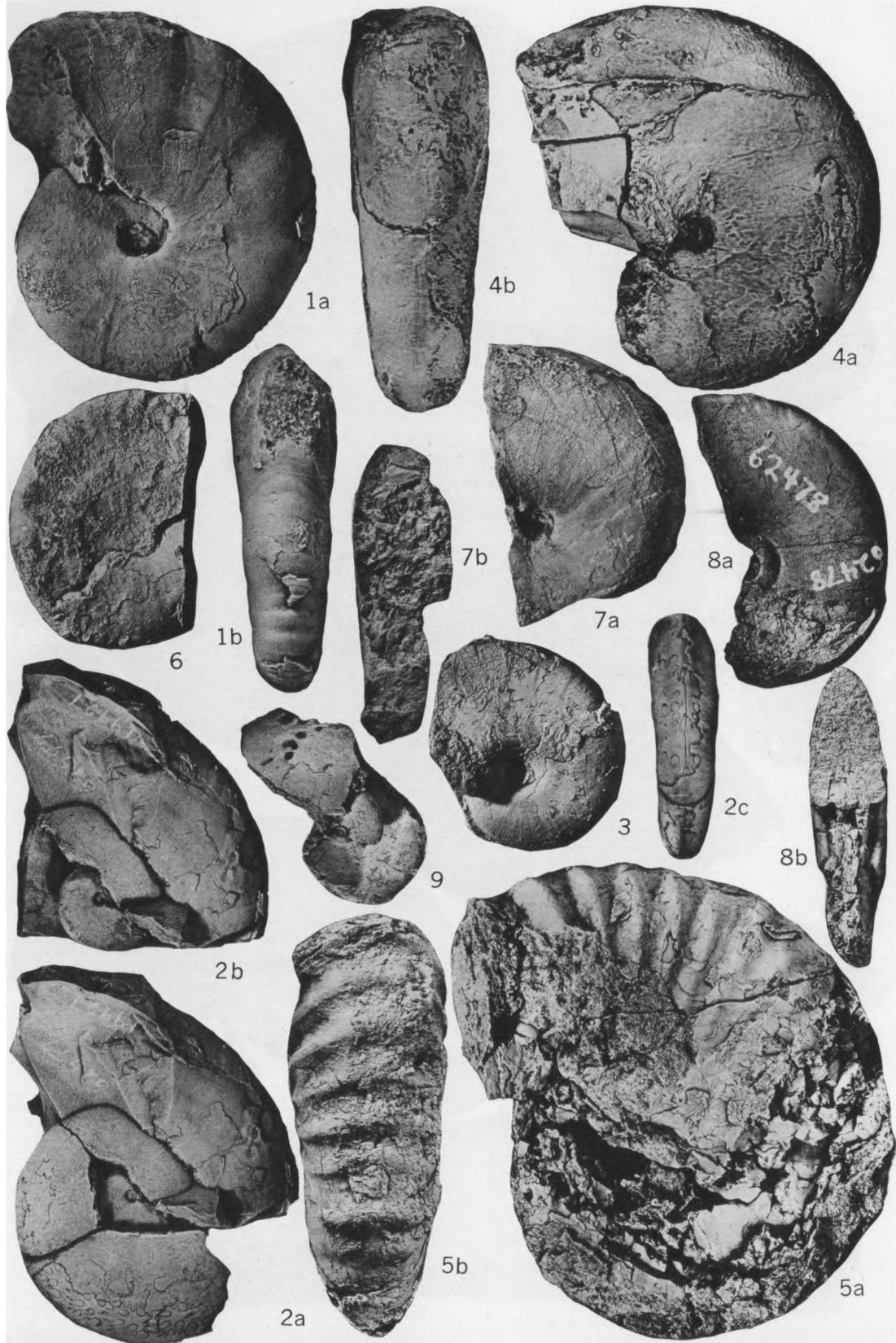
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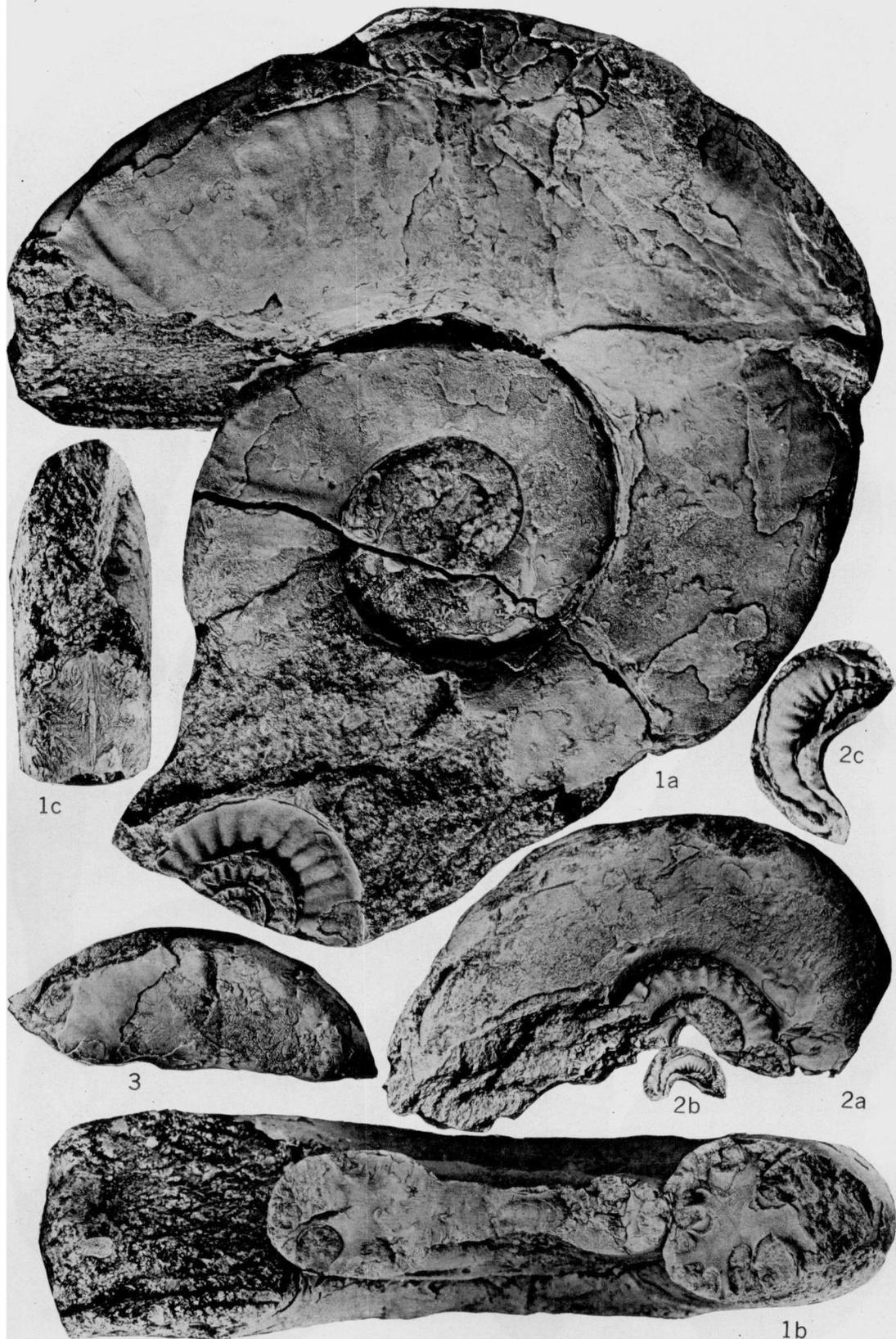
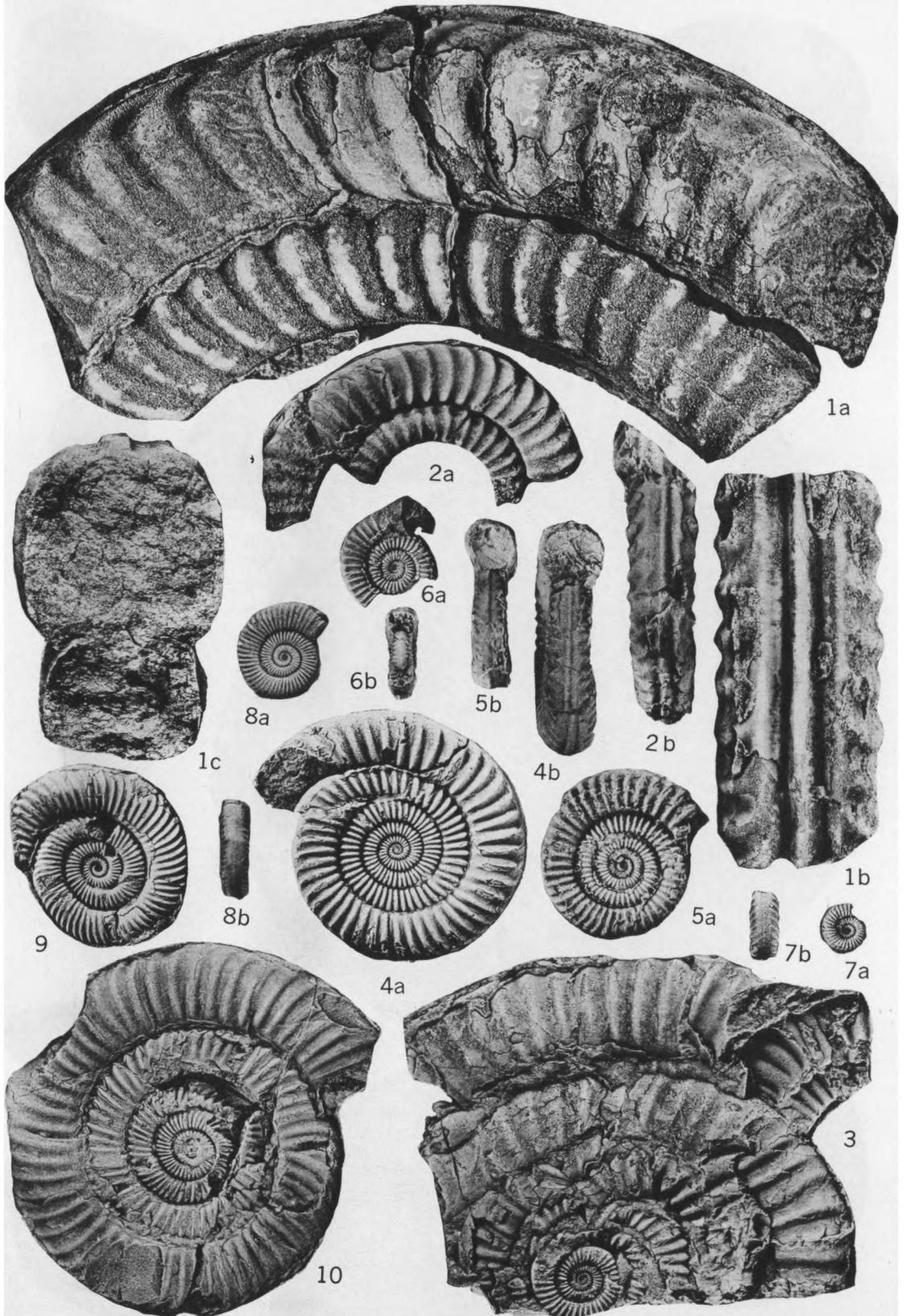


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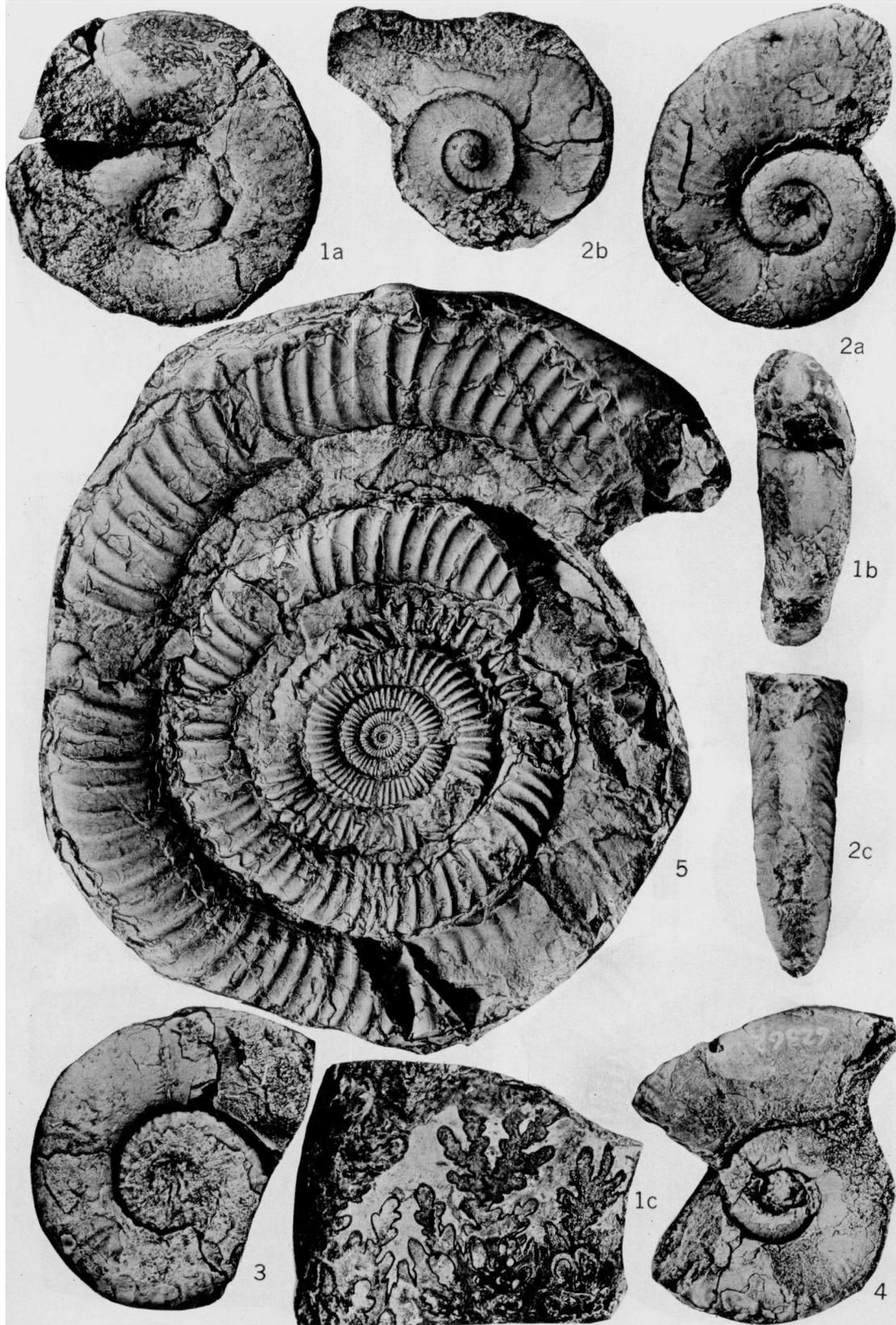


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PLATE IX

Figure 1.

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