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UPPER VOLGIAN (LATEST JURASSIC) AMMONITES AND BUCHIAS OF ARCTIC CANADA

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Abstract

The completed study of the palaeontology and stratigraphy of the latest Jurassic (latest Lower and Upper Volgian stages) rocks of Arctic Canada revealed the presence of the following ammonite and *Buchia* (=*Aucella*) faunas (in ascending order):

1. Late Lower Volgian (=Portlandian s. str.) beds with *Buchia piochii* var. *russiensis, B. piochii* var. *mniovnikensis,* and *B.* aff. *fischeriana* s. lato.
2. Early Upper Volgian or (?) latest Lower Volgian beds with *Buchia richardsonensis* n. sp. This *Buchia volgensis*-like species may locally occur in association with index fossils of (1) or (3) and may range upward into (3). These beds may, thus, be but a faunal facies either of the upper part of *Buchia piochii* zone or of the basal part of *Buchia fischeriana* s. lato zone.
3. Early Upper Volgian. *Buchia fischeriana* s. lato zone characterized by the predominance of large and typical representatives of this species. Other important but rare and/or poorly preserved fossils of this zone include: *Dorsoplanites* cf. *gracilis* Spath, *D.* n. sp. ex aff. *crassus* Spath?, *Laugeites*? sp. indet. and other dorsoplanitid ammonites.
4. Late Upper Volgian beds with *Craspedites* (*Taimyroceras*?) *canadensis* n. sp., *Buchia unschensis,* and *B.* aff. *subinflata.*

All ammonites and buchias of above-mentioned faunas are described and figured. The *Craspedites* (*Taimyroceras*?) *canadensis* n. sp. beds are believed to be overlain by yet another latest Jurassic or earliest Cretaceous fauna consisting of a new craspeditid ammonite and *Buchia* ex gr. *uncitoides,* which will be described in another report. This fauna occurs only 28 feet stratigraphically below the basal Berriasian beds with *B. okensis* s. lato, *Tollia* (*Subcraspedites*) aff. *hoeli,* and *T.* (*S.*) aff. *suprasubditus.*

Résumé

Une étude complète de la paléontologie et de la stratigraphie des roches les plus récentes du Jurassique (étages les plus récents du Volgien inférieur et supérieur) de l'Arctique canadien a révélé la présence des faunes à ammonites et à *Buchia* (= *Aucella*) suivantes (dans l'ordre ascendant):

1. Couches du Volgien inférieur récent (Portlandien s. str.) avec *Buchia piochii* var. *russiensis. B. piochii* var. *mniovnikensis,* et *B.* aff. *fischeriana* s. lato.
2. Couches du Volgien supérieur ancien ou (?) du Volgien inférieur récent avec *Buchia richardsonensis* n. sp. Cette espèce semblable à *Buchia volgensis* peut par endroits se trouver en association avec les fossiles indicateurs de (1) ou (3) et peut se retrouver en montant jusqu'à (3). Ces couches peuvent par conséquent n'être qu'un faciès faunique soit de la partie supérieure de la zone à *Buchia piochii* soit de la partie inférieure de la zone à *Buchia fischeriana* s. lato.
3. Volgien supérieur ancien. Zone à *Buchia fischeriana* s. lato caractérisée par la prédominance de grqs représentants typiques de cette espèce. Cette zone renferme d'autres fossiles importants rares et mal conservés, savoir: *Dorsoplanites* cf. *gracilis* Spath *D.* n. sp. ex aff. *crassus* Spath?, *Laugeites*? sp. indét. et autres ammonites dorsoplanitidées.
4. Couches du Volgien supérieur récent avec *Craspedites* (*Taimyroceras*?) *canadensis* n. sp., *Buchia unschensis* et *B.* aff. *subinflata.*

Toutes les ammonites et les buchias des faunes susmentionnées sont décrites et illustrées. On croit que les *Craspedites* (*Taimyroceras*?) *canadensis* n. sp. seraient recouvertes par une autre faune du Jurassique le plus supérieur ou du Crétacé le plus inférieur consistant en une nouvelle ammonite craspéditidée et de *Buchia* ex gr. *uncitoides,* qui seront décrites dans un autre rapport. Du point du vue stratigraphique, cette faune ne se trouve qu'à 28 pieds sous les couches inférieures du Berriasien qui renferment *B. okensis* s. lato, *Tollia* (*Subcraspedites*) aff. *hoeli,* et *T.* (*S.*) aff. *suprasubditus.*

INTRODUCTION

Recognition of the boreal facies of the uppermost Jurassic (Upper Volgian stage) in the European and North American Arctic is made difficult by the extreme scarcity or absence of the diagnostic ammonites, such as *Craspedites* s. str. and its allies, outside of Central Russian basin. This scarcity was explained by some workers (Sokolov and Bodylevsky, 1931, pp. 141-2)[1] as the result of a widespread regression of the sea from the circumboreal province; the Central Russian sea was believed to have been separated from the boreal sea during Upper Volgian time.

This idea has led to the assumption (Arkell, 1956, p. 612; Callomon, 1961, p. 267) that the true *Craspedites* of the Upper Volgian were a geographically restricted perisphinctid offshoot unknown outside of Central and Arctic Russia. Arkell (1956, pp. 500, 502, 504, 524) went so far as to deny or to question all previous identifications of *Craspedites* s.str. from the European Arctic and Greenland, although some of these ammonites have been adequately described and figured (Frebold, 1930, pp. 77-81, Pls. 27-28). Arkell (1956, p. 736) assumed all of these ammonites to be misidentified Berriasian craspeditids and disregarded the conclusion of Bodylevsky (1936, p. 115) who claimed that it was no longer possible to doubt the existence of the Upper Volgian stage on Novaya Zemlya after publication of Frebold's (1930) work. Furthermore, Arkell did not take into account the evidence of close similarity or complete identity of the Upper Tithonian *Buchia* faunas of California (Anderson, 1945) with the Upper Volgian faunas of Central Russia (Pavlow, 1907). As stressed by Bodylevsky (1936, pp. 130-1), these similarities of *Buchia* faunas clearly indicate the existence of a marine connection between the Upper Volgian basin of Central Russia and the Upper Tithonian basin of California via the subpolar parts of the northern hemisphere. The validity of this conclusion was more recently confirmed by the discovery of true *Craspedites* s.str. and closely allied Upper Volgian ammonites (*Taimyroceras* Bodylevsky, 1956) in northern Siberia (Bodylevsky, 1956; Bodylevsky and Shulgina, 1958, Pl. X, fig. 1; Saks, *et al.*, 1958; Shulgina, 1962, p. 197; Bassov, *et al.*, 1962, pp. 38, 39, 42; Saks, 1962).

Casey (1962, pp. 97-8) has recently challenged the accepted early Lower Cretaceous dating of the lower part of Spilsby sandstone; he has correlated these beds with the late Portlandian s.str. and the Upper Volgian stages of the international standard instead. Thus Casey (1962) exhumes Pavlow's (1889, 1892)

[1]Names and/or dates in parentheses are those of *References* cited at end of report.

original latest Jurassic dating of the beds concerned based on his identification of *Craspedites* s.str. and other latest Jurassic ammonites from them. Although insufficiently documented (*see* Jeletzky, 1965), this conclusion is compatible with other occurrences of true *Craspedites* outside of the Central Russian basin and may well merit serious consideration.

No ammonites assignable to the Upper Volgian stage have hitherto been recognized in the Canadian Arctic (Frebold, 1961, p. 31). The writer (1958, pp. 5-7, corr. table; 1960, p. 4, corr. table; 1961b, p. 537, fig. 1, and in several unpublished intradepartmental fossil reports) has, however, assigned an Upper Tithonian (= Upper Volgian) age to the widespread *Buchia fischeriana* zone of the region. He has also suggested that the poorly preserved representatives of *Dorsoplanites* sp. indet. and *Pavlovia*? sp. indet. described and figured by Frebold (1961, pp. 23-24, Pls. XX-XXI) from the Deer Bay Formation of Ellesmere Island are probably of the Upper Tithonian age because of their association with the large, morphologically advanced forms of *B. fischeriana* (d'Orbigny, 1845).

Ammonite and *Buchia* faunas recently found by Dr. R. Thorsteinsson in the Deer Bay Formation near Eureka weather station on Ellesmere Island include well-preserved, numerous representatives of a new species of *Craspedites* (*Taimyroceras*?) and *Buchia unschensis* (Pavlow, 1907) of an indubitable Upper Volgian age, in addition to *B. fischeriana* s. lato and poorly preserved dorsoplanitid ammonites. This report deals with the diagnostic elements of the above-mentioned Arctic Archipelago collections and the approximately contemporary *Buchia* faunas of the Richardson Mountains collected by the writer.

SYSTEMATIC DESCRIPTIONS

Family CRASPEDITIDAE Spath, 1924

Subfamily CRASPEDITINAE Spath, 1924 emend.

As interpreted in this report, the subfamily Craspeditinae Spath, 1924 includes both Craspeditinae Spath, 1924 and Tollinae Spath, 1952, the latter being suppressed as superfluous. The writer (1965) considers *Tollia* Pavlow, 1914 and *Subcraspedites* Spath, 1924 to be immediate basal Cretaceous descendants of *Craspedites nodiger* and allied late Upper Volgian *Craspedites* species of Central Russia and Northern Siberia. *Subcraspedites* is considered to be only a subgenus of *Tollia.* The conflicting opinions about its affinities and age have already been discussed (Jeletzky, 1965, pp. 21-23). *Praetollia* Spath, 1952 and *Hectoroceras* Spath, 1947 are, likewise, considered to be the basal Cretaceous members of subfamily Craspeditinae as emended in this report. They can only be treated as subgenera of *Tollia,* however. The endemic North American genus *Homolsomites* Crickmay, 1930, including its subjective synonym *Wellsia* Imlay, 1957, is considered to be the immediate descendant of *Tollia* and the youngest known (mid-Valanginian to Hauterivian) member of the subfamily.

The extreme infraspecific variability of *Craspedites* has already been stressed by Nikitin (1885, p. 134). The extreme morphological plasticity of that stock was repeatedly stressed by Spath (1947, pp. 11-20) who refused to subdivide the craspeditid genera among various families or subfamilies. Spath states (p. 17): "If I do not now accept this interpretation [i.e., the polyphyletic origin of different craspeditid genera — the writer's remarks], it is because, as already mentioned, *Kachpurites* and *Garniericeras* are intimately connected with *Craspedites okensis* and its allies as are the ribbed and tuberculated species of *Craspedites* of the higher zones, above mentioned. The apparent difficulties may be explained if we assume *Kachpurites* to represent a very plastic stock producing innumerable transitions to the ribbed *Craspedites* on the one hand and the oxycone *Garniericeras* on the other, but showing its ancestry in the occasional fine ribbing of the type of that of *Laugeites schurowskii* (Nikitin), or the bundled costation of one of extreme examples of *K. fulgens* figured by the same author." Nevertheless in a somewhat later paper (Spath, 1952, pp. 8-12) he split off the subfamilies Garniericeratinae and Tollinae from Craspeditinae proper. This interpretation was followed by Arkell, *et al.* (1957, pp. 342-4) in the ammonite part of *Anglo-American Treatise.* In the writer's opinion, however, the earlier, more conservative attitude of Spath (1947, p. 17) followed in the *Soviet Treatise* (Luppov, *et al.*, 1958, pp. 91-3) is prefer-

able. It is illogical to treat such immediate Berriasian and early Valanginian descendants of *Craspedites* s.str. as *Tollia* (=? *Surites*), *Subcraspedites* (as interpreted by Jeletzky, 1965), *Praetollia,* and *Hectoroceras* as members of a separate subfamily. It is considered equally illogical to place such immediate mid-Valanginian to Hauterivian descendants of *Tollia* s. lato as *Homolsomites* Crickmay, 1930 (inclusive of *Wellsia* Imlay, 1960) in the family or subfamily Polyptychitidae Spath, 1924. *Homolsomites* possesses indeed a characteristic, although considerably modified, craspeditid suture line (e.g., Arkell, *et al.,* 1957, p. L348; Luppov, *et al.,* 1958, p. 94).

Genus *Craspedites* Pavlow, 1892

Type species. Ammonites okensis d'Orbigny, 1845, Pl. XXXIV, figs. 15-17 *non* 13-14.

Remarks on the type species. Ammonites okensis d'Orbigny, 1845 is the type species of *Craspedites* by the subsequent designation (Douville, 1911, p. 213a). As noted by Spath (1947, p. 11), this choice is unfortunate as it conflicts with the original concept of the genus promulgated by Pavlow (1892, p. 474) who erected it expressly for the completely ribbed *Craspedites* ex gr. *subditus* (Trautschold, 1876). *A. okensis* d'Orbigny, 1845 differs considerably from these completely ribbed craspeditids in having completely smooth lower flanks and umbilical walls; it may, furthermore, have greatly weakened ribs in the middle of the venter, as pointed out below. There is, also, considerable uncertainty about the true nature and locality of d'Orbigny's (1845) cotypes of *A. okensis,* as well as about their being conspecific with *Perisphinctes okensis* of Nikitin (1881, pp. 312-14, Pl. XI, figs. 57-59), which formed the basis for the interpretation of this species until Douville (1911) provided photographic reproductions of *A. okensis* d'Orbigny.

Nikitin (1884, pp. 78-9) pointed out that the smaller cotype of *Ammonites okensis* (d'Orbigny, 1845, Pl. XXXIV, figs. 13, 14) was not conspecific with the larger cotype or with his own representatives of *Olcostephanus okensis,* as it lacks the considerable lateral compression so characteristic of the early whorls of the species. According to Nikitin, this specimen probably belongs not to *Olcostephanus okensis,* as he interpreted it, but to *Olcostephanus nodiger,* which occurs in association with the former species. The photographs of d'Orbigny's (1845) cotypes of *Ammonites okensis* published by Douville (1911) confirm this conclusion; they show, besides, that d'Orbigny's (1845, Pl. XXXIV, figs. 13, 14) drawings of the smaller cotype are inaccurate. The lower flanks of this specimen (Douville, 1911, fig. C.1) are not smooth as they should be in the corresponding growth stages of *Craspedites okensis* but are covered by well-developed and heavy primary ribs that are distinctly bullate in their lower parts. The secondary ribs of this specimen are heavy and widely spaced; they are markedly sinuous on the flank and projected forward on the venter. This ribbing habit and the low, bluntly rounded whorl shape of the specimen concerned are indistinguishable from those of *Craspedites jugensis* Prigorovsky (1906, Pl. X, fig. 9) and *Craspedites* cf. *jugensis* (Frebold, 1930, Pl. XXVII, fig. 5), which may well be only extreme morpho-

logical variants of *C. nodiger* s. lato. The only apparent difference between this cotype of *A. okensis* and *C. jugensis* is in the latter form being more widely umbilicate than d'Orbigny's (1845, Pl. XXXIV, figs. 13-14) specimen. The cotype concerned is accordingly designated herewith as *Craspedites* aff. *jugensis* Prigorovsky, 1906 pending the investigation of the taxonomic status of the latter form. It is excluded from the synonymy of *C. okensis* (d'Orbigny, 1845). This necessitates the formal designation of the larger cotype of d'Orbigny (1845, Pl. XXXIV, figs. 15-17) as the lectotype of *Craspedites okensis,* which is here proposed.

Frebold (1930, p. 8) has noted that the ammonites figured by Nikitin (1881, Pl. XI, figs. 57-59) under the name of *Perisphinctes okensis* (d'Orbigny, 1845) differ from the cotypes of *Ammonites okensis* of d'Orbigny (1845, Pl. XXXIV, figs. 13-17) in their whorl shape, and he questioned their being conspecific. The hitherto neglected observation of d'Orbigny (1845, p. 436) that the secondaries of *A. okensis* are: "presque effacées sur la ligne médiane du dos" and Nikitin's (1881, p. 313) insistence that the siphonal part of *Perisphinctes okensis* is covered by thick and round ribs, which become lost on the flanks, tend to support Frebold's (1930) suggestion. The photographs of the here selected lectotype of *Craspedites okensis* (d'Orbigny) published by Douville (1911, Pl. 213, figs. C and C.a) are certainly suggestive of d'Orbigny's (1845, p. 436) observation being correct. This semismooth appearance of the venter of the lectotype could, however, be due to its worn out state, and this question cannot be settled without restudy of the original specimens of d'Orbigny and Nikitin[1]. The problem is not pertinent for the purpose of this study, as it would not affect the selection of the lectotype of *Craspedites okensis* made herein, but could only necessitate the removal of Nikitin's (1881, Pl. XI, figs. 57-59) specimens of *Perisphinctes okensis* from the synonymy of this species.

Concept of the genus Craspedites. The genus *Craspedites* Pavlow, 1882 is interpreted in this report essentially following Arkell, *et al.* (1957, pp. L341-2); the genus *Taimyroceras* Bodylevsky, 1956 is treated as a subgenus of *Craspedites* s. str., contrary to Luppov, *et al.* (1958, p. 93). Since the publication of the *Soviet Treatise,* it has become obvious that *Taimyroceras* is essentially contemporaneous with *Craspedites* s. str. and occurs in association with the typical representatives of the latter genus in northern Siberia (V. A. Bassov, *et al.,* 1962, pp. 38-9; Saks, 1962, p. 72, corr. table). *Craspedites* s. str. and *Taimyroceras* appear, furthermore, to be connected by transitional forms in Central Russia [*Craspedites mosquensis* Gerassimov (1960, p. 172) and possibly *Craspedites okensis* (d'Orbigny, 1845) itself] and Arctic Canada (*Craspedites canadensis* n. sp.; *see* below).

Judging by the infraspecific variability of *Craspedites* (*Taimyroceras*?) *canadensis* n.sp., most of the Central Russian *Craspedites* forms described as independent species are mere morphological variants of only three or four evolutionary stages (species) of this genus. This problem is, however, beyond the scope of this report.

[1]Since this was written the writer was able to observe this weakening (and even a complete interruption) of ribs in the middle of the venter of a semismooth but still septate, well-preserved whorl of a Central Russian specimen of *Craspedites okensis* (d'Orbigny, 1845 non? Nikitin 1881) at the Sedgewick Museum, Cambridge, England (Cat. No. F.9613).

Craspedites (*Taimyroceras*?) *canadensis* n.sp.

Plate I, figures 5-9; Plate II, figures 1-9; Plate III, figures 1-6; Plate IV, figures 1, 2, 4; Plate V, figures 1, 2; text-figs. 1A-1L

Craspedites n.sp. aff. *nodiger* Jeletzky, 1965, Fig. 2.

Holotype. GSC No. 18034, Pl. IV, figs. 2A-2F.

Material. Seventy-seven almost complete to more or less fragmentary, virtually uncrushed and undeformed to fairly strongly deformed and partly crushed specimens as well as several small, strongly deformed but readily identifiable fragments collected by R. Thorsteinsson in 1956 from the Deer Bay Formation on Reptile Creek 2½ miles due north of the airstrip of Eureka weather station, Slidre Fiord, Ellesmere Island (GSC loc. 28712). These specimens have been collected in place in the same 1½-foot limestone concretion, according to the personal communication of R. Thorsteinsson; they are, therefore, considered to be geologically contemporary and to form part of a single palaeontological population. To the best of the writer's knowledge, this is the first and the only occurrence of *Craspedites* in North America.

Diagnosis. A representative of *Craspedites* showing more or less well defined primary ribs at most growth stages combined with somewhat pronounced weakening or/and complete interruption of secondary ribs in the middle of the venter of the "adult" penultimate and/or ultimate whorls. This weakening and/or interruption of ribs may be limited to some parts of these whorls only and may be invisible in the feebly sculptured variants of the species whose "adult" penultimate and ultimate whorls are almost to quite smooth. Suture line similar to that of the Central Russian and Siberian representatives of *Craspedites* s.str. but more primitive than that of *Taimyroceras*; it may, however, acquire a *Taimyroceras*-like character, or even become somewhat *Tollia*-like, in the extreme *Craspedites subditus*-like (*Craspedites canadensis* subsp. *pseudosubditus* n. subsp.) forms in losing the descendant (or suspensive) character of its external auxiliary part. All other morphological features of the species are extremely variable and unsuitable for its characterization.

Whorl shape. The whorl shape of our species is variable. In the "adult" representatives of our population sample the cross-section varies from the slender and discus- to egg-like shape with narrow venter and gradually sloping flanks similar to that of *Craspedites okensis* (d'Orbigny, 1845) or *Craspedites subditus* (Trautschold, 1876) (Pl. II, figs. 2, 3, 5, 9; Pl. IV, fig. 1) to the rounded-rectangular (higher than wide), broadly and obtusely ventered shape with subparallel flanks indistinguishable from that of *Taimyroceras taimyrense* Bodylevsky, 1956 (Pl. III, figs. 3, 4, 6). The third extreme is represented by forms that are more sturdily built, relatively low-arched but still have essentially egg-shaped whorl sections with the flanks gradually sloping down to the umbilical shoulder where the greatest width of the whorl lies (Pl. I, figs. 6, 7; Pl. II, figs. 1, 8; Pl. III, figs. 1, 5).

earliest and early growth stages of *C. canadensis* is, thus, based on the study of scant material, which often cannot be definitively assigned to any particular subspecies erected in this paper.

The most constant sculptural feature of *Craspedites* (*Taimyroceras*?) *canadensis* n.sp. is the presence of both primary and secondary ribs at all but the earliest and latest growth stages. The ribs may be reduced to faint indications, in most or even all growth stages of the rare, feebly sculptured representatives of the species (e.g., Pl. I, figs. 5A, 9A; Pl. III, fig. 4A; Pl. IV, fig. 2E; Pl. V, figs. 2A, 2B). They are nevertheless always discernible in oblique light at most growth stages of every specimen studied, if the preservation is sufficiently good. This morphological feature places *C.* (*T.*?) *canadensis* in the group of the completely ribbed *Craspedites* s. str. species centred around *C. subditus* (Trautschold, 1876) and *C. nodiger* (Eichwald, 1865). Some of the extreme, sparsely ribbed and bullate representatives of our species are closely similar to *C. subditus* (Pl. II, figs. 2, 5), whereas the more sturdy, distinctly bullate forms are closely similar to *C. nodiger* (Pl. III, figs. 3, 5), in their general whorl shape and ribbing habit. It is for that reason that *C.* (*T.*?) *canadensis* n.sp. was previously referred to as *Craspedites* n.sp. aff. *nodiger* (Eichwald) (Jeletzky, 1965, Fig. 2).

The earliest whorls appear to be completely smooth (Pl. II, figs. 8A, 8B; *see* innermost whorl visible). More or less heavy primary ribs first appear on the lower and middle parts of the flanks at the whorl heights ranging from 2 to 3 mm in the material studied. These ribs are most pronounced in the middle parts of the flanks and gradually peter out upward and downward. The umbilical wall and shoulder as well as the ventral shoulder and venter remain perfectly smooth throughout this growth stage (Pl. I, figs. 9A-9C), which ends at the whorl heights ranging from 3½ to 5 mm in the material studied. This growth stage appears to be of the longest duration in the feebly sculptured forms (Pl. I, figs. 9A-C) where it lasts for about one whorl or somewhat longer and may only end at the whorl height of 4 to 4½ mm. In the strongly sculptured forms, however, this growth stage lasts less than one whorl and was not observed in the specimens with whorl height exceeding 3 mm (Pl. III, fig. 2).

The above described growth stage ends somewhat abruptly with the primary ribs beginning to cross the venter. These ribs remain, however, single, rather weak, irregularly spaced, and thin for some one quarter to one half whorl thereafter. Within the next one half to one whorl following their first appearance, the ribs on the ventral shoulders and venter gradually become stronger and heavier until they are more marked than the attenuated parts of the ribs on the upper parts of the flanks. At about the same time the primary ribs begin to bifurcate. The bifurcation becomes increasingly common until most of the ribs are biplicated. The here discussed growth stage is accordingly named the biplicated growth stage. The point of bifurcation is often within the lower third of the flank. However, most of the ribs bifurcate closely below the middle of the flank in some specimens and closely above the umbilical shoulder in others. All three types of ribbing may occur together but as a rule only one type predominates in any given specimen. A certain mostly small number of unattached, single ribs is intercalated between the biplicate

bundles in the middle and upper part of the flanks. A few triplicate bundles were seen in some specimens; these bundles tend to increase in number towards the end of the biplicate growth stage. In the triplicate bundles the anterior secondary rib usually remains undivided whereas the posterior rib subdivides again a little higher on the flank. The fasciculate, triplicate bundles rarely occur. In more feebly sculptured specimens many ribs may be only indistinctly arranged in bundles. In the strongly and more coarsely sculptured forms the primary ribs are as a rule stronger and heavier built than any parts of the secondaries. They are sometimes also distinctly bullate, mostly only towards the end of biplicate growth stage (Pl. II, fig. 6A). In the feebly and/or extremely finely sculptured forms, however, the primary ribs are either equally strongly developed (Pl. I, fig. 8A) or distinctly weaker (Pl. II, fig. 7A) than the secondary ribs.

Except in the relatively rare, feebly sculptured forms resembling *Craspedites fragilis* (d'Orbigny, 1845) (*see* Pl. I, figs. 5, 9), the primary ribs gradually spread onto the umbilical shoulder early in the biplicate growth stage; they occupy most or all of this shoulder during the rest of this growth stage and throughout most or all of the "adult" growth stage as well.

On the flanks, all ribs are either virtually straight and radially directed (Pl. I, fig. 6A; Pl. II, fig. 8A) or more or less distinctly sinuous (Pl. II, fig. 7A; Pl. III, fig. 1A). In the former, any of the two (or three) secondaries of the bundle may be the closest to the radius; in the latter, all secondaries become markedly deflected forward as they approach the ventral shoulder. In both cases the secondary ribs are markedly deflected forward at the ventral shoulder and then cross the venter in a more or less distinct forward loop (Pl. I, figs. 8B, 8C; Pl. II, figs. 7B, 7C; Pl. III, figs. 2B, 2C). This forward projection may be barely noticeable in some specimens (Pl. II, figs. 6B and 6C), except at the anterior end where the ribs are already markedly weakened.

All ribs are more or less rounded and blunt, both on the surface and on the internal cast; they are always closely spaced and moderately coarse to very fine throughout most or all of biplicate stage of growth. None of the specimens representing the early phase of the biplicate stage is well enough preserved to permit the count of both primaries and secondaries and the computation of the bundling coefficient. GSC No. 17207 (Pl. III, fig. 2) has, however, approximately sixty-seven secondaries per whorl; it represents the moderately finely ribbed form. A somewhat larger specimen, GSC No. 17203 (Pl. II, fig. 7), representing the very finely ribbed and moderately strongly sculptured form of the species has approximately eighty-two secondaries per whorl. The moderately coarsely ribbed, but fragmentary innermost whorl of GSC No. 17204 (Pl. II, fig. 8A; *see* the innermost clearly ribbed whorl visible) is estimated to have between twenty-three and twenty-five primary ribs. Other unfigured specimens appear to have between twenty-three and thirty primaries and sixty-five to eighty secondaries per whorl (mostly estimated values only). This would result in the estimated bundling coefficient fluctuating between 2.7 and 2.8.

Two specimens, GSC Nos. 17202 (Pl. II, fig. 6) and 17195 (Pl. I, fig. 8), represent respectively the moderately coarsely and extremely finely ribbed forms

of the strongly sculptured variant of the late phase of biplicate growth stage. The former specimen has twenty-six primaries and sixty-five secondaries per whorl whereas the latter has about thirty-four (estimated value only) primaries and eighty-eight secondaries. The resulting bundling coefficients fluctuate between 2.5 and 2.6.

The strength of the ornament varies greatly in the studied material of the biplicate growth stage of *Craspedites* (*Taimyroceras*?) *canadensis* n.sp. One extreme is represented by the pronouncedly but moderately to very finely ribbed specimens like those shown in Plate II, figure 7 and Plate III, figure 2. Another extreme is represented by the almost equally pronounced but more coarsely ribbed and sometimes bullate (mostly in the end phase of biplicate growth stage only) specimens like those shown in Plate II, figures 6, 8 and Plate IV, figure 4. Yet another extreme is represented by the finely to very finely but feebly to barely perceptibly ribbed inner whorls, like those shown in Plate I, figures 5A, 5B, 9A-9C; Plate IV, figures 2E, 2F. Even the limited material available clearly shows that all these morphological extremes are connected by transitions. In the feebly to slightly ribbed forms the ribbing may be partly or even completely lost in the middle of the flanks and in the middle of the venter before the end of the biplicate growth stage (Pl. II, fig. 6C). Also the primaries may become greatly weakened or even largely lost.

The biplicate growth stage generally persists over three or four intermediate whorls; in the material studied, it ends at the whorl heights ranging between 10 and 16 mm.

The next, or "adult", growth stage is characterized by the predominance of triplicate to quadruplicate ribbing habit. A number of bundles appear to be only biplicate, however, as a considerable number of secondaries are only indistinctly attached to the biplicate bundles. In other specimens, particularly in the feebly to slightly sculptured forms, all secondaries may be only indistinctly attached to the feebly developed primaries or completely detached. A considerable number of ribs are, furthermore, intercalated between the bundled secondaries in the middle and upper thirds of the flanks. The rib bundles may be bidichotomous, virgatotome, or fasciculate. As in the biplicate growth stage, all ribs may be virtually straight and radially directed on the flanks (Pl. II, figs. 1A, 8A) with the secondaries spreading finger-like on both sides of the central, radially directed secondary rib, or sinuous (Pl. II, fig. 9A; Pl. III, figs. 3B, 4A, 6A). In both forms, all secondaries become more or less markedly deflected forward at the ventral shoulder. Generally speaking, the radially ribbed forms have the least noticeably deflected ribs at the ventral shoulder whereas the forms with sinuous ribs have much more markedly deflected ribs. There are, however, exceptions. All ribs cross the venter in a more or less marked forward loop, which is again more strongly developed in the sinuously ribbed forms. As a rule, this forward projection increases when they become weakened and/or interrupted in its middle (*see* below). This is exemplified by the specimen shown in Plate III, figures 5A, 5B where the ribs are crossing the venter almost without any forward projection in the early part of the whorl (end of the

"adult" penultimate whorl) but become markedly projected forward on its anterior part where they become weakened or interrupted in the middle of the venter.

The appearance and length of the primary ribs are more variable in the "adult" growth stage than in the "biplicate". The point of subdivision of the primary ribs may be within the lower third of the flank (Pl. I, fig. 6; Pl. II, figs. 1, 8; Pl. III, fig. 1), within its middle third (Pl. II, figs. 2, 9; Pl. III, figs. 3, 5) or low in its upper third (Pl. II, figs. 3, 5; Pl. III, fig. 6). These morphological extremes are connected by all possible transitions in the material studied and so are obviously of subspecific rank only. The primary ribs themselves may be either thick, swollen, and more or less pronouncedly bullate (e.g., Pl. III, figs. 3, 5; Pl. V, fig. 1), or more or less thin and non-bullate (e.g., Pl. III, fig. 6). In the weakly to slightly sculptured forms, the primary ribs (bullate or otherwise) may become barely perceptible (Pl. I, figs. 5, 7), or partly or wholly transformed into groups of striae (Pl. III. fig. 4; Pl. IV, fig. 2). In one exceptional, probably pathological, instance no traces of the primary ribs have been observed anywhere on the intermediate whorl representing the beginning of the "adult" growth stage (Pl. I, figs. 9A, 9B). Similarly, the secondary ribs may become weak, barely perceptible, and striae-like, or even disappear altogether, in the "adult" growth stage. Except in the extremely weakly sculptured forms of *Craspedites canadensis* n.sp., this only happens, however, on the adult living chamber and, more rarely, on the anterior part of penultimate whorl.

The more or less marked weakening and/or complete interruption of ribs in the middle part of the venter is perhaps the most distinctive feature of the late phase of the "adult" growth stage. As a rule, this weakening and/or interruption is limited to the "adult" penultimate and/or ultimate whorls, including the "adult" living chamber. It often is limited to some parts of these whorls and may be invisible in the extremely feebly sculptured forms of the species, the "adult" penultimate and ultimate whorls of which are almost to quite smooth. In rare instances (e.g., Pl. II, fig. 6C) the weakening of ribs on the venter becomes apparent on the intermediate whorls representing either the end of the biplicate or the beginning of the "adult" growth stage.

Constrictions occur in some of the specimens, most commonly on the "adult" living chamber (Pl. III, fig. 4), and are probably present at its mouth border in most or all representatives of the species.

The degree of coarseness and spacing of primary and secondary ribs is, perhaps, the most variable morphological feature of the "adult" growth stage of *C. (T.?) canadensis*. It certainly is considerably more variable during this growth stage than during the preceding, biplicate stage. This may, however, reflect (in part at least) the fact that most of the specimens studied represent the various "adult" forms of the species. One extreme is represented by the sparsely but coarsely ribbed (and mostly bullate) forms such as those shown in Plate I, figure 6; Plate II, figure 5; Plate IV, figure 1; Plate V, figure 1. These have only twelve or thirteen primary ribs and fifty to fifty-four secondary ribs, as illustrated by the following table:

GSC No.	Number of Primaries	Number of Secondaries	Coefficient Bundling
17178	13	51	3.9
17193	12	50 (est.)	4.1
17201	13	54 (est.)	4.1

The other extreme is represented by the densely and relatively thinly ribbed but often bullate forms like those shown in Plate II, figures 1, 2, 9; Plate III, figures 1, 6. These forms have nineteen to twenty-three primaries and sixty to sixty-five secondaries per whorl, with the resulting bundling coefficient of only 2.8 to 3.3. These relationships are illustrated by the following table:

GSC No.	Number of Primaries	Number of Secondaries	Coefficient of Bundling
17205	19	61	3.2
17206	19	63	3.3
17211	23	64	2.8

The group of forms with the primary and secondary ribs partly transformed into groups of fine striae (Pl. III, fig. 4; Pl. IV, fig. 2) probably has an even greater number of ribs; it is, however, difficult even to estimate the number with any degree of accuracy.

The above-described extreme forms of the species are connected by a host of forms that are intermediate with regard to the number and coarseness of their primary and secondary ribs. A selection of these intermediate forms is shown in Plate II, figures 3, 4; Plate III, figures 3, 5; Plate IV, figure 4. Complete intergradation of these extreme forms makes it obvious that, like many other equally pronounced morphological features, coarseness and spacing of ribs is of subspecific value only.

Suture line. No early and/or earliest whorls with well-preserved suture lines were seen in the material studied. In the holotype of the species (Pl. IV, fig. 2B), the earliest visible, well-preserved suture line represents the middle phase of the biplicate growth stage (at the whorl's height of about 7 mm). Except for being much less frilled, smaller, and having only two auxiliary lobes, it is *Craspedites*-like and virtually similar to the adult suture line of the holotype (Pl. IV, figs. 2A, 2B; text-fig. 1D). The only other reasonably complete but not too well preserved comparable suture line (at whorl's height of about 7 mm) belongs to the young representative of subsp. *pseudotaimyrense* n. subsp. (Pl. II, fig. 7; text-fig. 1A). This suture line is rather different from that of the holotype (subsp. *canadensis* n. subsp.); it has an essentially dorsoplanitid appearance (compare text-fig. 2), with only two lateral lobes and the first auxiliary lobe well differentiated and slightly ascendant. The rest of the auxiliary part is completely undifferentiated and pro-

nouncedly descendant (or retractive). Lacking any additional material, it is not possible to say which of these young suture lines is more typical of the middle phase of the biplicate growth stage of our species. Considering the extraordinary variability of the "adult" suture line of *C.* (*T.*?) *canadensis* n. sp., however, these two suture lines suggest its young suture line varies as strongly as or stronger than the "adult" suture line.

The "adult" external suture line of *C.* (*T.*?) *canadensis* n.sp. agrees well with that of all hitherto described forms of *Craspedites* s.str. (compare Spath, 1947, text-figs. 1a-1g) in the orientation and number of its lateral and auxiliary elements, their proportions, spacing, and degree of branching and frilling. Like the suture of all these *Craspedites* s.str. forms, the "adult" suture line of our species has, as a rule, only three auxiliary lobes between the second lateral lobe and the umbilical seam (not counting the intervening short and small lobules). The length of the lobes decreases gradually and more or less evenly from the venter towards the umbilical seam. The length of the first lateral lobe is usually about three fourths to four fifths of that of the ventral lobe. That of the second lateral lobe may fluctuate anywhere between five sixths and three quarters of the length of the first lateral. The length of the first auxiliary lobe varies even more widely. In some specimens (text-fig. 1G) it is only slightly shorter than that of the second lateral whereas in others (text-fig. 1I) it may be only half as long. The second auxiliary is usually only half as long as the first, and the third auxiliary may be either only slightly shorter than the second or somewhat less than one half. If present at all (text-fig. 1L), which is exceptionally rare, the fourth auxiliary is smaller than the third. The lobule separating the third and fourth auxiliaries may, however, be almost as long as the third auxiliary. In such instances, especially when a tiny notch appears between the lobule and the third auxiliary, the lobule may be mistaken for the fourth auxiliary.

The average width of the lobes usually decreases in the same direction as does their length and at about the same rate. The saddles are almost invariably wider than the next ventralward lobe. The ratio of their widths varies, however, in very wide limits. The ventral saddle is, for example, 1¼ to 2½ times wider than the first lateral lobe. However, in some aberrant and possibly pathological specimens (text-figs. 1E, 1F) it may be only slightly wider than this lobe. The other saddles show similar relationships. There is a definite tendency for all saddles to be relatively narrower in the forms with the widest and stubbiest lobes and vice versa.

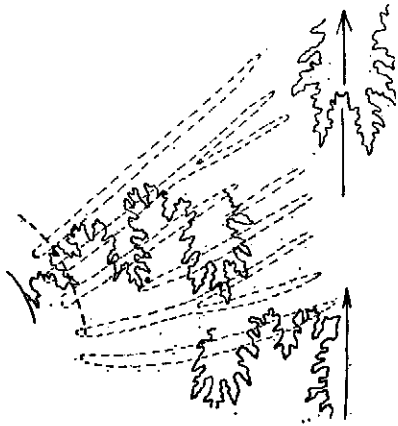
In the typical variant the lateral and auxiliary lobes tend to be stubby and short (*see* text-figs. 1B-1D, 1F, 1L); they resemble closely those of *Craspedites okensis* figured by Spath (1947, text-figs. 1a, 1b). Width of the lobe stems (measured between branches) tends to vary between one third to three quarters of their length. These relationships are best exemplified by the first lateral lobe of the forms concerned. In exceptional specimens the width of the first lateral lobe may even equal its length (text-fig. 1F). In this common variant, which forms one of the morphological extremes, the first lateral lobe usually maintains its width, but there are specimens whose stubby and short first lateral lobes taper markedly downward.

In the other less common morphologically extreme variant of *Craspedites* (*Taimyroceras*?) *canadensis* n.sp. the lobes are more slender and longer (text-figs. 1E, 1G, 1I). This suture line resembles closely those of *C. okensis* var., *C. subditus,* and *C. jugensis* figured by Spath (1947, text-figs. 1c, 1f, and 1g) but may occasionally have even more slender and longer lobes (*see* text-fig. 1I). The first lateral lobe may be three to four times longer than wide, and the same is true of all other lobes. The stems of all lobes of these extreme forms are often markedly pinched in their upper third and widen gradually downward to about their middle. Thereafter they either maintain their greater width or taper gradually all the way to their lower ends. The first lateral lobe may, however, also taper markedly and evenly throughout its length (text-fig. 1J). These extreme modifications of the lobes are connected by all possible transitions. No definite correlation between the character of the lobes and that of any other morphological features has been noted, except that the more stubby and short lobes are more common in subsp. *canadensis* n.subsp., whereas the more slender and long lobes appear to be more common in the subsp. *pseudosubditus* and *pseudotaimyrense.*

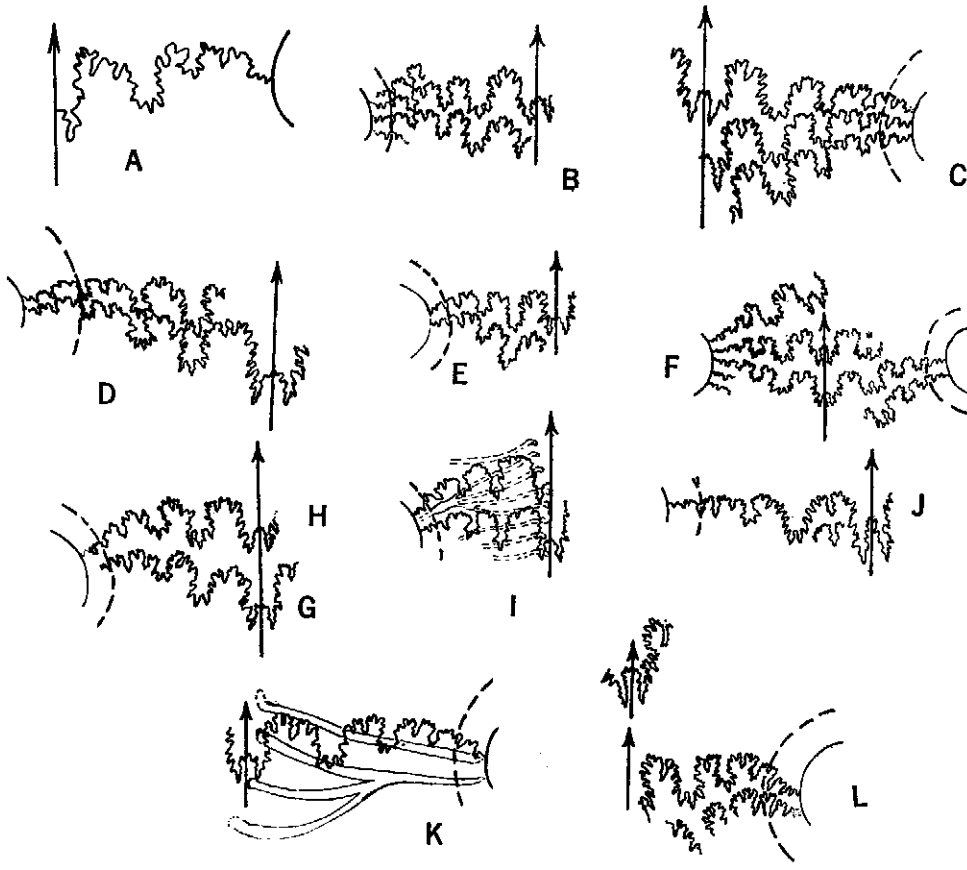
The first lateral lobe is almost invariably symmetrically trifid. Only two exceptions have been noted (text-figs. 1F, 1J), and in both these the bifid first lateral lobes occur on one side of the whorl only. This suggests pathological origin. Also the second lateral and first auxiliary lobes are, as a rule, more or less symmetrically to asymmetrically trifid. Here also there are some exceptions (text-fig. 1F) in the material studied. The second auxiliary lobe may be either indistinctly trifid or simple and the third auxiliary lobe is almost invariably simple.

The imaginary line joining the tops of the lateral lobes and saddles (*see* text-fig. 1L) is always slightly to markedly ascendant towards the umbilicus. Its continuation joining the tops of the auxiliary lobes and saddles is, on the contrary, usually feebly descendant (or suspensive; *see* text-figs. 1C, 1D, 1I, 1K). As a whole, the line concerned is thus more or less convex (or abruptly bent in the middle as in text-fig. 1L) towards the anterior end of the phragmocone. It should be stressed, however, that the top of this arch or bend may not coincide with the boundary between the lateral and auxiliary parts of the external suture line but may occur within the latter part as well.

Rarely that part of the imaginary line joining the tops of the auxiliary elements of the suture may be either subradial (text-figs 1B, 1F) or more or less pronouncedly descendant (or suspensive) (text-figs. 1G, 1L). In the latter form, the complete line is very strongly bent or arched in the middle. In some exceptionally rare instances (text-fig. 1J), the part of the line joining the tops of the auxiliary elements of the suture line may become more or less ascendant towards the umbilicus throughout. When this occurs the whole line becomes almost to quite straight and similar to that of the basal Cretaceous *Subcraspedites* or *Tollia* s.str. species (*compare* Spath, 1947, text-figs. 6a, 7d). It remains, nevertheless, distinguishable from the last suture lines because of the presence of only three auxiliary lobes, its lesser degree of frilling and subdivision of lobes by shorter and stubbier branches.



TEXT-FIGURE 2. Three incomplete suture lines of *Dorsoplanites* n. sp. ex aff. *crassus* Spath, 1936? Specimen GSC No. 18031 shown in Pl. VIII, figs. 11A-11B. All of these suture lines are outlined in white on the surface of the largest and least deformed fragment of the intermediate whorl reproduced in above-mentioned figures, X1.



TEXT-FIGURE 1. Suture lines of *Craspedites (Taimyroceras?) canadensis* n. sp. 1A. Suture of the early phase of biplicate growth stage. Specimen GSC No. 17203 shown in Pl. II, fig. 7, X3; 1B. "Adult" sutures of the specimen GSC No. 17179 shown in Pl. V, fig. 2 (the same sutures as visible in figs. 2B, 2C, 2D, and 2E); 1C. "Adult" sutures visible on the anterior end (Pl. V, fig. 2A) of the specimen GSC No. 17179; 1D. "Adult" suture lines of the holotype (GSC No. 18034; Pl. IV, fig. 2). The same as those visible in figs. 2B, 2E; 1E. Two suture lines of the late biplicate growth stage. Specimen 17198 shown in Pl. II, fig. 2. This suture line is somewhat *Tollia*-like in its unusually long and slender lobes and only slightly retractive (or descendant) appearance of its auxiliary part; it retains, however, such *Craspedites*-like features as the absence of long branches, weakly frilled appearance, and the presence of only three auxiliary lobes. The innermost element at the umbilical edge is a lobule separating the third and fourth auxiliary lobes; 1F. Several sutures of the latest phase of biplicate or earliest phase of "adult" growth stage. Specimen GSC No. 17196 shown in Pl. I, fig. 9. These sutures are visible in figs. 9A, 9B; they are not only extremely "primitive" but probably pathological as well. The first lateral lobes are, indeed, invariably bifid on the right flank but invariably trifid on the left flank; 1G. Two "adult" suture lines of the specimen GSC No. 17206 shown in Pl. III, fig. 1 (the same sutures as those outlined in black in figs. 1D, 1E); 1I. Two "adult" suture lines of the specimen GSC No. 17210 shown in Pl. III, fig. 5 (the same as those visible in the left side of fig. 5A); 1J. The last "adult" suture line of the specimen GSC No. 17201 shown in Pl. II, fig. 5 (this suture is inked in on the left side of fig. 5A). The suture is strongly weathered and indistinct in part and so the tracing may be inaccurate in some details; it seems to have, however, only a lobule but not the fourth auxiliary lobe at the umbilical rim; 1K. "Adult" suture line of the specimen GSC No. 17208 shown in Pl. III, fig. 3. This suture is outlined in black and white on left upper part of fig. 3A; 1L. Two "adult" suture lines of the specimen GSC No. 17193 shown in Pl. I, fig. 6. These sutures are visible on the right lower side of fig. 6A; they are unusually dorsoplanitid-like in the strongly retractive appearance of the auxiliary parts and in the relatively undifferentiated, crowded appearance of all auxiliary lobes. The suggested (dotted) presence of the fourth auxiliary lobe in the lower suture is uncertain. Sutures 1B-1L, X1.

Subspecies. The exceedingly great infraspecific variability of most morphological features of *Craspedites* (*Taimyroceras*?) *canadensis* n.sp. makes it expedient to separate its morphologically extreme forms from the typical form of the species. Three such subspecies are recognized. Although formally named as subspecies according to the *Rules of Zoological Nomenclature,* all these extreme morphological forms may well be only extreme morphological variants of one and the same palaeontological population. The grouping of the studied representatives of *C.* (*T.*?) *canadensis* according to the variation of the whorl shape (including that of the umbilicus) and ribbing habit appears to be the best solution of the intricate organization problems of the rather distinct morphological forms referable to this species. The strength of the ribbing was not used and all of the subspecies proposed below include pronouncedly ribbed forms alongside with the feebly and slightly ribbed ones. The following subspecies are recognized in the material studied:

1. *Craspedites* (*Taimyroceras*?) *canadensis* subsp. *pseudosubditus* n. subsp. The specimen GSC No. 17201 reproduced in Plate II, figure 5 is herewith designated as the holotype of this subspecies. Measurements (in mm) of the holotype and two other representatives of the subspecies are as follows:

GSC No. and Figure	Diameter	Umbilicus	Height	Thickness
17201 (Pl. II, fig. 5) (anterior end)	77	25 (0.35)	29	23.5
17198 (Pl. II, fig. 2) (one cm before anterior end)	40 (approx.)	10 (0.25)	17	13.5
18033 (Pl. IV, fig. 1) (anterior end)	124 (approx.)	43 (0.35)	46	42 (approx.)

C. (*T.*?) *canadensis* subsp. *pseudosubditus* n. subsp. is characterized by the bullate appearance and wide spacing (only twelve to thirteen primaries per whorl in "adult" representatives) of its unusually long (at least one third of whorl's height) primary ribs on the "adult" penultimate and ultimate whorls. These features are combined with the moderately wide (0.25-0.35 per cent of the diameter) and shallow umbilicus and with the slender, laterally compressed, narrowly and high ventered cross-section (Pl. II, figs. 5A, 5B). In the biplicate growth stage (Pl. II, fig. 2) the representatives of the subspecies have essentially the same cross-section as the "adult" representatives; they are, however, finely and relatively feebly ribbed. So far as is known this subspecies tends to have the adult suture line with long and narrow lobes and essentially radially directed or only feebly retracted inner part of its external auxiliary section (text-figs. 1E, 1J).

C. (*T.*?) *c.* subsp. *pseudosubditus* could easily be mistaken for the Central Russian *C. subditus* (Trautschold, 1876) except for the characteristic interruption or/and weakening of the ribs in the middle of the venter of its "adult" penultimate and ultimate whorls characteristic of all representatives of *C.* (*T.*?) *canadensis* n.sp. It has the highest evolutionary grade of all subspecies recognized in this report and could easily be misidentified with some basal Cretaceous subcraspeditids, except for its suture line, which retains most of the characteristic *Craspedites* s.str. features (*see* above). It seems probable that the earliest representatives of *Tollia* s. lato arose out of *Craspedites* forms similar to *Craspedites* ex gr. *subditus* through the modification of the suture line.

2. *Craspedites* (*Taimyroceras*?) *canadensis* subsp. *pseudotaimyrense* n. subsp. Specimen GSC No. 17211 is herewith designated as the holotype of this subspecies; its measurements (in mm) are as follows:

GSC No. and Figure	Diameter	Umbilicus	Height	Thickness
17211 (Pl. III, fig. 6) (2 inches before anterior end)	57	17.5 (0.31)	20	17.5

C. (*T.*?) *c.* subsp. *pseudotaimyrense* is characterized by the rounded-rectangular (higher than wide), broadly and obtusely ventered whorl section with subparallel flanks on the "adult" penultimate and ultimate whorls. This shape is combined with strong to weak (Pl. III, fig. 4) sculpture consisting of relatively fine, and closely spaced, non-bullate ribs. In the biplicate growth stage our subspecies has essentially the same cross-section, but much finer ribs (Pl. II, fig. 7). It differs from *Craspedites* (*Taimyroceras*) *taimyrense* Bodylevsky, 1956 largely in the presence of primary ribs on the umbilical wall and shoulder of the early and intermediate whorls (throughout the biplicate growth stage) and in the lack of interruption of ribs on the venter on these same whorls. In the "adult" whorls the former distinction is expressed in the distinctly ribbed appearance of the inner whorls visible in the umbilicus (Pl. III, fig. 6A) contrasted with the completely smooth appearance of the corresponding parts of the inner whorls in the umbilicus of "adult" whorls of *Taimyroceras taimyrense* (Bodylevsky, 1956, Pl. XVIII, figs. 1a, 2). Otherwise it is probably only possible to distinguish the penultimate and ultimate "adult" whorls of the forms concerned by the persistently higher branching point of primaries in *Craspedites* (*Taimyroceras*) *taimyrense*.

3. *Craspedites* (*Taimyroceras*?) *canadensis* subsp. *canadensis* n. subsp. Specimen GSC No. 18034, previously designated as the holotype of the species, is

also the holotype of its typical subspecies. The measurements (in mm) of the holotype and five other representatives of the subspecies are given below:

GSC No. and Figure	Diameter	Umbilicus	Height	Thickness
18034 (Pl. IV, fig. 2) (anterior end)	64	14 (0.22)	27	26
17179 (Pl. V, fig. 2) (anterior end)	54.5	12 (0.24)	25	22 (est.)
17204 (Pl. II, fig. 8) (at the break)	48 (est.)	13 (0.27)	21	19
17202 (Pl. II, fig. 6) (anterior end)	36	11 (0.30)	14.5	14
17193 (Pl. I, fig. 6) (anterior end)	65	15 (0.23)	28	23
17178 (Pl. V, fig. 1) (6 cm before anterior end)	69	18 (0.26)	29	26

The typical subspecies of *C.* (*T.*?) *canadensis* n.sp. is characterized by the whorl cross-section that is lower and wider than that of any other subspecies; its venter is, furthermore, broader and lower arched. Cross-section is egg-shaped rather than discus- or rounded-rectangular-shaped with the flanks gradually sloping most or all of the way down to the umbilical shoulder, with the maximum width of the whorl at or closely above the umbilical shoulder. Umbilicus is considerably deeper and narrower (characteristically 0.22 to 0.27 of the whorl's diameter) than in any other subspecies recognized in this report; furthermore, the umbilicus is usually more or less funnel-like, exposes only one quarter to one sixth of the preceding whorls (sometimes less: *see* Pl. V, figs. 2A, 2B), and its walls usually converge at angles between 85 and 95 degrees.

The sculpture of the typical subspecies may be either coarse or fine and the spacing of primaries and secondaries varies within wide limits. The primary ribs are, however, characteristically short and bullate with the branching point usually in the lower part of the flanks. This subspecies includes representatives in which the external elements of the suture line are shorter, stubbier, and less frilled than those of any other subspecies recognized in this report (text-figs. 1B, 1C, 1F). The external auxiliary parts of these suture lines are, furthermore, often more strongly descendant (or suspensive) than those of any other sutures observed in the species (text-fig. 1L) and so are distinctly dorsoplanitid-like (*see* text-fig. 2). Other representatives of the typical subspecies have, however, suture lines that are entirely similar to the more advanced sutures common in subspecies *pseudosubditus, pseudotaimyrense* and transitional forms between the two. On the whole, however, the morphology and suture line of *C.* (*T.*?) *canadensis* subsp. *canadensis* are less advanced and more comparable with *Craspedites* ex gr. *okensis* than those of the other subspecies.

C. (*T.*?) *canadensis* subsp. *canadensis* is the most common morphological form. About 40 per cent of the material studied is assigned to this subspecies.

4. *Craspedites* (*Taimyroceras*?) *canadensis* subsp. *eurekae* n. subsp. Specimen GSC No. 17208 is herewith designated the holotype of this rare but peculiar subspecies; its measurements (in mm) are as follows:

GSC No. and Figure	Diameter	Umbilicus	Height	Thickness
17208 (Pl. III, fig. 3) (anterior end of septate whorl)	70	16 (0.24)	25	24

C. (*T.*?) *canadensis* subsp. *eurekae* n.subsp. is a morphologically intermediate form combining the deep, funnel-like and narrow umbilicus, short and nodose primary ribs with low branching point, and the primitive suture line of subsp. *canadensis* n.subsp. with the higher than wide, rounded-subquadrate whorl section and almost flat venter of subsp. *pseudotaimyrense* n.subsp. This subspecies is morphologically closest to *Craspedites nodiger* (Eichwald), from which it differs markedly, however, in its much more slender whorl with subparallel flanks, not to mention the interruption or weakening of ribs on the venter characteristic of the species as a whole.

Affinities and differences. From all known completely ribbed *Craspedites* s.str. forms, such as *C. nodiger, C. subditus,* etc., *C.* (*T.*?) *canadensis* n.sp. differs strongly in the more or less pronounced weakening or/and complete interruption of secondary ribs in the middle of the venter of the "adult" penultimate and ultimate whorls. The generally speaking lower (2.8 to 4.2 as against 4.5 to 8) bundling coefficient in the "adult" representatives seems to represent another reliable distinction, which requires, however, further verification on the Central Russian material. From the partly ribbed (i.e., with the completely smooth lower flanks and umbilical walls) representatives of *Craspedites* s.str., such as *C. okensis* d'Orbigny (*non* Nikitin?) and *C. mosquensis* Gerassimov, 1960, *C.* (*T.*?) *canadensis* n.sp. differs markedly in the constant presence of the primary ribs on the lower flanks, umbilical shoulder, and umbilical wall throughout most of its growth stages. It should be noted that this distinction appears to be more reliable than the weakening and/or interruption of ribs on the venter. *C. mosquensis* definitely possesses this feature whereas *C. okensis* may well have it too (*see* above).

From all better known representatives of subgenus *Taimyroceras,* such as *C.* (*T.*) *taimyrense, C.* (*T.*?) *canadensis* n.sp. differs in the ornament of its inner and intermediate whorls. These whorls have, indeed, a typical *Craspedites* s.str. like ornament consisting in strong ribs crossing the venter without any weakening, let alone interruption. This is at variance with *Taimyroceras* (Bodylevsky, 1956, pp. 82-3), whose ribs are first weakened and then interrupted in the corresponding growth stages. The primaries of *C.* (*T.*?) *canadensis* n.sp. extend onto the umbilical wall already on the inner whorls whereas those of *C.* (*T.*) *taimyrense* do not cross the umbilical shoulder on the inner and intermediate whorls (Bodylevsky, 1956, Pl. XVIII, figs. 1a, 2). The secondaries of *Taimyroceras taimyrense* lack the

forward projection on the ventral shoulder and venter almost invariably found in *C.* (*T.*?) *canadensis* n.sp. In the subspecies *canadensis* and *eurekae* the ribbing habit (low point of branching) and often the discus- to egg-shaped whorl shape with narrowly arched venter (in subsp. *canadensis* only) of "adult" penultimate and ultimate whorls are clearly distinct from those of *T. taimyrense*. The ribbing habit and whorl shape (in subsp. *pseudotaimyrense* only) of the corresponding whorls of the subspecies *pseudosubditus* and *pseudotaimyrense* are, however, often indistinguishable from those of *T. taimyrense*. In such cases the clearly ribbed appearance of the parts of inner whorls visible in the umbilicus provides the best means of differentiation of these subspecies from *Taimyroceras taimyrense*. Although it is commonly more primitive than that of *Taimyroceras*, judging by the description of the latter provided by Bodylevsky (1956, pp. 82-3), the suture line of *C.* (*T.*?) *canadensis* does not seem to be sufficiently distinctive to provide a reliable criterion for the differentiation of our species from *Taimyroceras*. Its use for this end is made particularly difficult by the fact that the suture line of *Taimyroceras* was so far only described but not figured whereas that of *C.* (*T.*?) *canadensis* is extremely variable.

Judging by its obviously transitional morphology, *C.* (*T.*?) *canadensis* n.sp. appears to be a connecting link between subgenera *Craspedites* s.str. and *Taimyroceras*. Its subgeneric assignment is, therefore, somewhat difficult. Considering scarcity or complete lack of data about the infraspecific variability of *T. taimyrense*, not to mention other *Taimyroceras* species (Bodylevsky, 1958, p. 33, Pl. IX, figs. 2, 5, 6) based on mere fragments, it seems advisable to questionably assign the Canadian species to *Taimyroceras*. The lack of information about its stratigraphic position in relation to the typical *Craspedites* forms and to the typical *Taimyroceras* forms precludes any conclusions about the evolutionary significance of *C.* (*T.*?) *canadensis*. To our knowledge it could equally well be a geographical subspecies of one of the already known *Taimyroceras* species, an ancestor of the same, or a descendant of *Taimyroceras* and a connecting link to one of the basal Cretaceous craspeditid genera, such as *Hectoroceras* or *Tollia* s. lato.

Stratigraphic position and age. Considering the essential geological contemporaneity of *Craspedites* s.str. and *Taimyroceras* and their association in the Upper Volgian beds of the Khatanga Depression (Bassov, *et al.*, 1962, pp. 38-9; Saks, 1962, p. 72, corr. chart), there is little doubt that *Craspedites* (*Taimyroceras*?) *canadensis* n.sp. is an Upper Volgian (=Upper Tithonian or ? Purbeckian) species. The recent discovery of *Craspedites* s.str. forms in the upper part of the Lower Volgian stage (Gerassimov, 1960, pp. 169-171, Pl. 38, figs. 4-6; text-figs. 28-29) does not contradict this conclusion as these forms are quite unlike the Canadian species and its closest allies, which are largely restricted to the middle and upper parts of the Upper Volgian stage above the zone of *Kachpurites fulgens* (Arkell, 1956, pp. 493-4; Sazonov, 1956, p. 25). The association of *C.* (*T.*?) *canadensis* n.sp. with the numerous and typical representatives of *Buchia unschensis* (Pavlow, 1907) and with *B.* aff. *subinflata* (Pavlow, 1907), which only rarely occur below *Craspedites nodiger* zone of the late Upper Volgian stage, supports this conclusion.

C. (*T.*?) *canadensis* n.sp. and the above-mentioned *Buchia* species occur, finally, stratigraphically above beds containing large and advanced forms of *Buchia fischeriana* (d'Orbigny, 1845) s. lato, which themselves can hardly be older than the basal part of the Upper Volgian stage (*see* below). It is, thus, most likely that the *Craspedites* (*Taimyroceras*?) *canadensis* bed of the Eureka Sound area represents either middle or upper part of the Upper Volgian stage as known in the Central Russian basin. It seems probable, furthermore, that they are equivalent to part or all of the late Upper Volgian zone where *Craspedites nodiger, C. kaschpuricus,* etc., reach their acme.

Although they undoubtedly occur near the top of the Jurassic System, *Craspedites* (*Taimyroceras*?) *canadensis* beds possibly are not the youngest Jurassic rocks exposed in the Canadian Arctic Archipelago. The section of Deer Bay Formation, 4 miles southwest of Buchanan Lake, Axel Heiberg Island, has indeed yielded apparently younger craspeditid ammonites and *Buchia* ex gr. *uncitoides* (Pavlow). This still undescribed fauna was found by R. Thorsteinsson in 1962 (pers. com.) only 28 feet below a bed containing the basal Cretaceous (Lower Berriasian) *Tollia* (*Subcraspedites*) aff. *suprasubditus* (Bogoslovsky, 1902), *Tollia* (*Subcraspedites*) aff. *hoeli* (Frebold, 1930) and numerous and typical (including giant forms) *Buchia okensis* (Pavlow, 1907) and var. *canadiana* (Crickmay, 1930). The stratigraphic position of these ammonites closely below the basal Cretaceous rocks and their higher evolutionary grade than that of *Craspedites* (*Taimyroceras*?) *canadensis* suggest that they are younger than the latter species and than any part of the type Upper Volgian stage. The ammonites concerned may, thus, represent an entirely new fauna corresponding to the hiatus (*see* p. 43) that separates the topmost Volgian (latest Jurassic) beds from the basal Ryasanian (early Berriasian) beds. This interpretation agrees well with the apparently transitional nature of the Jurassic-Cretaceous boundary in the Canadian Arctic Archipelago (R. Thorsteinsson, pers. com).

Family PERISPHINCTIDAE Steinmann, 1890

Subfamily DORSOPLANITINAE Arkell, 1950

Genus *Dorsoplanites* Semenov, 1898

Dorsoplanites n.sp. ex aff. *crassus* Spath 1936?

Plate VIII, figures 11A-11B; text-fig. 2

Material. One fragmentary and partly deformed, wholly septate specimen (GSC No. 18031) from GSC locality 47883.

Description and remarks. The outer whorl of the only incomplete specimen available seems to be about 32 mm high and 25 mm wide in its least deformed part, but was probably appreciably wider and lower prior to its deformation. Its blunt and heavy, reasonably closely spaced, essentially bifurcating ribbing habit

is closely similar to that of the corresponding growth stages of *Dorsoplanites crassus* Spath (1936, p. 74, Pl. 29, fig. 5). The suture line (text-fig. 2) is, however, characterized by much broader ventral and first lateral lobes and, although more complex, is readily comparable to *D. dorsoplanatoides* Spath (1936, Pl. 26, fig. 2). First lateral lobe is almost symmetrically trifid whereas the relatively narrower second lateral lobe is asymmetrically trifid. The auxiliary part of the suture line is moderately suspensive, which is characteristic of all *Dorsoplanites* species; its visible part consists of two auxiliary lobes. Two lobules are intercalated between the first auxiliary and second lateral lobes; only one tiny lobule is intercalated between the first and second auxiliaries. The second auxiliary is almost covered by the umbilical shoulder in Plate VIII, figure 11A but is clearly shown in text-figure 2. The secondary ribs are either distinctly weakened or, more rarely, completely lost on the venter (Pl. VIII, fig. 11B). This feature seems to distinguish our specimen from all hitherto described *Dorsoplanites* species; it might conceivably be simulated, however, by its poor preservation. The venter appears to be broadly and very bluntly rounded, the middle part being almost flat (Pl. VIII, fig. 11B). The poorly preserved and almost completely flattened inner whorl is covered by sharp, but fine and closely spaced, simply bifurcating ribs (Pl. VIII, fig. 11A) comparable to those of *Dorsoplanites* cf. *gracilis* Spath shown in Plate VIII, figure 10A. This fine ribbing seems to grade into considerably heavier, although still closely spaced, ribbing within the same whorl. This differentiates *Dorsoplanites* n.sp. ex aff. *crassus* Spath 1936? from *D.* cf. *gracilis* Spath, which retains its finer ribbing habit to considerably larger growth stages.

The above-described specimen seems to be morphologically distinct from all known representatives of the genus *Dorsoplanites* Semenov; it may even be a representative of a new, closely related subgenus or genus of Dorsoplanitinae, if the strong weakening or disappearance of the secondary ribs on its venter is an original and constant feature rather than the result of poor preservation of the only specimen available. No definite specific and generic assignment of this interesting form is possible, however, until more and better specimens become available.

Occurrence and age. Found in the same section as *Dorsoplanites* cf. *gracilis* Spath where it occurs stratigraphically above that form. As already mentioned, this section was not measured and so the stratigraphic distance between these two forms is not known beyond the suggestion that it may be in order of a score of feet or somewhat more (R. Thorsteinsson, pers. com.). The age is believed to be about the same as that of *Dorsoplanites* cf. *gracilis* Spath.

Dorsoplanites cf. *gracilis* Spath, 1936

Plate VIII, figures 10A-10B

Material. One fragmentary and deformed specimen (septate to the end) exposing parts of the intermediate and inner whorls (GSC No. 18029; Pl. VIII, figs. 10A-10B) and one fragment of a larger but still fully septate whorl (unfigured) from GSC locality 47881.

Description and remarks. The material agrees well with the East Greenland ammonites described and figured by Spath (1936, pp. 72-4; Pl. 27, fig. 1; Pl. 28, fig. 3; Pl. 29, fig. 2; Pl. 30, fig. 2; Pl. 32, figs. 2, 5; Pl. 33, figs. 3-6; Pl. 35, fig. 3) as *Dorsoplanites gracilis* and *D.* aff. *gracilis* in the ribbing habit, appearance of suture line, and most other observable features. The specimen shown by Spath (1936) in Plate 32, figures 5a, 5b appears to be particularly similar to our figured specimen in its ribbing habit and other observable features. Constrictions were not observed, however, on our specimens and both are considerably deformed. This precludes their positive identification and more detailed comparison with *D. gracilis* Spath and allied *Dorsoplanites* species, some of which (e.g., *Dorsoplanites panderi* Michalski, 1890) could possibly be conspecific with the East Greenland form concerned.

From *Chetaites chetae* Shulgina 1962 and *C. sibiricus* Shulgina 1962 the Canadian form differs in the less retractive (or suspensive) character and lesser number (only two) of auxiliary lobes, considerably wider and shorter first lateral lobe, predominantly biplicate mode of subdivision of ribs on the intermediate whorls, considerably coarser ribbing on the external whorls of comparable size, and the absence of any tendency to the weakening of ribs on the venter of the last-mentioned whorls. Our form cannot, thus, be congeneric, let alone conspecific, with these Upper Volgian forms.

Stratigraphic position and age. Collected from the lower part of the Deer Bay Formation (probably some 100 to 150 feet above base, although the section was not measured according to R. Thorsteinsson). The bed containing *D.* cf. *gracilis* Spath, 1936 occurs stratigraphically above that containing *Buchia richardsonensis* n.sp., which in turn overlies the sandstone member forming the top part of Awingak Formation and locally containing the late Lower Volgian (= late Portlandian s.str.) *Buchia piochii* Gabb s. lato (including *B. p.* var. *russiensis* Pavlow and var. *mniovnikensis* (Pavlow) and *B.* aff. *fischeriana* (*see* Pl. VII, figs. 3, 10). This strongly suggests an early Upper Volgian (= early Upper Tithonian or ? Purbeckian) age for *D.* cf. *gracilis* in this section, although latest Lower Volgian age (*Epivirgatites nikitini* zone) cannot be ruled out (*see* pp. 34-35). The Canadian form concerned is, at any rate, younger than the *Dorsoplanites gracilis* and *D.* aff. *gracilis* of East Greenland as these forms were collected in the late Kimmeridgian and early Portlandian s.str. beds locally containing *Buchia mosquensis* (Buch) s. lato (including *B. m.* var. *rugosa* Fischer) (Spath, 1936, pp. 74, 99, 100). In the Greely Fiord section the equivalent beds must occur beneath the top sandstone member of the Awingak Formation.

Unless the above-described Canadian specimens of *Dorsoplanites* cf. *gracilis* Spath represent a new species (a descendant of *D. gracilis*?), this East Greenland species is extremely long ranging. Unless the bed containing *D.* cf. *gracilis* in the Greely Fiord Section is of latest Portlandian age, the forms comparable with *D. gracilis* range at least into the early Upper Volgian.

Dorsoplanites sp. indet. ex gr. *D. panderi* (Michalski 1890)

Plate VIII, figure 1

1961 *Dorsoplanites* sp. indet. ex gr. *D. panderi* Michalski, Frebold, p. 23, Pl. XVII, fig. 2.

Material. One fragmentary specimen (GSC No. 18036) collected by R. Thorsteinsson from the Deer Bay Formation, 2½ miles due north of Eureka weather station, Ellesmere Island, GSC locality 53398.

Description and remarks. The only specimen found is incomplete, almost completely flattened, with a somewhat weathered surface. The ribbing habit and width of the umbilicus are generally similar to those of *Dorsoplanites* sp. indet. ex gr. *D. panderi* described and figured by Frebold (1961, p. 23, Pl. XVII, fig. 2) from an adjacent and near-contemporary locality in the Deer Bay Formation. The apparently weaker ribbing of our specimen is believed to have been caused by its less satisfactory preservation and the absence of the more pronouncedly ribbed innermost whorl preserved in Frebold's specimen. Our specimen is accordingly compared with that figured by Frebold (1961), although neither of them can be determined specifically.

Occurrence and age. Collected in place 24 to 25 feet stratigraphically below the limestone concretion containing *Craspedites* (*Taimyroceras*?) *canadensis* n.sp. and *Buchia unschensis* (Pavlow, 1907) s.str. (*see* below) in the same continuous section. This bed appears to correspond to that at GSC locality 28714 in which similar dorsoplanitid ammonites (described by Frebold, 1961) and numerous, advanced forms of *Buchia fischeriana* (d'Orbigny) (described in this report) occur in association (R. Thorsteinsson, pers. com.). An early Upper Volgian age is accordingly proposed for this ammonite (*see* under the description of *Buchia fischeriana* s. lato).

Genus *Laugeites* Spath, 1936?

Laugeites? sp. indet.

Plate VIII, figures 7A-7B

Material. One fragmentary specimen (GSC No. 18028) collected by R. Thorsteinsson in the Deer Bay Formation, 2½ miles due north of Eureka weather station, Ellesmere Island, GSC locality 53398.

Description and remarks. The only specimen known comprises about one third of the last whorl (living chamber) and one third of the penultimate whorl (all septate). Both whorls are almost completely flattened and their surface is poorly preserved. The ammonite is widely umbilicate, about one half of the penultimate whorl being covered by the ultimate whorl. The flanks of both whorls are ornamented by single, straight to almost straight, heavy, blunt and reasonably widely spaced ribs. These ribs begin at the umbilical rim on both whorls and are almost radial. On the ultimate whorl the ribs seem to fade out on the umbilical shoulder and the venter (Pl. VIII, fig. 7B), so that the venter appears to be quite smooth.

The appearance of the venter of penultimate whorl is not known. An almost smooth band occupies the gently rounded umbilical shoulder between the umbilical rim and umbilical seam.

No bifurcation of the ribs has been observed on the ultimate whorl (living chamber). Some of the ribs on this whorl show a distinct backward bend near the dorso-ventral shoulder whereas others continue on a straight, near radial course to the point of their disappearance.

Suture line not preserved.

The specimen resembles some of the East Greenland *Laugeites* (= *Kochina*) described by Spath (1936, p. 81), particularly those that lose secondaries and retain bulging primaries. The primaries may become more and more distantly spaced. Our specimen is not definitely determinable generically and is tentatively referred to *Laugeites*.

Occurrence and age. As for *Dorsoplanites* sp. indet. ex gr. *D. panderi* (Michalski) shown in Plate VIII, figure 1.

Family BUCHIIDAE Cox, 1953

(= Aucellidae Lahusen, 1897)

Genus *Buchia* Rouillier, 1845

(= *Aucella* Keyserling, 1846; Opinion 492 of Intern. Comm. on Zool. Nomenclature, 1957)

General comments. The taxonomic value of most morphological features of *Buchia* shell has already been discussed (Jeletzky, 1965). One additional taxonomically valuable feature not previously used by the writer must, however, be briefly commented upon. Sokolov (1903, pp. 371-2) has introduced the term "Rückenlinie" for an imaginary line joining the highest points of the left valve of *Buchia*. This term was subsequently used by Pavlow (1907), who translated it into French as "ligne de fâite". The writer proposes the term "crest line" as the English equivalent of these terms.

The "crest line" is an artificial line, which does not correspond to any definite biological feature of the animal; it is, nevertheless, rather useful taxonomically in giving us an idea about the direction of the maximum growth of the valve and its changes during the ontogenetic development of the animal. This feature appears to be most useful on the specific level within the closely allied species groups of *Buchia*. The more distantly related species are indeed likely to have very similar to indistinguishable outlines of crest lines. This rarely happens with the closely related species of about the same age, which can often be easily distinguished on the shape of their crest lines alone. The writer cannot follow Sokolov (1926, pp. 33-4) in his later conclusion denying the taxonomic usefulness of the crest line because: 1. Its shape is identical or closely similar in many species; 2. Its outline

cannot be precisely established in the swollen *Buchia* forms, notably in many Neocomian forms. While granting that Sokolov's (1926) observations are correct, the writer feels that it would be wrong not to use the crest line in those *Buchia* species where these observations do not apply. This is particularly true of the less swollen to flattish Jurassic and Berriasian representatives of the genus, some of which can be best distinguished from one another by using the shape of the crest line.

All measurements of *Buchia* valves given in this report have been made using the method adopted in Sokolov's paper (1908b, pp. 1-3). The writer fully agrees with Sokolov's (1908b, p. 2; 1926, p. 32) criticisms of a different method of measurement of *Buchia* shells proposed by Pavlow (1907, pp. 9-11).

Buchia fischeriana (d'Orbigny, 1845) s. lato

Plate IV, figure 3; Plate VII, figures 2, 3, 7; Plate VIII, figures 2-6, 8-9

1845 *Avicula fischeriana*, d'Orbigny, p. 472, Pl. XLI, figs. 8-10.
1888 *Aucella fischeriana*, Lahusen, p. 15, Pl. II, figs. 14-20.
1888 *Aucella trigonoides*, Lahusen, p. 14, Pl. II, figs. 21-24.
1907 *Aucella stremoouhovi*, Pavlow, p. 47, Pl. I, fig. 38.
1907 *Aucella fischeri*, Pavlow, p. 58, Pl. IV, figs. 15-19.
1908a *Aucella rjasanensis*, Sokolov, p. 64 (foot note).
1955 *Aucella fischeriana*, Gerassimov, p. 93, Pl. XIII, figs. 1-3.
1959 *Aucella fischeriana*, Imlay, p. 159, Pl. 17, figs. 2-6, 11 *non.* fig. 1.
1964 *Buchia fischeri*, Jeletzky in: Tozer and Thorsteinsson, p. 140, Foss. loc. 37245, etc.

Concept of species. Synonymy and illustrations show the writer's interpretation of *Buchia fischeriana* s.lato. This interpretation is essentially that of Gerassimov (1955, p. 93, Pl. XIII, figs. 1-3), which appears to be in agreement with the original concept of *B. fischeriana* s. lato (d'Orbigny, 1845, p. 472, Pl. XLI, figs. 8-10).

None of the specimens figured by Sokolov (1908a, Pl. II, figs. 6-10) under the name of *Buchia fischeriana* belongs to this species as interpreted in this report. The left valves shown in Sokolov's figures 6 and 7 appear to be transitional between *B. piochii* var. *russiensis* and *B. fischeriana* s. lato, but are closer to the first form in their narrow, elongated shape and the predominantly downward growth resulting in the nearly straight and downward trending crest line. These specimens are closely comparable to *Buchia piochii* s. lato var. from the latest Portlandian s.str.? rocks of the Aklavik Range shown in Plate VII, figure 6 of this report. The right valve shown in Sokolov's figures 8 and 9 and the left valve shown in his figure 10 probably belong either to *B. uncitoides* s. lato or to *B. terebratuloides* s. lato, judging by their general shape and the cited Neocomian age. The inclusion of such narrow, high, and elongated shells in *Buchia fischeriana* s. lato probably accounts for many of Sokolov's (1908a-b) and other workers' records of the typical representatives of the species from the late Lower Volgian rocks of the Central Russian basin corresponding to the late Portlandian s. str. stage of northwestern Europe.

Material. Several hundred specimens from some 40 to 45 localities in the Richardson Mountains and Canadian Arctic Archipelago have been examined by

the writer. The following GSC localities, which have yielded the best preserved or otherwise important material of the species, should be specifically mentioned: Richardson Mountains, west slope, locality 38743 (Jeletzky, 1961a, p. 30, Sec. 5, 550- to 570-foot level); same, east slope localities 26987, 25751 (Jeletzky, 1958, p. 21, Sec. 1, bed 18); Canadian Arctic Archipelago, Ellesmere Island, Eureka Sound, locality 28714; Prince Patrick Island, north of head of Intrepid Inlet, locality 37245.

Description and remarks. Shell medium-sized for the genus, pronouncedly oblique posteriorly in relation to the hinge line, broad, irregularly pear-shaped, the width increasing towards broadly rounded posterior lower margins, thin to very thin and only feebly convex in anterior aspect. Surface covered by regularly to irregularly spaced concentric folds. These folds are mostly fine and closely spaced in the typical representatives. Some aberrant specimens may, however, have much coarser and more widely spaced concentric folds resembling those of *B. okensis* var. *subokensis* (Pavlow) and *B. unschensis* (Pavlow) s. str. Such coarser sculptured and subtriangular-shaped forms have been treated as independent species by most workers (e.g., *Buchia trigonoides* Lahusen 1888 *non* Pavlow 1907, *Buchia rjasanensis* Sokolov, 1908b). They are here considered as mere morphological variants of *B. fischeriana* s. lato, however, as they occur together with its typical specimens and intergrade into them. In another extreme variant (Pavlow, 1907, Pl. IV, fig. 15) the concentric ornament consists largely of fine to very fine striae interspersed with a greater or smaller number of fine concentric folds locally. Moderately coarse to very fine radial striation, and even radial ribbing, commonly occurs in *B. fischeriana* s. lato. It is especially common and pronounced in specimens preserved as internal casts or in those missing the uppermost shell layer. This radial striation or ribbing is usually finer and less prominent than that of *Buchia* (*Anaucella*) *concentrica* (Sowerby) and allied older species; it may, however, be confused with this latter in some extreme specimens (Pl. IV, fig. 3A; Pl. VIII, fig. 8A).

GSC No.	Maximum length (mm)	Maximum width (mm)	Thickness of Valve (mm) Left	Right	Beak's angle (degrees)	Concentric folds per cm approx.
17991	40	30	10.0	7.0	85	6-7
17992	35	24	9.0	6.0	85	8
No. 3 Can. Nat. Mus.	47	31	14.0	—	75	7-8
18017	34	22	10.5	6.8	65	7-9
18016	41	31	9.1	—	85	5-9

The left valve is commonly more convex than the right, but in some flat specimens the two may be almost equally convex in anterior aspect. In some exceptionally thick specimens the left valve may be considerably thicker and more convex than the right valve. The left beak is small but sharp, it is either abruptly bent towards

the right valve or tightly coiled, but does not, or only slightly, overhang the right valve. The beak tends to be feebly right-handedly incurved throughout its length. Specimens with either straight or feebly left-handedly incurved beaks are known, however.

The crest line of the beak proper is directed more or less downward. The crest line of younger parts of the valve is, however, directed obliquely backward. The resulting somewhat abrupt bend of the crest line occurring between the base of the beak and the main part of the valve (Pl. VIII, figs. 8A, 9A) is a diagnostic feature of *B. fischeriana* s. lato.

The left valve of *B. fischeriana* s. lato, begins more or less like that of *B. piochii* s. lato. As its early growth stages are also otherwise similar to that predominantly older species, it may be a case of "recapitulation". Later, however, the direction of maximum growth changes from the one directed essentially downward to one directed towards the lower posterior corner of the valve. This latter direction of growth continued throughout life. The left valve tends to become gradually wider and flatter with age. The abrupt change of direction of crest line in *B. fischeriana* s. lato helps to differentiate it from the broad and flat forms of *B. mosquensis* (Buch) s. lato (including *B. m.* var. *rugosa*) and the late Lower Volgian (late Portlandian s.str.) *Buchia* forms transitional between *B. mosquensis* s. lato and *B. fischeriana* s. lato (Pl. VII, figs. 3A, 7A). In the pre-Upper Volgian forms the direction of crest line tends to change gradually from essentially downward to essentially backward. This results in its broadly and regularly rounded (convex downward) rather than abruptly bent shape.

The posterior ear of left valve is, as a rule, small to barely noticeable, somewhat rounded and generally ill-developed; it may, however, become relatively larger and distinctly angular in some extreme representatives of the species (Pl. VIII, fig. 9A).

The anterior margin is regularly convex in most specimens but it may become almost or quite straight in forms transitional to or typical of *B. fischeriana* var. *trigonoides* Lahusen 1888 *non* Pavlow 1907. The anterior margin is, usually, two to one and a half times shorter than the posterior margin but the two may become about equal in length in *B. fischeriana* var. *trigonoides* Lahusen *non* Pavlow.

The posterior margin is mostly straight to somewhat concave. The anterior-lower and posterior-lower corners of left valve are more or less regularly and broadly rounded in most representatives. In some, however, the corners are subangular, which may result in the rounded-trapezoidal or subquadrate shape of the valve.

The right valve is always thinner and less convex than the left and may be almost flat in some specimens; its posterior ear is similar to that of the left valve. The beak is very small and rather obtuse; it is barely elevated above the surface of the valve. The shape of the valve varies from almost regularly rounded to almost triangular, sharp at the beak and gradually widening towards the lower and posterior margins; both lower corners of the valve are broadly rounded. The posterior margin tends to be considerably longer than the anterior margin; the two may, however, be nearly equal in some representatives.

Byssus ear is small to very small as compared with that of other Upper Tithonian *Buchia* forms; its anterior surface forms an angle of 40 to 60 degrees with the contact plane of the valves and is distinctly spoon-like but shallow. The byssus ear has, thus, the evolutionary grade of the less advanced to conservative representatives of *B. piochii* var. *russiensis* (Pavlow 1907) and var. *mniovnikensis* (Pavlow 1907) (Jeletzky, 1965, pp. 4-5, Pl. I, figs. 4D, 5E). So far as known, no advanced ears comparable to those of *B. piochii* var. *russiensis* figured by Jeletzky (1965, pp. 4-5, Pl. I, fig. 3D) occur in *B. fischeriana* s. lato; its byssus ear, thus, appears to be less advanced as compared with that of its immediate predecessors and is definitely less advanced in comparison with that of most other Upper Volgian (= Upper Tithonian) *Buchia* forms such as *B. terebratuloides* s. lato or *B. unschensis* s. lato.

The maximum thickness of both valves occurs near the hinge margin. From this point on, the shell tapers gradually and more or less evenly downward and much more markedly so towards the beaks. When viewed from the beaks, the cross-section of the complete shell is irregularly lens-like.

Affinities and differences. From *Buchia unschensis* (Pavlow) s. str., *B. fischeriana* s. lato differs in its much thinner shell, almost complete absence of feeble development of posterior ear, and in the feeble right-handed curvature of its beak. These two species differ, furthermore, in the evolutionary grade of byssus ear. That of *B. unschensis* has the grade of Berriasian to early Valanginian buchias whereas that of *B. fischeriana* has the evolutionary grade of less advanced to conservative representatives of the late Portlandian s.str. forms of *Buchia piochii* s. lato. *B. terebratuloides* s. lato (? = *B. obliqua* Tullberg, 1881; *see* Bodylevsky, 1936, pp. 117-120, Pl. I, figs. 1-8) differs from *B. fischeriana* s. lato essentially in the same features as *B. unschensis* does.

From *Buchia okensis* f. typ. et var. *canadiana* (Crickmay, 1930), *B. fischeriana* s. lato clearly differs in its smaller size, much finer and much more closely spaced concentric ornament, considerably thinner shell, and much more feebly developed posterior ear. The ribbing habit and shell thickness of the smaller representatives of *B. okensis* var. *subokensis* (Pavlow, 1907) may closely approach those of *B. fischeriana* var. *trigonoides* Lahusen 1888 *non* Pavlow 1907. Other features usually serve, however, to differentiate *B. o.* var. *subokensis* from this extreme variant of *B. fischeriana* s. lato. Transitional forms between *B. fischeriana* s. lato and *B. okensis* s. lato, and apparently the mixed faunas of these two species as well, are known to occur in the uppermost Upper Volgian and earliest Berriasian rocks of the boreal province (Jeletzky, 1965, pp. 25-26). These transitional forms and(?) faunas can, naturally, only be designated as such and no attempt should be made to subordinate them arbitrarily to either of the two species concerned.

Buchia volgensis (Lahusen, 1888) is a much larger shell than *B. fischeriana* s. lato. The left beak of *B. volgensis* is much larger, longer, and has a characteristic hook-like inflection; furthermore it overhangs the almost flat left valve, unlike the small, coiled left beak of *B. fischeriana* s. lato. The distinctions from *B. richardsonensis* n.sp. are discussed under the description of that species. *Buchia keyserlingi*

(Lahusen, 1888) is considerably thicker and, as a rule, larger than *B. fischeriana* s. lato (Pl. VI, fig. 5); its concentric sculpture is also coarser and much more regular. *Buchia uncitoides* (Pavlow, 1907) s. lato is a much narrower, longer, and higher arched shell with almost straight and downwardly directed crest line. Neither it nor any other Lower Cretaceous *Buchia* species can be easily confused with *Buchia fischeriana* s. lato.

Among older or contemporary forms, *Buchia piochii* s. lato is narrower, thicker, and considerably longer than *B. fischeriana* s. lato; its left beak is much longer, pronouncedly pinched, and not coiled. The shell of *B. piochii* s. lato grows predominantly downward throughout its life span. This results in a nearly straight, largely downwardly directed crest line contrasting with that of the "adult" *B. fischeriana* s. lato and in the much less posteriorly oblique shell of *B. piochii* s. lato. Numerous transitional forms between the two species occur, however, in the late Portlandian s.str. and early Upper Volgian rocks of the boreal province. As in *B. okensis* and *B. fischeriana*, these transitional forms (e.g., Pl. VII, fig. 6) cannot be rigidly subordinated to either of the species concerned and must be recognized for what they are. *Buchia piochii* var. *mniovnikensis* (Pavlow, 1907) (*see* Pl. VII, fig. 10) may become more similar to *B. fischeriana* s. lato than any other known variant of this species. Even this thin and broad form is clearly distinguishable from our species in the previously mentioned morphological characters. The posterior ear is, furthermore, usually better developed in *B. p.* var. *mniovnikensis* (Jeletzky, 1965, Pl. I, figs. 9A, 9B) than in *B. fischeriana* s. lato.

Buchia aff. *fischeriana* (d'Orbigny, 1845) (Pl. VII, figs. 3, 7) differs from the typical *B. fischeriana* in the smaller size, somewhat evenly curved rather than abruptly bent crest line, and more markedly right-handed incurvature of left beak. All these distinctions are slight and far from constant. It may, thus, be impossible to distinguish single or scarce and/or poorly preserved representatives of this late Portlandian s.str. precursor of *B. fischeriana* s. lato from its smallish, half-grown or simply conservative representatives, which are common in the early Upper Volgian rocks. Sizable series of well-preserved specimens are usually necessary for this purpose and even then the results may be inconclusive. Numerous transitional forms connect *B.* aff. *fischeriana* with *B. fischeriana* s. lato; some late Portlandian? and/or early Upper Volgian? collections studied were found to contain them in equal amounts. The feasibility of specific separation of the two forms concerned remains to be proven. It is because of this that the writer used open nomenclature for *B.* aff. *fischeriana* instead of several formal names available (e.g., *Aucella sollasi* Pavlow, 1907, *Aucella dilatata* Pavlow, 1907, etc.).

Buchia mosquensis (Buch, 1837) s. lato and allied forms, such as *B.* cf. *blanfordiana* of Jeletzky (1965), cannot be easily confused with *B. fischeriana* because of the pronounced right-handed incurvature of the much larger and stouter left beak. *Buchia* (*Anaucella*) *concentrica* (Sowerby) and allied forms are, however, less easily distinguishable unless their hinge structure (Jeletzky, 1963,

p. 157, Pl. 21, figs. 3-4, 8; 1965, pp. 4-5; Pl. I, figs. 1-2, 10) can be worked out. So far as its shape, thickness, beak, crest line, and size are concerned, *B.* (*A.*) *concentrica* is an older homoeomorph of *B. fischeriana* s. lato. Even the much employed considerably coarser and wavering radial ornament of *B.* (*A.*) *concentrica* is not an entirely reliable distinguishing feature. As is well illustrated by specimens of *B. fischeriana* s. lato shown in Plate IV, figure 3A; Plate VIII, figures 8A, 8B, its radial ornament may be closely similar to and even indistinguishable from that of *B.* (*A.*) *concentrica.*

Occurrence and age. In the Canadian Arctic the first representatives of *B. fischeriana* s. lato were seen in the late Portlandian s.str. part of the Husky Formation (= Lower Shale-siltstone Division) of the Richardson Mountains (Jeletzky 196-), in the correlative beds of the Mould Bay Formation, and in the correlative top beds (sandstone member) of Awingak Formation. In all these beds *B. fischeriana* s. lato appears to be a rare to very rare form associated with much more common representatives of *B.* aff. *fischeriana* s. lato and *B. piochii* s. lato (including *B. p.* var. *russiensis* and var. *mniovnikensis*). In the immediately overlying beds of the Husky Formation (= Lower Shale-siltstone Division) and in the basal beds of the Deer Bay Formation largely overlying those with *B. richardsonensis* n.sp. (*see* pp. 34-35) *B. fischeriana* is definitely much more common. It is not known whether or not the equivalent beds are present in the Mould Bay Formation, although advanced representatives of *B. fischeriana* s. lato (as shown in Pl. VII, fig. 2) in this formation are certainly suggestive of that. In the Richardson Mountains, at least, *B. fischeriana* s. lato is the dominant, and often the only, *Buchia* form occurring in these beds. The same may well be true also of the interval 100 to 150 feet above the base of the Deer Bay Formation, judging by the mass occurrence of *B. fischeriana* s. lato at the GSC loc. 28714 and in some other collections. Other fossil lots from about the same interval have, however, yielded *Buchia richardsonensis* n.sp. and other *Buchia* forms. *B. fischeriana* s. lato appears to be rare or ?absent in all younger Upper Volgian rocks of this region, such as the beds with *Craspedites* (*Taimyroceras*?) *canadensis* n.sp. near Eureka weather station, the apparently younger craspeditid- and *Buchia* ex gr. *uncitoides*-bearing beds near Buchanan Lake on Axel Heiberg Island, and the apparently equivalent uppermost 25 to 35 feet of the Jurassic part (immediately below *Buchia okensis* zone) of the Husky Formation (Jeletzky, 196-). In the present state of our knowledge, *Buchia fischeriana* s. lato appears to be essentially restricted to the lower part of the Upper Volgian stage throughout Arctic Canada. These beds are, for the time being, considered to be its zone. The upper part of the Upper Volgian stage appears to be characterized by other *Buchia* forms, such as *B. unschensis* (Pavlow, 1907), *B.* aff. *subinflata, B.* ex gr. *uncitoides,* etc. This relatively restricted time-range of *B. fischeriana* s. lato in Arctic Canada may well be only a regional phenomenon, as this species is known to occur in great numbers in most or all of the Upper Volgian stage in the Central Russian basin (Pavlow, 1907, pp. 48, 58, table opp. p. 84; Gerassimov, 1955, p. 93).

Buchia richardsonensis n.sp.

Plate VII, figures 1, 4-5, 8-9

1958 *Aucella transitional* between *A. mniovnikensis* and *A. volgensis*, Jeletzky, p. 23, Sec. 1, bed 12.

Material. Four reasonably well preserved complete specimens, and several determinable fragmentary left and right valves, northeastern Richardson Mountains, Aklavik Range (Jeletzky, 1958, p. 23), GSC locality 26959 (Sec. 1, bed 12); one well-preserved, almost complete specimen and several identifiable fragments, same area and section as last, GSC locality 26954 (Sec. 1, bed 3); one well-preserved right valve and several fragments probably belonging to *B. richardsonensis* n.sp., same area as last, Mount Gifford, southeast shoulder, GSC locality 35863; one fairly well preserved left valve and several fragments, same area as last, GSC locality 35629; one reasonably well preserved left valve, one reasonably well preserved right valve, several identifiable fragments, same area as last, GSC locality 35752. Two fairly well preserved left valves and one right valve, Eureka Sound, Ellesmere Island, GSC locality 28753; one reasonably well preserved left valve, Greely Fiord, Ellesmere Island, GSC locality 47880; three reasonably well preserved left valves, Axel Heiberg Island, GSC locality 25944.

Derivation of name. From the Richardson Mountains where the holotype and several topotypes have been found.

Type specimen. The almost complete, medium-sized left valve from GSC locality 26959 is herewith selected as the holotype of *Buchia richardsonensis* n.sp.; it is figured in Plate VII, figures 8A-8C. GSC No. 18013.

Diagnosis. A *Buchia* species combining the generally *Buchia volgensis*-like shape and size with the exceptionally large and angular posterior ear resembling that of *B. unschensis* and *B. okensis* but is commonly larger than this latter. The crest line is almost straight. The left beak is moderately short and more or less coiled instead of being hook-like bent as in *B. volgensis*.

Description. Shell medium-sized to large for the genus, slightly to moderately oblique posteriorly in relation to the hinge margin, usually considerably longer than wide, pear-shaped (Pl. VII, figs. 1, 4) to irregularly rounded-trapezoidal (Pl. VII, figs. 5, 8, 9). The width of the shell gradually increases towards the broadly rounded lower margin in the pear-shaped forms but remains nearly the same throughout in the broad, irregularly rounded-trapezoidal representatives. The surface is covered by the more or less regularly to fairly irregularly but generally closely spaced concentric folds. These folds are fine like those of *B. fischeriana* s. lato. This concentric ornament may be feeble in some specimens or on some parts of the shell in other specimens. Fine to very fine, radial striation may cross the concentric folds in some parts of the shell (e.g., Pl. VII, fig. 9B). The shell is more or less thin; its cross-section is commonly lens-like (Pl. VII, fig. 9D) with the flanks gradually and evenly sloping down from the crest line when the shell is viewed from above. In rare instances, however, the cross-section loses its lens-

like shape and becomes considerably higher with the flanks sloping down more steeply and often more or less abruptly (Pl. VII, figs. 4C, 5E). Such specimens are probably transitional to *Buchia occidentalis* (Anderson, 1945) and *B. unschensis* (Pavlow, 1907). The posterior ear is markedly angular, like that of *B. unschensis* (Pavlow, 1907) and *B. okensis* (Pavlow, 1907) s. lato and large to exceptionally large for the genus. In the left valve it is often clearly separated from the rest of the shell by a furrow-like boundary (Pl. VII, fig. 9A).

The measurements (in mm) of the holotype and three topotypes are:

	GSC No. and Figure	Maximum Length	Maximum Width	Thickness of Valve Left	Thickness of Valve Right	Beak's angle (degrees)
1.	18012 (Pl. VII, fig. 9)	50+ (est.)	36+ (est.)	12.5	9.5	85
2.	18014 (Pl. VII, fig. 5)	41+ (est.)	32	12.3	8.6	75
3.	18013 (Pl. VII, fig. 8)	47	32	14.6	—	80
4.	18011 (Pl. VII, fig. 4)	43	26+ (est.)	12.0	8.5	70

The left valve is usually more convex than the right but in some extremely flat representatives (Pl. VII, fig. 9) the two may be almost equally convex when viewed from above and from the anterior or posterior sides. In some exceptionally thick specimens (Pl. VII, fig. 4), however, the left valve may be considerably thicker and more convex than the right. The left beak is moderately small but pinched and sharp; it is more or less distinctly coiled (Pl. VII, figs. 1B, 4B, 8B) and either does not or only slightly overhangs the right valve. There are exceptions (Pl. VII, fig. 5C) in which the left beak becomes essentially similar to that of *B. volgensis* (Lahusen, 1888). Mostly it is almost straight throughout and is not noticeably laterally incurved (Pl. VII, figs. 4A, 8A); it may, however, be feebly incurved to the right (Pl. VII, fig. 5A). The crest line is predominantly downwardly directed, nearly straight and its posterior deflection does not exceed 20 degrees. The anterior and posterior margins tend to be either straight or slightly convex; they pass gradually into the regularly rounded lower margin. The hinge margin is normally unusually long and quite straight.

The right valve is thinner and less convex than the left and may be almost flat in some exceptional specimens. Its beak is very small, rather obtuse, and barely elevated. The shape of the valve varies from irregularly rounded to rounded-trapezoidal; the upper corners of the valve are mostly angular whereas its lower corners are invariably more or less regularly rounded. The posterior and anterior margins tend to be of similar length. The byssus ear has the same evolutionary grade and appears to vary in the same limits as that of *B. piochii* from the late Portlandian s.str. rocks of Prince Patrick Island (Jeletzky, 1965, pp. 4-5, Pl. I, figs. 3, 4, 5); it is, however, relatively smaller than that of the latter species (in relation to the shell's size). The maximum thickness of both valves occurs at the mid-length of the shell. From this point it decreases gradually and more or less evenly in the anterior and posterior directions.

Affinities and differences. From its closest ally and immediate ancestor — *Buchia piochii* var. *mniovnikensis* (Pavlow, 1907) (*see* Pavlow, 1907, Pl. II, fig. 9; this paper, Pl. VII, fig. 10) — *Buchia richardsonensis* n.sp. differs primarily in its much larger and markedly angular posterior ear. It is considerably larger (usually at least 1½ to 2 times in the adult) and has a less regular and feebler concentric ornament. The most reliable distinction of *B. richardsonensis* n.sp. from its apparently immediate descendant *B. volgensis* (Lahusen, 1888) is also its much larger and pronouncedly angular posterior ear (Pl. VII, figs. 1A, 5A, 5B, 8A, 9A, 9B), which contrasts strongly with the small to barely noticeable, rounded posterior ear of the latter species. Another, apparently constant distinction between the two is the much less posterior obliquity of the shell in *B. richardsonensis* n.sp. and the more or less straight crest line. *Buchia volgensis* is, indeed, just as oblique posteriorly as is *B. fischeriana* s. lato and its crest line is always more or less convex towards the anterior-lower corner of the shell. The third, less reliable distinction is the commonly broader, somewhat rounded-trapezoidal shape of the left valve of *B. richardsonensis* n.sp. as compared with the commonly narrower and more or less pear-shaped left valve of *B. volgensis*. The left beak of *B. richardsonensis* n.sp. is, finally, almost straight or, rarely, slightly incurved to the right; that of *B. volgensis* is slightly incurved to the right.

B. occidentalis (Anderson, 1945, Pl. 12, figs. 2a-2c) differs from *B. richardsonensis* n.sp. mainly in its feebly developed, rounded posterior ear. The left and right valves of this somewhat enigmatic Upper Tithonian form are considerably thicker, shorter and at the same time narrower than those of *B. richardsonensis* n.sp. The left beak of *B. occidentalis* (op. cit.) appears to be thicker and blunter than that of *B. richardsonensis* n.sp., but in some exceptionally stout specimens of the latter form (Pl. VII, fig. 5) the shape of the beak may closely approach that of *B. occidentalis*.

From all other comparable *Buchia* species, *B. richardsonensis* n.sp. differs in the same features as does *B. volgensis* (Lahusen, 1888). Considering the immediate superposition of beds carrying *B. richardsonensis* n.sp. on those carrying *B. piochii* var. *mniovnikensis* as well as the apparent intergradation and association of these two forms in some collections studied, the former species is probably a direct descendant of *B. piochii* var. *mniovnikensis*. *B. richardsonensis* may, furthermore, well be a connecting evolutionary link between *B. piochii* var. *mniovnikensis* and *B. volgensis* proper. No connecting forms bridging the stratigraphical gap between the two forms concerned have yet been found by the writer in Arctic Canada. The Upper Volgian representatives of *B. volgensis* mentioned but not figured by Lahusen (1888, p. 3) and some other Russian workers may, however, either belong to *B. richardsonensis* n.sp. itself or represent such connecting forms. The same may well be true of *Aucella* ex gr. *volgensis* reported to be numerous in the Upper Volgian rocks of some North Siberian areas (e.g., Bassov, *et al.*, 1962, p. 40). *B. richardsonensis* n.sp. appears to be the immediate ancestor of *B. unschensis* (Pavlow, 1907) as restricted in this report, as it occurs in beds immediately underlying those carrying *B. unschensis* and the two forms appear to be

connected by the transitional ones. The genetic relationships of these two forms is discussed in greater detail in connection with the description of *B. unschensis*.

Stratigraphic position and age. On the eastern slope of Richardson Mountains, *B. richardsonensis* n.sp. was found only in beds immediately underlying those characterized by the numerous, advanced forms of *Buchia fischeriana* s. lato closely comparable to those associated in the Arctic Islands with the dorsoplanitid ammonites described in this report pp. 20-24; Pl. VIII, figs. 1, 7, 10, 11. In the Richardson Mountains sections, *B. richardsonensis* n.sp. is locally associated with *B. piochii* s. lato (including its variants *russiensis* Pavlow and *mniovnikensis* Pavlow) and *B.* aff. *fischeriana* s. lato, and more typical but still early variants of the latter species. In some of the sections concerned *B. richardsonensis* n.sp. was recorded (Jeletzky, 1958, p. 23) as: *"Aucella* transitional between *A. mniovnikensis* and *A. volgensis."* The corresponding beds of the Husky Formation (= Lower Shale-siltstone Division; *see* Jeletzky, 196-) are now tentatively considered to be slightly younger than the late Portlandian s.str. beds of the Mould Bay Formation on Prince Patrick Island containing *B. piochii* s. lato (Jeletzky, 1965, Pl. I, figs. 3, 4, 5) and *B.* aff. *fischeriana* s. lato but apparently devoid of *B. richardsonensis* n.sp. and more typical forms of *B. fischeriana* s. lato. The beds concerned may admittedly yet be found to be but different faunal facies of the same zone; this is, however, considered unlikely (*see* below).

On Ellesmere Island in the Greely Fiord area, *Buchia richardsonensis* n.sp. occurs at about the same stratigraphic position as on the eastern slope of Richardson Mountains in the lower 150 feet of the Deer Bay Formation. It was found, however, underneath as well as closely above the beds containing advanced forms of *Buchia fischeriana* s. lato and dorsoplanitid ammonites described by Frebold (1961) and in this report. Closely below beds with *B. richardsonensis* n.sp. is the topmost sandstone member of the Awingak Formation containing *Buchia* aff. *fischeriana* s. lato and *B. piochii* var. *mniovnikensis* (Pl. VII, figs. 3, 10). These latter beds are tentatively correlated with the lower part of Mould Bay Formation containing the same fauna. Elsewhere in the Canadian Arctic Archipelago, *B. richardsonensis* occurs in beds whose stratigraphic position is uncertain.

The beds with *B. richardsonensis* n.sp. always closely overlie the late Portlandian s.str. rocks referable either to the *Virgatites virgatus* zone or to *Epivirgatites nikitini* zone (or to both) of the late Lower Volgian stage. Furthermore, they are usually (except for the GSC loc. 28753 which occurs about 10 feet stratigraphically above the bed with *Dorsoplanites* sp. indet. figured by Frebold, 1961, Pl. XX, fig. 1) directly overlain by beds with numerous advanced forms of *Buchia fischeriana* s. lato referable already to the early Upper Volgian stage. The beds with *B. richardsonensis* n.sp., therefore, obviously occur at the boundary between these two stages. On the stratigraphic evidence alone, they could be either of latest Lower or of earliest Upper Volgian age (except for GSC loc. 28753 which is early Upper Volgian). For the time being the *B. richardsonensis* beds are tentatively placed in the basal part of the *Kachpurites fulgens* zone of the early Upper Volgian because of the evolutionary grade of the species concerned. The

underlying beds with *B.* aff. *fischeriana* s. lato and *B. piochii* var. *mniovnikensis*, etc. are assumed to correspond to the *Virgatites virgatus* and *Epivirgatites nikitini* zones of the late Portlandian s.str. (= Lower Volgian) stage. These tentative conclusions may well be subject to a revision if and when the diagnostic ammonites are found in the beds concerned.

Buchia richardsonensis n.sp. appears to be a rather rare form in all fossil collections studied. It seems, therefore, to be inappropriate as the zonal index for the beds concerned, even though no better zonal indices are known to occur in them. *B. richardsonensis* n.sp. was referred to as *Buchia* n.sp. aff. *volgensis* in several unpublished intradepartmental fossil reports. The closely allied *Buchia* forms from the early Berriasian and from the *Craspedites* (*Taimyroceras*?) *canadensis* bed referred to *Buchia* n.sp. aff. *volgensis* in these reports are, however, now excluded from *B. richardsonensis* n.sp.

Buchia unschensis (Pavlow, 1907) emend.

Plate I, figures 1-4; Plate V, figures 3-7; Plate VI, figures 1-4, 6-8

1907 *Aucella unschensis*, Pavlow, pp. 71-2, Pl. VI, fig. 12 *non* (?) 13-14.
1926 *Aucella unschensis*, Sokolov, pp. 36-37, text-fig. 4.

Material. More than 100 complete specimens and fragmentary but readily determinable right or left valves representing all growth stages and morphological variants of the species from GSC locality 28712. Fourteen fragmentary left and right valves and several fragments from GSC locality 25887.

Type specimen. The specimen from the presumably late Upper Volgian rocks at village Ogarkova on River Unzha, Gouvernment de Kostroma, USSR figured in Plate VI, figures 12a-12c of Pavlow's (1907) work is chosen here as the lectotype of *B. unschensis*, no previous selection being known to the writer. None of the Berriasian to Middle Valanginian *Buchia* forms figured by Pavlow (1907, Pl. VI, figs. 13, 14) under the name of *B. unschensis* is believed to be conspecific with our lectotype (*see* under Stratigraphic position and age).

Description. The "adult" shell is medium-sized to large for the genus, feebly to moderately oblique posteriorly; it is, as a rule, short and thick, its height (here measured perpendicular to posterior ear) being usually either slightly greater than the width or about equal to it. In some extremely wide forms, however, the height may be somewhat less than the width (Pl. VI, fig. 2). The extremely elongated variants are, on the contrary, characterized by the significant excess of height over width (Pl. VI, fig. 1). These extremes are connected by the numerous transitional forms shown in Plates V and VI and are obviously of infraspecific value only. Except for the protrusion of the posterior ear, which may give it a rounded-trapezoidal appearance (Pl. V, fig. 4A; Pl. VI, fig. 4A), the shell is mostly essentially rounded-triangular with the anterior and posterior margins more or less clearly delimited from the regularly rounded lower margin. The anterior and posterior margins tend to be about equal or closely comparable in length, although

there are exceptions; they are mostly approximately straight to somewhat concave. The posterior ear is exceptionally strongly developed and pronouncedly angular; when completely preserved (e.g., Pl. V, figs. 4A, 4B, 6A; Pl. VI, figs. 1A, 2A, 2B, 7A, 7B) it usually protrudes strongly backward and is clearly set off from the main body of the shell. Neither the general shape of the shell nor its proportions and the appearance of the posterior ear change greatly in the course of the ontogeny. This is well illustrated by the different growth stages of the species shown in Plate I, figures 1-4 and Plate V, figures 3-7. In most specimens the surface of both the internal cast and the shell is ornamented by the extremely regularly and fairly closely spaced (5 to 8 per cm in "adults"; 11 to 15 per cm in juveniles), strong to fairly strong concentric folds similar to those of *B. okensis* var. *subokensis*. These folds may, however, become more or less strongly subdued and lose their regular spacing in some extreme forms of the species (Pl. V, fig. 7; Pl. VI, figs. 1, 7, 8). Fine to fairly coarse, radial striae, sometimes resembling those of *Buchia* (*Anaucella*) *concentrica*, may be present in some specimens (Pl. V, fig. 3A; Pl. VI, figs. 1A, 8A); these are especially distinct on the surfaces of internal casts. The measurements (in mm) of ten "adult" and juvenile representatives of the species are as follows:

GSC No. and Figure	Maximum Length	Maximum Width	Thickness of Valve Left	Thickness of Valve Right	Beak's Angle (degrees)	Ribs per cm
17212 (Pl. VI, fig. 1)	64	50	20.5	—	70	7-8
17213 (Pl. VI, fig. 2)	48	53 (est.)	16	11.6	70	5
17189 (Pl. I, fig. 2)	12.6	12	5.8	—	75	12-13
17188 (Pl. I, fig. 1)	17.5	14.5	6.5	—	75	12
17190 (Pl. I, fig. 3)	16.0	13.0	5.1	—	65	12-13
17217 (Pl. VI, fig. 6)	38	33	14	—	70	6
17218 (Pl. VI, fig. 7)	44	37	15.5	9	75	7-8?
17215 (Pl. VI, fig. 4)	30	26	11	7.5 (est.)	70	5
17219 (Pl. VI, fig. 8)	45	38	18	—	75	11-12?
17191 (Pl. I, fig. 4)	13	10	4.5	—	70	14

Both valves appear to arch gently and more or less evenly all the way to the point of their maximum thickness, when viewed from above into the beaks (Pl. VI, figs. 3D, 4C, 6C, 8C). In some exceptionally thick and narrow representatives, however (Pl. V, figs. 3D, 7E), the slope of the flanks increases markedly away from the point of maximum thickness. This results in a somewhat more obtuse central part of the cross-section flanked by the somewhat more abruptly dropping outer parts. In anterior aspect (Pl. V, figs. 4C, 5C, 7C; Pl. VI, fig. 2C) the maximum thickness of both valves is mostly situated in the upper third to two fifths of the shell, which tapers gradually and more or less evenly downward and evenly but much faster forward from this point. Less commonly, especially in extremely thin and/or elongate forms (Pl. V, figs. 3B, 3C; Pl. VI, figs. 1B, 6B), the maximum thickness is about midway; there are numerous transitions between these two extremes.

The left valve is noticeably to markedly thicker and more convex than the right. The left beak is of medium size, but fairly short and blunt; it is regularly incurved rather than abruptly bent and either does not overhang, or only slightly, the right valve. On the whole, it is similar to the left beak of *B. keyserlingi* (Lahusen) in its general proportions and shape. The left beak shows noticeably to markedly left-handed incurvature near its tip, but is commonly almost straight closer to its base. Because of this and the considerable thickness of the beak part of the valve its left-handed curvature can mostly only be observed when looking down into the beak part of the shell (e.g., Pl. V, fig. 3D; Pl. VI, figs. 1C, 2D, 4C, 7D). The crest line is nearly always straight; it is generally directed downward and only relatively feebly backward; the deviation from the downward direction is usually about 10 to 20 degrees. In exceptionally broad and short specimens, however (Pl. VI, figs. 2A, 4A, 6A), the direction of the crest line changes more or less abruptly in the middle of the valve from that directed predominantly downward to that directed obliquely (40 to 50 degrees) backward. The shape of such crest lines resembles strongly that characteristic of *B. fischeriana* s. lato (*see* p. 27). In the forms where most of the left beak shows more or less left-handed incurvature (Pl. VI, figs. 1A, 8A) the early part of the crest line may become somewhat anteriorly deflected.

Although thinner and less convex than the left valve, the right valve is more or less evenly arched and is not known to become flat or nearly flat. The right beak is small, short, and blunt; it is, however, reasonably clearly separated from the surrounding surface of the valve and slightly overhangs the byssus ear. The byssus ear always has the evolutionary grade of such Berriasian forms as *Buchia okensis* s. lato or *B. volgensis* but is less advanced than that of the typical *B. uncitoides* s. lato (Jeletzky, 1965, p. 6); it is thus more advanced than the byssus ear of any other hitherto known latest Jurassic *Buchia* species. Only the byssus ear of the most advanced representatives of *B. piochii* s. lato (Jeletzky, 1965, pp. 4-5, Pl. I, fig. 3) is somewhat more advanced if considered alone. The anterior surface of byssus ear of *B. unschensis* (Pavlow) is strongly bent towards the left valve, forming an angle of 45 to 55 degrees with the hinge margin (Pl. V, fig. 4E; Pl. VI, figs. 2D, 7D). Smaller angles are rare and some larger angles (Pl. V, fig. 7E) up to about 70 degrees were observed occasionally. It is not known whether the inside of the byssus ear is spoon-like as in other late Jurassic buchias or already more or less wedge-like as in most early Lower Cretaceous buchias (Jeletzky, 1965, pp. 6-7). The size and thickness of the byssus ear are comparable to those of *B. okensis* or *B. volgensis* but markedly smaller and thinner than those of *B. inflata* (Toula).

Affinities and differences. From all Jurassic *Buchia* species, except for the closely allied *B. richardsonensis* n.sp., *B. unschensis* differs sharply in the constant presence of a large and markedly angular posterior ear essentially similar to, but larger than that of *B. okensis* s. lato. Other distinguishing features include the noticeable to pronounced left-handed curvature of the left beak, the essentially Berriasian evolutionary grade of the byssus ear, the unusually short and thick shell, and the large

size of the "adults". Among Jurassic species, only *B. terebratuloides* (Lahusen) and *B. obliqua* (Tullberg, 1881 *non* Sokolov, 1908) resemble *B. unschensis* in most of these features; they lack, however, its characteristic posterior ear. The distinctions of *B. unschensis* from *B. richardsonensis* n.sp. have already been discussed in connection with the description of the latter species.

Buchia unschensis apparently arose directly out of *B. richardsonensis* n.sp. via the gradual shortening and thickening of the shell and the replacement of the weaker and mostly somewhat irregular concentric ornament of the latter species by the regular, strong and evenly but only moderately widely spaced one. The presence of broad but feebly and irregularly ornamented forms amongst the available population sample of *B. unschensis* has already been mentioned (Pl. VI, figs. 7-8) and is strongly suggestive of the intergradation of the two species concerned. Even more *B. richardsonensis*-like forms (Pl. VI, fig. 1) occur in this population sample. These forms combine the irregularly, more finely and indistinctly ribbed appearance of the previously mentioned aberrant representatives of *B. unschensis* with the considerably greater downward elongation of the shell that is characteristic of *B. richardsonensis* n.sp.; they remain, however, much thicker than most representatives of the latter species and have a pronounced left-handed incurvature of left beak (Pl. VI, figs. 1A, 1C) typical of *B. unschensis*. These apparently transitional forms between *B. unschensis* and *B. richardsonensis* comprise between 10 and 15 per cent of the population sample at GSC locality 28712.

Of the early Cretaceous species, *Buchia okensis* s. lato is closely similar to *B. unschensis*. Considering the only slightly younger age of *B. okensis* s. lato and the fact that the concentric ornament of *B. unschensis* resembles most closely that of its most primitive and oldest variants (such as *B. okensis* var. *subokensis*), one could assume these two species to be directly genetically connected. The often far-reaching morphological similarity of the oldest known representatives of *B. okensis* s. lato to *B. fischeriana* s. lato (*see* below), the presence of the transitional forms between the oldest representatives of *B. okensis* s. lato and *B. fischeriana* var. *trigonoides* (Lahusen, 1888 *non* Pavlow, 1907), and the apparent absence of such between *B. okensis* s. lato and *B. unschensis* suggest, however, that they are only homoeomorphs. The circumstance that the older *B. unschensis* is a morphologically more advanced species than the younger *B. okensis* s. lato also favours this conclusion.

The "adult" representatives of *B. okensis* f. typ. and *B. okensis* var. *canadiana* (Crickmay, 1930) are easily distinguishable from *B. unschensis* because of their coarser and more widely spaced concentric ornament and generally larger size. The shell of these forms is, furthermore, wider, rounded-trapezoidal-shaped and so only similar to that of the exceptionally wide representatives of *B. unschensis* (Pl. VI, fig. 2) but not to the distinctly triangular-shaped shell of its more typical representatives. Their crest line tends, finally, to be similar to that of *B. fischeriana* s. lato rather than to that of *B. unschensis*. The juvenile and half-grown representatives of these forms of *B. okensis* s. lato are, as a rule, similarly distinguishable. *B. okensis* var. *subokensis* (Pavlow, 1907) and similar medium- to small-sized

variants from the basal part of *Buchia okensis* zone (Jeletzky, 1965, Pl. IV) may be indistinguishable from the less swollen and broad representatives of *B. unschensis* on the appearance of their concentric ornament. The left beaks of these forms show, however, mostly more or less distinct right-handed curvature and apparently never distinct left-handed curvature. Their crest line is, furthermore, shaped like that of *B. fischeriana* s. lato (*see* p. 27) and is unlike that of the typical *B. unschensis*. Their shell shape is, finally, even more different from that of *B. unschensis* than the more advanced representatives of *B. okensis* s. lato.

Among the Valanginian *Buchia* species, *B. keyserlingi* (Lahusen, 1888) (*see* Pl. VI, fig. 5) resembles *B. unschensis* most closely. The absence of the large and angular posterior ear and the essentially *B. fischeriana* s. lato-like shape of its crest line distinguish it, however, from the latter species. Other less constant morphological distinctions include the more elongate and thinner shell, mostly somewhat right-handedly incurved to straight left beak, considerably finer and somewhat more closely spaced concentric ornament, and less distinctly rounded-triangular shape of the shell. All these distinctions apply, however, only to *B. keyserlingi* f. typ. not to *B. keyserlingi* var. *sibirica* Sokolov, 1908b and other late forms of the species. These last mentioned forms may sometimes only be distinguishable from *B. unschensis* in the complete absence or very feeble development of their posterior ear. It cannot be overstressed, therefore, that *B. unschensis* and *B. keyserlingi* s. lato are closely similar and can only be distinguished with certainty in well-preserved and more or less typical specimens. Single, atypical and/or fragmentary or otherwise poorly preserved representatives of these two species may often be indistinguishable. This has probably led Pavlow (1907, p. 71, Pl. VI, figs. 13, 14) and Sokolov and Bodylevsky (1931, pp. 42-3) to refer some Berriasian and Valanginian *Buchia* ex gr. *keyserlingi* with exceptionally well developed posterior ear to *B. unschensis*.

Despite the extensive morphological similarity of *B. unschensis* and *B. keyserlingi*, the writer doubts their direct genetical relationship. As with *B. okensis* s. lato, *B. unschensis* appears to be most similar to the late but not to the early representatives of *B. keyserlingi* s. lato. The latter are, furthermore, more similar to *B. volgensis* (Pl. VI, fig. 5) and other descendants of *B. fischeriana* s. lato and probably arose directly out of the former species (Jeletzky, 1965, text-fig. 4). It seems likely that *B. unschensis* is an unrelated, uppermost Jurassic homoeomorph of *B. keyserlingi*, which arose as a short-lived side branch of the *Buchia piochii-fischeriana* plexus and adapted itself to some peculiar living conditions, perhaps to bottom conditions similar to those which the early Cretaceous *B. keyserlingi* s. lato favoured. This is suggested by the rather peculiar mode of occurrence of *B. unschensis* in Eurasia and Canada. According to Sokolov (1926, p. 34) it mostly occurs alone but in a great number of specimens, which suggests that its requirements for living conditions were unlike those of other contemporary *Buchia* species. This observation certainly applies to GSC locality 28712 where *B. unschensis* fills the rock but is only associated with an ammonite species unique for the whole region and a couple of specimens of *B.* aff. *subinflata* (Pavlow), which may well be but its morphologically extreme variant. The same seems also to be true of

GSC locality 25887 but this fossil sample is too small to be representative. None of the other early Cretaceous *Buchia* species is to be easily confused with *B. unschensis* (Pavlow, 1907) as restricted in this report.

Stratigraphic position and age. Pavlow (1907, pp. 71, 76) refers the beds containing *Buchia unschensis* at its type locality and in the adjacent areas to the earliest Cretaceous; he states (p. 76): "Dans la région de la Petchora les nombreuses *Auc. unschensis* se rencontrent avec *Craspedites pressulus*. Il paraît que la même zone est bien développée sur la rive droite de l'Ouncha, gouv. de Kostroma, vill. Koslovo, Ivanovskoïe; dans la littérature elle a été rapportée a la zone à *Olcost. nodiger*. Elle est assez riche en aucelles, parmi lesquelles nous rencontrons: *Auc. unschensis, Auc. Keyserlingi, Auc. inflata.*" The Ryasanian beds carry, however, an entirely different *Buchia* fauna consisting of *B. okensis* s. lato, *B. volgensis* s.str., etc. Pavlow (1907, p. 76) himself does not list *B. unschensis* from these beds. Considering that in Arctic Canada (GSC loc. 28712) *B. unschensis* was so far found only in association with a typical Upper Volgian *Craspedites* species, which is best referable to the late Upper Volgian and probably represents part or all of *Craspedites nodiger* zone of the Central Russian basin (*see* pp. 19-20), the writer believes Pavlow's (1907) conclusions to be erroneous. He accepts instead Nikitin's (1885, pp. 101-3) late Upper Volgian (zone of *Craspedites nodiger*) dating of the beds that contain *B. unschensis* at its type locality and elsewhere on River Unzha. As already mentioned, the early Cretaceous buchias referred by Pavlow (1907, Pl. VI, figs. 13-14) to *B. unschensis* are here excluded from this species. Concerning Pavlow's (1907, p. 76) identification of *A. keyserlingi* and *A. inflata* in association with *A. unschensis* in its type area, the writer believes these forms to belong to the extremely elongated and indistinctly sculptured forms of *B. unschensis* (Pl. VI, fig. 1) and *B.* aff. *subinflata* (Pavlow) (Pl. VI, fig. 9; Pl. VII, fig. 11) respectively. These often exceptionally large and robust homoeomorphs of the early Cretaceous buchias can, indeed, be easily confused with *B. volgensis, B. keyserlingi,* and *B. inflata.* They are, furthermore, not restricted to the *B. unschensis* beds of Arctic Canada and appear to be present in association with the Upper Volgian ammonites in northern Siberia as well, judging by the citation of *A.* aff. *crassa* and *A.* ex gr. *volgensis* from these beds (Bassov, *et al.,* 1962, pp. 38, 40).

To our knowledge at least, *Buchia unschensis* is thus restricted to the upper part of the Upper Volgian stage and does not occur either in the underlying or in the overlying rocks. Because of its rather erratic distribution, however, this probably facies-bound *Buchia* species can hardly be considered a reliable zonal index fossil despite its rather wide geographical range.

Buchia aff. *subinflata* (Pavlow, 1907)

Plate VI, figure 9; Plate VII, figure 11

Material. Two almost complete specimens from GSC locality 28712.

Description and remarks. Besides the numerous representatives of *B. unschensis* (Pavlow, 1907) emend. and its morphological variants, the fossil collection GSC locality 28712 contains two rather well preserved and almost complete, medium-sized *Buchia* shells, which differ strongly from even the sturdiest and thickest representatives of this species (Pl. V, fig. 7) and do not seem to be connected by transitional forms with these latter. Their measurements (in mm) are given below:

GSC No. and Figure	Maximum Length	Maximum Width	Thickness of Valve Left	Thickness of Valve Right	Beak's Angle (degrees)
17220 (Pl. VI, fig. 9)	34	27	13	11.8	70
17024 (Pl. VII, fig. 11)	29.4	23	11.6	6.9	65

So far as the thickness, length, width, and the general shape are concerned, these shells are difficult to distinguish from the specimen of *B. inflata* (Toula) figured by Pavlow (1907, Pl. VI, figs. 5a-5c) and from the holotype of *B. subinflata* (Pavlow, 1907, Pl. VI, figs. 3a-3c). From the latter specimen they differ, however, in the markedly left-handedly incurved left beaks (Pl. VI, figs. 9A, 9D; Pl. VII, figs. 11A, 11E), generally straight and downward directed crest line, and in the more or less irregular and partly subdued (especially in the specimen GSC No. 17024) concentric ornament. The left beak of the representative of *B. inflata* (Toula) figured by Pavlow (1907, Pl. VI, figs. 5a-5c) is exactly like those of our specimens; the same is true of its crest line. Its regular, fairly closely spaced and thin concentric ornament is, however, similar to that of *B. subinflata* and unlike that of our specimens. The taxonomic value of this distinction is uncertain, however. The posterior ear is only feebly developed in GSC No. 17220 (Pl. VI, fig. 9B) and is barely indicated in GSC No. 17024. This feature alone sets these specimens sharply apart from *B. unschensis* of the same fossil lot.

The byssus ear is apparently built exactly like that of *B. inflata* (Toula) and other Valanginian representatives of this species group (*see* Jeletzky, 1965, p. 6, Pl. I, figs. 7-8). To begin with, it is similarly large in proportion to the size of the shell and similarly heavily built. Its anterior surface is, furthermore, very strongly bent towards the left valve and forms an angle of 65 to 75 degrees with the hinge margin (Pl. VI, figs. 9B, 9C; Pl. VII, figs. 11C, 11E). It is consequently almost invisible when viewed laterally from the right valve much as with *B. inflata* (Jeletzky, 1965, Pl. I, figs. 8A, 8D). Only one representative of *B. unschensis* in the material studied possesses a similar angle of the byssus ear (Pl. V, fig. 7E); its byssus ear appears, however, to be proportionately smaller and less heavily built than that of *B.* aff. *subinflata*. The structure of the inner side of the byssus ear could not be studied in any of the two specimens available. This critical feature might provide the desired information as to whether or not they are more closely allied to the late Jurassic than to the Valanginian buchias.

Until additional material of this enigmatic form clarifies its genetic relationships with *B. unschensis* and with the much younger *Buchia* ex gr. *inflata*, it seems

best to describe it by means of open nomenclature. It is herewith attached to *B. subinflata* rather than to *B. inflata* because of its essential contemporaneity with the former. It should be noted, furthermore, that similar *Buchia* forms are probably present in the Upper Volgian rocks of northern Siberia as well, judging by the citation of *Buchia* very close to *B. crassa* by Bassov, *et al.* (1962, p. 38) from beds containing *Craspedites* ex gr. *nodiger, Taimyroceras* sp., and *Laugeites* (?) sp. in the Khatanga Depression.

Stratigraphic position and age. The same as for the *Craspedites* (*Taimyroceras*?) *canadensis* n.sp. and *Buchia unschensis.*

SEQUENCE OF THE UPPER VOLGIAN FAUNAS

The following table shows the stratigraphic and age relationships of the Upper Volgian ammonite and *Buchia* faunas described and figured in this report. For further details *see* Jeletzky (1965, text-figs. 1-2).

Stage	Standard Zone	Canadian Arctic Faunas
LOWER BERRIASIAN (RYASANIAN)	*Berriasella rjasanensis*	*Subcraspedites* aff. *hoeli* (Frebold), *Subcraspedites* aff. *suprasubditus* (Bogoslovsky), *Buchia okensis* (Pavlow). Widespread
? ? ? ? ? ?	Regional unconformity	Undescribed craspeditid ammonites and *Buchia* ex gr. *uncitoides* (to be described elsewhere). Known on Axel Heiberg Island only
UPPER VOLGIAN (= UPPER TITHONIAN AND (?) PURBECKIAN)	*Craspedites (Craspedites) nodiger*	*Craspedites (Taimyroceras?) canadensis* n. sp. and *Buchia unschensis* emend. Known near Eureka weather station only
	Craspedites (Craspedites) subditus	*Buchia fischeriana* (d'Orbigny) s. lato and poor dorsoplanitid ammonites. Widespread
	Craspedites (Craspedites) okensis and *Kachpurites fulgens*	*Buchia richardsonensis* n. sp. Widespread. Locally(?) ranges up in the overlying *Buchia fischeriana* beds
LATE LOWER VOLGIAN	*Epivirgatites nikitini*	*Buchia piochii* var. *russiensis* (Pavlow), *B. piochii* var. *mniovnikensis* (Pavlow) and *B.* aff. *fischeriana* s. lato. Widespread. In places appears to range up into *Buchia richardsonensis* beds
	Virgatites (Virgatites) virgatus	

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FOSSIL LOCALITIES

1. GSC loc. 22776: *Buchia* aff. *fischeriana* (d'Orbigny, 1845) s. lato; and *Buchia piochii* (Gabb, 1865) var. *mniovnikensis* (Pavlow, 1907). Upper Portlandian s. str., *Buchia piochii* s. lato zone (lower part).

   Canadian Arctic Archipelago, N.W.T., District of Franklin, Ellesmere Island, north coast of Slidre Fiord, 1.2 miles northwest of the Eureka weather station. Top sandstone member of Awingak Formation. Collected by J. C. Troelson, 1952.

2. GSC loc. 25751: *Buchia fischeriana* (d'Orbigny, 1845) s. lato. Early Upper Volgian, *Buchia fischeriana* s. lato zone.

   Northern Richardson Mountains, N.W.T., District of Mackenzie; collected in clay-ironstone concretions about 3 feet above base of unit 18 in Section 1, Jeletzky (1958, p. 21) 421½ to 435 feet above base, section measured along north side of Husky Creek, where it cuts through east slope of Aklavik Range, about 5 miles north of the top of Mount Goodenough; Husky Formation, Lower Member. Collected by J. A. Jeletzky, 1955.

3. GSC loc. 25887: *Buchia unschensis* (Pavlow, 1907) emend. Late Upper Volgian, *Craspedites* (*Taimyroceras*?) *canadensis* n. sp. beds?

   Canadian Arctic Archipelago, N.W.T., District of Franklin, Axel Heiberg Island; 900 feet above base of Deer Bay Formation, in creek on south side of piercement structure 20 miles east of Cape Levvel, south side of Strand Fiord. Collected by E. T. Tozer, 1955.

4. GSC loc. 25944: *Buchia richardsonensis* n. sp. Early Upper Volgian?, basal part of *Buchia fischeriana* s. lato zone or upper part of *Buchia piochii* zone.

   Canadian Arctic Archipelago, N.W.T., District of Franklin, Axel Heiberg Island, in J. G. Souther's Section 12, 2 miles northeast of Strand Fiord; Deer Bay Formation. Collected by J. G. Souther, 1955.

5. GSC loc. 26871: *Buchia* aff. *keyserlingi* (Lahusen, 1888). Upper Berriasian, top part of *Buchia volgensis* zone?

   Northern Richardson Mountains, N.W.T., east slope of Aklavik Range, south wall of Fault Creek canyon, about ⅜ of a mile up from its lower end, collected in bed 55 of Section 3 of Jeletzky (1958, p. 32), about 218½ feet above the assigned base of the Lower Sandstone Division, Buff Sandstone Member. Collected by J. A. Jeletzky, 1955.

6. GSC loc. 26954: *Buchia richardsonensis* n. sp. Early Upper Volgian?, basal part of *Buchia fischeriana* s. lato zone or upper part of *Buchia piochii* zone.

   Northern Richardson Mountains, N.W.T., District of Mackenzie; from unit 3 of Section 1, Jeletzky (1958, pp. 25-26), 26 to 36½ feet above base of section, in swelling, lenticular sandstone bed; section measured along north side of Husky Creek where it cuts through the east slope of Aklavik Range, about 5 miles north of the top of Mount Goodenough; Husky Formation, Lower Member. Collected by J. A. Jeletzky, 1955.

7. GSC loc. 26959: *Buchia* aff. *fischeriana* (d'Orbigny, 1845) and *Buchia richardsonensis* n. sp. Early Upper Volgian?, basal part of *Buchia fischeriana* s. lato zone or upper part of *Buchia piochii* zone.

Northern Richardson Mountains, N.W.T., District of Mackenzie, unit 12 of Section 1 of Jeletzky (1958, p. 24), collected 283½ to 297 feet above base of section; Husky Formation, Lower Member. Collected by J. A. Jeletzky, 1955.

8. GSC loc. 26987: *Buchia fischeriana* (d'Orbigny, 1845) s. lato and s. lato var. Early Upper Volgian, *Buchia fischeriana* s. lato zone.

   Richardson Mountains, N.W.T., District of Mackenzie, north end of Aklavik Range, from clay-ironstone concretions, 331½ to 344½ feet above base of section, unit 22 of Section 1 of Jeletzky (196-), measured along crest of southeastern promontory (middle part) of Mount Gifford, ⅛ to ⅝ of a mile southeast of its top; Husky Formation, Lower Member (restricted). Collected by J. A. Jeletzky, 1955.

9. GSC loc. 28712: *Craspedites* (*Taimyroceras*?) *canadensis* n. sp.; *Buchia unschensis* (Pavlow, 1907) emend.; and *Buchia* aff. *subinflata* (Pavlow). Late Upper Volgian, *Craspedites* (*Taimyroceras*?) *canadensis* n.sp. bed.

   Canadian Arctic Archipelago, N.W.T., District of Franklin, Ellesmere Island; Slidre Fiord, Reptile Creek, 2½ miles due north of the Eureka weather station; Deer Bay Formation, about 24 to 25 feet stratigraphically above the beds containing *Dorsoplanites*- and *Laugeites*-like ammonites (GSC loc. 53398). Collected by R. Thorsteinsson, 1956.

10. GSC loc. 28714: *Buchia fischeriana* (d'Orbigny, 1845). Early Upper Volgian, *Buchia fischeriana* s. lato zone.

    Canadian Arctic Archipelago, N.W.T., District of Franklin, Ellesmere Island; Slidre Fiord, Reptile Creek, 1-1½ miles north of Eureka weather station; Deer Bay Formation. Collected by R. Thorsteinsson, 1956.

11. GSC loc. 28753: *Buchia richardsonensis* n. sp. Early Upper Volgian, *Buchia fischeriana* s. lato zone.

    Canadian Arctic Archipelago, N.W.T., District of Franklin, Ellesmere Island; Slidre Fiord, about 1 mile north of the Eureka weather station; 10 feet stratigraphically above the bed containing *Dorsoplanites* sp. indet. figured by Frebold (1961, Pl. XX, fig. 1). Collected by R. Thorsteinsson, 1956.

12. GSC loc. 35822: *Buchia fischeriana* (d'Orbigny, 1845) s. lato; *Buchia piochii* (Gabb, 1865) s. lato; and *Lima* (*Pseudolimea*) cf. *blackei* Cox. Early Upper Volgian, *Buchia fischeriana* s. lato zone.

    Northern Richardson Mountains, N.W.T., District of Mackenzie, north end of Aklavik Range; collected from clay-ironstone concretions forming the basal part of Bed 10 of Section 41 of Jeletzky (196-), about 46¾ to 47 feet above base of section, about ¾ of a mile south of the top of Mount Gifford; north bank of First Creek south of Mount Gifford, just below point where creek changes course from north to east; shown in middle background in Jeletzky, 1961b, Fig. 13; Husky Formation, Lower Member. Collected by J. A. Jeletzky, 1958.

13. GSC loc. 37245: *Buchia fischeriana* (d'Orbigny, 1845) s. lato. Early Upper Volgian, *Buchia fischeriana* s. lato zone.

    Canadian Arctic Archipelago, N.W.T., District of Franklin, north of head of Intrepid Inlet, Prince Patrick Island; Mould Bay Formation, Middle Sandstone Member. Collected by R. Thorsteinsson, 1959.

14. GSC loc. 38743: *Buchia fischeriana* (d'Orbigny, 1845) s. lato var. Early Upper Volgian stage, *Buchia fischeriana* s. lato zone.

    Western flank of northern Richardson Mountains, Yukon Territory, at about 68°N and 137°20'W; from fresh, locally derived float between 1,075 and 1,095 feet above base of Section 5 of Jeletzky (1961a, p. 30); measured across a nameless, 5,500-foot north-trending ridge about 28 miles northwest of Summit Lake and forming the divide between the headwaters of Bell River and Johnson Creek. Collected by J. A. Jeletzky, 1959.

15. GSC loc. 47880: *Buchia richardsonensis* n. sp. Early Upper Volgian?, basal part of *Buchia fischeriana* s. lato zone or upper part of *Buchia piochii* zone.

Canadian Arctic Archipelago, N.W.T., District of Franklin, Ellesmere Island, southeast of syncline situated 2⅓ miles east of the mouth of a major unnamed river entering a prominent bay that joins Greely Fiord 4 miles east of Hare Fiord; Deer Bay Formation. Collected by R. Thorsteinsson, 1961.

16. GSC loc. 47881: *Dorsoplanites* cf. *gracilis* Spath, 1936. Early Upper Volgian (= early Upper Tithonian or Purbeckian)?, basal part of *Buchia fischeriana* zone or upper part of *Buchia piochii* zone.

    Canadian Arctic Archipelago, N.W.T., District of Franklin, Ellesmere Island, within a few yards of GSC loc. 47880, and stratigraphically slightly above it; Deer Bay Formation. Collected by R. Thorsteinsson, 1961.

17. GSC loc. 47883: *Dorsoplanites* n. sp. ex aff. *crassus* Spath, 1936? Early Upper Volgian (= early Upper Tithonian or Purbeckian)?, *Buchia fischeriana* (d'Orbigny, 1845) s. lato zone?

    Canadian Arctic Archipelago, N.W.T., District of Franklin, Ellesmere Island within a few yards of GSC localities 47880 and 47881, and about 20 feet stratigraphically above the latter. Deer Bay Formation. Collected by R. Thorsteinsson, 1961.

18. GSC loc. 53398: *Dorsoplanites* sp. indet. ex gr. *D. panderi* (Michalski, 1890); and *Laugeites*? sp. indet. Early Upper Volgian, *Buchia fischeriana* s. lato zone.

    Canadian Arctic Archipelago, N.W.T., District of Franklin, Ellesmere Island; Slidre Fiord, Reptile Creek, 2½ miles due north of the Eureka weather station; occurs in the same section as, and 24 to 25 feet stratigraphically below, GSC loc. 28712; Deer Bay Formation. Collected by R. Thorsteinsson, 1962.

PLATES I to VIII

All specimens natural size unless otherwise indicated. To facilitate comparison of their shapes, the lateral views of *Buchia* valves are oriented with hinge margins uppermost.

PLATE I

All specimens from GSC loc. 28712

Figures 1A-1D. *Buchia unschensis* (Pavlow, 1907) GSC No. 17188.
An internal cast of left valve of juvenile specimen. Some patches of shell layer preserved near the posterior ear. The large and angular posterior ear distinguishes this species from *B. keyserlingi* s. lato. The more regularly and closely spaced, finer concentric ornament differentiates it from *B. okensis*, to which it seems to be closely allied. 1A. Lateral view; 1B. anterior view; 1C. oblique posterior view; 1D. beak and hinge margin viewed from above. (Pages 35–40.)

Figures 2A-2D. *Buchia unschensis* (Pavlow, 1907) GSC No. 17189.
A *B. fischeriana*-like juvenile left valve. Internal cast with considerable remnants of inner shell layer near posterior margin. Most of posterior ear is broken off. 2A. Lateral view; 2B. oblique posterior view; 2C. anterior view; 2D. beak and hinge margin viewed from above. (Pages 35–40.)

Figures 3A-3D. *Buchia unschensis* (Pavlow, 1907) GSC No. 17190.
A left valve of the juvenile specimen transitional between those shown in figs. 2 and 4. Same views as for the specimen shown in fig. 1. An internal cast. (Pages 35–40.)

Figures 4A-4D. *Buchia unschensis* (Pavlow, 1907) GSC No. 17191.
A left valve of the juvenile specimen resembling *B. okensis* var. *elliptica* (Pavlow) in its shape. Mostly covered by imperfectly preserved inner shell layer. Same views as for the specimen shown in fig. 2. (Pages 35–40.)

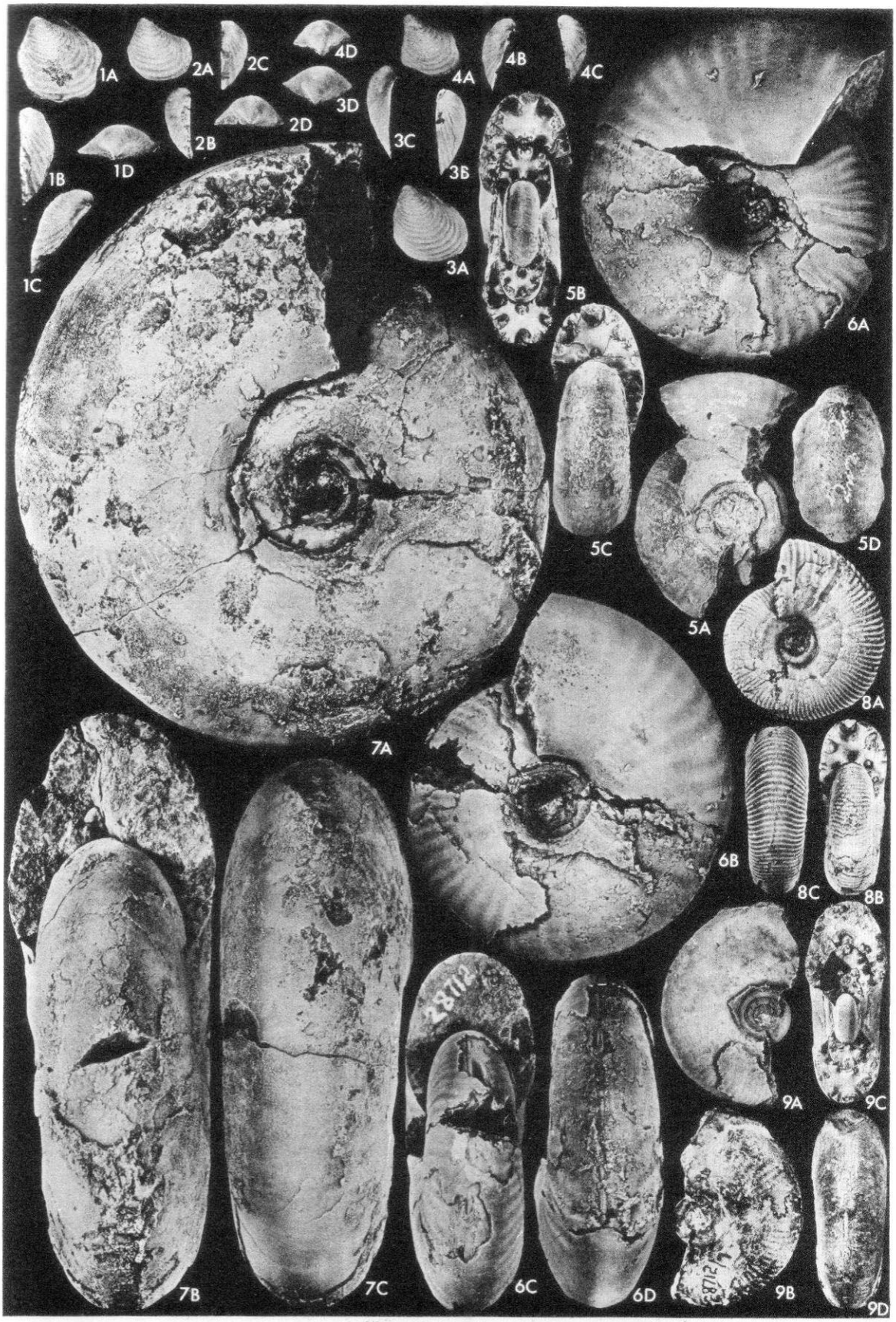
Figures 5A-5D. *Craspedites* (*Taimyroceras*?) *canadensis* n. sp. subsp. *canadensis* n. subsp. GSC No. 17192.
Fragments of two intermediate whorls of a feebly sculptured variant lacking bullae enclosing a complete earlier whorl. Outer whorl is mostly an internal cast; visible parts of two inner whorls are mostly covered by shell layer. 5A. Lateral view; 5B. cross-section of two outer whorls and the venter of the inner whorl. The ribbing of inner whorl is very fine, dense, and already indistinct; 5C. cross-section of outer whorl and semi-smooth venter of intermediate whorl; 5D. semi-smooth venter of outer whorl. (Pages 16–17.)

Figures 6A-6D. *Craspedites* (*Taimyroceras*?) *canadensis* n. sp. subsp. *canadensis* n. subsp. GSC No. 17193.
Medium-sized specimen showing the beginning (about ¼ of a whorl) of the living chamber. Covered by the shell layer in part. A moderately strong- and coarse-sculptured, nodose representative of the subspecies retaining its ribbing throughout the preserved part of the living chamber. 6A. Lateral view of the stronger sculptured side. On the earliest visible part of the whorl the bullae-like primary ribs split into 3 to 4 secondary ribs low on the flanks; 6B. lateral view of the other side; 6C. cross-section of whorl end and the venter of its earliest exposed part; 6D. ventral view of middle part of a whorl showing ventral lobes and first lateral lobes. The photograph is inverted as compared with figs. 6A-6C. (Pages 16–17.)

Figures 7A-7C. *Craspedites* (*Taimyroceras*?) *canadensis* n. sp. subsp. *canadensis* n. subsp. GSC No. 17194.
A large and virtually smooth (except for feeble, bullae-like swollen lower ends of primary ribs) representative with most of the living chamber preserved. This is the largest known representative of the subspecies. The septate part is all shell-covered whereas the last half-whorl occupied by the living chamber is an internal mould. 7A. Lateral view; 7B. cross-section of anterior end of whorl and the venter of its earlier part; 7C. ventral view of the middle part of last half-whorl. (Pages 16–17.)

Figures 8A-8C. *Craspedites* (*Taimyroceras*?) *canadensis* n. sp. subsp. *canadensis* n. subsp. GSC No. 17195.
A shell-covered inner whorl of a strongly sculptured variant. Young representative of the strongly but finely ribbed form of the typical subspecies representing the latest phase of biplicate and the earliest phase of "adult" growth stage. 8A. Lateral view showing the transition from predominant bifurcation to predominant trifurcation and quadrifurcation of primaries low on the flanks; 8B. cross-section of the whorl end and the venter of its earlier part. The secondary ribs cross the venter without becoming either interrupted or weakened and with a distinct forward swing. 8C. ventral view of the middle part of the whorl. (Pages 16–17.)

Figures 9A-9D. *Craspedites* (*Taimyroceras*?) *canadensis* n. sp. subsp. *canadensis* n. subsp. GSC No. 17196.
An internal cast of the fragmentary inner whorls of the extremely feebly sculptured representative of the subspecies lacking the lower parts of primaries on the outer half-whorl preserved. This possibly pathological specimen is unique in this respect in the material studied. 9A. Lateral view; 9B. lateral view of the other side showing the weak ribbing and well preserved suture line. The ribbing retains its tri- and quadrifurcation low on the flanks. The suture line is essentially similar to that of the specimen shown in figs. 6A-6B. It has, however, considerably wider and shorter lobes. The first lateral lobes are invariably bifid on the right flank (fig. 9A) whereas those of the left side (fig. 9B) are invariably trifid (compare text-fig. 1F). 9C. Cross-section of the three fragmentary whorls and the venter of the innermost of these whorls. The latter is preserved as a somewhat abraded internal cast, which appears to be almost smooth. Unlike the forms of the species shown in fig. 8 and in Pl. II, fig. 7, the flanks of all three whorls contract gradually towards the venter. The maximum diameter is situated at the umbilical shoulder instead of in the middle part of the flank. 9D. Ventral view of outer whorl. (Pages 16–17.)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6C
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9B
9D

PLATE II

All specimens from GSC loc. 28712

Figures 1A-1D. *Craspedites* (*Taimyroceras*?) *canadensis* subsp. *canadensis* n. subsp. GSC No. 17197.
Mostly shell-covered intermediate whorls of a form transitional between the strongly sculptured representatives of subsp. *canadensis* n. subsp. and the equally strongly sculptured representatives of subsp. *pseudosubditus* n. subsp. (*see* Pl. II, figs. 3, 4). 1A. Lateral view. Primary ribs are invariably very short and branch in the lowest third of the flank; 1B. ventral view. Secondary ribs cross the venter without any noticeable forward swing; they are neither weakened nor interrupted on this intermediate whorl; 1C. cross-section of three whorls with the venter of the earlier part of the innermost whorl. The innermost whorl representing the early biplicate stage is strongly sculptured, unlike the early whorls of the variants shown in Pl. I, figs. 5 and 9; 1D. the lateral part of the suture line. (Pages 16–17.)

Figures 2A-2C. *Craspedites* (*Taimyroceras*?) *canadensis* subsp. *pseudosubditus* n. subsp. GSC No. 17198.
The intermediate whorl (an internal cast) of the feebly sculptured form of this extreme, *Craspedites subditus*-like variant. Suture line (compare text-fig. 1E) shows three auxiliary lobes (not counting the intervening short and small lobules). Its inner part is still descendant (suspensive); this feature is, however, not as well defined here as it is in the other variants. 2A. Lateral view; 2B. venter of end part of whorl; 2C. cross-section of end of whorl and venter of its earlier part. (Pages 16–17.)

Figures 3A-3B. *Craspedites* (*Taimyroceras*?) *canadensis* n. sp. subsp. *pseudosubditus* n. subsp. GSC No. 17199.
An "adult" representative of the strongly sculptured form of this subspecies with a considerable part of the living chamber preserved. Mostly covered by the shell layer. Primary ribs are more closely spaced and somewhat shorter than in other representatives of the subspecies. This specimen is thus transitional to subsp. *canadensis* n. subsp. 3A. Lateral view; 3B. cross-section of anterior end of whorl (living chamber) and venter of its earlier part. Secondary ribs are already weakened on the venter. (Pages 15–16.)

Figures 4A-4C. *Craspedites* (*Taimyroceras*?) *canadensis* subsp. *pseudosubditus* n. subsp. GSC No. 17200.
A fragmentary "adult" representative of the subspecies mostly preserved as an internal mould. Anterior half of outer whorl is occupied by living chamber. This specimen is transitional between those shown in figs. 3 and 5 in its ribbing habit and strength of the sculpture. Primaries are longer and heavier than those of the specimen shown in fig. 3A. This specimen is fairly typical of the subspecies so far as its ribbing habit is concerned. 4A. Lateral view; 4B. cross-sections of living chamber and three inner whorls. The venter of the earlier part of the innermost of these whorls representing the early biplicate growth stage is also visible, it is feebly and finely ribbed; 4C. ventral view of living chamber. Secondary ribs are markedly weakened in the middle of the venter. This specimen has a somewhat flattened venter and is therefore somewhat transitional to subsp. *pseudotaimyrense* in this respect (*see* Pl. III, fig. 6). The bullae-like, swollen appearance of the lower parts of primaries is clearly visible on the left side of the photograph. (Pages 15–16.)

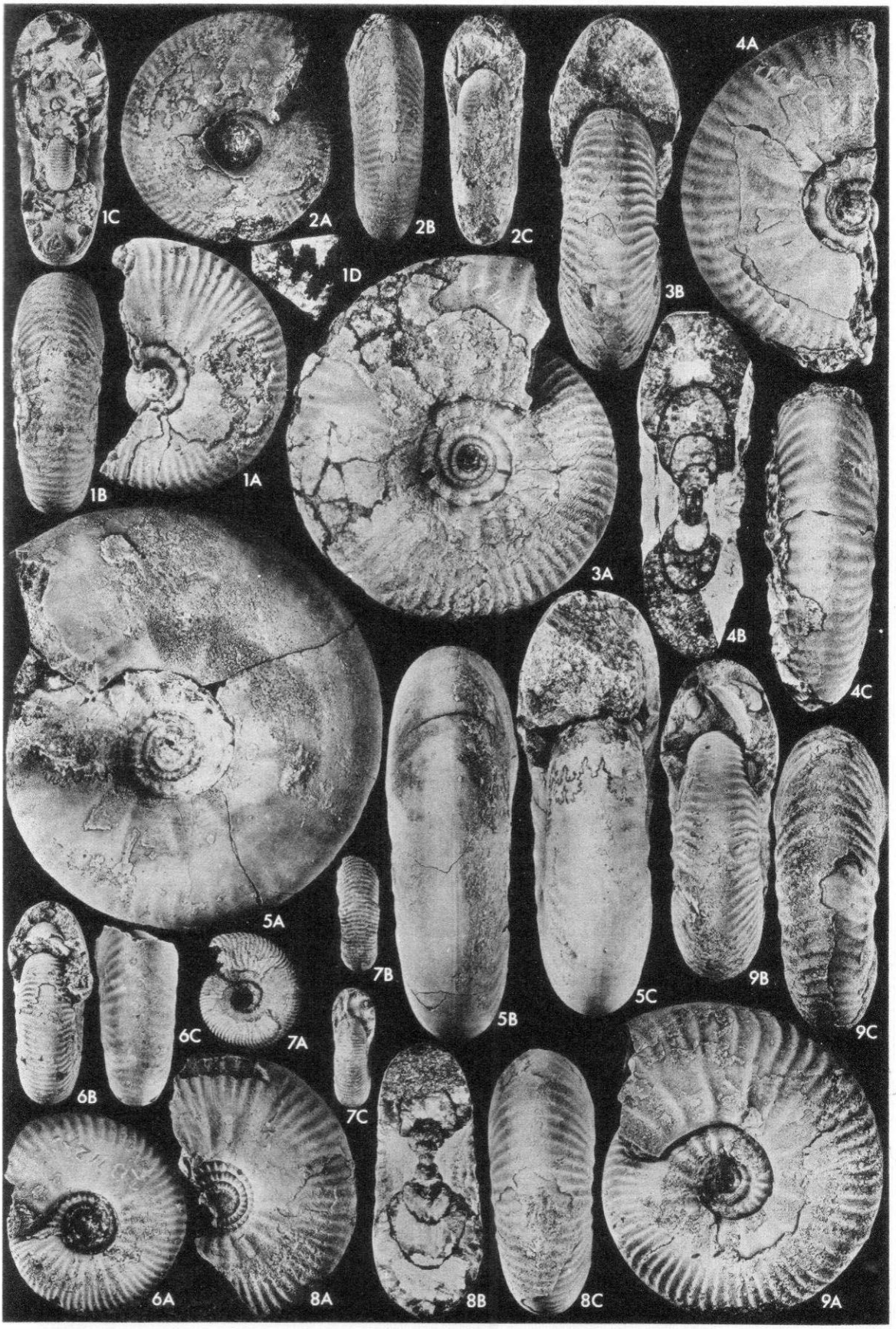
Figures 5A-5C. *Craspedites* (*Taimyroceras*?) *canadensis* subsp. *pseudosubditus* n. subsp. Holotype of the subspecies. GSC No. 17201.
A large "adult" representative of the typical form of this extreme subspecies with an almost completely preserved living chamber. A constriction is clearly visible near the mouth border. Preserved as an internal mould, except for the innermost visible septate part of the whorl (fig. 5A). This growth stage of typical form is characterized by relatively feeble sculpture except for the strong, widely spaced and long primary ribs. The suture line is somewhat ascendant throughout; it retains, however, such features of *Craspedites* s. str. as the simple character, broad and short, widely spaced lobes and the presence of only three auxiliary lobes. The very short secondary ribs are restricted to the upper third of the flanks; they are feebly developed already on the inner part of the whorl and gradually become weaker and weaker on the living chamber until they finally disappear completely near its anterior end. The swollen, bullae-like lower parts of the primaries persist throughout the living chamber. 5A. Lateral view. The last suture line is inked in; 5B. ventral view of the middle part of the living chamber; 5C. cross-section of the end of the living chamber and the venter of the earliest visible part of the whorl. Unlike its earlier part (fig. 5B), the venter of the end of the living chamber is relatively broad and markedly flattened in the middle and so resembles that of the subspecies *pseudotaimyrense* n. subsp. (Pages 15–16.)

Figures 6A-6C. *Craspedites* (*Taimyroceras*?) *canadensis* subsp. *canadensis* n. subsp. GSC No. 17202.
An early whorl representing the end phase of the biplicate growth stage of the subspecies. The relatively narrowly rounded venter, markedly sloping flanks of the whorl, relatively short primary ribs and their alternate bifurcation and trifurcation agree well with this assignment. An internal cast. 6A. Lateral view; 6B. cross-section of anterior end of whorl and venter of its earlier part; 6C. venter of anterior part of whorl. The marked weakening of secondary ribs on the venter may be due to abrasion, in part at least. (Pages 16–17.)

Figures 7A-7C. *Craspedites* (*Taimyroceras*?) *canadensis* n. sp. subsp. *pseudotaimyrense* n. subsp. GSC No. 17203.
An early whorl of the strongly sculptured form of the subspecies representing the middle phase of the biplicate growth stage. An internal cast with patches of poorly preserved shell layer. 7A. Lateral view; 7B. ventral view of the middle part of the whorl; 7C. imperfectly preserved cross-section of anterior end of whorl and venter of its earlier part. The rounded-rectangular (higher than wide) cross-section is diagnostic of the subspecies. (Page 16.)

Figures 8A-8C. *Craspedites* (*Taimyroceras*?) *canadensis* n. sp. subsp. *canadensis* n. subsp. GSC No. 17204.
An extremely heavily built representative of the strongly sculptured form of the subspecies. All of the outer half-whorl seems to be occupied by the living chamber. The cross-sections of all whorls are low, wide, narrow-ventered, the flanks slope markedly all the way down towards the umbilical shoulder. Primary ribs are relatively long but closely spaced. Part of one of the earliest whorls representing the smooth growth stage is visible; this appears to be completely smooth. The next youngest whorl is already fairly strongly sculptured (fig. 8B). Mostly covered by the shell layer. 8A. Lateral view; 8B. cross-section of four whorls and parts of venters of two of the earliest whorls; 8C. venter of outer whorl. Ribs begin to weaken in the middle of the venter near the anterior end. (Pages 16–17.)

Figures 9A-9C. *Craspedites* (*Taimyroceras*?) *canadensis* n. sp. GSC. No. 17205.
A medium-sized representative of a form transitional between the strongly sculptured form of subsp. *pseudosubditus* n. subsp. (figs. 2-4) and that of *pseudotaimyrense* n. subsp. (Pl. III, fig. 6). An almost complete specimen with much of the living chamber preserved. Ribbing habit is similar to that of specimen shown in Pl. III, fig. 6 except for the somewhat bullate appearance of primaries, whereas the cross-section is more like that of the specimen shown in fig. 3B. Mostly covered by the shell layer. Bifurcating ribs and intercalated single ribs are more common than in any other form of the species except for that shown in Pl. III, fig. 6. 9A. Lateral view; 9B. cross-section of anterior end of whorl (living chamber) and venter of its earliest visible part. Ribs first weaken and then become interrupted in the middle of the venter; 9C. ventral view of middle part of whorl. The ribs are weakened or interrupted only closer to the anterior end of the whorl but not in its posterior half. (Pages 6–20.)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All specimens from GSC loc. 28712

Figures 1A-1E. *Craspedites* (*Taimyroceras*?) *canadensis* n.sp. subsp. *canadensis* n. subsp. GSC No. 17206.

A septate, well-preserved, intermediate whorl of the strongly sculptured form of the subspecies, essentially similar to that shown in Pl. II, fig. 1. Represents the early phase of the "adult" growth stage. Partly covered by shell layer. Whorl section is more slender than in most other representatives of the subspecies, and ribs are unusually markedly sinuous. Umbilicus is, however, deeper and narrower than in any other form of the subspecies. 1A. Lateral view; 1B. cross-section of anterior end of whorl and venter of its earlier part; 1C. ventral view of anterior part of whorl. The ribs in the middle of the venter are only weakened or interrupted near the anterior end but not on the earlier part of the whorl; 1D. lateral part of the suture line; 1E. ventral part of the external suture line. (Pages 16–17.)

Figures 2A-2C. *Craspedites* (*Taimyroceras*?) *canadensis* n.sp. subsp. *pseudotaimyrense* n. subsp. GSC No. 17207.

An early whorl representing the early phase of the biplicate growth stage. Assigned to the strongly sculptured form of this extreme subspecies because of its slender, subparallel-flanked whorl shape. 2A. Lateral view; 2B. cross-section of the anterior end of the whorl and the venter of its earlier part; 2C. ventral view of the middle part of the whorl. (Page 16.)

Figures 3A-3E. *Craspedites* (*Taimyroceras*?) *canadensis* n. sp. subsp. *eurekae* n. subsp. Holotype of the subspecies. GSC No. 17208.

A complete penultimate whorl of the coarsely ribbed, nodose form of the subspecies combining the short, bullate primaries similar to those of subsp. *canadensis* n. subsp. with the rounded-rectangular (higher than wide) whorl section of subsp. *pseudotaimyrense* n. subsp. The subsp. *eurekae* n. subsp. is very similar to the medium-sized specimen of *Craspedites* (*Craspedites*) *nodiger* figured by Nikitin (1885, Pl. V, fig. 21) in lateral aspect; it differs, however, from the adult form of that species (op. cit., Pl. V, fig. 19) in its longer, bullate but not nodose primary ribs, and in higher rounded-rectangular, subparallel flanked, and higher than wide whorl section. 3A. Lateral view. The lower parts of the flanks of the living chamber are attached to the essentially complete fully septate penultimate whorl; 3B. lateral view of the opposite side; 3C. ventral view of the anterior end of penultimate whorl showing ventral part of external suture line; 3D. almost the same view as last but inverted to show the gradually increasing weakening of the secondary ribs in the middle of the venter towards the living chamber; 3E. cross-section of the anterior end of penultimate whorl and the venter of its earlier part. Partly covered by the remnants of the lower flanks of strongly bullate living chamber. (Pages 18–19.)

Figures 4A-4C. *Craspedites* (*Taimyroceras*?) *canadensis* n. sp. subsp. *pseudotaimyrense* n. subsp. GSC No. 17209.

A complete but somewhat deformed representative of the extremely feebly sculptured form of this extreme subspecies. All "adult" living chamber is preserved. Mostly covered by the shell layer. This extreme form combines the subparallel whorl flanks, the flat-topped venter and the complete absence of bullae-like, swollen primary ribs with the generally obsolete appearance of the ornament. The latter feature distinguishes it from the holotype of the subspecies, which is characterized by strong ornamentation persisting right to the end of the living chamber (fig. 6). 4A. Lateral view; 4B. cross-section of mouth of living chamber and venter of the earlier part of ultimate whorl; 4C. ventral view of middle part of living chamber, showing the interruption of ribs in the middle of the venter. (Page 16.)

Figures 5A-5B. *Craspedites* (*Taimyroceras*?) *canadensis* n. sp. GSC No. 17210.

A medium-sized but almost complete "adult" (part of the "adult" living chamber is preserved) specimen transitional between the subsp. *eurekae* n. subsp. (*see* fig. 3) and subsp. *pseudotaimyrense* n. subsp. (*see* fig. 6). The ornament does not decline markedly on the preserved part of the living chamber and the secondary ribs are strongly weakened or interrupted there. Bullae-like primaries and the secondary ribs are developed much as in the subspecies *eurekae* in fig. 3. The specimen is at the same time transitional to subsp. *pseudosubditus* n. subsp. shown in Pl. II, fig. 3 in the increased length of its bullate primaries and in the high but narrowly ventered and egg-shaped whorl section. 5A. Lateral view. Suture line differs from that of other representatives of the species in its much narrower lobes; otherwise it is similar to that of the specimen shown in Pl. I, fig. 6. The retractive (or suspensive) character of its auxiliary part is just as strongly developed as in this specimen and the auxiliary lobes are but feebly individualized and very small; 5B. cross-section of the living chamber and the venter of its early part. The smooth band in the middle of the venter between the ends of secondary ribs is already clearly visible. (Pages 6–20.)

Figures 6A-6C. *Craspedites* (*Taimyroceras*?) *canadensis* n. sp. subsp. *pseudotaimyrense* n. subsp. Holotype of the subspecies. GSC No. 17211.

A medium-sized, strongly sculptured representative of this extreme subspecies. The whole of the "adult" living chamber is preserved. 6A. Lateral view. The living chamber is contracted near the mouth resulting in marked externumbilication of the end part of the chamber; 6B. cross-section of anterior end of living chamber, and the venter of the early part of ultimate whorl. Secondary ribs are neither interrupted nor markedly weakened at this part of the whorl; 6C. ventral view of anterior part of living chamber showing first the weakening and then a more or less complete interruption of ribs in the middle of the venter. (Page 16.)

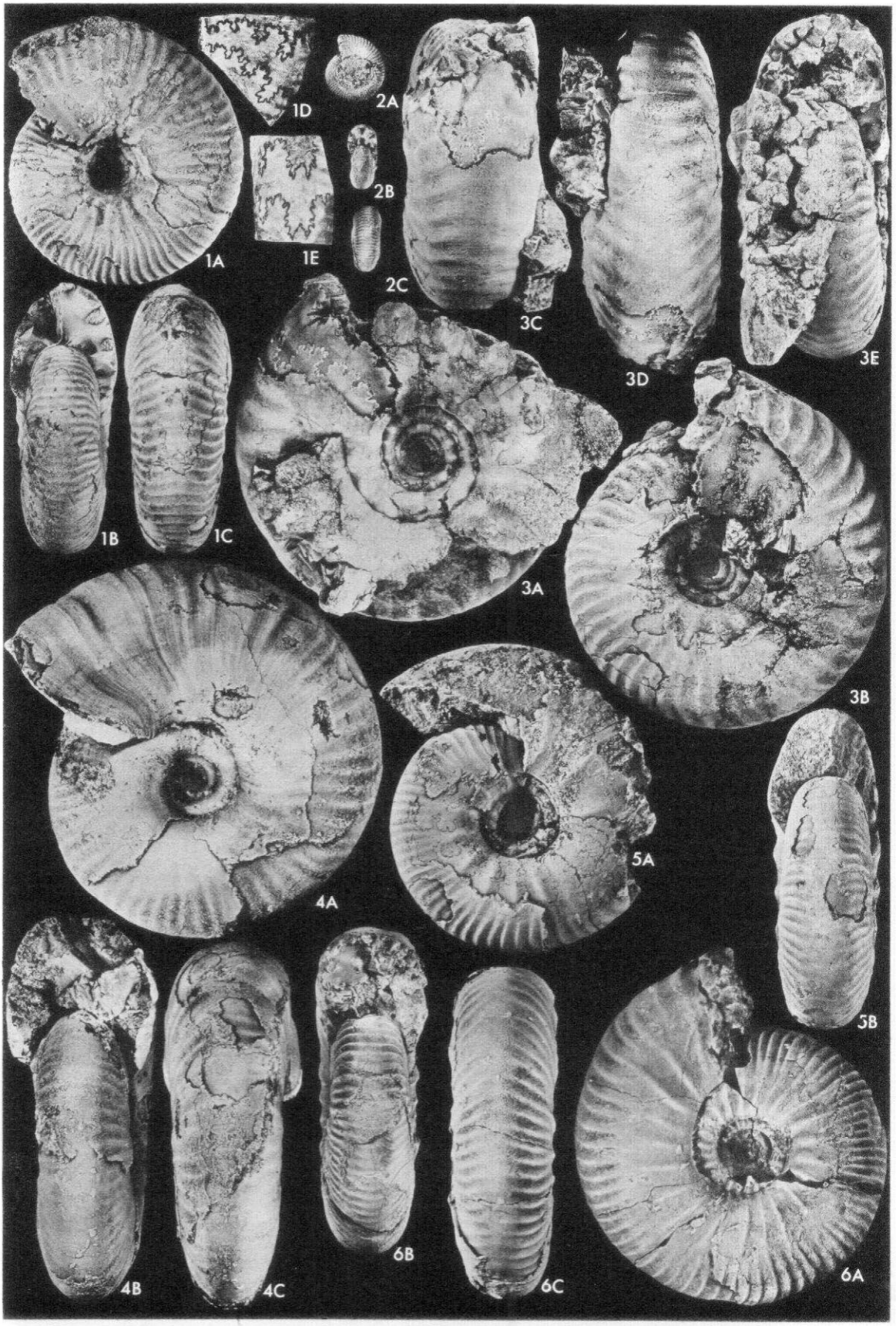
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Plate IV

Figures 1A-1C. *Craspedites* (*Taimyroceras*?) *canadensis* n. sp. subsp. *pseudosubditus* n. subsp. GSC loc. 28712. GSC No. 18033.

An internal cast with some patches of poorly preserved shell layer. In this largest known representative of the species and subspecies the almost complete living chamber occupies all of the whorl. The long, bullate primaries are the only ornament. 1A. Lateral view. Visible parts of inner whorls are just as strongly bullate as the ultimate whorl; 1B. cross-section of anterior end of whorl and ventral view of its early part; 1C. ventral view of middle third of whorl. (Pages 15–16.)

Figures 2A-2F. *Craspedites* (*Taimyroceras*?) *canadensis* n. sp. subsp. *canadensis* n. subsp. Holotype of the species and subspecies. GSC loc. 28712. GSC No. 18034.

A fragmentary but otherwise well-preserved intermediate (wholly septate) whorl of the feebly sculptured form of the typical subspecies showing parts of the early whorls. Largely shell-covered. As in many other weakly sculptured representatives of the species, the ribs are covered by a number of crenulated striae. Although weak, the primaries can be followed across the umbilical shoulder in the early as well as in the intermediate growth stages. 2A. Lateral view taken in oblique light in order to stress the sculpture; 2B. lateral view of the other side taken in ordinary light. Parts of inner whorl with well-preserved suture line are visible. Three "adult" suture lines are visible near the anterior end of the whorl; 2C. cross-section of the anterior end and the venter of the early part of the whorl; 2D. ventral view of the early part of the whorl photographed in oblique light to emphasize the sculptural detail; 2E. lateral view of the same side as in fig. 2B but with part of the whorl removed disclosing an early whorl of the early biplicate growth stage with its typical sculpture; 2F. cross-section of early part of whorl, those of two previous whorls, and the venter of the same early whorl as that shown in lateral aspect in Fig. 2E. Although weak, as is usual in the feebly sculptured forms of the typical subspecies, the ribs cross the anterior part of the venter without any weakening. The venter of the early part of this whorl is still smooth, and the single primary ribs stop just below ventral shoulders. (Pages 16–17.)

Figures 3A-3C. *Buchia fischeriana* (d'Orbigny, 1845) s. lato. GSC loc. 37245. GSC No. 18016.

A medium-sized, almost complete left valve of the extremely flat variant of the species. The radial ornament is exceptionally strong and *Buchia concentrica*-like. Such variants of *B. fischeriana* s. lato may be easily confused with *B. concentrica* if their hinge structure and the beak part are unknown. 3A. Lateral view of the exterior; 3B. anterior view of same; 3C. beak part and hinge margin viewed from above. (Pages 25–30.)

Figures 4A-4C. *Craspedites* (*Taimyroceras*?) *canadensis* subsp. *canadensis* n. subsp. GSC loc. 28712. GSC No. 18035.

A mostly shell-covered, somewhat laterally deformed, intermediate whorl of the strongly and coarsely sculptured form of the subspecies representing the early phase of its "adult" (triplicate to quadruplicate) growth stage. Primaries are already markedly bullate in anterior part of whorl. 4A. Lateral view; 4B. cross-section of anterior end and venter of early part of whorl. Because of the deformation, the whorl appears to be higher and more slender than it actually is; 4C. ventral view of anterior part of whorl. Ribs cross the venter without any noticeable weakening. (Pages 16–17.)


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PLATE V

All specimens from GSC loc. 28712

Figures 1A-1C. *Craspedites* (*Taimyroceras*?) *canadensis* n. sp. subsp. *canadensis* n. subsp. GSC No. 17178.
Large and almost complete, "adult" specimen of the moderately strongly sculptured, distinctly bullate form of the typical subspecies transitional to subsp. *pseudosubditus* n. subsp. Ultimate whorl with most or all of the "adult" living chamber preserved. Mostly shell-covered (except for the living chamber in fig. 1B). Unlike the feebly sculptured forms of the subspecies shown in Pl. I, figs. 5-7, this specimen retains its ribbing almost to the end of the "adult" living chamber; it agrees well with the specimen shown in Pl. I, fig. 6. 1A. Lateral view of the more complete side of the whorl probably extending almost to the mouth of the living chamber. Completely covered by the shell layer; 1B. lateral view of the other side, which shows the very end of penultimate whorl in addition to the "adult" living chamber. The sculpture is more distinct on this side, mostly preserved as an internal cast. Juvenile representatives of *Buchia unschensis* are visible inside of the anterior part of the living chamber; 1C. ventral view of middle part of whorl clearly showing the narrowly rounded venter and the discus-like shape of the whorl transitional to subsp. *pseudosubditus* n. subsp. (Pages 16–17.)

Figures 2A-2E. *Craspedites* (*Taimyroceras*?) *canadensis* n. sp. subsp. *canadensis* n. subsp. GSC No. 17179.
A wholly septate, intermediate whorl of a feebly sculptured specimen. The primaries and secondaries are only faintly visible, and the former lack the bullate swellings such as occur in specimen shown in fig. 1A, 1B. The narrow, funnel-like umbilicus, strongly involute and sturdy whorls are typical of the subspecies. Probably represents the intermediate whorls of the "adult" form shown in Pl. I, fig. 7. 2A. Lateral view. This side is mostly preserved as an internal cast showing well-preserved suture lines; 2B. lateral view of the other side mostly covered with well-preserved shell layer but showing two well-preserved suture lines in the middle (*see* fig. 2D); 2C. cross-section of the anterior end and the venter of the early part of the whorl. Interruption of ribs in the middle of the venter is visible where the shell layer is preserved; 2D. lateral parts of the external suture lines (the same as on the lower side of fig. 2B) outlined in black. The third auxiliary lobe is not visible; 2E. ventral parts of the same suture lines (also seen in fig. 2C). (Pages 16–17.)

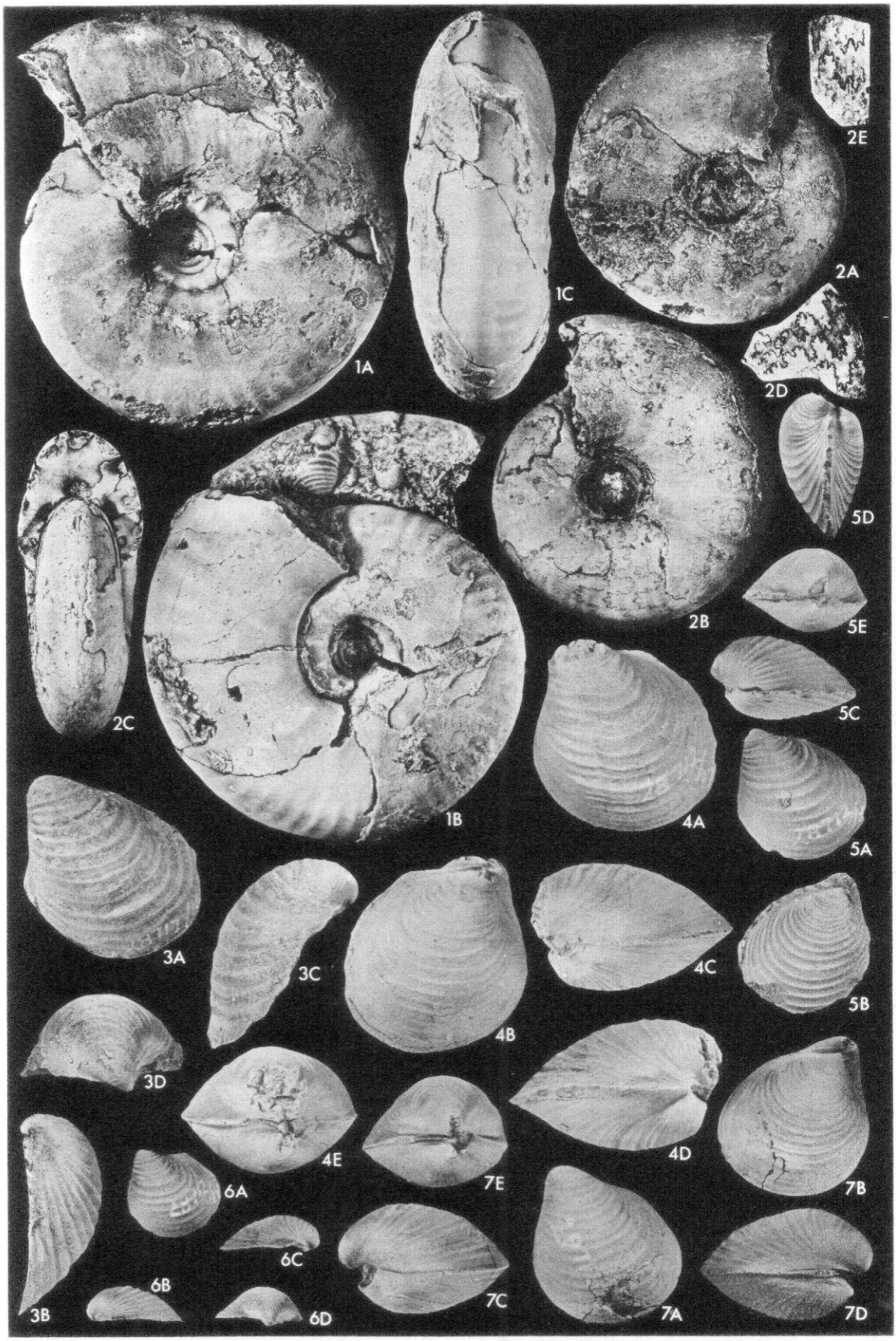
Figures 3A-3D. *Buchia unschensis* (Pavlow, 1907) var. GSC No. 18022.
Internal cast of a medium-sized left valve with small patches of poorly preserved shell layer. The posterior ear is broken off and the posterior margin is incomplete. This extreme variant is characterized by the pronouncedly left-handed incurvature of beak similar to the Valanginian forms and by the coarse, fairly strongly developed radial ornament similar to that of *Buchia* (*Anaucella*) *concentrica*. 3A. Lateral view of the exterior; 3B. antererior view; 3C. posterior view; 3D. hinge margin and beak part seen from above. Note the exceedingly strong left-handed (right-handed in this aspect) curvature of the beak. (Pages 35–40.)

Figures 4A-4E. *Buchia unschensis* (Pavlow, 1907). GSC No. 18027.
Internal cast of a medium-sized, almost complete, typical representative of the species. The furrow on the anterior half of the left valve (fig. 4A) is a pathological feature. The posterior ear is completely preserved but most of the left beak is broken off. 4A. Lateral view of the exterior of left valve; 4B. same view of the right valve; 4C. anterior view of both valves; 4D. posterior view; 4E. beak parts of both valves and hinge margin viewed from above. The tip of the right beak and all of the beak part of the left valve are broken off. (Pages 35–40.)

Figures 5A-5E. *Buchia unschensis* (Pavlow, 1907). GSC No. 18025.
A partly shell-covered, half-grown, almost complete shell of the typical representative of the species. The left posterior ear and part of the right posterior ear are broken off. A small, pathological indentation occurs at the beak of the left valve (fig. 5A). 5A. Lateral view of the exterior of the left valve; 5B. same view of the right valve; 5C. anterior view of both valves; 5D. posterior view of the same; 5E. beak parts of both valves and the hinge margin viewed from above. Most of the left beak is broken off. (Pages 35–40.)

Figures 6A-6D. *Buchia unschensis* (Pavlow, 1907). GSC No. 18023.
Internal cast of a complete, juvenile left valve similar to *B. okensis* var. *subokensis* and *B. fischeriana* in the anteriorly convex shape of its crest line but otherwise typical of the species. 6A. lateral view of the exterior; 6B. anterior view; 6C. posterior view; 6D. beak part and the hinge line viewed from above. (Pages 35–40.)

Figures 7A-7E. *Buchia unschensis* (Pavlow, 1907) var. GSC No. 18026.
Internal cast of a complete, medium-sized shell transitional to *B.* aff. *subinflata* (Pavlow, 1907) in its reduced posterior ear and concentric ornament as well as in the increased thickness of the shell and the more steeply arched cross-section of the left valve (fig. 7E). 7A. lateral view of the exterior of the left valve; 7B. same view of the right valve; 7C. anterior view of both valves; 7D. posterior view of the same; 7E. beak parts of both valves and the hinge line viewed from above. The anterior surface of the byssus ear forms an angle of 65 to 70 degrees with the hinge as compared with that of 40 to 50 degrees characteristic of typical representatives of *B. unschensis*. (Pages 35–40.)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All specimens from GSC loc. 28712 unless otherwise stated

Figures 1A-1C. *Buchia* aff. *unschensis* (Pavlow, 1907) GSC No. 17212.
An internal cast of a large left valve of a form transitional between *B. richardsonensis* n. sp. (*see* Pl. VII, figs. 1, 4, 5, 8, 9) and *B. unschensis*. The general outline of the shell, its longer beak and the feeble development of a regular, moderately widely spaced concentric folding on the cast's surface ally it with the former species. The extremely large, angular posterior ear allies it, however, with the extreme forms of *B. unschensis* shown in figs. 7-8. 1A. Lateral view of the exterior; 1B. anterior view; 1C. beak and hinge margin viewed from above. Beak shows markedly left-handed incurvature, which is, generally speaking, diagnostic of early Lower Cretaceous *Buchia* species. (Pages 35–40.)

Figures 2A-2D. *Buchia unschensis* (Pavlow, 1907) var. GSC No. 17213.
An internal cast of an almost complete shell of a large, broad representative of the species. In its shape, thickness of the valves and ornamentation this specimen is exceedingly close to *B. okensis* var. *subokensis* Pavlow. It is largely the greater thickness of the shell of *Buchia unschensis*, markedly left-handed incurvature of its left beak, and the complete absence of more typical forms of *B. okensis* in its populations as contrasted with their abundance in *Buchia okensis* zone that permits the safe differentiation of such forms of these two closely similar species. 2A. Lateral view of the exterior of the left valve. Part of the posterior margin is broken off. The valve is much wider than high and its beak is somewhat right-handedly incurved. The posterior ear is very large, part of it is broken off; 2B. lateral view of the exterior of the right valve and the projecting part of the beak of the left valve; 2C. anterior view of both valves. The considerable thickness and size of both valves combined with the regular, moderately widely spaced concentric ornament, which is equally well visible on the internal cast and the shell's surface, are diagnostic of the species; 2D. beaks and hinge margins of both valves viewed from above. The beak of the left valve is somewhat left-handedly incurved. The anterior surface of the byssus ear (right valve) is bent towards the left valve at about 50 degrees and is, thus, of the same evolutionary grade as the anterior surfaces of the byssus ear of Upper Tithonian (*B. plochil*) and Berriasian (*B. okensis, B. volgensis*) *Buchia* species (Jeletzky, 1965, pp. 5-6). (Pages 35–40.)

Figures 3A-3D. *Buchia unschensis* (Pavlow, 1907). GSC No. 17214.
An internal cast of an almost complete, juvenile representative of the species, which differs from its "adult" representatives only in smaller size and thinner shell. The latter circumstance makes it virtually indistinguishable from the juvenile representatives of *B. okensis* var. *subokensis* (Pavlow). 3A. Lateral view of the exterior of the left valve. The posterior part of the lower margin is incomplete; 3B. lateral view of the exterior of the right valve and the protruding part of the beak of the left valve; 3C. anterior view of both valves; 3D. beaks and hinge margins of both valves viewed from above. The left beak is essentially straight. (Pages 35–40.)

Figures 4A-4C. *Buchia unschensis* (Pavlow, 1907), f. typ. GSC No. 17215.
An internal cast of an almost complete, medium-sized typical representative of the species. Considerable patch of the shell layer is preserved around the left beak. This specimen matches closely that figured by Pavlow (1907, Pl. VI, fig. 12). Most of the posterior ear is broken off. 4A. Lateral view of the exterior of the left valve; 4B. anterior view of the exterior of both valves. The beak part of the right valve is almost completely broken off; 4C. beaks and hinge margins of both valves viewed from above. The beak of the left valve is very feebly left-handedly incurved. (Pages 35–40.)

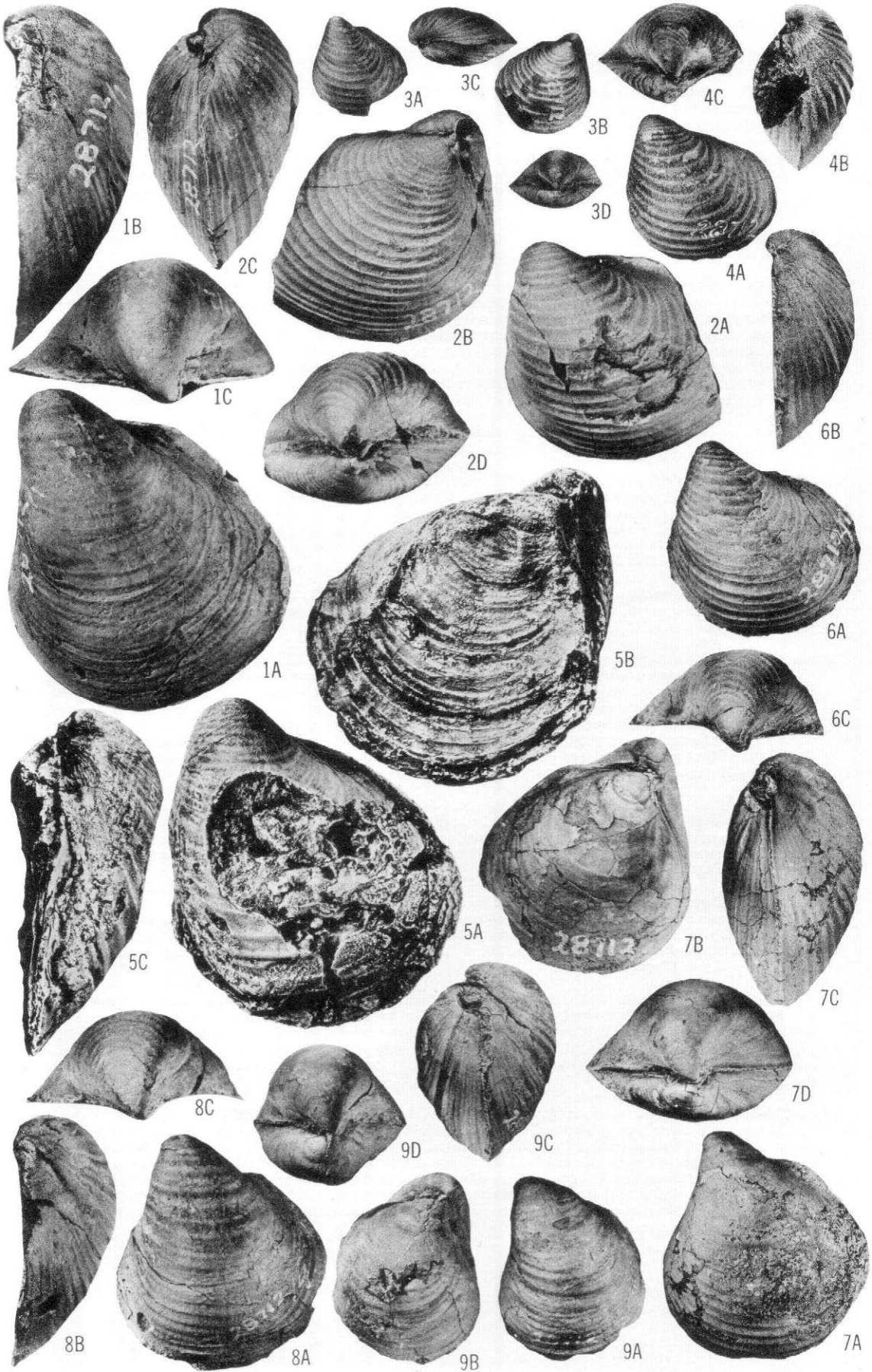
Figures 5A-5C. *Buchia* aff. *keyserlingi* (Lahusen, 1888). GSC loc. 26871. GSC No. 17216.
An almost complete, but partly laterally distorted (especially the right valve) form apparently transitional between *Buchia volgensis* s. str. and *B. keyserlingi* s. lato. Left valve is an internal cast; right valve is partly shell covered. Compare with the specimens of *B. unschensis* shown in figs. 1, 2, 7 and 8. Only the almost complete absence of the posterior ear in this representative of *B.* aff. *keyserlingi* differentiates it from *B. unschensis* and *B.* aff. *unschensis*, which possess a large, angular posterior ear. 5A. Lateral view of exterior of left valve. The width of the valve almost equals its length and the beak is shorter than in typical *B. volgensis*. This circumstance and the fact that the evenly spaced concentric ornament is equally well developed on the surface of the shell and on that of its internal cast account for considerable similarity of this specimen to *B. keyserlingi* from *T.* (*T.*) *tolli* zone; 5B. lateral view of exterior of right valve and the protruding part of the beak of left valve. The right valve is almost completely flattened; 5C. anterior view of the exterior of both valves. So far as it is possible to judge, the beak of the left valve is transitional between that of *B. volgensis* s. str. and *B. keyserlingi* s. lato in its length, overhanging of the right valve and hook-like bend.

Figures 6A-6C. *Buchia unschensis* (Pavlow, 1907) var. GSC No. 17217.
A medium-sized left valve of the flatter variant especially closely approaching *B. okensis* var. *subokensis* (Pavlow). An internal cast with considerable patches of poorly preserved, inner shell layer. Most of the posterior ear is broken off. 6A. Lateral view of exterior; 6B. anterior view of same; 6C. beak and the hinge margin viewed from above. Beak is slightly left-handedly incurved. (Pages 35–40.)

Figures 7A-7D. *Buchia unschensis* (Pavlow, 1907) var. GSC No. 17218.
Internal cast of a medium-sized representative of a flattish variant with partly obsolete concentric ornament. The large and angular posterior ear combined with the general shape indicate, however, its placement in *B. unschensis* s. lato. 7A. Lateral view of the exterior of the left valve; 7B. lateral view of the exterior of the right valve and the protruding beak part of the left valve. Concentric ornament is strongly subdued to barely perceptible on the surface of both the internal cast and the shell layer; 7C. anterior view of the exterior of both valves. Unlike some representatives of the species (fig. 4B), the right valve is considerably thinner than the left valve. The well-preserved byssus ear has the general evolutionary grade of *B. okensis* or *B. volgensis* (*see* Jeletzky, 1965, pp. 5-6). 7D. beaks and hinge margins of both valves viewed from above. (Pages 35–40.)

Figures 8A-8C. *Buchia unschensis* (Pavlow, 1907), var. GSC No. 17219.
An internal cast of the left valve of medium-sized specimen transitional between that shown in fig. 7 and *B.* aff. *unschensis* shown in fig. 1. An internal cast with considerable patches of poorly preserved shell layer. The regular, moderately widely spaced concentric ornament of typical representatives of *B. unschensis* (*see* figs. 3-4, 6) is largely replaced by the irregularly and closely spaced concentric ornament of *B.* aff. *unschensis* and *B. richardsonensis* n.sp. This is, furthermore, supplemented by clearly distinguishable radial ornament of the type characteristic of *B. concentrica* (?= *B. bronni*), which is equally clearly developed in *B.* aff. *unschensis* (fig. 1A). 8A. Lateral view of the exterior; 8B. anterior view of the same; 8C. beak and hinge margin viewed from above. (Pages 35–40.)

Figures 9A-9D. *Buchia* aff. *subinflata* (Pavlow, 1907). GSC No. 17220.
An almost complete specimen of a strongly swollen *Buchia* form closely similar to *B. subinflata* (Pavlow). Except for the unusual thickness of both valves and their resulting *B. crassicollis*-like appearance in lateral aspect (*see* fig. 9C) this form is closely similar to the extreme variant of *B. unschensis* shown in fig. 8 and to *B.* aff. *unschensis* shown in fig. 1. It seems probable that this form is but an extreme variant of *B. unschensis* possibly transitional to *B. subinflata* (Pavlow). 9A. Lateral view of the left valve. The beak is somewhat left-handedly incurved. Parts of the posterior and lower margins of the valve are broken off. Were they preserved, the valve would look even more like *B. unschensis* var. shown in fig. 8A. The posterior ear is smaller than in typical representatives of *B. unschensis*; 9B. lateral view of the exterior of the right valve and the projecting beak part of the left valve. The anterior surface of byssus ear is bent toward the left valve at about 75 degrees, which is most unusual in pre-Valanginian *Buchia* forms (*see* Jeletzky, 1965); 9C. anterior view of both valves. Note the unusually wide appearance of the anterior surface of the byssus ear resembling that of *B. inflata* (Toula); 9D. beaks and hinge margins of both valves viewed from above. The strongly swollen and angular appearance of the shell in this aspect contrasts strongly with that of typical *B. unschensis*. (Pages 40–42.)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7A

Figures 1A-1B. *Buchia richardsonensis* n. sp. GSC loc. 47880. GSC No. 18030.
Internal cast of a large, typical but strongly deformed left valve. 1A. Lateral view of the exterior; 1B. anterior view of the same. (Pages 31–35.)

Figures 2A-2C. *Buchia fischeriana* (d'Orbigny, 1845) s. lato. Property of the National Museum of Canada. Mould Bay Formation. Early Upper Volgian Stage? West slope of "Crozier Hills" facing Crozier Channel, Prince Patrick Island, District of Franklin, N.W.T. Loose on the surface of soft clay, etc., about 400 to 600 feet above sea-level. Collected by Mr. S. D. MacDonald, 1949.
Internal cast of a large, almost complete and undeformed left valve typical of the advanced forms of the species. Some patches of shell layer occur on the beak part and elsewhere. 2A. Lateral view of the exterior; 2B. anterior view of the same; 2C. beak part and hinge margin viewed from above. (Pages 25–30.)

Figures 3A-3C. *Buchia* aff. *fischeriana* (d'Orbigny, 1845) s. lato. GSC loc. 22776. GSC No. 18009.
Internal cast of a complete left valve. This small to medium-sized form appears to be typical of the early representatives of *B. fischeriana* species group appearing already in the late Portlandian s.str. and probably ancestral to its larger, morphologically advanced forms characteristic of the Upper Volgian Stage. 3A. Lateral view of the exterior; 3B. anterior view of the same; 3C. beak part and hinge margin viewed from above. (Pages 25–30.)

Figures 4A-4C. *Buchia richardsonensis* n. sp. GSC loc. 26959. GSC No. 18011.
A medium-sized, largely complete shell of the thick and narrow variant of the species mostly preserved as an internal cast. Most part of the posterior ear is broken off. This gives the shell the appearance of *Buchia piochii* var. *mniovnikensis* (*see* fig. 10). The beak is characteristically coiled. 4A. Lateral view of exterior of left valve; 4B. anterior view of exterior of both valves; 4C. beak parts of both valves and the hinge margin viewed from above. (Pages 31–35.)

Figures 5A-5E. *Buchia richardsonensis* n. sp. GSC loc. 26959. GSC No. 18014.
A medium-sized, largely complete shell of the broad and low-arched variant (typical) preserved as an internal cast with considerable patches of poorly preserved shell layer. 5A. Lateral view of the exterior of left valve; 5B. same view of right valve; 5C. posterior view of exterior of both valves. The tip of the left beak is broken off; 5D. anterior view of exterior of both valves; 5E. beak parts of both valves and the hinge margin (valves are somewhat displaced) viewed from above. (Pages 31–35.)

Figures 6A-6B. *Buchia piochii* (Gabb, 1865) s. lato var. GSC loc. 35822. GSC No. 18032.
A mostly shell-covered, medium-sized, complete left valve transitional between *B. p.* var. *russiensis* (Pavlow, 1907) and *B.* aff. *fischeriana* (d'Orbigny, 1845) (*see* fig. 3). 6A. Lateral view of exterior; 6B. anterior view of same.

Figures 7A-7D. *Buchia* aff. *fischeriana* (d'Orbigny, 1845). GSC loc. 26959. GSC No. 18015.
A largely shell-covered, smallish but thick, almost complete shell transitional between *B.* aff. *fischeriana* shown in fig. 3 and *Buchia* ex gr. *mosquensis-rugosa*. Especially the strongly right-handedly incurved left beak is similar to that of the latter species group (*see* figs. 7A, 7D). 7A. Lateral view of exterior of left valve; 7B. same view of right valve. The well-preserved byssus ear is indistinguishable from that of advanced forms of *B. mosquensis* s. lato. 7C. anterior view of exterior of both valves. The shell is considerably thicker than the typical *B. mosquensis* s. lato; 7D. beak parts of both valves and hinge margin viewed from above. Anterior surface of byssus ear forms an angle of only about 35 degrees with the hinge margin. (Pages 25–30.)

Figures 8A-8C. *Buchia richardsonensis* n. sp. Holotype. GSC loc. 26959. GSC No. 18013.
A partly shell-covered (especially around the beak), medium-sized, somewhat incomplete left valve of a typical representative of the species. The large and angular posterior ear is almost completely preserved. 8A. Lateral view of exterior; 8B. anterior view of same showing the characteristically coiled beak; 8C. beak part and hinge margin viewed from above. (Pages 31–35.)

Figures 9A-9D. *Buchia richardsonensis* n. sp. GSC loc. 26959. GSC No. 18012.
Internal cast of a large but incomplete (in the posterior-lower part) representative of the extremely flat and large-eared variant. 9A. Lateral view of exterior of left valve; 9B. same view of right valve; 9C. anterior view of exterior of both valves. Most of the end part of the left beak is broken off; 9D. beak parts of both valves and hinge margin viewed from above. (Pages 31–35.)

Figures 10A-10B. *Buchia piochii* (Gabb, 1865) var. *mniovnikensis* (Pavlow, 1907). GSC loc. 22776. GSC No. 18010.
Internal cast of a medium-sized, incomplete but typical left valve. Like many other well-preserved casts of the Portlandian s. str. to Upper Volgian Buchias, this shell shows marked radial ornament resembling that of *Buchia* (*Anaucella*) *concentrica* (Sowerby). Unlike the otherwise similar and probably immediately descendant *B. richardsonensis*, the posterior ear is small and rounded. 10A. Lateral view of exterior; 10B. anterior view of same. Most of the beak part is broken off.

Figures 11A-11E. *Buchia* aff. *subinflata* (Pavlow, 1907). GSC loc. 28712. GSC No. 17024.
Mostly shell-covered, complete, medium-sized shell of the form. Unlike typical *B. unschensis*, the posterior ear is almost absent. This form differs from *B. subinflata* in its markedly left-handedly incurved left beak, straight crest line and pronouncedly angular shape. 11A. Lateral view of exterior of left valve; 11B. same view of right valve. The byssus ear is almost invisible; 11C. anterior view of exterior of both valves. The height of the anterior surface of byssus ear in this aspect is similar to that of the Valanginian *B. inflata* (Toula); 11D. posterior view of same; 11E. beak parts of both valves and hinge margin. The anterior surface of byssus ear forms an angle of at least 70 degrees with the contact plane of the valves. (Pages 40–42.)

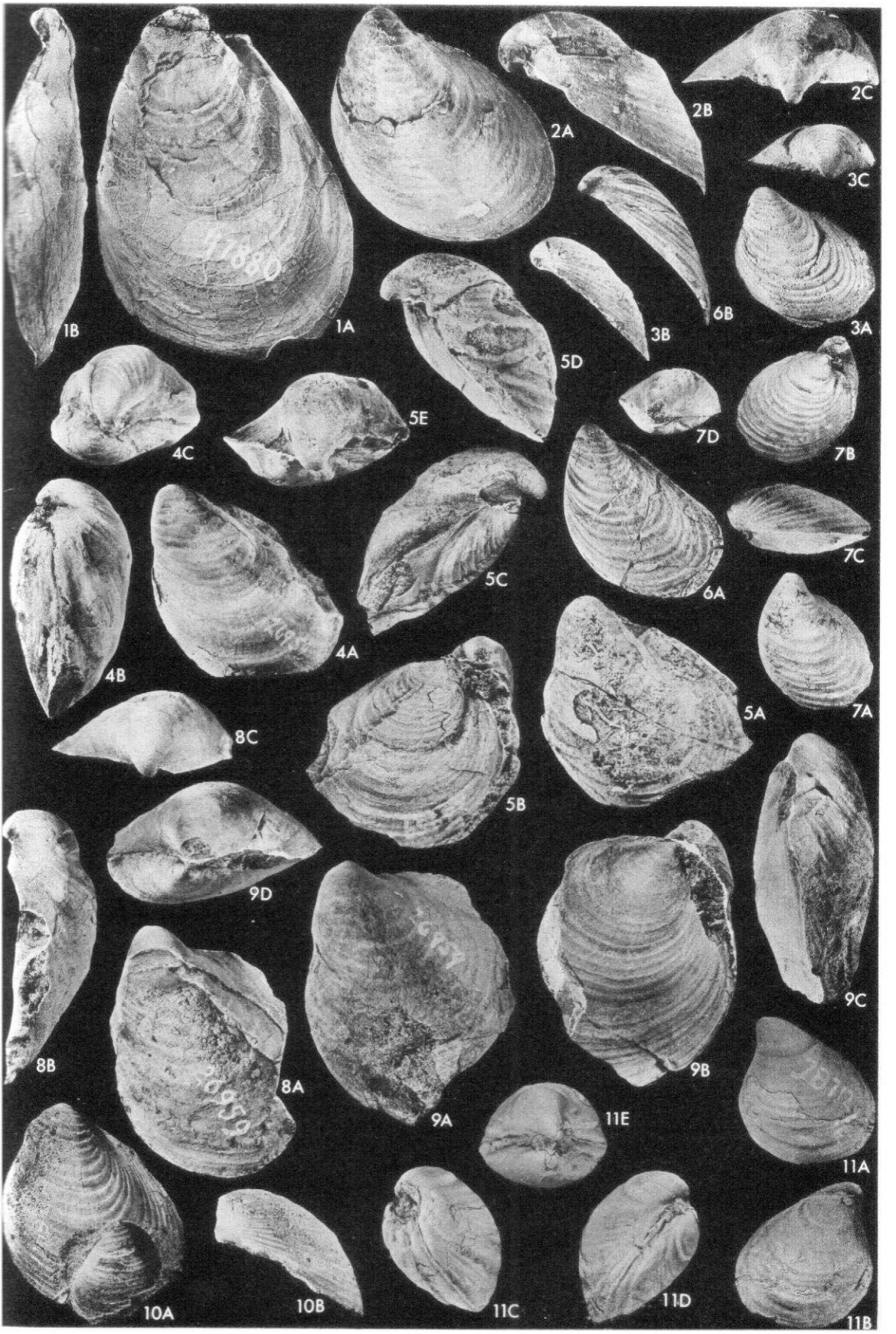
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Plate VIII

Figure 1. *Dorsoplanites* sp. indet. ex gr. *D. panderi* (Michalski, 1890). GSC loc. 53398. GSC No. 18036.
Lateral view of an almost completely flattened, shell-covered specimen. (Page 23.)

Figure 2. *Buchia fischeriana* (d'Orbigny, 1845). GSC loc. 28714. GSC No. 18020.
Internal cast of a large and complete right valve of the advanced, flattish form similar to that shown in Pl. VII, fig. 3. Lateral view of the exterior. (Pages 25–30.)

Figure 3. *Buchia fischeriana* (d'Orbigny, 1845). GSC loc. 28714. GSC No. 18021.
A partly shell-covered, incomplete and almost completely flattened, very large right valve of the same variant as that shown in fig. 2. Although fully as large as the medium-sized representatives of *B. okensis*, this specimen retains the fine and fairly closely spaced concentric ornament characteristic of *B. fischeriana* s. lato. Lateral view of the exterior. (Pages 25–30.)

Figure 4. *Buchia fischeriana* (d'Orbigny, 1845). GSC loc. 28714. GSC No. 18018.
Internal cast of a smallish but complete and apparently undeformed right valve of the same advanced variant as that shown in figs. 2-3. Lateral view of the exterior. (Pages 25–30.)

Figure 5. *Buchia fischeriana* (d'Orbigny, 1845). GSC loc. 28714. GSC No. 18019.
A mostly shell-covered, medium-sized, partly flattened and distorted left valve of the same advanced variant as that shown in figs. 2-4. This valve apparently duplicates the much better preserved left valve of the specimen shown in fig. 6A. Lateral view of the exterior. (Pages 25–30.)

Figures 6A-6C. *Buchia fischeriana* (d'Orbigny, 1845) s. lato. GSC loc. 26987. GSC No. 17991.
A partly shell-covered, almost complete and undeformed, medium-sized shell of the same advanced variant as that shown in figs. 2-5. The posterior ear is mostly broken off. 6A. Lateral view of exterior of left valve; 6B. same view of right valve; 6C. anterior view of exterior of both valves. Right valve is deformed and partly squeezed into left valve. (Pages 25–30.)

Figures 7A-7B. *Laugeites*? sp. indet. GSC loc. 53398. GSC No. 18028. 7A. Lateral view of the shell-covered, partly flattened fragments of two whorls; 7B. ventral view of outer whorl. (Pages 23–24.)

Figures 8A-8C. *Buchia fischeriana* (d'Orbigny, 1845) s. lato var. GSC loc. 38743. GSC No. 18017.
Internal cast of an almost complete, smallish shell of the narrow and thick variant of the species transitional to *B. piochii* (Gabb) var. *russiensis* (Pavlow) and its variant shown in Pl. VII, fig. 6. In the marked, right-handed curvature of its left beak this specimen is, furthermore, similar to *B.* aff. *fischeriana* shown in Pl. VII, fig. 7. The exceptionally strong radial ornament is, finally, rather similar to that of *Buchia* (*Anaucella*) *concentrica* (Sowerby). 8A. Lateral view of exterior of left valve. The end part of the beak is broken off; 8B. same view of right valve. The byssus ear is of about the same evolutionary grade as that of *B.* aff. *fischeriana* shown in Pl. VII, fig. 7; 8C. anterior view of exterior of both valves. (Pages 25–30.)

Figures 9A-9C. *Buchia fischeriana* (d'Orbigny, 1845) s. lato var. GSC loc. 26987. GSC No. 17992.
A shell-covered, almost complete, smallish shell of the narrow and high variant possessing an unusually large and angular posterior ear for the species. The right valve is partly squeezed into the left valve and the large rounded bump near the posterior-lower corner of the left valve (fig. 9A) is pathological in nature. 9A. Lateral view of exterior of almost undeformed left valve; 9B. same view of the largely undeformed right valve; 9C. anterior view of exterior of both valves. Because of the right valve being squeezed into the interior of the left valve, the shell appears considerably thinner than it really is. (Pages 25–30.)

Figures 10A-10B. *Dorsoplanites* cf. *gracilis* Spath, 1936. GSC. loc. 47881. GSC No. 18029.
10A. Lateral view of the almost complete but partly laterally deformed intermediate (wholly septate) whorl with a fragment of a larger but still septate whorl superimposed in the lower left corner of the photograph; 10B. ventral view of the least deformed, early part of the whorl and the deformed cross-section of its anterior end. The outlined ventral parts of suture lines are the continuations of the lateral parts of the sutures outlined in white in fig. 10A. (Pages 21–22.)

Figures 11A-11B. *Dorsoplanites* n.sp. ex aff. *crassus* Spath, 1936? GSC loc. 47883. GSC No. 18031.
11A. Lateral view of the almost complete but strongly deformed inner whorl and of two fragments of a less deformed, larger but still fully septate whorl. Parts of two suture lines are outlined in white on the latter; 11B. ventral view of the least deformed part of the largest fragment of the whorl. The outlined ventral lobe belongs to the suture line different from those outlined in fig. 11A. The latter are visible near the lower end of the photograph. (Pages 20–21.)


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