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PACHYGRYCIA, A NEW *SONNERATIA*-LIKE AMMONITE FROM THE LOWER CRETACEOUS (EARLIEST ALBIAN?) OF NORTHERN CANADA

J.A. JELETZKY
C.R. STELCK

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PACHYGRYCIA, A NEW SONNERATIA-LIKE AMMONITE FROM THE LOWER CRETACEOUS (EARLIEST ALBIAN?) OF NORTHERN CANADA

Abstract

The desmoceratid genus ***Pachygrycia*** *n. gen., an external homeomorph of* ***Sonneratia*** *Bayle 1878, represents the earliest Albian? ammonite fauna yet recognized in the Mackenzie River drainage of Northwest Territories, northern Yukon Territory and from Banks Island, District of Franklin. This widespread, regionally zonal fauna is correlated tentatively with the basal part of the European* ***Leymeriella tardefurcata*** *Zone. Two species,* ***Pachygrycia warreni*** *n. sp. and* ***P. canadensis*** *n. sp., are described and figured. A third form,* ***Pachygrycia?*** *n. sp. indet. A, is described in open nomenclature and only questionably assigned to the genus* ***Pachygrycia***. *True* ***Sonneratia*** *remains unknown in the Boreal Realm of North America.*

The new genus is interpreted as a derivative of a still unknown boreal beudanticeratinid stock. That ***Grantziceras****-like stock also gave rise to such taxa as* ***Grantziceras*** *Imlay,* ***Cleoniceras*** *Parona and Bonarelli s. str.,* ***Neosaynella*** *Casey and* ***Grycia*** *Imlay. All these taxa comprising the subfamily Cleoniceratinae as amended by the writers are removed from the family Hoplitidae H. Douvillé 1890 and assigned to the family Desmoceratidae Zittel 1895. A northeast Asian origin is suggested for the Cleoniceratinae as amended.*

Résumé

Parmi les Desmocératidés, le genre ***Pachygrycia*** *n. gen., homéomorphe externe de* ***Sonneratia*** *Bayle 1878, représente la plus ancienne faune d'Ammonitidés de l'Albien? maintenant identifiée dans le bassin hydrographique du Mackenzie, dans les territoires du Nord-Ouest, le nord du territoire du Yukon et sur l'île Banks dans le district de Franklin. On tente d'établir une corrélation entre cette faune étendue, qui, à l'échelle régionale, a la valeur de fossile-guide, et la portion basale de la zone européenne à* ***Leymeriella tardefurcata***. *Deux espèces,* ***Pachygrycia warreni*** *n. sp. et* ***P. canadensis*** *n. sp., sont décrites et illustrées. On décrit une troisième forme,* ***Pachygrycia?*** *n. sp. indet. A., en utilisant la nomenclature ouverte, et on la classe sous toutes réserves dans le genre* ***Pachygrycia***. *Dans le domaine boréal nord-américain, les vraies* ***Sonneratia*** *sont pour l'instant inconnues.*

On interprète le nouveau genre comme étant issu d'une racine de Béudanticératinidés encore inconnue. Cette racine de type ***Grantziceras*** *a aussi donné naissance à des taxons tels que* ***Grantziceras*** *Imlay,* ***Cleoniceras*** *Parona et Bonarelli s. str.* ***Neosaynella*** *Casey et* ***Grycia*** *Imlay. Tous ces taxons, comprenant la sous-famille des Cleoniceratinae, conformément aux corrections introduites par les auteurs, sont exclus de la famille des Hoplitidae H. Douvillé 1890 et placées dans la famille des Desmoceratidae Zittel 1895. D'après les modifications apportées, on suggère que les Cleoniceratinae sont originaires du nord-est de l'Asie.*

INTRODUCTION AND ACKNOWLEDGEMENTS

Lower Cretaceous fossils from the lower Mackenzie River area were described by Warren in 1937 and 1947. Among the various suites Warren (1947) mentioned two unfigured specimens as questionably belonging to the genus *Sonneratia* Bayle 1878. Warren (1947, Pl. 29, figs. 8-11) also figured specimens, as *Gastroplites* spp., that the present writers consider to be homeomorphs of other genera, such as *Sonneratia*.

The ammonites identified questionably as *Sonneratia* by Warren (1947) were identified subsequently as *Sonneratia* cf. *kitchini* by Stelck et al. (1956, p. 9). A similar ammonite collected by geologists of Shell Oil Company of Canada, Limited in the Liard River Basin was published by Jeletzky (1964, p. 74, Pl. XXIII, fig. 1a-1c) as *Sonneratia* (s. lato)? n. sp. A. Other similar ammonites collected subsequently by oil company geologists and staff members of the Geological Survey of Canada have been identified by Jeletzky (e.g. Jeletzky, 1971a, p. 209; 1975a, p. 26; 1975b, p. 242, Fig. 3; Young, 1973, p. 280; 1975, p. 318, Fig. 5 and in unpublished fossil reports) as *Sonneratia* (s. lato) or *Sonneratia* (s. lato)? n. sp. A.

Because of their biostratigraphic, palaeozoogeographic and palaeozoologic interest, these *Sonneratia*-like ammonites have been made the subject of this special study and most of them were found to belong to the new genus *Pachygrycia*.

The catalogue numbers of specimens belonging to the Geology Department Musuem, University of Alberta, Edmonton and either figured or mentioned in this paper are prefaced by the letters U. of A. Those belonging to the National Type Fossil Collection, Geological Survey of Canada, Ottawa are prefaced by GSC.

C.J. Yorath and F.G. Young are thanked for collecting specimens of *Sonneratia*-like ammonites and providing the writers with stratigraphic and locality data. Many specimens of *Pachygrycia* and important stratigraphic information relative to these specimens were provided by geologists of the following Calgary-based companies: Gulf Oil Co. Ltd. of Canada; Shell Oil Co. Ltd. of Canada; Sproule Stratigraphic Services Ltd.; Texaco Oil Co. Ltd. of Canada; and Triad Oil Co., Ltd. of Canada.

J.A. Jeletzky's assistants, F.M. McLaughlin and K. Vincent, supervised photographing of most of the specimens and helped in many other ways. All photographs were taken by J. White of the Geological Survey of Canada.

PALEONTOLOGICAL DESCRIPTIONS

Superfamily Desmoceratacеae Zittel 1895
Family Desmoceratidae Zittel 1895
Subfamily Cleoniceratinae Whitehouse 1926, emend.

The similarity of the adult external suture lines of *Pachygrycia* n. gen., *Beudanticeras* Hitzel and *Grantziceras* Imlay, to those of *Cleoniceras* s. str. and *Grycia* documented below, requires substantial revision of the presently accepted scope and affinities of the subfamily Cleoniceratinae (e.g. Casey, 1966, p. 548-553; Wright in Arkell et al., 1957, p. L394; Glazunova, Luppov and Ssaveliev, in Luppov and Drustchits, 1958, p. 114). Only genera and subgenera possessing a *Cleoniceras*- and *Grycia*-like adult external suture line with a broad- to very broad-stemmed, asymmetrically trifid to asymmetrically bifid lateral lobe and five or more auxilliary lobes are referable to the Cleoniceratinae s. restr. These early to mid-Albian taxa, which include *Cleoniceras* (s. str.) Parona and Bonarelli 1896, *Grycia* Imlay 1961, *Neosaynella* Casey 1954, *Pachygrycia* gen. nov. and, questionably, *Aioloceras* Whitehouse 1926, appear to be evolutionary offshoots of a beudanticeratinid rootstock morphologically similar to but older than the presently known early to late Albian representatives of *Beudanticeras* s. str. and its subgenus *Grantziceras* Imlay 1961. Among *Beudanticeras* s. str. forms, *B. (B.) beudanti* (Brogniart) (see Jacob, 1907, p. 28, Fig. 14; Wright in Arkell et al., 1957, p. L368, 369, Fig. 482, 2a-2c) is particularly similar to Cleoniceratinae s. restr. because of the pronounced asymmetrical trifid shape and great width of the lateral lobe, the great number of linearly arranged auxiliary lobes (six to seven), the strongly and deeply indented character of the suture line and the pronounced discoidal shape of the shell. Among the *Grantziceras* forms, *B. (G.) glabrum* (Whiteaves 1893) is particularly similar to the Cleoniceratinae s. restr. because of a distinctly to markedly asymmetrically trifid shape and great width of the lateral lobe combined with a strongly and deeply indented, closely spaced and partly overlapping character of external suture lines and the presence of at least six linearly arranged auxiliary lobes. Furthermore, *B. (G.) glabrum* is characterized by the absence of constrictions in the adult state and a pronouncedly discoidal cross-section of the shell (compare Jeletzky, 1964, Pl. XXIV, figs. 5A, 6G; Jones, 1967, p. 36, Fig. 16, Pl. 6, figs. 1-3, 7-9). *B. (G.) glabrum* particularly resembles *Grycia* in all these features.

The genus *Uhligella* Jacob 1907 resembles juvenile to halfgrown *Cleoniceras* s. str. and adult *Pachygrycia* in the cross-section of the whorl and in the ribbing habit (see Wright in Arkell et al., 1957, p. L369, Fig. 482, 1a, 1b). However, the suture lines of *Uhligella* differ strongly from those of the Cleoniceratinae s. restr. in the almost regularly trifid shape of the long and narrow lateral lobe combined with a smaller number (three to four) of auxiliary lobes (see Jacob, 1907, p. 30, Fig. 16; p. 31, Figs. 17, 18; p. 33, Fig. 19; p. 34, Fig. 20). *Uhligella* is, therefore, interpreted as not being directly related to any member of the Cleoniceratinae s. restr.

Casey's (1966, p. 553) conclusion that the distinction of the *Cleoniceras* s. str. suture line from that of *Sonneratia* is taxonomically insignificant and that the presence of more numerous auxiliaries in the *Cleoniceras* s. str. suture line is a feature correlative with its platyconic whorl shape is unacceptable to the writers. This conclusion is but one more instance of a strong underestimation of the taxonomic value of the suture line characteristic of so many contemporary students of Mesozoic ammonites (see Jeletzky, 1979, p. 4-7 for further details). In this particular instance, Casey's (loc. cit.) conclusion is invalid as entirely *Cleoniceras* s. str.-like adult external suture lines with at least six auxiliary lobes are found in the sturdily built, round-whorled *Pachygrycia* (e.g. p. 3; Pl. 4, fig. 1D, 3, 4). Furthermore, exactly the same external suture line is present in *Grycia*, which is intermediate between *Cleoniceras* s. str. and *Pachygrycia*, in the shape and proportions of its adult whorl. The same adult external suture line occurs, finally, in *Neosaynella* in spite of its oxyconic whorl shape. It appears, therefore, reasonable to state that the cleoniceratinid suture line is just as conservative (and hence just as taxonomically high ranking) a feature as is the suture line of the latest Jurassic and early Early Cretaceous perisphinctids recently investigated by Jeletzky (1965; 1966; 1979, p. 4-7, Figure 1). In particular, the morphology of the external suture lines of the Cleoniceratinae appears to be just as independent of their whorl shape as that of the above perisphinctids.

The European genus *Anadesmoceras* Casey 1954, placed into the Cleoniceratinae by Wright (in Arkell et al., 1957, p. L394) and Casey (1966, p. 575, 576), must be excluded from this subfamily because of great differences in the morphology of its external suture line. The latter is identical with that of *Sonneratia* in all essential details (see Casey, 1966, p. 580, Text-figs. 218f, 218g). The unreserved placement of *Sonneratia* Bayle 1878, *Pseudosonneratia* Spath 1925, *Anadesmoceras* Casey 1954, *Puzosigella* Casey 1954 and *Leconteites* Casey 1954 into the Cleoniceratinae proposed by Glazunova, Luppov and Ssaveliev, (in Luppov and Drustchits, 1958, p. 114) is untenable for the same reason.

The *Sonneratia*-like appearance of the early whorls of *Cleoniceras* s. str. noted by a number of workers (e.g. Jacob, 1907; Casey, 1966, p. 554) and interpreted as an indication of its derivation from *Sonneratia* and/or *Anadesmoceras* is considered by the writers to be a matter of homeomorphy only because of the above mentioned great differences in the morphology of the *Sonneratia* and *Anadesmoceras* suture line. Furthermore, these sturdy, *Sonneratia*-like inner whorls of *Cleoniceras* ex gr. *morgani* Spath can now be much more convincingly interpreted as a recapitulation of adult whorl morphology of *Pachygrycia*, which does possess a *Cleoniceras* s. str.-like external suture line and occurs in older beds than *Cleoniceras* s. str.

The above proposed re-interpretation of the Cleoniceratinae Whitehouse 1926 indicates its removal from the superfamily Hoplitaceae and placement into the superfamily Desmoceratacеae. In the latter superfamily, Cleoniceratinae is most closely allied to the subfamily Beudanticeratinae, some of the late Aptian, *B. (Grantziceras) glabrum*-like representatives of which may be suggested as its most likely ancestors. It should be noted in this connection that Owen (1971, p. 138) has already noted the similarity of *Grycia* to the beudanticeratine ammonites and suggested its derivation from that stock. However, he failed to recognize that the same is true of *Cleoniceras* s. str. and *Neosaynella*, which are extremely closely related to *Grycia*.

The above re-interpretation of the scope and origin of the Cleoniceratinae suggests strongly that the European representatives of *Cleoniceras* s. str. and *Neosaynella* are a cryptogenic stock that has no generic roots in that faunal province. The superficial similarity (in the whorl shape and ornament only) of these cleoniceratinid taxa to the true Hoplitidae of the West European faunal subprovince is yet another example of homeomorphy, which is so common in the ammonites. It is premature to speculate about the exact ancestry at the generic level and migration routes of the *Cleoniceras* s. str. and *Neosaynella* stock beyond suggesting that these taxa are evolutionary offsprings of the same beudanticeratine stock as *Grycia* and *Pachygrycia*. Because of the inferred northeast Siberian origin of *Pachygrycia* (see below) and the apparent absence of any suitable beudanticeratinid ancestors in the Aptian marine basins of mid-western and Arctic Canada, *Cleoniceras* s. str. and *Neosaynella* must have arisen elsewhere in the Boreal Realm. The apparent presence of *Pachygrycia canadensis* n. sp. in the Anadyr'-Koriak Province of Siberia (see p. 7 for further details) and the abundance of *Neosaynella*- and *Grantziceras*-like ammonites in the poorly dated Albian rocks of that region (Avdeiko, 1968) suggest a northeast Siberian ancestry for the European and North American cleoniceratinid ammonites.

Genus *Pachygrycia* Jeletzky and Stelck n. gen.

Genotype. *Pachygrycia canadensis* Jeletzky and Stelck n. sp. (described below).

Diagnosis. Cleoniceratinid ammonites combining *Sonneratia*-like whorl proportions, shape and sculpture with *Grantziceras*-like strongly and deeply denticulated, crowded and mostly overlapping adult suture lines; the adult suture line has six or ?more auxiliary lobes; the lateral lobe has a broad to very broad stem, is distinctly to markedly asymmetrically bifid and has the adventral branch directed markedly obliquely to the shell's diameter.

Specific composition. *Pachygrycia canadensis* Jeletzky and Stelck n. sp., *P. warreni* Jeletzky and Stelck n. sp. and *?P.* n. sp. indet. A.

Remarks. Within the subfamily Cleoniceratinae as re-defined in the preceding section, *Pachygrycia* is most closely similar to *Grycia* Imlay 1961. However, *Pachygrycia* differs from *Grycia* in:

1. A prominent, *Sonneratia*-like ribbing habit characterized by an alternation of bifurcating and trifurcating rib bundles, which spring from prominent to distinctly bullate primaries, most of which extend across the lower third of the flank;

2. A common persistence of the near umbilical bullae to the oral end of the adult living chamber;

3. More strongly and deeply denticulated suture lines, much more crowded to overlapping adult suture lines; and

4. Sturdier (in *Pachygrycia canadensis* n. sp.) to much sturdier and nearly globular (in *P. warreni* n. sp.), generally *Sonneratia*-like shape and proportions of the adult whorl.

Furthermore, *Pachygrycia* appears to be restricted to the basal Albian beds, which are older than the lower part of the *Arcthoplites* spp. Zone. The earliest known representatives of *Grycia* appear, in contrast, in some part of the *Arcthoplites* spp. Zone (Figure 1). In conjunction with the different time ranges of *Grycia* and *Pachygrycia*, the above morphological distinctions are ample for their full generic separation.

The data available are insufficient for a decision as to whether or not *Pachygrycia* is an ancestor of *Grycia*. However, it seems more likely that the two represent independent offshoots of the previously mentioned *B. (Grantziceras) glabrum*-like rootstock of the Cleoniceratinae as the ontogeny of *Grycia* is not known to include a *Pachygrycia*-like early growth stage.

Pachygrycia differs from *Cleoniceras* s. str. in:

1. An entirely different course of ontogeny in which the *Sonneratia*-like adult growth stage is preceded by two slender, respectively *Grantziceras*- and *Grycia*-like late juvenile growth stages. *Cleoniceras* s. str. is characterized, in contrast, by the presence of sturdier and more strongly sculptured, generally *Sonneratia*- or *Pachygrycia*-like late juvenile growth stages followed by a much more slender but still strongly sculptured intermediate growth stage. The latter growth stage grades into a sculptured intermediate growth stage. The latter growth stage grades into a slender, generally discus-like but entirely smooth adult growth stage.

2. Incomparably more sturdy, *Sonneratia*-like adult whorls ornamented by strong, bifurcate and trifurcate rib bundles; and

3. Presence of elevations or well developed bullae at the junction points of primary and secondary ribs in the adult penultimate and ultimate whorls.

Furthermore, *Cleoniceras* s. str. is restricted to younger beds than *Pachygrycia*. In Europe the oldest representatives of *Cleoniceras* s. str. appear in the upper part of the *Leymeriella tardefurcata* Zone (Casey, 1966, p. 553) whereas in Canada they appear in the upper part of the late lower Albian *Arcthoplites* spp. Zone, which corresponds to the *Douvilleiceras mammillatum* Zone and the upper and middle parts of the *Leymeriella tardefurcata* Zone of the European standard (Jeletzky, 1964, p. 80, Pl. XXVI, fig. 14).

Pachygrycia and *Cleoniceras* s. str. are obviously generically distinct, although their stratigraphic relationships and the presence of a *Pachygrycia*-like growth stage in the early ontogeny of *Cleoniceras* s. str. (see the discussion of the subfamily Cleoniceratinae for further details) are somewhat suggestive of *Pachygrycia* ex. gr. *canadensis* sp. nov. being a direct ancestor of *Cleoniceras* s. str.

Pachygrycia differs from *Neosaynella* Casey 1954 in:

1. A complete absence of any tendency to acquire a slender, oxyconic shape of the whorl's cross-section so characteristic of the adult and intermediate growth stages of *Neosaynella*;

2. A persistence of pronounced, *Sonneratia*-like ornament to the oral end of the adult living chamber. *Neosaynella* is characterized, in contrast, by completely smooth to faintly striated intermediate and adult whorls; and

3. An absence of pronounced cupid-bow-like swing of the secondary ribs characteristic of the early growth stages of *Neosaynella*.

Grycia and *Cleoniceras* s. str. as well as *Pachygrycia* are all restricted to older rocks than *Neosaynella*, which is not known to occur in rocks older than the lower part of the *Douvilleiceras mammillatum* Zone of the European standard. Therefore *Pachygrycia* and *Neosaynella* are obviously generically distinct and there is no reason to think that they are directly related generically.

Pachygrycia differs from *Aioloceras* Whitehouse 1926 (see Wright in Arkell et al. 1957, p. L394, Fig. 513-3 for further details) in the same features as from *Cleoniceras* s. str. Furthermore, *Aioloceras* lacks umbilical tubercles at any growth stage (Whitehouse, 1926, p. 206). This poorly understood late Aptian to early Albian genus may, however, be only an Antiboreal homeomorph of Cleoniceratinae.

Outside of the subfamily Cleoniceratinae as re-defined in this paper, *Pachygrycia* may be confused with some representatives of the genus *Brewericeras* Casey 1954 s. lato (i.e. including the genera *Leconteites* Casey 1954 and *Puzosigella* Casey 1954). However, *Pachygrycia* differs markedly from *Brewericeras* s. lato in having a much greater width and marked asymmetry of its lateral lobe and auxiliary lobes. Although crowded to overlapping and very strongly and deeply denticulated, (Jones et al., 1965, Figs. 11, 12, 15, 16), these sutural elements of *Brewericeras* ex gr. *lecontei-hulenense* are slender to very slender stemmed and entirely (i.e. the lateral lobe) to almost entirely (i.e. the auxiliary lobes) trifid. Furthermore, the adult external suture lines of *Brewericeras* s. lato have only three auxiliary lobes and are strongly retractive (or suspensive) in their auxiliary parts.

Another equally distinctive feature of generic rank is the consistently sharp-edged appearance of the umbilical shoulder in *Brewericeras* s. lato caused by a meeting of the straight, subtransverse umbilical wall with the but slightly convex, adventrally converging flank at almost right angles. *Pachygrycia* is characterized, in contrast, by a perfectly to almost perfectly rounded umbilical wall that merges imperceptibly to indistinctly into the shell's flank.

The pronouncedly sinuous ribbing habit of adult representatives of *Brewericeras* s. lato with the majority of ribs either beginning singly at the umbilical shoulder or starting in pairs in the very poorly formed bullae in that position (e.g. Jones et al., 1965, Pl. 6, figs. 1, 6, 8, 10, 12, 16; Pl. 8, figs. 2, 3; Pl. 9, figs. 1, 7) is yet another generic distinction from *Pachygrycia* in which the mostly well attached secondaries branch in twos and threes from well defined, commonly elevated to bullate primaries within the lower third of the flanks.

The wide range of infraspecific variation in *Brewericeras lecontei* (Anderson) illustrated by Jones et al. (1965, Pl. 5, figs. 4-25) includes forms in which the umbilical shoulder is ornamented by pronounced nodes and bundles of secondary ribs springing up from these nodes. Such morphological variants may be similar to some *Pachygrycia* forms in their ornamentation and whorl shape. However, the typical *Brewericeras* s. lato suture line and the sharpness of the umbilical shoulder serve to discriminate these homeomorphs.

In the writers' opinion *Brewericeras* s. lato does not belong to the same genetic stock with *Pachygrycia* but represents an independent evolutionary development out of an *Uhligella*-like root-stock (see under the discussion of Cleoniceratinae).

Pachygrycia canadensis n. sp.

Pl. 1, figs. 1-4; Pl. 2, figs. 2, 5; Pl. 3, fig. 2; Pl. 4, figs. 1-3, 5, 6.

1947 *Sonneratia* sp. Warren, p. 123 (partim, unfigured)
1956 *Sonneratia* cf. *kitchini* Stelck et al., p. 9 (partim, unfigured)
1964 *Sonneratia* (s. lato)? n. sp. A. Jeletzky, p. 74, Pl. XXIII, figs. 1A-1C.
?1965 *Sonneratia* sp. Verestchagin et al., p. 33, Pl. 18, figs. 2a-2v.

Type specimen. The almost complete but partly deformed adult shell GSC Cat. No. 17389 figured by Jeletzky (1964, Pl. 23, fig. 1A-1C) and reproduced in this paper (Pl. 1, figs. 4A-4C; Pl. 4, 1A-1E) is designated herewith the holotype of *Pachygrycia canadensis* n. sp.

Diagnosis. A *Pachygrycia* species characterized by moderately sturdy, appreciably higher than wide, late juvenile, intermediate and adult whorls; these whorls have slightly adventrally convergent, slightly convex flanks, broadly rounded venter and moderately involute umbilicus (20 to 25 per cent); closely spaced (some 16 to 18 primaries and 40 to 42 secondaries per whorl), prominent and wide ribs of the intermediate and adult whorls form well defined, dichotomous and trichotomous bundles with short nonbullate to distinctly bullate primaries; all ribs thicken and widen gradually adventrally reaching their maximum strength on the venter where they are slightly to distinctly bent forward.

Material. Some seventy almost complete to fragmentary, adult to late juvenile shells, most of which are strongly distorted to almost flattened. Nine of these shells are figured in this paper.

Description.

Whorl shape and proportions. The earliest growth stage seen was observed in the holotype (Pl. 1, fig. 4C) where about one-third of a late juvenile whorl with the terminal height of about 8.5 mm and corresponding width of about 5.0 mm (est.) is exposed. This whorl is slender (estimated height/width ratio about 1.5) and has slightly convex but generally subparallel flanks that merge gradually into a broadly rounded venter. The umbilicus is moderately deep but almost funnel-like with only the umbilical shoulders of preceding juvenile whorls exposed. The umbilical shoulder is regularly rounded. The terminal part of this juvenile growth stage, with the approximate whorl height of about 8 mm and estimated whorl width of about 5.5 mm (estim. height/width ratio about 1.3), is exposed in GSC paratype 64165 (Pl. 3, figs. 2A-2B, 2E-2F). The beginning of this late juvenile growth stage, the whorl shape of which resembles closely that of adult *B. (Grantziceras) affine* (e.g. Jeletzky, 1964, Pl. XXIV, fig. 3B), was not observed.

The next late juvenile growth stage has a still more slender whorl (height/width ratio of about 1.6) with almost flat flanks that converge evenly and gradually all the way from the broadly rounded umbilical shoulder to the regularly rounded ventral shoulder. The venter and moderately involute umbilicus of this stage are just as broadly and regularly rounded as those of the preceding growth stage. This *Grycia*-like shaped growth stage was observed in three dimensions in GSC paratype 64165 (Pl. 3, figs. 2A, 2B, 2D-2F) where it extends for at least three-quarters of a whorl from the whorl's height of about 8 mm to that of about 13 mm.

Measurements.

Catalogue or/and locality No. and illustration	Shell diameter (mm)	Width of umbilicus (mm)	Ratio	Width of umbil. / shell diam.	Height of whorl (mm)	Width of whorl (mm)	Ratio	Height of whorl / Width of whorl
Holotype, GSC 17389 (Pl. 1, fig. 4)(all measurements at the beginning of living chamber)(somewhat distorted)	84.0	18 (appr.)		0.22	43.0	34.5		1.3
Univ. of Alberta, 3848, paratype (Pl. 1, fig. 3) (undistorted) (all measurements at the oral end of living chamber)	54.5	13		0.24	30.5	25.5		1.2
GSC paratype 64160; (Pl. 1, fig. 1) (all measurements in the middle of preserv. segment)	-	-		-	38.5	31.5		1.2
GSC paratype 64165 (Pl. 3, fig. 2) (all measurements at oral end of the exposed undeformed inner whorl)	25	6.5		0.26	13.5	8.5 (est.)		1.6

Its cross-section is exposed in GSC paratype 64160 (Pl. 1, fig. 1D). The oral end of this growth stage is concealed in these specimens. However, it extends somewhat less than the whole whorl in GSC paratype 64165 because the cross-section of the oral end of its inner whorl (Pl. 3, fig. 2B) already has a considerably lower (whorl's height 18 mm; whorl's width 15 mm; ratio 1.2), distinctly hoof-like adult appearance (see below for further details). The fairly slender, rounded-trapezoidal whorl shape, which first appears in this cross-section and also in the cross-section of GSC paratype 64160 (Pl. 1, fig. 1D), persists essentially unchanged to the oral end of all undeformed to relatively slightly deformed representatives of *Pachygrycia canadensis* n. sp. (e.g. GSC paratype 64160; U. of Alberta paratype 3848 or GSC holotype 17389; see Pl. 1, figs. 1D, 3B, 4C). This adult cross-section is characterized by distinctly to slightly convex flanks that expand gradually adventrally between the broadly rounded and rather indistinct umbilical shoulder and the level about one-third up the flank. Then the flanks converge gradually and almost evenly all the way to the broadly and ill-defined ventral shoulder. The broadly rounded venter is appreciably flattened throughout as compared with the Roman arch, which results in a better delimitation of the ventral shoulder in comparison with the almost regularly rounded umbilical shoulder. The latter merges imperceptibly in the almost regularly rounded umbilical wall of the deep, almost regularly funnel-like umbilicus. The shell is moderately involute (20 to 25 per cent) and exposes only the umbilical shoulders of preceding whorls.

Sculpture. The earliest exposed whorl segment of the holotype and GSC paratype 64165 (Pl. 1, fig. 4C; Pl. 3, figs. 2A, 2B, 2E, 2F) ending at the whorl's heights between 8.0 and 8.5 mm appear to be ornamented only by one or ?more of the laterally flexuous constrictions which form broad forward convex loops on the venter. The first faint ribs appear on the flanks of the GSC paratype 64165 at the whorl's height of about 8.5 mm. These fine, closely spaced and round-topped (in the internal cast preservation) ribs mostly form dichotomous bundles including short and straight, forward inclined primaries beginning on the umbilical shoulder and restricted to the lower one-fifth to one-third of the flank. None of the primaries are perceptibly thickened, let alone bullate. Some bundles almost lack primaries as the furcation point is situated either at or but slightly above the umbilical shoulder. The secondaries are essentially straight and inclined forward at the same angle as the primaries all the way to the ventral shoulder (Pl. 3, figs. 2E, 2F). They either weaken or disappear on the venter. The still discernible secondaries form broad adorally convex loops there. Two strong constrictions, which follow the same course as the adjacent ribs, occur in the early part of this *Grycia*- like sculptural stage (Pl. 3, fig. 2F). The end of this stage is concealed in the only specimen (GSC paratype 64165; Pl. 3, figs. 2E, 2F) where it is well exposed. However, it must end shortly after the greatest whorl height of about 13.5 mm visible in it as other specimens (e.g. U. of A. paratype 3848, GSC paratypes 64163, 64164 or 64161, Pl. 1, figs. 2, 3; Pl. 2, figs. 2, 5) exhibit the pronounced, predominantly dichotomous ribbing habit (with some solitary ribs and trichotomous bundles intercalated) characteristic of adult *Pachygrycia canadensis* at similar or slightly larger whorl heights. One can argue that this adult or *Sonneratia*-like ribbing habit may begin somewhat earlier in the strongly deformed late juvenile to half-grown specimens GSC paratypes 64163, 64161 and 64164. If so, there must be a wide variation in the time of replacement of the fine *Grycia*-like ribbing habit by the coarse *Sonneratia*-like ribbing habit in *P. canadensis*.

The material of these growth stages is too fragmentary to attempt a rib count per whorl. However, the adult or *Sonneratia*-like ribbing habit of *P. canadensis* n. sp. features 14 to 18 short and heavy primary ribs, which usually begin just below the umbilical shoulder. These thin ribs gradually strengthen all the way to the furcation point which is situated at or close to the lower third of the flank. In some specimens (e.g. GSC 64160, Univ. of Alberta paratype 3848; Pl. 1, figs. 1A, 1B, 3A) the primaries are entirely nonbullate. In other specimens, typified by the holotype (Pl. 4, fig. 1A), they are slightly to distinctly elevated just below the branching point. The strongest of these elevations may be designated weak bullae. In yet other specimens, typified by GSC paratypes 64163 and 64164 (Pl. 2, figs. 2, 5) most primaries become distinctly to markedly bullate beginning with whorl heights of 13 mm and possibly somewhat less and remain bullate to the oral end of the adult living chamber.

The primaries of the *Sonneratia*-like ornamental stage are approximately straight but feebly (e.g. specimen U. of A. Cat. UA3848, Pl. 1, fig. 3A) to distinctly (e.g. the holotype; Pl. 1, fig. 4A) inclined adorally. The pronounced adoral inclinations of primaries observed on some strongly deformed to almost flattened specimens (e.g. GSC paratypes 64164 and 64161, U. of A. paratype 3850 or GSC paratype 64167, Pl. 1, fig. 2; Pl. 2, fig. 5; Pl. 4, fig. 6) is probably a result of deformation, in part at least.

The strongly elevated, round-topped secondary ribs, which number 40 to 45 per whorl in the adult growth stage, are somewhat markedly deflected backward at their branching points (e.g. in the holotype or GSC paratype 64164; Pl. 1, fig. 4A; Pl. 2, fig. 5). Then they become subradial to exactly radial and continue on that course across the middle and upper flank gradually becoming more and more prominent and widened adorally. Most of the secondaries are either straight or nearly straight on the flank but some are slightly to distinctly flexuous. All secondaries exhibit a distinct to marked forward swing at the ventral shoulder and then form broad, slight but distinct forward loops on the venter (e.g. Pl. 1, figs. 3A, 3B, figs. 4A, 4B). The secondaries continue to increase gradually in prominence and width to

the middle of the venter and then begin to decrease in strength equally gradually. No weakening of secondaries on the venter was observed in the material studied. Neither was any thickening of the secondaries on the ventral shoulder observed. The ribs are separated by deep, round-bottomed depressions. In some specimens exemplified by the holotype (Pl. 1, fig. 4A) these depressions are about twice as wide as the adjoining primaries on the lower flank. On the upper two-thirds of the flank these depressions become about 1.5 times wider than the adjacent ribs and on the venter their width becomes about equal to that of the ribs (Pl. IV, fig. 1A). In other more heavily ribbed and bullate specimens exemplified by U. of A. Cat. 3848 (Pl. 1, fig. 3A) or the unfigured specimen of U. of A. Cat. 3851 the depressions separating the ribs are either about as wide as or up to 1.5 times wider than the ribs throughout their course.

Most of the secondary ribs form well attached bifurcating bundles. Some trifurcating bundles may or may not be intercalated with them. The bifurcating bundles are always much more common and there are many specimens, exemplified by the holotype (Pl. 1, fig. 4A), on which trifurcating bundles are almost to entirely absent. There are other rare specimens, however, in which trifurcating bundles are fairly common (e.g. GSC paratype 64164; Pl. 2, fig. 5). Some specimens (e.g. GSC paratype 64160; Pl. 1, figs. 1A, 1B) may exhibit many secondaries which are only indistinctly attached to their primaries. Furthermore, there may be a considerable ratio of single intercalated secondaries in such specimens.

No weakening of sculpture on the adult ultimate whorl is known in the material studied. However, the apertural margin is not preserved in any of the specimens studied including the holotype which retains almost half a whorl of adult living chamber.

Suture line. The suture is exposed in the holotype at whorl height 35 mm; on U. of A. paratype 3848 at a whorl height of 20 mm; and on GSC paratype 64165 at whorl height of 10 mm. A partial suture was obtained on GSC paratype 64166 at whorl height of 32.5 mm (Pl. 4, fig. 2). The adult suture lines of the holotype are very complex with successive sutures mostly interlocking (Pl. IV, figs. 1B-1D). The first lateral saddle is slightly asymmetrically bifid and relatively finely and deeply indented with a moderately wide stem. The lateral lobe is very asymmetrically trifid or asymmetrically bifid as interference with earlier sutures often reduces the innermost branch of the lobe. The lateral lobe is almost equal in length to the ventral lobe, a character that seems to differentiate the suture of *P. canadensis* from that of *B. (Grantziceras) glabrum* (Jones 1967, p. 32, 36). The second lateral saddle is about one-half the width and about one-half the height of the first lateral saddle. From the second lateral saddle the suture descends to the umbilical seam in a long series of successively smaller saddles separated by 6 gradually diminishing auxiliary lobes. The seventh auxiliary lobe seems to be exposed at the umbilical seam.

On the inner whorls the number of auxiliaries seems to decrease to four at a whorl height of 20 mm (Pl. 2, fig. 3; Pl. 4, fig. 3) but the general character of the suture line does not change much otherwise. At a whorl height of 10 mm the suture is somewhat less intricately subdivided and does not interlock (Pl. 4, fig. 5) but the pattern remains essentially the same. The innermost auxiliaries were not observed at 10 mm (Pl. 2, figs. 2E, 2F; Pl. 4, fig. 5) but there does not seem to be room for more than four of them.

The suture of *P. canadensis* is very like that of *B. (Grantziceras) glabrum* from Alaska as illustrated by Jones (1967, Fig. 16), except for the more shallow ventral saddle of the latter and the presence of only five auxiliaries. The suture of *Beudanticeras (Grantziceras)* cf. *B. glabrum* illustrated by Warren and Stelck (1959, Pl. 2, fig. 3) exhibits a similarly shallowed ventral saddle and also differs in the presence of only five auxiliaries.

The sutures of *Subarcthoplites* cf. *S. macconnelli* and *S. belli* illustrated by Warren and Stelck (1959, Pl. 2, fig. 2, 4) from Alberta are also similar to *P. canadensis* n. sp. However, the second lateral saddle of the latter is somewhat narrower relative to the first lateral saddle and there are at least six auxiliary lobes.

The suture of *Freboldiceras remotum* illustrated by Nagy (1970, Fig. 11e) from Spitzbergen shows a similar suture to *P. canadensis* with all elements of the suture equivalent but the relative overall height of both lobes and saddles is somewhat lessened or compressed in *F. remotum*. Furthermore, the external part of its suture has only three distinctive auxiliary lobes.

The suture of *"Sonneratia" cleon* d'Orbigny *(= Cleoniceras cleon)* illustrated by Jacob (1907, text-fig. 44) from Europe is almost identical in design to that of *P. canadensis* at 10 mm.

Age and geographic range. The age and geographic range of *Pachygrycia canadensis* n. sp. in northern and Arctic Canada is discussed below in the section dealing with stratigraphy, etc. of the *Pachygrycia* fauna. The species is unknown outside of these Canadian regions, except possibly in the Anadyr'-Koriak Province of northeastern Siberia. The *"Sonneratia* sp." from undifferentiated Albian rocks of that region described and figured by Verestchagin et al. (1965, p. 33, Pl. 18, figs. 2a-2v) is better referred to *Pachygrycia canadensis* n. sp. as its unfigured suture line is stated to be (Jeletzky's translation from the original Russian): "rather strongly denticulated and to possess asymmetrical lobes and saddles". The external appearance of the only figured specimen of this *"Sonneratia* sp." matches very closely that of the halfgrown Canadian representatives *P. canadensis* n. sp. The data presently available are judged to be insufficient for a definitive assignment of this Siberian form to *P. canadensis* n. sp. and it is only tentatively synonymized with it at this time.

Pachygrycia warreni n. sp.

Pl. 2, figs. 1, 3, 4; Pl. 3, fig. 1; Pl. 4, fig. 4

Type specimen. The adult living chamber GSC Cat. 64162, reproduced in Pl. 2, fig. 1; Pl. 3, fig. 1 is selected herewith as the holotype of *P. warreni* n. sp.

Origin of name. Named after the late Professor P.S. Warren in recognition of his contributions to the Phanerozoic geology of mid-western Canada.

Diagnosis. *Pachygrycia* species combining a sturdy, regularly rounded, wider than high whorl cross-section with extremely sparse and prominent ribbing (8 to 9 primaries and 21 to 23 secondaries per whorl) and an involute, funnel-like (about 14 to 16 per cent of the shell diameter) umbilicus.

Material. Three fragmentary adults. The holotype is from GSC loc. 84792. Two paratypes are from University of Alberta loc. 42200.

Measurements.

Catalogue or/and locality No. and Figure	Holotype, GSC Cat. 64162; Pl. 2, fig. 1; Pl. 3, fig. 1 (moderately deformed)	Paratype, Ct. 990 (Univ. of Alberta Cat. No. 225; Pl. 2, fig. 4) (undeformed)
Shell diameter (mm)	143 (appr.)	-
Width of umbilicus (mm)	22 (appr.)	-
Ratio Width of umbil. / shell diam.	0.15 (or 15%)	-
Height of whorl (mm)	60 (probably increased by lateral deform.)	43.5
Width of whorl (mm)	61 (probably decreased by lateral deformation)	54.0
Ratio Height of whorl / Width of whorl	1.00 (probably too high)	0.8

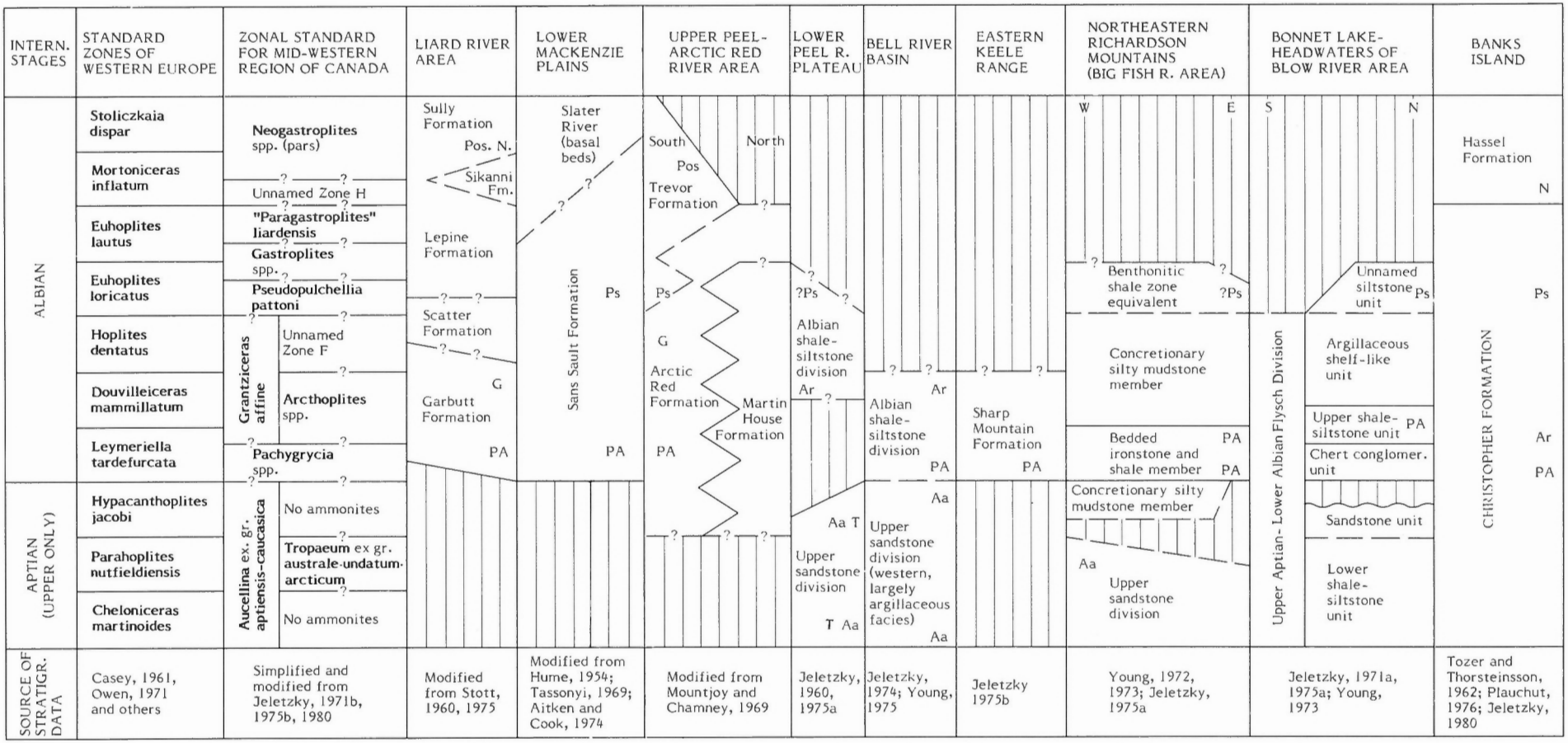
Description.

Whorl shape and proportions. The material available consists almost exclusively of adult living chambers and the oralmost ends of the phragmocones. However, the only segment of the early part of the adult penultimate whorl visible inside of the adult living chamber of the holotype (Pl. 2, fig. 1B) does not differ from the latter chamber in shape and ribbing habit.

The adult ultimate whorl is appreciably wider than high (the height/width ratio of about 0.8 appears to be typical) and somewhat irregularly rounded. The cross-section is broadly hoof-shaped (Pl. 2, fig. 4C) with the venter and flanks appreciably flattened. This results in the presence of a distinct, broadly rounded ventral shoulder. The umbilicus is involute (estimated to comprise about 15 per cent of the shell diameter), deep and funnel-like. Earlier whorls are completely covered in both suitably preserved examples (Pl. 2, figs. 1A, 1B, 3A). The umbilical shoulder is almost regularly rounded, which makes it difficult to delimit the umbilical wall from the flank. The maximum width of the whorl is situated at the umbilical shoulder. The shape and proportions of the only known, short (about one-fifth of the whorl) segment of the early part of the penultimate whorl visible inside of the adult living chamber of the holotype does not seem to differ from those of the adult ultimate whorls. Nothing is known about the shape and proportions of earlier whorls.

Sculpture. The adult ultimate whorl is ornamented by about 8 to 9 rib bundles with 21 to 23 ribs crossing the venter. The primary ribs originate low within the umbilicus and the secondary ribs branch from, or are inserted low on the flanks, near the umbilicus. The primary ribs are short and prominent. In some examples (e.g. Pl. 2, fig. 3A) they develop round-topped, rounded-triangular bullae on the flank near the umbilical shoulder in the region of branching. The primaries split into either two or three heavily built, prominent, mostly round-topped secondary ribs separated by approximately equally wide and deep round-bottomed depressions. Bifurcating bundles are much more common than trifurcating bundles. Some of the secondary ribs are indistinctly attached to the primaries and there are a few single intercalated ribs restricted to the upper half of the flank (Pl. 2, figs. 1A, 1B).

The secondary ribs are straight to slightly flexed; they cross the middle and upper flank subradially. On GSC holotype 64162 deviation of that course seems to be caused by deformation of the shell. The secondaries gradually widen and become more and more prominent upflank until they become broadly fold-like at the ventral shoulder. The intervening depressions gradually widen and deepen in this direction so that their width and depth remain proportional to the width and elevation of the ribs. The secondary ribs either do not become deflected or exhibit only a slight adoral deflection at the ventral shoulder. They cross the venter either subtransversally (Pl. 2, figs. 3B, 4A) or form barely perceptible forward loops there (Pl. 3, fig. 1A). No increase in prominence or width of the secondaries occurs at the ventral shoulder. In the holotype the secondaries appear to be distinctly weakened in the middle of the venter (Pl. 3, fig. 1A). However, they do not exhibit any weakening on the venter of the two paratypes (Pl. 2, figs. 3B, 4A), in which the secondaries continue to increase in prominence and width to the middle of the venter and then decrease equally gradually on its other side.



EXPLANATION OF SYMBOLS AND ABBREVIATIONS

Vertically lined compartments denote hiatuses.
Broken lines with or without question marks denote uncertainty about the age of formational and zonal boundaries.

PA - *Pachygrycia* fauna.
Aa - *Aucellina* ex gr. *aptiensis-caucasica* fauna.
T - *Tropaeum* ex gr. *australe-undatum-arcticum* fauna.
Ar - *Arcthoplites* spp. fauna.
G - *B. (Grantziceras)* ex gr. *affine-glabrum* fauna.
Ps - *Pseudopulchellia* spp. fauna which was previously identified as *Gastroplites (Paragastroplites?)* nov. sp. ex aff. *G. liardense* (Whiteaves) fauna and placed into the uppermost middle or upper Albian (Jeletzky, 1964, Table 1). This ammonite is now assigned to *Pseudopulchellia* and dated as of a general mid-Albian age (Jeletzky, 1980).
N - *Neogastroplites* fauna.
Pos - *Posidonia? nahwisi* s. lato fauna.

Figure 1. Stratigraphy and biochronology of *Pachygrycia* fauna.

Suture line. The external suture line of *Pachygrycia warreni* n. sp. was only observed on the fragmentary paratype U. of A. 225 Ct. 990 (Pl. 2, figs. 4A, 4B; Pl. 4, Figure 4), on which several partial oralmost lines are visible. Although incomplete, these adult suture lines are of the same type as the better known external suture lines of *P. canadensis* sp. nov. The great width, pronouncedly asymmetrically bifid shape and strong denticulation of the best preserved lateral lobe of this specimen are combined with the very close spacing and prevalent overlap of the lateral lobes in all adult suture lines observable. The less satisfactorily preserved first auxiliary and ventral lobes of these suture lines are equally strongly denticulated and closely spaced to overlapping. Six auxiliary lobes are definitely present and the seventh may straddle the umbilical seam. This information suffices to exclude *P. warreni* n. sp. from the genus *Sonneratia* Bayle 1878 and the family Hoplitidae and to place it in the genus *Pachygrycia* of the Cleoniceratinae (as emended in this paper).

Age and geographic range. The age and geographic range of *Pachygrycia warreni* n. sp. are discussed below in the section dealing with stratigraphy, etc. of the *Pachygrycia* fauna. The species is so far unknown outside of the Lower Mackenzie River area of northern Canada.

Pachygrycia? n. sp. indet. A

Pl. 3, fig. 3

Material and locality. One somewhat deformed fragment (about one-half of a whorl) of the living chamber. This unique specimen, U. of A. 3849 (Sta. 6557) 43703 is from: "Lower Cretaceous, Ramparts River, Lat. 65°28'N; 130°30'W, collected by Canol geologists".

Measurements. Shell diameter - 102 mm (appr.); whorl diameter (at apical end) - 36 mm (appr.); width of umbilicus - 48 mm (appr.).

Remarks. The only preserved flank of the living chamber includes all of the umbilical wall and locally one-third to almost one-half of the venter. The ribbing habit of the flank and venter does not differ materially from that of *Pachygrycia canadensis* n. sp. However, the umbilical wall is subtransversely oriented and the umbilical shoulder is considerably more narrow and better defined (although still rounded) than in the best preserved representatives of that species. Furthermore, the primary ribs are thick and prominent all across the umbilical wall. Finally, the umbilicus of the fragment is moderately evolute (about 47 per cent), in contrast to the moderately involute (20 to 25 per cent) umbilicus of *P. canadensis* n. sp. Therefore, the fragment is not conspecific with *P. canadensis* n. sp. and apparently belongs to a new species of *Pachygrycia*. The only fragment being unsuitable as the holotype, this new species is designated herewith as *Pachygrycia?* n. sp. indet. A, pending discovery of additional, better preserved material. Its placement in the genus *Pachygrycia* is tentative because of the absence of a suture line.

STRATIGRAPHY, AGE AND PALEOGEOGRAPHY OF THE PACHYGRYCIA FAUNA

Stratigraphy and regional correlations. The previously inferred stratigraphic position of the fauna now called the *Pachygrycia* fauna (e.g. Stelck et al., 1956, p. 9; Jeletzky, 1964, Table 1; 1971b, p. 8, 42, Fig. 2; 1975a, p. 26; 1975b, p. 241, 242, Fig. 3) beneath the *Arcthoplites* spp. Zone (previously the *Beudanticeras-Subarcthoplites* or *Lemuroceras-Beudanticeras affine* Zone) was recently confirmed by Young's (1975, p. 317, 318, Fig. 5) field work in unfaulted Aptian-Albian sections of the Bell Basin, northern Yukon Territory. Young (l. cit.) found the *Pachygrycia canadensis* n. sp. fauna (previously identified as *Sonneratia* (s. lato) n. sp. A. by Jeletzky) in the Albian shale-siltstone division on Waters River, about 400 m (1,400 feet) stratigraphically above the assigned top of the thick western facies of the Upper sandstone division. The latter has yielded the diagnostic Aptian *Aucellina* ex gr. *aptiensis-caucasica* fauna in this and adjacent sections. Some of these fossils were found immediately below the gradational contact between the divisions. An adjacent section of the Albian shale-siltstone division measured by Young (loc. cit.) has yielded the *Arcthoplites* cf. *belli* fauna about 700 m (1,800 feet) above the assigned top of the Upper sandstone division (Figure 1). These stratigraphic relationships indicate that the southernmost known occurrence of the *Pachygrycia canadensis* n. sp. fauna (i.e. that of its holotype; see Pl. 1, fig. 4, Figures 1, 2) on Jackfish Creek, a tributary of the Liard River is also older than the *Arcthoplites* spp. Zone. This *P. canadensis* n. sp. shell was reportedly found at the very base of the otherwise unfossiliferous Garbutt Formation where it onlaps onto the Mississippian strata in the Liard area. Therefore, the Garbutt Shale does not appear to include any beds equivalent to the Upper sandstone division, contrary to the opinion of some workers (e.g. Stott, 1975, p. 446, Text-fig. 3), in the Liard Plain area at least.

The occurrence of *Pachygrycia warreni* n. sp. near the base of the Sans Sault Formation, in the Sans Sault Rapids area of the lower Mackenzie River (i.e. its paratypes; Pl. 2, figs. 3, 4), where the formation overlies Devonian strata, appears to be of the same age as the occurrence in the Garbutt Shale. These two occurrences of the *Pachygrycia* fauna suggest it may be restricted to the basal beds of that sequence, representing the onlap of the Albian Clearwater Sea in a southerly direction from the Arctic Ocean into midwestern Canada.

In the eastern Richardson Mountains and adjacent parts of the upper Peel River and Arctic Red River area, *Pachygrycia canadensis* n. sp. occurs in the Arctic Red Formation (Mountjoy and Chamney, 1969). The bulk of this fauna (e.g. GSC collections 52608, 55170 and 55171; see Pl. 2, fig. 2) was found between 30 and 35 miles above the mouth of Snake River in the middle of a large outcrop-area of the Arctic Red Formation (loc. cit., Figs. 1, 2). These fossil collections were not referred to in

their paper. The beds containing *Pachygrycia canadensis* n. sp. on Snake River are interpreted as correlative with most of the lower part of the Glauconitic member of the Martin House Formation (loc. cit., p. 6, Figure 3) that underlies the *Arcthoplites* sp.-and *Beudanticeras (Grantziceras)*-bearing upper beds. These lower beds of the Glauconitic member were assigned an earliest Albian and an Aptian/Albian transition age by Chamney (loc. cit., p. 44, Tables 3, II) on the basis of their foraminifer fauna. Numerous older collections of *Pachygrycia canadensis* n. sp. from the upper Peel River area (mainly on Snake River; e.g. GSC loc. 13600, 13602, 13604 and 13606) are believed to represent the same level in the Arctic Red Formation.

In the Stony Creek-Vittrekwa River area of the northeastern Richardson Mountains no trace of the *Pachygrycia* fauna was found in the basal beds of the Albian shale-siltstone division in spite of an intensive search. Instead, the presumably younger *B. (Grantziceras) affine* and *Arcthoplites* sp. fauna was found in the basal 61 to 76 m of the division on Stony Creek (Jeletzky, 1960, p. 18 and unpublished). The lowermost occurrence of this fauna is estimated to be 30 to 46 m above the base of the division. The underlying Upper sandstone division has yielded the *Tropaeum* ex gr. *arcticum-undatum* fauna, which includes *Aucellina aptiensis* (d'Orbigny) and *A. caucasica* (von Buch). This fauna was found to range to within a few feet stratigraphically below the disconformable and probably regionally unconformable upper contact of the division. Therefore, only the basal 100 feet or so of the Albian shale-siltstone division, which only yielded long-ranging pelecypods and gastropods, could correspond to the *Pachygrycia*-bearing beds of the Arctic Red Formation of the more southerly areas. Because of the proximity of the Stony Creek-Vittrekwa River outcrops of the Albian shale-siltstone division to the crestal area of Aklavik Arch (see Jeletzky, 1961, p. 535, 577, Text-figs. 1, 22) and the erosional, presumably regionally unconformable nature of the contact between the Upper sandstone and Albian shale-siltstone divisions in that area, the writers assume that the *Pachygrycia* beds are absent there either by non-deposition or by subsequent erosion. This hypothesis agrees well with the reappearance of the *Pachygrycia* beds in the Big Fish River area northeast of Aklavik Arch.

In the Big Fish (=Fish River of Young 1972) area of the Arctic Coastal Slope, *Sonneratia*-like ammonites belonging to *Pachygrycia* sp. indet. (e.g. GSC loc. 87960) were found in the ferruginous, phosphate-rich unit that was informally named the Bedded ironstone and shale member by Young (1972, p. 231, 232, Fig. 1). So far as known, the *Pachygrycia* sp. fauna is restricted to this member, which oversteps older rocks of the Aptian-Albian flysch division eastward until it comes to rest unconformably on the Upper sandstone division a short distance east of Mount Davies Gilbert. The intervening Concretionary silty mudstone member of the Big Fish River area (Young, 1972, p. 232, Fig. 1) is correlative with the Chert conglomerate unit of Blow Pass area (Jeletzky, 1971a, p. 209, 210; 1975a, p. 26) and appears also to be of *Pachygrycia* age. Because of the absence of diagnostic fauna in the upper beds of the underlying Upper sandstone division, the duration of the hiatus that separates it from the Concretionary silty mudstone member cannot be estimated.

In the northwestern Richardson Mountains and adjacent parts of the Blow Pass area *Pachygrycia canadensis* n. sp. (e.g. GSC loc. 86841; Pl. 1, fig. 2) was found near the top of the Upper shale-siltstone unit of the Upper Aptian-Lower Albian flysch division (Jeletzky, 1971a, p. 209, 210; 1975a, p. 26). These beds are, therefore, correlative with the Bedded ironstone and shale member of the Big Fish River area. The next older Chert conglomerate unit of the division is probably of the same age because it is apparently correlative with the *Pachygrycia* sp.-bearing Sharp Mountain Formation of the eastern Keele Range (Jeletzky, 1975a, p. 26; 1975b, p. 242, Fig. 3 and below). The Chert conglomerate unit of the Blow Pass area overlies, presumably disconformably, the Sandstone unit of the Upper Aptian-Lower Albian flysch division, which contains the presumably Aptian *Inoceramus* cf. *neocomiensis* d'Orbigny (Jeletzky, 1971a, p. 209). This unit and the underlying Lower shale-siltstone unit of the division are correlative with the upper part of the Upper sandstone division of the Rapid Creek area to the east.

The Upper Aptian-Lower Albian flysch division of the northwestern Richardson Mountains did not yield any Albian ammonites younger than *Pachygrycia*. However, the next younger, predominantly argillaceous shelf-like unit of the division is lithologically similar to and presumably correlative with the upper lower Albian *Beudanticeras (Grantziceras) glabrum*-bearing concretionary shale outcropping on the lower Bell River (Jeletzky, 1975a, p. 26). This shale is, in turn, lithologically similar to and presumably correlative with the *Arcthoplites* cf. *belli*-bearing concretionary shale of the Albian argillaceous division outcropping on Waters River and its confluents (Young, 1975, p. 317, 318, Fig. 5; see earlier in this section for further details).

Pachygrycia sp. previously identified as *Sonneratia* s. lato by Jeletzky (1975b, p. 241, Fig. 3) was also recovered from unit 3 of the conglomeratic Sharp Mountain Formation in the eastern Keele Range, northern Yukon Territory. As already mentioned, this unit is correlated with the Chert conglomerate unit of the Upper Aptian-Lower Albian flysch division of the Blow Pass area. The Sharp Mountain Formation did not yield any other diagnostic Albian faunas and its stratigraphic relationships with the older Lower Cretaceous rocks of the region are obscure because an extensive covered interval separates its lowermost exposed beds from the Upper Jurassic Porcupine River Formation (Jeletzky, 1975b, p. 242, Fig. 3). This interval most likely conceals a regional unconformity.

Well preserved specimens of *Pachygrycia canadensis* n. sp. have been collected by oil company geologists (GSC loc. 39512; Pl. 1, figs. 1A-1D, Pl. 3, figs. 2A-2F), on Purkis Creek, north of Blow Pass. Other less satisfactorily preserved specimens, apparently

referable to *P. canadensis* n. sp. (e.g. GSC loc. 86779), were collected in the same area by Jeletzky. These specimens were found in argillaceous rocks presumably corresponding to the upper part of the Upper shale-siltstone unit of the Upper Aptian-Lower Albian flysch division of Jeletzky (1971a, p. 209, 210). However, the sections concerned are extremely faulted and contorted so that it was impossible to work out the stratigraphic relationships of these argillaceous beds with the conglomeratic beds of the division presumably corresponding to the Chert conglomerate unit of the Blow Pass area.

Poorly preserved ammonites identified as *?Sonneratia* (sensu lato) n. sp. A by the writer (i.e. GSC loc. 87917 in Young, 1973, p. 280) have been found in the sandstone overlying the basal conglomeratic unit of his "Aptian-Albian Flysch Sequence" on the highland situated between Blow River and Purkis Creek. These ammonites appear to be referable to *Pachygrycia* sp. They indicate the basal Albian age of this sandstone unit and inferentially of the underlying basal conglomeratic unit of the flysch sequence. The stratigraphic position of the latter is suggestive of a general equivalence with the Chert conglomerate unit of the Blow Pass area and with the lower part of the Sharp Mountain Formation of the eastern Keele Range. The shale formation that underlies this basal conglomeratic unit (Young, 1973, p. 280) presumably is equivalent to the Lower shale-siltstone unit of the flysch division in the Blow Pass area (Jeletzky, 1971a, p. 209, 210).

In the Mackenzie Delta *Pachygrycia canadensis* n. sp. (GSC loc. 87570; Pl. 2, fig. 5) was found in the core of Gulf-Mobile E Reindeer G.-04 Well situated in Caribou Hills at Lat. 68°53'15.94"N; Long. 133°46'03.28"W at the depth of 6,276 feet. This is the first subsurface occurrence of *Pachygrycia canadensis*. It was not previously used to corroborate the dating and correlation by microfaunas at that depth.

The *Pachygrycia* fauna is known in the Canadian Arctic Archipelago only from Banks Island. There, poorly preserved *Sonneratia*-like ammonites collected by oil company geologists at GSC locs. 47019 and 75254 (e.g. Pl. 4, fig. 6) are referrable to *Pachygrycia* cf. *canadensis* n. sp. These ammonites were found in the Christopher Formation on Thomsen River. The *Arcthoplites* cf. *belli* and *"Gastroplites"* (now *Pseudopulchellia;* see Fig. 1) faunas are found in the upper part of the Christopher Formation in that area (Thorsteinsson and Tozer, 1962, p. 65), so these representatives of *P.* cf. *canadensis* n. sp. are inferred to have been derived from its lower part.

Age and intercontinental correlation

Historical remarks. The Lower Cretaceous ammonites from the interior of Western Canada were first described by Whiteaves as *Buchiceras cornutum* (1885) *(=Neogastroplites cornutus); Placenticeras liardense* (1889) *(="Paragastroplites" liardensis)* and, in 1893, *Desmoceras affine (=Beudanticeras (Grantziceras) affine), Desmoceras affine* var. *glabrum (=Beudanticeras (Grantziceras) glabrum), Hoplites mcconnelli (=Arcthoplites mcconnelli)* and *Hoplites canadensis (=Gastroplites canadensis).*

Although further subdivisions have been made, these ammonites formed the basis of zonation of western Canadian Lower Cretaceous faunas for many years (e.g. Warren, 1937, 1947; McLearn and Kindle, 1950; Mellon and Wall, 1956; Stelck et al., 1956; Jeletzky, 1964, 1968, 1971b, 1975b). This zonation covering much of the Albian stage is, in descending order:

Neogastroplites spp. Zone
"Paragastroplites" liardensis Zone
Gastroplites spp. Zone; and
Arcthoplites spp. (formerly *Beudanticeras-Subarcthoplites* or *Lemuroceras-Beudanticeras (Grantziceras) affine*) Zone.

Following the discovery of *Sonneratia*-like ammonites on the lower Mackenzie River (Warren, 1947), it was soon realized (Stelck et al., 1956, p. 9) that these new ammonites represented a faunal horizon older than the *Arcthoplites* Zone but probably within the Albian and/or uppermost Aptian. Historically, Warren (1937) considered *Beudanticeras affine* to be Aptian, as Spath (1923-1942) had referred *Hoplites mcconnelli*, which occurs with the former species, to the Aptian genus *Deshayesites* Kazansky. However, Stelck et al. (1956, p. 9) had moved this species of *Beudanticeras* into the Middle Albian *Douvilleiceras mammillatum* Zone (now the upper part of the lower Albian; see Casey, 1961, Tab. 1) and had placed two other faunas, *Cleoniceras* cf. *subbaylei* Spath (= *Grycia* n. sp.) and *Sonneratia* cf. *kitchini* Spath (= *Pachygrycia canadensis* n. gen. et n. sp.) into the lower Albian. Casey (1954, p. 110) had questioned whether *Sonneratia* occurred in North America and his doubts are fully confirmed by the results of this study.

Jeletzky (1964, Table 1; 1968, p. 16, 17, Table 2; 1971b, p. 8, 42, Fig. 2) was apparently the first to suggest that the generalized *Arcthoplites* spp. Zone (then named *Lemuroceras* or *Beudanticeras affine* Zone) is partly correlative with the earliest Albian *Leymeriella tardefurcata* Zone of the European standard. At the same time Jeletzky (loc. cit.) continued to correlate the underlying *Cleoniceras* cf. *subbaylei* and *Sonneratia* cf. *kitchini* zones with the larger part of that European zone following Stelck et al. (1956, p. 9). In a later paper Jeletzky (1975b, p. 241) changed his mind. He returned the whole of the *Arcthoplites (=Lemuroceras auctorum)* spp. Zone into the late early Albian (sensu Casey, 1961 non Spath, 1923-42) and correlated it with either all or most of the *Douvilleiceras mammillatum* Zone. The underlying *Sonneratia* (sensu lato) n. sp. A Zone was correlated (Jeletzky, 1975b, p. 241): "with either (most likely) the upper part of the *Leymeriella tardefurcata* zone or ?the lower part of *Douvilleiceras mammillatum* zone of the European standard." This now discarded (see below) hypothesis was advanced because of the presence of a widespread discordance and a hiatus at the base of the *Sonneratia* (sensu lato) n. sp. A Zone. The *Cleoniceras (Grycia)* cf. *subbaylei* Zone was treated as a faunal facies of the *Arcthoplites* spp. Zone.

Age and correlation. In the writers' opinion the *Pachygrycia* fauna is of a pre-mid *tardefurcata* age as it occurs stratigraphically below the beds carrying *Freboldiceras, Arcthoplites* and *Grantziceras*. Representatives of these three genera either closely related to or specifically identical with their Canadian representatives are associated in Spitzbergen with faunal elements of the mid-*Leymeriella tardefurcata* Zone (i.e. its Milletianus Subzone), such as *Leymeriella germanica* (Nagy, 1970, p. 20).

The lower age limit of the *Pachygrycia* Zone is more difficult to ascertain than its upper time limit, as the youngest diagnostic fauna known to occur in the immediately underlying Upper sandstone division (see in the preceding section for further details) contains *Tropaeum* n. sp. aff. *arcticum* (Stolley, 1912), *T. undatum* Whitehouse 1926 and *T. australe* (Moore 1856). These forms, which were figured and briefly described by Jeletzky (1964), are closely related to and presumably contemporary with the *Tropaeum* forms found in the *Tropaeum subarcticum* Subzone of Casey (1961, p. 497, Table 1) in the lower part of the *Parahoplites nutfieldiensis* Zone of the European standard. This late, but not latest, Aptian fauna is known to range up to within a couple of metres of the top of the Upper sandstone division in those sections where it disconformably underlies the *Pachygrycia*-bearing beds.

The above stratigraphic relationships of the *Pachygrycia* fauna indicate its being either of the latest Aptian (i.e. *Hypacanthoplites jacobi* Zone; see Casey, 1961, p. 497, Table 1) or of the earliest Albian (i.e. the lower part of the *Leymeriella tardefurcata* Zone) age. However, an erosional disconformity, which apparently reflects a regional discordance (see p. 11 and Figure 1 for further details), separates the *Parahoplites nutfieldiensis*-aged uppermost beds of the Upper sandstone division from the *Pachygrycia*-bearing beds of the Bedded ironstone and shale member and equivalent shallow water units of eastern Richardson Mountains. In the mid-basinal Aptian-Albian sections of northern Yukon Territory where the Upper sandstone division and its argillaceous equivalents appear to grade imperceptibly into the *Pachygrycia*-bearing beds, its *Tropaeum*-bearing (i.e. *P. nutfieldiensis*-aged) beds are separated from the *Pachygrycia*-bearing beds by thick intervals of rocks devoid of any diagnostic fossils (e.g. in the headwaters of Blow River, those of the Rapid Creek, and in Bell Basin). Therefore, the authors assume that the equivalents of the uppermost Aptian *Hypacanthoplites jacobi* Zone are either absent or unfossiliferous in all hitherto studied late Aptian-early Albian sections of northern Yukon Territory and the Northwest Territories and that the superjacent *Pachygrycia*-bearing beds of these regions are of earliest Albian age (Figure 1). The transgressive basal Cretaceous beds of the Liard region and the lower Mackenzie River region are also assumed to be of the basal Albian age because they carry the *Pachygrycia* fauna.

The status of Pachygrycia fauna

The information presented in the preceding sections indicates that representatives of the genus *Pachygrycia* are widespread in the northern part of the mid-western region of Canada and are confined to a narrow interval of presumably lowermost Albian beds everywhere in that region (Figure 1). The principal occurrences of *Pachygrycia* fauna are indicated in Figure 2. This fauna, which was previously known as *Sonneratia* cf. *kitchini* or *Sonneratia* (sensu lato)? n. sp. A fauna, obviously is of a zonal rank. It is so treated in this paper and the beds bearing it are named the *Pachygrycia* Zone. This regional ammonite zone may possibly prove to be subdivisible on a subzonal basis at least. *Pachygrycia canadensis* n. sp. has not been found either in association with, or in the same profile with, the morphologically distinctive *P. warreni* n. sp.; nor are any transitional forms between these two species known to date. However, it would be premature to treat these *Pachygrycia* species as potential subzonal indices at present as their apparent segregation could have been caused instead by ecological control of some kind. For example, the lower whorled, almost sphaeroidally shaped *P. warreni* n. sp. could have been an inhabitant of the shallow water zone as it seems to be restricted to the marginal facies of the earliest Albian basin of mid-western Canada (i.e. the Lower Mackenzie Plains). The considerably more slender-whorled *P. canadensis* n. sp. could have been an inhabitant of the deeper water. It was so far only found in argillaceous rocks of the outer shelf zone (e.g. the Liard River area, the Upper Peel-Arctic Red River area and the Bell Basin) and turbidites of the upper bathyal zone (e.g. the flysch trough of western Yukon; see Jeletzky, 1971a, p. 209, 210; 1975a, p. 25-27, 40, 41, Figure 16; Young 1972, 1973 for further details) of the same basin. Because of these considerations, the hypothesis of an environmental control of the distribution of the above mentioned *Pachygrycia* species is presently favored by the writers.

Palaeogeography

All presently known occurrences of the *Pachygrycia* fauna, with the exception of those on the Banks Island, are confined to the northern part of the western interior region of Canada. With only the exception of the northwesternmost occurrences in the headwaters of Blow River, the geographically marginal occurrences of the *Pachygrycia* fauna (i.e. those on the Jackfish River, (a tributary of the Liard River), the eastern Keele Range, the Sans Sault Rapids on the lower Mackenzie River north of Norman Wells and on Banks Island) are in a shallow water to littoral marine facies. Therefore, these marginal occurrences are assumed to be situated in reasonable proximity of the southern, western and eastern margins of the earliest Albian basin of mid-western Canada. The inferred configuration of this basin, which is shown in Figure 2, resembles closely that of the next older Aptian

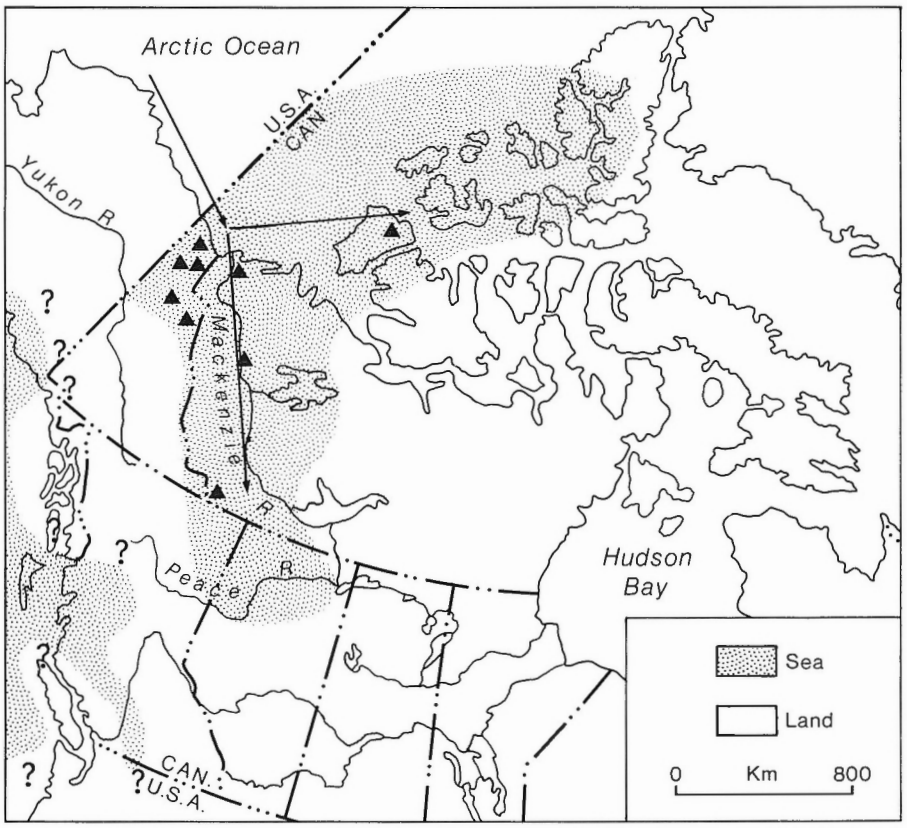


Figure 2

Earliest Albian paleogeography of western and Arctic Canada showing the inferred maximum extent of *Pachygrycia* and *Leconteites lecontei* (probably early only) seas.
Black triangles mark approximate positions of the most important (including all geographically extreme) localities of *Pachygrycia* fauna.
Black arrows indicate the inferred migration route of *Pachygrycia* into the Arctic and mid-western basins of Canada.

basin (Jeletzky, 1971b, p. 41, Fig. 8), except in the southernmost part. There the *Pachygrycia* sea must have covered most or all of the lower Mackenzie Plains and a considerable part of the upper Liard area. Furthermore, the *Pachygrycia* sea may have covered all of the Liard River Basin and extended into the northernmost parts of the Peace River and Lower Athabasca River areas where the basal beds of the Fort St. John Group and their equivalents are mostly devoid of diagnostic fossils.

Except on Banks Island, the *Pachygrycia* fauna is unknown in the lower part of the Christopher Formation, which underlies its upper lower Albian beds locally containing the *Arcthoplites* spp. fauna. However, the apparently gradational contact of the so far undated, marine Lower shale member of the Christopher Formation with its overlying palaeontologically dated Sandstone member and Upper shale member (Balkwill, in preparation; Jeletzky 1980) suggest the presence of the equivalents of the *Pachygrycia* beds in the former.

Nothing is known about the extension of the *Pachygrycia* sea beneath the present Beaufort Sea and in northern Alaska. However, it is assumed to have extended into these areas because of the deep water character of the *Pachygrycia*-bearing beds in the headwaters of Blow River (Jeletzky 1971a, 1975a; Young 1972, 1973), and the inferred northeast Siberian origin of *Pachygrycia* (see next section).

Paleobiogeography

As already mentioned, the *Pachygrycia* fauna appears suddenly in the mid-western basin of Arctic Canada and in the Banks Basin of the Canadian Arctic Archipelago. Furthermore, the underlying Aptian rocks of these basins (i.e. the Upper sandstone division and the basal beds of the Christopher Formation) did not yield any ammonites, which could have been interpreted as ancestral to *Pachygrycia*. This strongly suggests that *Pachygrycia* is a cryptogenic taxon in northern and Arctic Canada. It is inferred to have evolved out of the Aptian beudanticeratinids elsewhere and to have migrated into Arctic and mid-western Canada during the earliest Albian transgression.

As already pointed out, the *Pachygrycia* fauna is unknown in the Canadian Arctic Archipelago north and northeast of the Banks Basin (i.e. in the Sverdrup Basin proper), although the marine Aptian rocks appear to be present in the lower part of the Christopher Formation and to be connected by transitional beds with the overlying *Arcthoplites* spp. beds. Therefore, and because of the previously mentioned (p. 3, 5, 7) apparent presence of *Pachygrycia canadensis* n. sp. in the Anadyr'-Koriak Province of northeastern Siberia, *Pachygrycia* is interpreted to be a migrant from that province. Its apparent absence in the basal Albian rocks of northern Alaska (i.e. in the Fortress Mountain Formation and its equivalents) could be a failure in collecting. However, the predominantly non-marine to deltaic nature of these rocks on the Arctic Slope and Plain of Alaska suggests that *Pachygrycia* n. gen. migrated into the northwestern Yukon Territory and then into the midwestern basin of Canada via that offshore part of the Colville Trough situated beneath the present Beaufort Sea (Figure 2).

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PLATES 1-4

PLATE 1

(All figures natural size unless otherwise stated)

Figures 1A-1D. *Pachygrycia canadensis* n. gen. et n. sp. GSC paratype 64160, GSC loc. 39512. Basal Albian? *Pachygrycia* Zone. Upper Aptian-Lower Albian flysch division (=Aptian-Albian flysch sequence of Young, 1973, p. 230). Arctic slope of northern Yukon Territory. Collected by Texaco Exploration Co. of Canada, 1959 on a nameless tributary (now Purkis Creek) of Blow River, approximately 20 km east of Mount Fitton, from a 365-455 meters unit of dark-grey, rust brown-weathering siltstone with clay ironstone concretions. Fragment of adult phragmocone (?penultimate whorl). 1A. Lateral view of almost unweathered flank with some shell fragments. 1B. Lateral view of other, mostly weathered flank exposing very strongly indented, very closely spaced to overlapping suture lines typical of *Pachygrycia*. 1C. Ventral view. The apparent weakening of secondaries on the venter appears to be a matter of their strong weathering only. 1D. Cross-section of four whorls outlined in white. Note a gradual thickening of the whorl's cross-section in the course of ontogeny.

Figure 2. *Pachygrycia canadensis* n. gen. et n. sp., GSC paratype 64161, GSC loc. 86841. Basal Albian?, *Pachygrycia* Zone. Upper Aptian-Lower Albian flysch division of Jeletzky (1971a, p. 209, 210), Upper shale-siltstone unit, on float of its uppermost 100 m, northern Yukon Territory, northwest flank of Richardson Mountains, Bonnet Lake area. From a bluff on the southern bank of a nameless southeastern branch of Blow River, Lat. 68°16'30"N; 137°40'30"W. Lateral view of a strongly laterally deformed, presumably halfgrown (or ?micromorph) representative with the adapical part of the living chamber preserved.

Figures 3A-3C. *Pachygrycia canadensis* n. gen. et n. sp. University of Alberta, Edmonton paratype 3848, U. of A. loc. 38426a. Basal Albian?, *Pachygrycia* Zone. Upper Peel River area, northeastern Yukon Territory, at the base of an unnamed equivalent of the Arctic Red River Formation. Collected by D. Bruce Bullock and Associates "on a nameless tributary to Margery Creek, east of dome, east of the fault." An almost undeformed but somewhat weathered whorl of a presumably halfgrown (or ?micromorph) representative with the apicalmost part of the living chamber preserved. 3A. Lateral view of the best preserved flank. 3B. Ventral view of the oralmost third of the whorl. 3C. Apicalmost preserved part of the whorl exhibiting a typical lateral lobe (marked L; compare Pl. 4, fig. 3) with a very broad and short stem and an asymmetrically bifid arrangement of principal branches, X3.

Figures 4A-4C. *Pachygrycia canadensis* n. gen. et n. sp. Holotype, GSC 17389, GSC loc. 25502. Basal Albian?, *Pachygrycia* Zone. Collected by the Shell Oil Co. of Canada Ltd. at the base of the Cretaceous Garbutt Shale overlying the Mississippian rocks. Upper Liard region, Northwest Territories, northeast side of Jackfish River at about Lat. 60°58'N.

Large, presumably adult (possibly macromorph) morphologically typical representative with about a half whorl of strongly deformed living chamber preserved. The phragmocone is but slightly deformed. 4A. Lateral view. Internal cast with considerable patches of poorly preserved shell matter. 4B. Ventral view of the almost deformed earliest exposed third of the whorl and the cross-section of its strongly deformed oral end. 4C. Cross-section of the whorl's middle with the cross-section of the preceding whorl and the poorly preserved ventral view of the next older (third before the adult ultimate) whorl. The latter appears to be smooth (except for the barely visible constriction) and *Grantziceras*-like shaped.

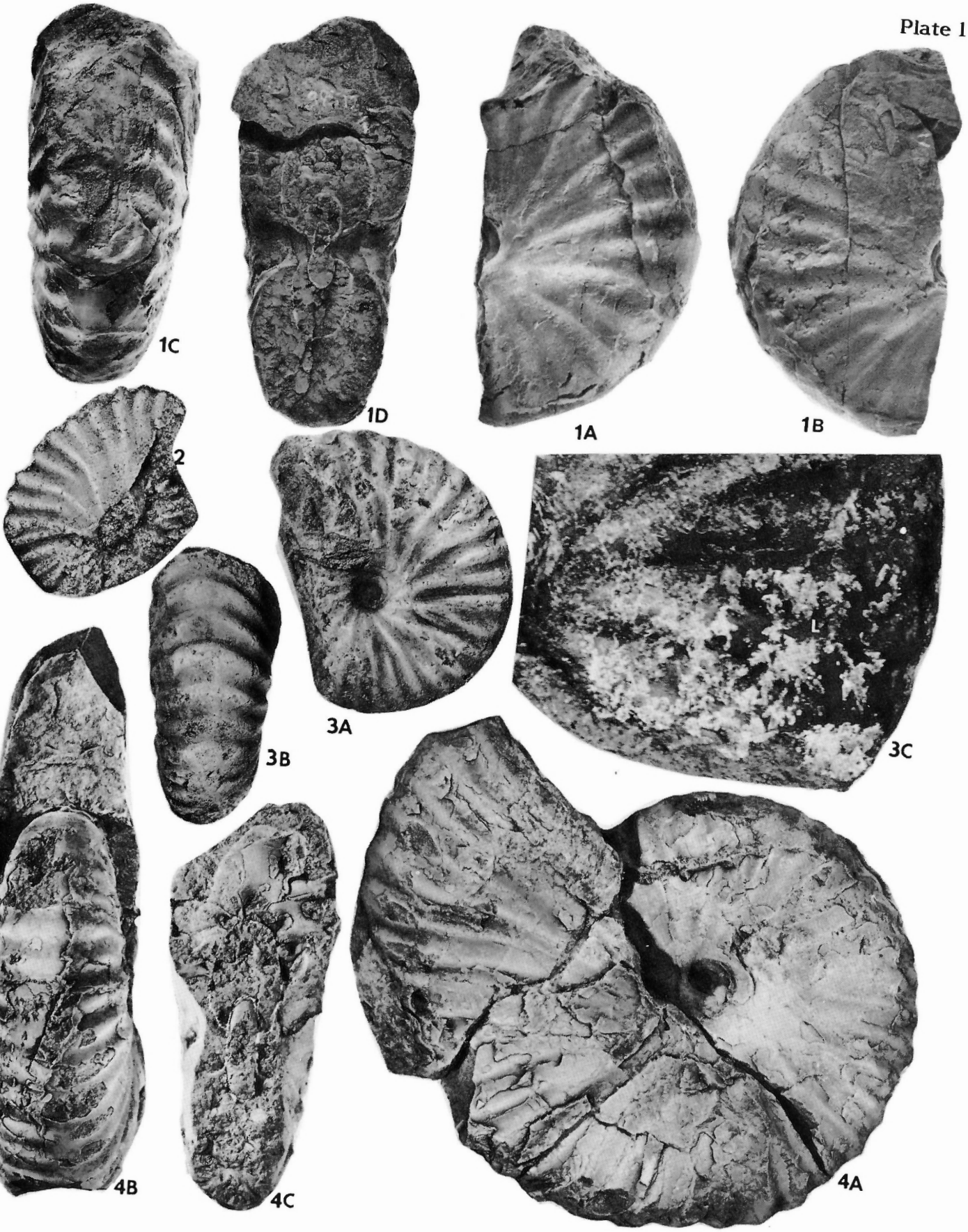

1C
1D
1A
1B
2
3A
3C
3B
4B
4C
4A

PLATE 2

(All figures natural size)

Figures 1A-1B. *Pachygrycia warreni* n. gen. et n. sp. Holotype, GSC 64162, GSC loc. 84792. Basal Albian?, *Pachygrycia* Zone. Sans Sault Formation. Collected by C. Yorath, Geological Survey of Canada, 1969 at Sans Sault Rapids on lower Mackenzie River, Northwest Territories, Lat. 65°42'N; Long. 128°47'W. Section 13, unit 10, 1,262-foot level.

An internal cast of a deformed, adult living chamber and almost completely crushed oralmost part of the phragmocone. 1A. Lateral view of the better preserved flank. 1B. Lateral view of the other flank, which exposes an internal cast of a segment of the penultimate whorl ornamented similarly to the living chamber.

Figure 2. *Pachygrycia canadensis* n. gen. et n. sp., GSC paratype 64163, GSC loc. 55170. Basal Albian?, *Pachygrycia* Zone. Arctic Red River Formation. Collected by D.K. Norris, Geological Survey of Canada, in 1962 on Snake River, northeastern Yukon Territory; Lat. 65°47'N; Long. 133°16'W. Lateral view of an almost completely flattened but otherwise well preserved, fully septate intermediate whorl.

Figures 3A-3B. *Pachygrycia warreni* n. gen. et n. sp. Univ. of Alberta paratype 226, Ct. 991 (42,200). Basal Albian?, *Pachygrycia* Zone. Basal beds of Sans Sault Formation. Collected by J.M. Parker, Canol Expedition, 1942 from Big Island below Sans Sault Rapids, lower Mackenzie River, Northwest Territories. A fragment of one flank of the adult living chamber and adjacent oralmost segment of the phragmocone preserved as an internal cast. 3A. Lateral view. 3B. Ventral view of the undeformed segment of the phragmocone. The secondary ribs do not actually weaken on the midventer.

Figures 4A-4C. *Pachygrycia warreni* n. gen. et. n. sp. Univ. of Alberta, Edmonton, paratype 225, Ct. 990 (42,200). The same age, formation and fossil locality as the specimen reproduced in Fig. 3. A fragment of undeformed, wholly septate, ?penultimate whorl. 4A. Ventral view. 4B. Lateral view of better preserved flank. 4C. Oral cross-section.

Figure 5. *Pachygrycia canadensis* n. gen. et n. sp., GSC paratype 64164, GSC loc. 87570. Basal Albian?, *Pachygrycia* Zone. Unnamed Albian shale unit. Northeastern rim of Mackenzie Delta, Caribou Hills, Northwest Territories. Gulf-Mobile E. Reindeer G.-04 Well, Lat. 68°53'15.94"N; Long. 133°46'03.28"W, depth 6,276 feet. Lateral view of a segment of a strongly deformed (almost flattened) but otherwise well preserved, fully septate, intermediate whorl.


1A
2
3A
3B
4B
4A
4C
5
1B

PLATE 3

(All figures natural size unless otherwise stated)

Figures 1A-1B. *Pachygrycia warreni* n. gen. et n. sp. Holotype, GSC 64162, GSC loc. 84792. See Pl. 2, fig. 1 for details of the age, formational assignment and fossil locality of this specimen. 1A. Ventral view of the oral part of the whorl. Most secondary ribs are distinctly weakened on the mid-venter which may possibly be a matter of preservation only. 1B. Cross-section of the least deformed middle part of the whorl and that of the mouth border.

Figures 2A-2F. *Pachygrycia canadensis* n. gen. et n. sp., GSC paratype 64165, GSC loc. 39512. The same collector, formation, and fossil locality as for the specimen reproduced in Pl. 1, fig. 1. 2A. Lateral view of the specimen with the segment of the outer whorl reproduced in Fig. 2C taken off. 2B. An oblique ventral view of the earliest exposed whorl of the specimen and that of the cross-sections of its two outer whorls. The outermost segment reproduced in Fig. 2C is not included. The earliest exposed part of the innermost whorl is smooth whereas the rest is only feebly sculptured but bears *Grantziceras*-like constrictions. 2C. Oralmost preserved, strongly deformed part of the specimen, which is removed in its other reproductions. Note the unusually heavily built and widely spaced appearance of secondary ribs of this ?penultimate whorl, which are somewhat transitional to those of *P. warreni* n. gen. et n. sp. 2D. Ventral view of the oralmost part of the innermost exposed whorl. 2E. Lateral view of the exposed part of the smooth to feebly sculptured innermost whorl, X3 to show details of its external suture line, which already exhibits a characteristically wide and short-stemmed, asymmetrically bifid lateral lobe. 2F. Oblique ventral view of the same whorl as in Fig. 2E, X3 to show details of its external suture line and sculpture.

Figure 3. *Pachygrycia?* n. sp. indet. A. University of Alberta, Edmonton, Cat. No. 3849, Ste. 6557 (43,703). ?Basal Albian, *?Pachygrycia* Zone. Unnamed Albian unit presumably equivalent to Sans Sault Formation. Collected by F.A. McKinnon, Canol Expedition, 1942 on Ramparts River, lower Mackenzie area, Lat. 65°28'N; Long. 130°30'W. Lateral view of the only preserved flank of the specimen.

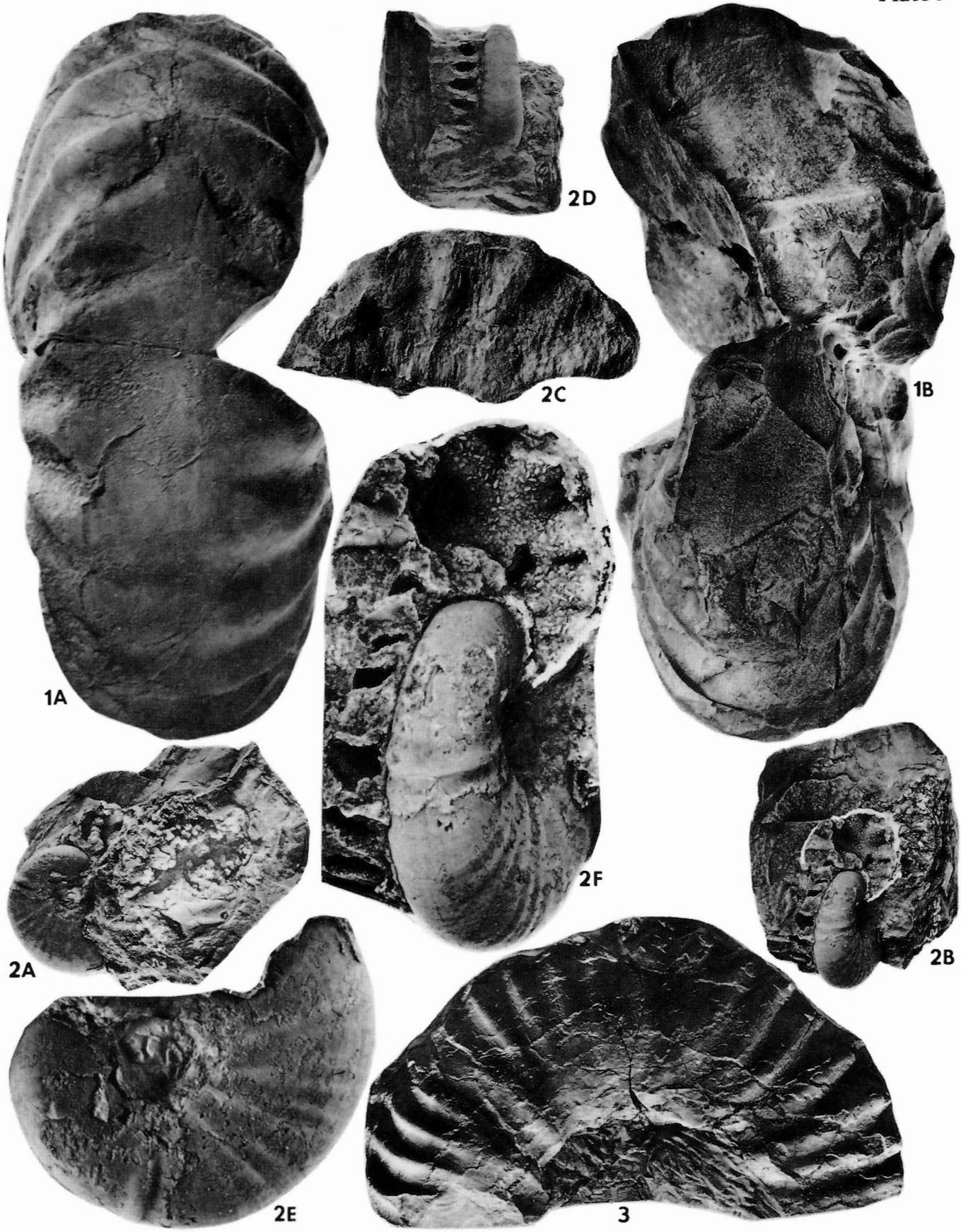

1A
1B
2A
2B
2C
2D
2E
2F
3

PLATE 4

(All figures natural size unless otherwise stated)

Figures 1A-1E. *Pachygrycia canadensis* n. gen. et n. sp. Holotype. GSC 17389, loc. 25502. See the description of Pl. 1, fig. 4 for further details concerning the age, zonal assignment and locality of this specimen. 1A. Lateral view of the flank opposite to that shown in Pl. 1, fig. 4A. 1B. Oblique view of the oralmost part of the phragmocone of the flank shown in fig. 1A, X2. The illustrated segment is situated closely adapically to the beginning of the living chamber indicated by arrow in fig. 1A. The surface is unwhitened and smeared with monochlornaphthalene to outline the otherwise invisible auxiliary lobes A2 to A6 drawn in fig. 1D. The first auxiliary lobe A1 is dimly visible at the extreme right margin of the photograph. 1C. Oblique lateral view of the same part of the phragmocone as in fig. 1B, X2. Unlike photograph 1B, this photograph is centered and focused at the adventral part of the flank exposing the lateral (L) and first auxiliary (A1) lobes. The surface is unwhitened and smeared with monochlornaphthalene to outline the otherwise invisible suture lines. Note the strongly and deeply indented, strongly crowded and partly overlapping character of these adult external suture lines. The lateral lobe is pronouncedly asymmetrically trifid and very wide stemmed. 1D. Camera lucida drawing of two of the suture lines reproduced in figs. 1B and 1C, X2.5 (approxim.). 1E. Lateral view of the septate part of the flank reproduced in its entirety in Fig. 1A. This natural size photograph, which was taken of unwhitened specimen smeared with monochlornaphthalene, is introduced to illustrate the overall morphology of adult external suture lines of *P. canadensis* n. gen. et n. sp.

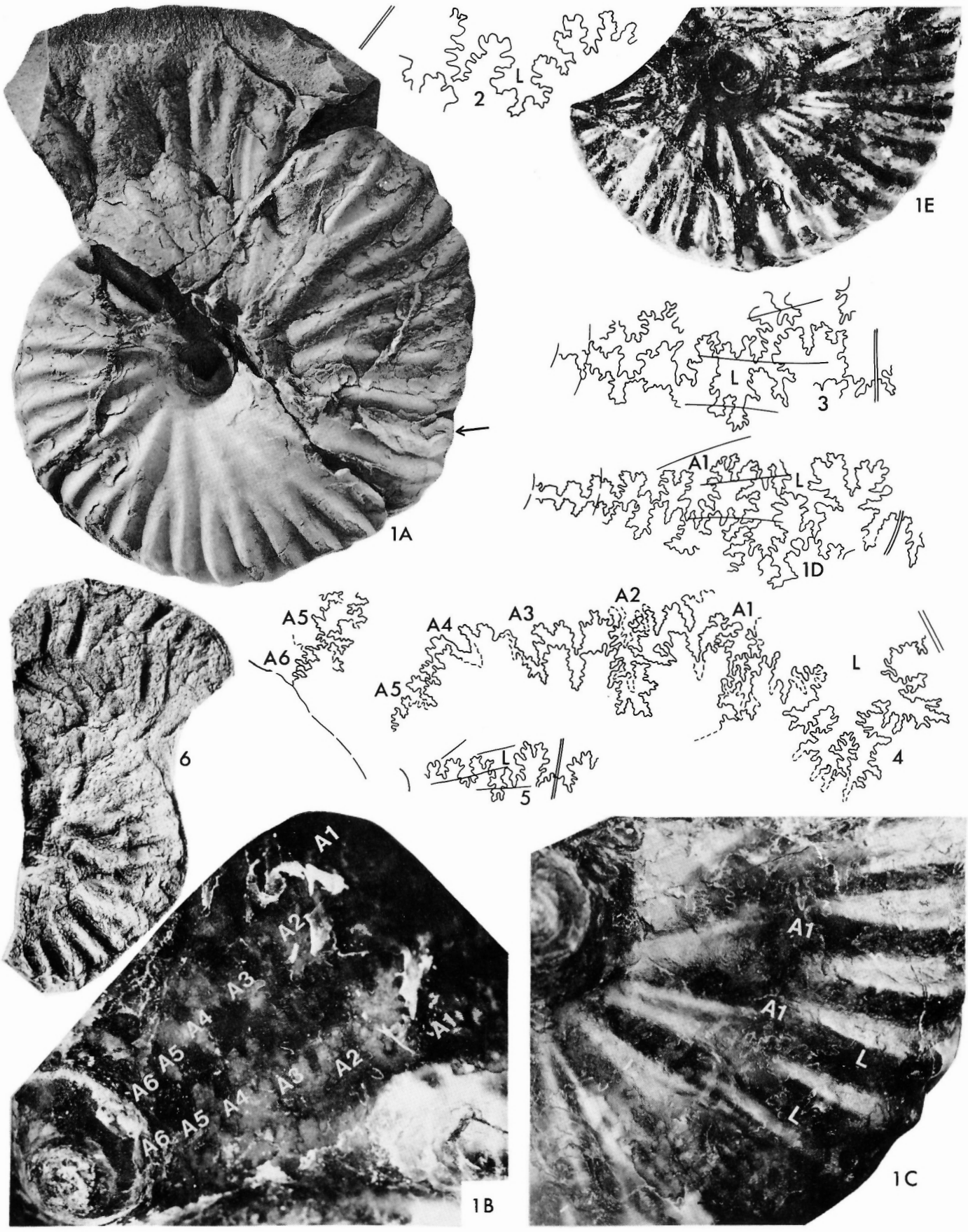
Figure 2. *Pachygrycia canadensis* n. gen. et n. sp. Paratype GSC 64166, GSC loc. 55170. This otherwise unfigured adult specimen is from the same locality as that reproduced in Pl. 2, fig. 2. See description of that figure for further details of its age, zonal assignment and locality. Camera lucida drawing of one of the adult lateral lobes in the proximity of the living chamber. Note the pronouncedly asymmetrically trifid appearance of the lateral lobe with a wide stem and an almost transversally oriented principal adventral branch, X3 (approxim.).

Figure 3. *Pachygrycia canadensis* n. gen. et n. sp. Paratype. U. of A., Edmonton paratype 3848, loc. 38426a. See description of Pl. 1, fig. 3 for further details concerning the age, zonal assignment and locality of this specimen. Camera lucida drawing of the apicalmost preserved suture line visible in Pl. 1, figs. 3A, 3C, X3 (approx.). This halfgrown external suture line has already acquired the very wide-stemmed, pronouncedly asymmetrically trifid lateral lobe and the close spacing of adjacent lines. However, it has only four auxiliary lobes. Lateral lobe is marked "L".

Figure 4. *Pachygrycia warreni* n. gen. et n. sp. U. of A. Edmonton, paratype 226, loc. Ct. 990 (42,200). See description of Pl. 2, fig. 4 for further details concerning the age, zonal assignment and locality of this specimen. Camera lucida drawing of parts of the two apicalmost preserved adult suture lines visible on the fragment (see Pl. 2, fig. 4C for the most distinct view). Ventral lobe is not included and the fifth (A5) and sixth (A6) auxiliary lobes are only visible in the fragment of another suture line situated farther adorally. This adult external suture line differs from the equivalent suture lines of *P. canadensis* n. gen. et. n. sp. (e.g. fig. 1D) only in stronger and deeper indentation coupled with greater crowding and overlap of adjacent suture lines, X3 (approxim.).

Figure 5. *Pachygrycia canadensis* n. gen. et. n. sp. Paratype GSC 64165, GSC loc. 39512. See description of Pl. 3, fig. 2 for further details concerning the age, zonal assignment and locality of this specimen. Camera lucida drawing of one of the late juvenile suture lines (at whorl diameter of 10 mm) clearly visible in Pl. 3, figs. 2E, 2F. Although its stem is relatively more narrow than those of the more advanced lateral lobes of the species, the lateral lobe of this suture line is asymmetrically bifid rather than asymmetrically trifid. This lobe is marked "L". The suture line probably has only four auxiliary lobes, X2.5 (approxim.).

Figure 6. *Pachygrycia* cf. *canadensis* n. gen. et n. sp. Paratype. GSC 64167, GSC loc. 75254. Basal Albian?, *Pachygrycia* Zone. Christopher Formation (presumably lower part). Banks Island, Northwest Territories, Thomsen River (no precise locality given). Collected by geologists of the Elf Oil of Canada Ltd. in 1966 (Field No. E30, 856). Photograph of a rubber mould prepared from an imprint of a completely flattened ?adult ultimate whorl. The ribbing habit is indistinguishable from that of typical representatives of *P. canadensis* (e.g. Pl. 1, fig. 3A; this plate, fig. 1A) but the suture line is invisible.


1A
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1B
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1C