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Late Triassic (Norian) Mollusks From the Taylor Mountains Quadrangle, Southwestern Alaska

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Abstract

We describe a diverse molluscan fauna of silicified fossils from two localities in the Taylor Mountains D–3 quadrangle of southwestern Alaska. The molluscan fauna consists of at least 8 species of bivalves, including 1 new species, *Cassianella cordillerana* McRoberts n.sp., and at least 11 species of gastropods, including 2 new species, *Neritaria nuetzeli* Blodgett n.sp. and *Andangularia wilsoni* Blodgett n.sp. Bivalve and gastropod affinities suggest an early Norian age, with taxonomic similarities to several southern Alaskan tectonostratigraphic terranes (for example, Alexander and Chulitna), as well as to the South American Cordillera of Peru. The mollusks are associated with numerous brachiopods that also support a Norian age and similar biogeographic affinities.

Introduction

Late Triassic faunas have been reported at several sites in southwestern Alaska, but little descriptive work has been published on macrofossils from this part of the State. The published work includes descriptions and illustrations of scleractinian corals, spongiomorphs and the hydrozoan *Heterastridium* from Lake Iliamna by Smith (1927) and Stanley (1979), and monotid bivalves by Silberling and others (1997, pl. 2) from the vicinity of Puale Bay on the Alaska Peninsula. All of these occurrences are in the Peninsular terrane. In this chapter, we provide the first formal description and illustration of Late Triassic mollusks (bivalves and gastropods) from rocks of the Farewell terrane in the Taylor Mountains D–3 1:63,360-scale quadrangle, southwestern Alaska (fig. 1). In addition, we discuss the broader paleogeographic implications of these fossils. Southern Alaska is composed of numerous accreted tectonostratigraphic (also referred to as lithotectonic) terranes (Jones and others, 1987; Silberling and others, 1994). Such paleobiogeographic data as those presented herein are extremely useful in constraining the past geographic positions of these mobile terranes over time, and so are of utmost utility in unraveling the tectonic history of this part of Alaska.

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Geologic Setting

The Farewell terrane of southwestern and west-central Alaska (fig. 1) was established by Decker and others (1994) as a tectonostratigraphic entity incorporating three previously named, genetically related terranes (Nixon Fork, Dillinger, and Mystic) that are relegated the status of subterranes of the Farewell terrane. The Farewell terrane is one of the largest terranes in southwestern Alaska, and recent evaluation of its biogeographically distinctive early and middle Paleozoic macrofaunas now indicates that it probably originated as a rifted continental-margin sequence derived from the Siberian Continent by a Devonian or slightly later rifting event (Blodgett and Brease, 1997; Blodgett, 1998; Blodgett and Boucot, 1999; Blodgett and others, in press; Dumoulin and others, in press).

Triassic strata of the Farewell terrane, which were deposited during the late Triassic, occur in two areas within the Nixon Fork subterrane and in one area of the Mystic subterrane. Upper Triassic strata of the Nixon Fork subterrane occur in the central part of the subterrane in the Medfra C–3 1:63,360-scale quadrangle (Patton and others, 1977, 1980; Silberling and others, 1997) and in the Taylor Mountains D–2 and D–3 quadrangles (fig. 1; Blodgett and others, 2000). Upper Triassic rocks of the Mystic subterrane occur in the Lime Hills C–6 1:63,360-scale quadrangle, where shale interbedded with a unit of pillow basalt and agglomerate has yielded ammonites and halobiid bivalves indicative of a late early to middle Norian age (Bundtzen and others, 1994).

Exposures in the Medfra C–3 quadrangle are similar to those in the Taylor Mountains D–2 and D–3 quadrangles, consisting of a lower interval of carbonate and minor siltstone beds succeeded by a gradationally overlying interval of dark-gray bedded chert. The chert is considered to be of latest Late

Triassic and possibly Jurassic age. The most detailed description of the Medfra succession was provided by Silberling and others (1997, p. 9), who reported a thickness of about 60 m for the lower carbonate-dominated unit and of about 100 m for the bedded-chert unit. Only the lower carbonate unit has yielded an identifiable fossil fauna, determined to be of Norian age, consisting of the bivalves *Monotis* and *Halobia* and the hydrozoan *Heterastridium* (the northernmost occurrence of the genus in North America). Monotid bivalves from several different levels in a 5- to 10-m interval of this unit were illustrated by Grant-Mackie and Silberling (1990) and Silberling and others (1997). Massive interbeds within and immediately overlying this fossiliferous interval within the lower unit were interpreted by Silberling and others (1997, p. 9) to represent debris-flow deposits within a deep-water sequence. No fossil fauna has been reported from the gradationally overlying chert unit. The entire Upper Triassic succession is unconformably underlain by Permian sandy limestone, grit, limy sandstone, and mudstone (Patton and others, 1977, fig. 18).

The fossils described herein are all from Late Triassic exposures in the Taylor Mountains D–2 and D–3 1:63,360-scale quadrangles, consisting of various rock types present in a deepening-upward succession, and differing from those in the Medfra quadrangle in being thicker and both lithologically

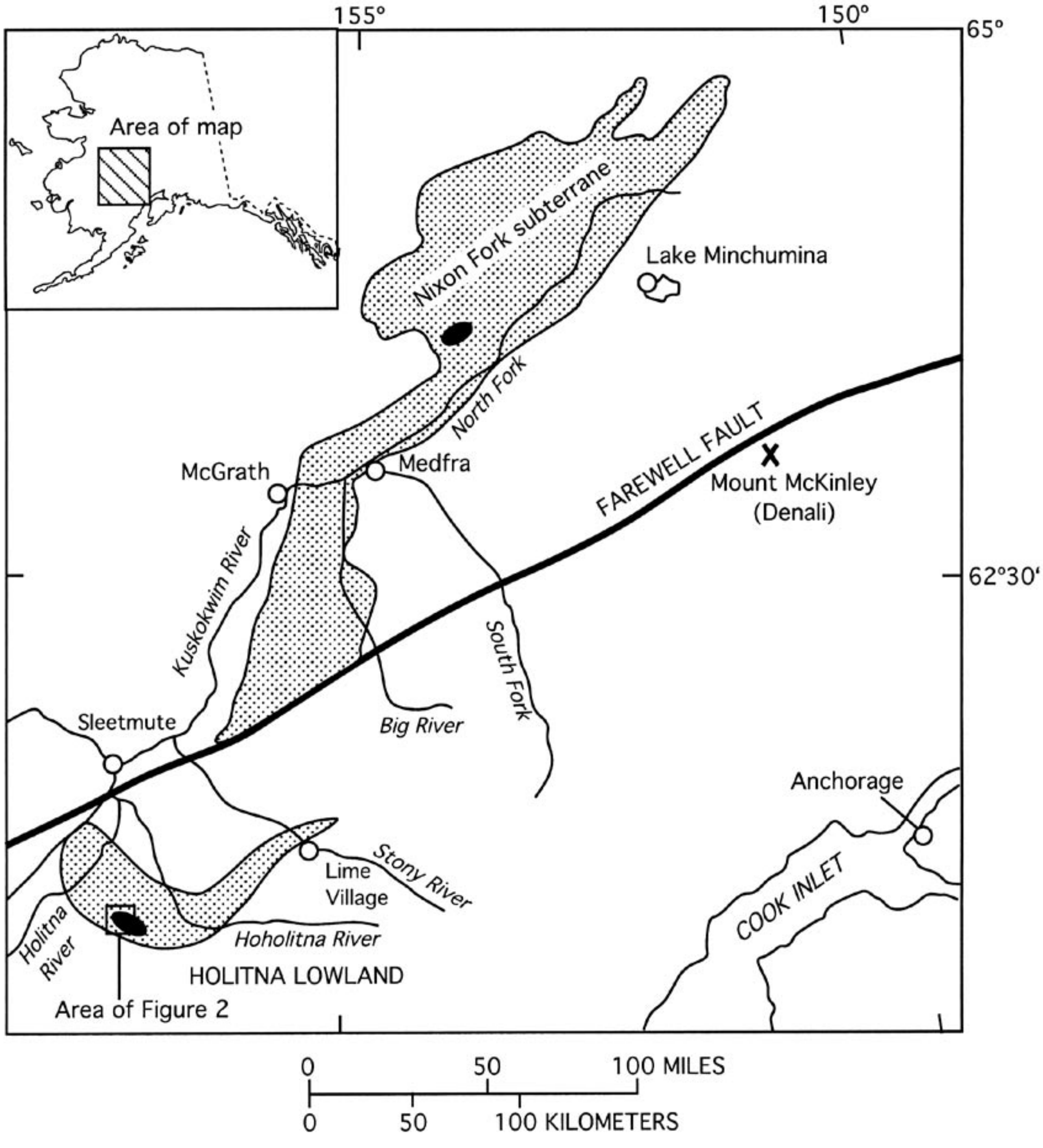

Figure 1. Study area in southwestern Alaska, showing locations of the Nixon Fork subterrane of the Farewell terrane (stippled areas) and two Upper Triassic outcrop belts referred to in text: (1) outcrop belt in the Taylor Mountains D–2 and D–3 quadrangles in the Holitna Lowland and (2) outcrop belt to the northeast in the northern Kuskokwim Mountains, Medfra C–3 quadrangle. Modified from Jacobson and others (1996).

and paleontologically more diverse. The Taylor Mountains Triassic outcrop belt, on the basis of several brief reconnaissance surveys, appears to contain three primary units. The lowest exposed unit consists of distinctive white to light-gray lime packstone containing scleractinian corals, indeterminate hydrozoans, and inozoan sponges of Norian age. The corals identified by G.D. Stanley, Jr. (in Blodgett and others, 2000), include *Astraeomorpha crassisepta*, possibly *Pamiroseris meriani*, *Rhaetiastraea* cf. *R. vesiculosa*, possibly "*Margarosmilia*" (*M. chalyana*?), ?*Distichophyllia* cf. *D. norica*, and *Procycolites* sp. This assemblage contains elements known from the Chulitna terrane of Alaska, other accreted terranes of western North America, and the former Tethys seaway. An excellent exposure of the Norian carbonates that is easily accessible by helicopter is situated in the NE¼SW¼NE¼ sec. 20, T. 10 N., R. 42 W., Taylor Mountains D–3 quadrangle. This lowermost unit is situated just south of conspicuous exposures of an Upper Silurian algal barrier-reef complex (a westward extension of unit Sab of Blodgett and Wilson, 2001, exposed in the northern part of the Taylor Mountains D–1 quadrangle); however, whether the units are in depositional or fault contact remains unclear at this time.

The next succeeding unit recognized in the Upper Triassic succession consists of yellow-orange- to yellow-gray-weathering silty limestone containing a richly diverse, silicified macrofauna of bivalves, brachiopods, and gastropods of late Norian age. This chapter is focused on a paleontologic study of the bivalve/gastropod portion of this fauna from two separate localities (1, 2, fig. 2) in the Taylor Mountains D–3 1:

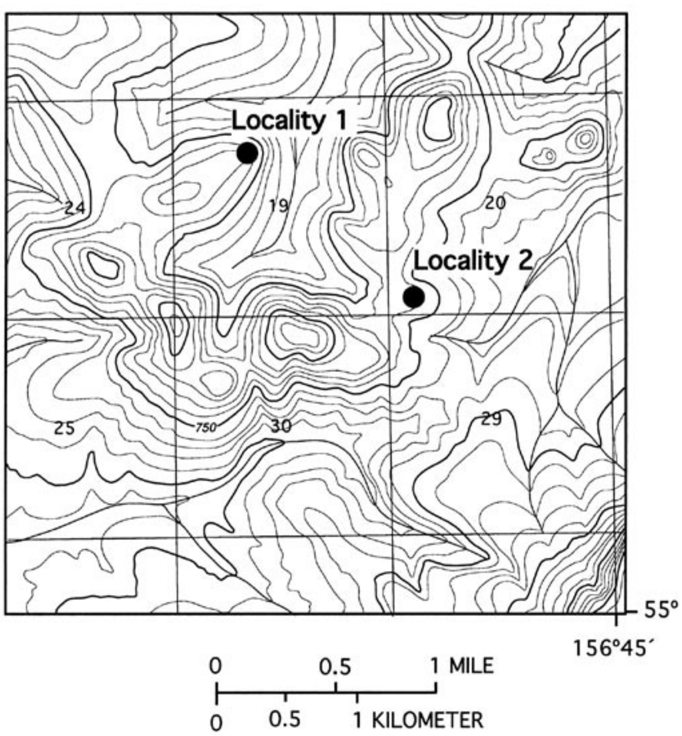

Figure 2. Part of the Taylor Mountains D–3 quadrangle, southwestern Alaska (see fig. 1 for location), showing both localities discussed in text.

63,360-scale quadrangle. The uppermost part of the succession is a thick sequence of medium- to thick-bedded siliceous argillite, chert, and minor lithic sandstone and (or) siltstone locally bearing undeformed, three-dimensional belemnoid cephalopods. The total thickness of the entire Upper Triassic succession is unknown because of the reconnaissance nature of the fieldwork conducted to date in the study area, the relatively poor quality of exposures in the dominantly tundra covered lowland, and the structural complexity of the regional geology, although a minimum thickness of 300 m is reasonable. No formal stratigraphic name has been applied to the Triassic rocks of the Taylor Mountains D–2 and D–3 quadrangles. These rocks were previously assigned to the now-abandoned Holitna Group of Cady and others (1955, pl. 1). This stratigraphic term was applied to all Paleozoic carbonates exposed along the middle course of the Holitna River and surrounding area; no subdivisions were designated for this group. Fossils of Silurian and Devonian age were reported by Cady and others, who inferred that Ordovician strata might also be present because of their occurrence in correlative rocks in the Medfra quadrangle to the northeast, as well as from the fact that the Silurian and Devonian fossils were recovered from only the upper part of the Holitna Group. They estimated the thickness of the group at 1,524 to 3,048 m (Cady and others, 1955, p. 24). On the basis of fieldwork conducted in the region since 1983, it is now obvious that this depositional sequence has a much greater total thickness and includes strata as old as Late Proterozoic and as young as Triassic. Adrain and others (1995, p. 724) suggested that the term "Holitna Group" was too broadly defined and should be abandoned in favor of better-divided stratigraphic units. LePain and others (2000) were the only workers who recognized Triassic strata in the Taylor Mountains D–2 and D–3 quadrangles; they designated these strata as unit Tzrlc (silty limestone and chert) on their geologic map and briefly discussed it (LePain and others, 2000, p. 9).

Fossil-Locality Descriptions and Repository

The two fossil localities reported on here (fig. 2) both occur in Upper Triassic (Norian) carbonate rocks of the Taylor Mountains D–3 1:63,360-scale quadrangle. All type and illustrated specimens are deposited at the University of Alaska Museum in Fairbanks.

Locality 1.—A conspicuous band of fossiliferous strata from the east end of a conspicuous rubble-crop exposure (approx 45 m wide) visible from the air, composed of yellow-orange-weathering, platy, silty lime mudstone beds that strike N. 45º W. and dip 25º NE. in the SW¼NE¼NW¼ sec. 19, T. 10 N., R. 42 W., Taylor Mountains D–3 1:63,360-scale quadrangle. Collected by R.B. Blodgett in 1984 and 1999, his field Nos. 84RB32 and 99RB35, respectively. Fossil fauna composed of numerous mollusks (bivalves, gastropods) and lesser brachiopods.

Locality 2.—Fossiliferous bed in the central part of a rubble-crop exposure of light-yellow-gray-weathering, platy, silty lime mudstone that strikes N. 85º E. and consists almost entirely of brachiopods and much rarer bivalves. Rubble crop is situated at the northwest end of a low ridge in the SW¼SW¼ sec. 20, T. 10 N., R. 42 W., Taylor Mountains D–3 1:63,360-scale quadrangle. Collected by R.B. Blodgett in 1999, his field No. 99RB37.

Systematic Paleontology

Class BIVALVIA Linné 1758

[Materials for this class were prepared by C.A. McRoberts]

Discussion.—A total of 8 distinct bivalve species (Table 1) are recognized from more than 150 individual specimens of varying preservational quality. From locality 1 (fig. 2), the most diverse fauna contains seven species: *Cassianella cordillerana* n.sp. (pl. 1, figs. 1–11). *Gryphaea arcuataeformis* Kiparisova, 1936 (pl. 1, figs. 12–19), *Maoritrigonia* sp. (pl. 1, figs. 20, 21), *Minetrigonia* cf. *M. suttonensis* (Clapp and Shimer, 1911) (pl. 1, fig. 22), *Minetrigonia* sp. (pl. 1, figs. 23, 24), *Tutcheria densestriata* (Körner, 1937) (pl. 2, figs. 1–6)*, Astarte* sp. (pl. 2, figs. 7, 8)*,* and *Septocardia* cf. *S. peruviana* (Cox, 1949) (pl. 2, figs. 9–14). All but one species (*Maoritrigonia* sp.) is from locality 1 (fig. 2).

The bivalves are dominated by shallow-burrowing infaunal suspension feeders within the orders Veneroida and Trigonoida. No infaunal detritus feeders (orders Nuculoida and Solemyoida) were identified. Although two epifaunal reclining bivalves are described (orders Pterioida and Ostreoida: Gryphaeidae), it is surprising that no epifaunal scallops (for example, Pectinoida) or cementing bivalves (for example, Ostreoida: Paleolophidae) were recognized because both bivalves are common in coeval mollusk-dominated faunas from low-latitude terranes (for example, Newton and others, 1987).

Except where indicated otherwise, higher-level systematic assignments and morphologic terms follow those of Cox and others (1969).

Subclass PTERIOMORPHIA Beurlen, 1944 [emend. Waller, 1978]

Order PTERIOIDA Newell, 1965

Family CASSIANELLAUDAE Ichikawa, 1958

Genus CASSIANELLA Beyrich, 1862

Cassianella cordillerana n.sp. (pl. 1, figs. 1–11)

?*Cassianella angusta* Bittner. Newton, 1986, pl. 2.1, figs. 1–5; Newton and others, 1987, p. 24, figs. 18.7–18.17, 19.1–19.17.

Material.—The collection consists of 42 specimens, all of which are left valves. All specimens are from locality 1 (fig. 2).

Etymology.—The species name refers to its only known occurrence in the North American Cordillera.

Diagnosis.—Large *Cassianella* specimens exhibiting broad umbo, smooth exterior with short anterior auricle possessing notch at lower junction with anterior flank, with centrally located triangular ligament pit and well-developed anterior septum.

Description.—Left valve of moderate size for genus (length of holotype, 17.9 mm; width of holotype, 9.9 mm), left valve exterior smooth, highly convex, and torted, with nearly centrally positioned incurved beak extending well above hinge margin. Central part of flank rounded and steeply sloping to posterior and anterior valve margins. Anterior auricle relatively short (5–7 mm), with upper surface slightly sloping (6º–12º) with respect to hingeline, and lower margin joining valve flank at around 120º (although in some specimens this angle may be as great as 160º). Anterior auricle separating from flank by a single furrow and, in at least two specimens, a lower anterior margin with a distinct notch (see pl. 1, figs. 5, 6). Posterior auricle is likely slightly more extended than anterior auricle and joins posterior flank at a more acute angle (approx 115º) and lacking a notch. Hinge plate broad and slightly concave, with numerous very fine lines paralleling hinge margin. Single triangular ligament pit conspicuous below beak is well developed in some valves (for example, pl. 2, fig. 9) and poorly so in others. Left-valve interior with anterior septum sloping obliquely from hinge plate to anterior-ventral position where auricle joins valve flank. Right valves unknown.

Remarks.—The species favorably compares with *Cassianella gravinaensis*, which Smith (1927) erected on the basis of poorly preserved internal molds from Gravina Island, southeastern Alaska. The new species differs from those described by Smith in that it is more upright, with a more extended anterior and posterior auricles and a straighter hingeline. Although this species compares well with *C. angusta* from the Carnian of northern Italy, the Carpathians, and Turkey (Bittner, 1891, 1895, 1901, Zardini, 1981), it has a distinctively broader umbo. Additionally, the Tethyan species clearly has a more anterior ligament pit, in contrast to the centrally located ligament pit of the new species. Although Newton (1986) and Newton and others (1987) assigned *Cassianella* specimens from Lower Norian rocks of the Wallowa terrane, Oreg., to *C. angusta*, they noted that their specimens were generally more compressed than their Alpine counterparts. *C. cordillerana* appears to differ less from the Wallowa material than from the Tethyan species in the positions of its ligament pit and anterior auricular notch, yet the Alaskan species has a typically more extended posterior auricle. This species also favorably compares with *C. beyrichi*, also from the Carnian St. Cassian fauna of northern Italy (Bittner, 1895; Zardini, 1981), but is considerably less inflated. *C. cordillerana* most certainly differs from the much-larger *C. lingulata* Gabb, well known from Rhaetian rocks of the New York Canyon section in west-central Nevada (Muller and Ferguson, 1939; Laws, 1982) and common in the Tyaughton Creek area of the Cadwaller terrane of British Columbia (McLearn,

Table 1. Norian bivalves from the Taylor Mountains quadrangle, Alaska.

[Life habits: B, byssate; F, free lying; M, mobile; Nb, non-siphonate burrower; R, reclining; S, suspension feeder; Se, sessile. Biogeographic affinities: AL, Alexander terrane; CH, Chulitna terrane; CR, North American craton; SA, South America; WA, Wallowa terrane; WR, Wrangellia composite terrane]

Taxon	Life habit	Biogeography
Astarte sp	MNbS	?WA, ?SA
Cassianella cordillerana n.sp	SeRBS	?WA
Gryphaea arcutaeformis Kiparisova	SeRF	AL, ?SA, CR
Maoritrigonia sp	MNbS	– – –
Minetrigonia cf. *M. suttonensis* (Clapp & Shimer)	MNbS	WR, WA
Minetrigonia sp	MNbS	– – –
Septocardia cf. *S. peruviana* (Cox)	MNbS	AL, CH, ?WA, SA
Tutcheria densestriata (Körner)	MNbS	WA, SA, WR

1942). Much systematic work needs to be done regarding the affinities of Late Triassic cassianellids, which are quite common through the Tethys, Panthalassa, and Arctic seas. For example, Krumbeck (1914) illustrated several smooth cassianellids (*Cassianella katialotica* and *C. verbeeki*) from Upper Ladinian or Lower Carnian rocks of Sumatra that, apart from their broad inflation and large size, are nearly identical to both *C. angusta* and *C. cordillerana*. As pointed out by Newton and others (1987), those species from the Arctic, such as *C. tectiformis* (Böhm, 1903), and from Siberia, illustrated as *C. lingulata* Gabb by Kiparisova and others (1966), are in need of further study.

Illustrated specimens.—Holotype, UAM No. 2591 (pl. 1, figs. 1, 2); paratypes, UAM Nos. 2592 through 2597 (pl. 1, figs. 3–11).

Order OSTREOIDA Férussac, 1822 [emend. Waller, 1978]

Superfamily OSTREACEA Rafinesque, 1815 [emend. Waller, 1978]

Family GRYPHAEIDAE Vyalov, 1936

Genus GRYPHAEA Lamarck, 1801

Gryphaea arcutaeformis Kiparisova, 1936 (pl. 1, figs. 12–19)

Gryphaea arcuataeformis Kiparisova, 1936, p. 133, pl. 4, figs. 1, 2, 4, 6–10; Kiparisova, 1938, pl. 7, figs. 17–21, pl. 8, figs. 1, 2, 11; Vyalov, 1946, p. 30, pl. 2, figs. 1–7, pl. 3, figs. 1, 2; Kiparisova and others, 1966, p. 157, pl. 27, figs. 14–17; McRoberts, 1992, p. 33, figs. 6.1–6.8.

Gryphaea chalkii McLearn, 1937, p. 96, fig. 8.

Material.—The collection consists of two right valves and more than 200 left valves. All specimens are from locality 1 (fig. 2).

Description.—Shells are moderately small (max height, 22.1 mm), somewhat narrow (mean height/width ratio, 0.74), moderately inflated (mean inflation/height ratio, 0.49), with a prosogyrous and occasionally strongly incurved umbo (mean height/periphery ratio, 0.68); posterior lobe moderately developed and conical; lobe separated from main part of shell by weak radial sulcus originating from just posterior of beak; surface generally smooth but sometimes covered with faint to moderate commarginal growth lines; attachment area (AA) commonly present but varying in size (0.5–2.8 mm). Right valve smaller than left, flat to slightly concave and spatulate, with moderately conspicuous commarginal growth lines.

Remarks.—The specimens illustrated here are similar in size, shape (fig. 3; table 2), and external sculpture to those of the syntypes (Kiparisova, 1936), as well as to other specimens of the species (see McRoberts, 1992). Statistical analysis of shape and size variables led McRoberts (1992) to include McLearn's (1937) *Gryphaea chalkii* within *G. arcuataeformis*. Additional specimens collected by the first author in the Norian Pardonet Formation of the Williston Lake area are also assigned to this species. Though similar in many regards to *G. keilhaui*, which mainly occurs in the Arctic regions of Spitsbergen, Russia, Canada, and Alaska (Böhm, 1903; Kiparisova and others, 1966; McRoberts, 1992), *G. arcuataeformis* has a significantly narrower left-valve breadth and less pronounced posterior flange. *G. arcutaeformis* is known from Carnian mudrocks of the Wallowa terrane, Oreg. (McRoberts, 1992), and probably also in Norian fauna of the Alexander terrane (Newton, 1983). It is also widespread in Carnian and Norian craton-bound strata mainly from middle to high paleolatitudes in northeastern British Columbia, Arctic Canada, and Siberia (Kiparisova and others, 1966; McRoberts, 1992). A possible Southern Hemisphere occurrence is in the Norian of Chile (Hayami and others, 1977).

Illustrated specimens.—UAM Nos. 2598 through 2602 (pl. 1, figs. 12–19).

Table 2. Left-valve measurements on *Gryphaea arcuataeformis* Kiparisova.

[AA, diameter of attachment area]

Height (mm)	Width (mm)	Periphery (mm)	Inflation (mm)	AA (mm)
15.6	10	24.5	8.8	2.3
18.4	12.7	27	9.8	1.1
20.4	15.9	33.5	9.7	2.1
12.3	9.6	18	5.4	.5
14.6	11.7	19	7.1	1.0
15.8	14.2	23	8.1	1.5
15.0	11.9	22	8.9	1.3
15.6	10.3	19.5	7.7	1.3
22.1	22.8	31	11.6	.6
17.5	12.1	38	8.8	.6
16.6	13	25	6.6	2.8
14.8	10.7	19	6.5	1.6
19.9	11.9	31	10	2.2
15.2	11.7	23	8.7	1.7
17.6	9.9	26	7.9	2.7
17.4	10.4	22	7.2	1.7

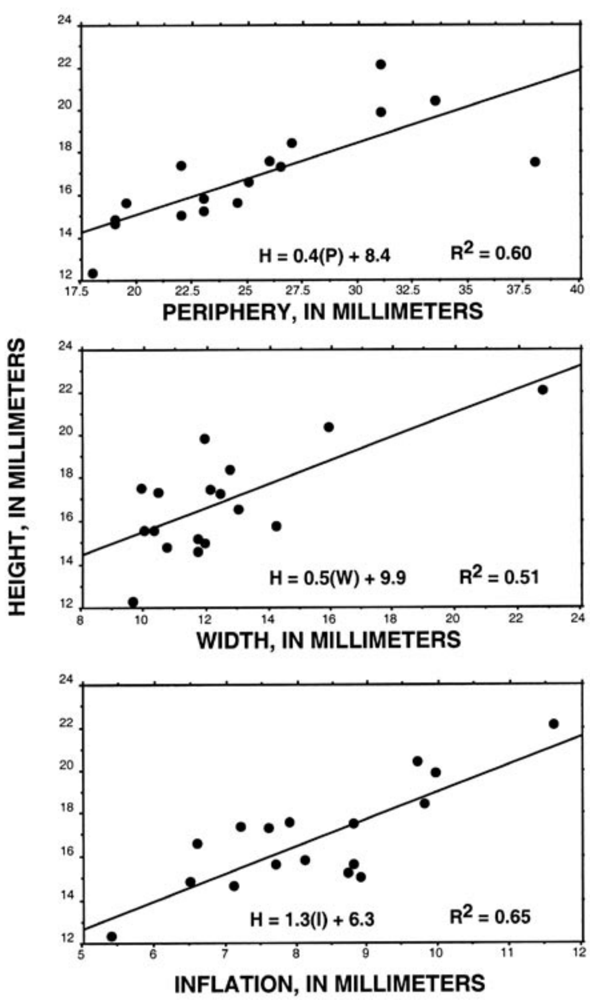

Figure 3. Scatterplot of measurements on *Gryphaea arcuataeformis* Kiparisova.

Order TRIGONIOIDA Dall, 1889

Superfamily TRIGONIACEA Lamarck, 1819

Family MINETRIGONIIDAE Fleming, 1982

Genus MAORITRIGONIA Fleming, 1962

***Maoritrigonia* sp.**
(pl. 1, figs. 20, 21)

"*Myophoria*" sp. Tozer, 1963, p. 26, pl. 12, fig. 10.

Material.—The collection consists of one partial left valve and one fragmented articulated valve pair. Both specimens are from locality 2 (fig. 2).

Description.—Shell small, triagonal to subtrapezoidal in outline, longer than high, flank covered with about seven angular tubercular radial ribs with relatively rounded and smooth interrib spaces; valve interiors not observed.

Remarks.—The specimens are somewhat small for the genus and may represent juveniles. Tozer (1963) illustrated a nearly identical specimen from the Norian Sutton Formation of Vancouver Island. They are similar to *Maoritrigonia columbiana* (McLearn) from British Columbia, Canada. *M. multicostata* from the Norian of Peru (listed as *Myophoria multicostata* by Körner, 1937, pl. 7, fig. 3) is also similar in size and subtrapezoidal shape and in details of sculpture but has more pronounced commarginal ribs across the valve flank. These differences in sculpture may reflect the relatively poor preservation of the Taylor Mountains fauna. These specimens are distinguishable from the New Zealand species *Maoritrigonia waddicki* described by Fleming (1987) by their smaller size and absence of distinct ornament on the area.

Illustrated specimens.—UAM Nos. 2603 and 2604 (pl. 1, figs. 20–21).

Genus MINETRIGONIA Kobayashi and Katayama, 1938

***Minetrigonia* cf. *M. suttonensis* (Clapp and Shimer, 1911)**
(pl. 1, fig. 22)

Myophoria suttonensis Clapp and Shimer, 1911, p. 433, pl. 41, figs. 12–14; Smith, 1927, p. 110, pl. 105, fig. 2; Tozer, 1963, p. 26, pl. 12, figs. 9a, 9b; Tozer, 1970, pl. 18, figs. 16a, 16b.

Material.—A single right valve from locality 1 (fig. 2).

Description.—The specimen is large (height, 16.4 mm; length, 14.8 mm), and moderately inflated (valve inflation, 6.1 mm), trigonally suboval in outline, with a rounded anterior; beak situated slightly anterior, sculpted with about 18 radial ribs covered with numerous small knoblike projections that appear to be extensions of commarginal ornament; posterior dorsal area separated from flank by angular marginal carina radiating from beak and extending to posterior ventral margin; marginal carina generally smooth; area covered with less conspicuous, slightly curved, radial ribs; valve interior unknown.

Remarks.—The specimen at hand is almost identical to *Minetrigonia suttonensis* (Clapp and Shimer), known primarily from Cowichan Lake, Vancouver Island, Canada (Wrangellia composite terrane), and, possibly, the Shasta area, Calif. (Eastern Klamath terrane). It may be conspecific with “*Myophoria cairnes*” from the Tyaughton Creek area, British Columbia, Canada (Caldwaller terrane). It is distinguishable from the other *Minetrigonia* specimens from locality 1 (fig. 2) in its smaller size and difference in sculpture on the area. The specimen differs from other Carnian minetrigoniids, such as *Myophorigonia kobayashi* from the Wallowa terrane, Oreg. (Tamura and McRoberts, 1993), which is ornamented by a transverse trellised ornament in the posterior area.

Illustrated specimen.—UAM No. 2605 (fig. 3.22).

Minetrigonia sp.
(pl. 1, figs. 23, 24)

Material.—The collection consists of a partial right valve. Two additional fragments are questionably assigned to this species. All specimens are from locality 1 (fig. 2).

Description.—Shell large, oval to trigonal in outline; umbo broad and rounded; surface of flank covered with numerous fine radial ribs; ribs generally rounded, with small and smooth interspaces and crossed with fine commarginal costellae; marginal carina weakly angular; posterior area mostly smooth early in ontogeny, later becoming transversed by oblique to almost-commarginal costellae. Trigoniid-grade dentition with conspicuous diverging cardinal teeth; anterior cardinal tooth (3a) nearly vertical, sloping slightly anterior, and about half the length of posterior tooth (3b) that is slightly narrower and runs at a less steep angle nearly parallel to hinge; both teeth covered with transverse ridges somewhat obscured by poor silicification.

Remarks.—The specimens are somewhat large for the genus but clearly have external sculpture and dentition characteristic of the genus. A survey of Triassic minitrigoniids reveals no described species similar in size and sculpture to that illustrated here; therefore, they probably represent a new species.

Illustrated specimen.—UAM No. 2606 (pl. 1, figs. 23, 24).

Order VENEROIDA Adams and Adams, 1854–58

Superfamily CARDITACEA Fleming, 1822

Family CARDITIDAE Fleming, 1828

Genus TUTCHERIA Cox, 1946

Tutcheria densestriata (Körner, 1937)
(pl. 2, figs. 1–6)

Table 3. Measurements on *Tutcheria densestriata* (Körner).

Valve	Length (mm)	Height (mm)
Left ---------	6.5	6.4
Right ---------	7.2	7.7
Left ---------	7.1	6.9
Left ---------	7.9	7.8

Cardium densestriatum Körner, 1937, p. 196, pl. 12, figs. 9a–9c.

Tutcheria densestriata (Körner) Cox, 1949, p. 30, pl. 2, fig. 8; Newton, 1986, p. 13, pl. 21, figs. 8, 9; Newton and others, 1987, p. 69, figs. 52.1–52.5.

Tutcheria cf. *T. densestriata* (Körner) Tozer, 1963, pl. 12, figs. 20a, 20b.

Material.—The collections consists of four left valves and one partial right valve. All specimens are from locality 1 (fig. 2).

Description.—Shells small (mean height, 7.2 mm; mean length, 7.2 mm), moderately inflated, circular in outline, beak central (table 3). Surface covered with numerous (more than 50) thin radial ribs that run rather straight in central part of disc and slope slightly away from medial position in an anterior and posterior direction; one or more widely spaced but distinct commarginal growth lines may be present. Lunule deep. Left-valve interior with long ligament groove above moderately narrow hinge plate. Left-valve cardinal dentition poorly preserved, consisting of a triangular socket below beak, presumably to accept triangular cardinal tooth (3b) of the right valve; with a short anteriorly sloping tooth (2) just in front of socket; well-developed posterior lateral tooth (P II) extending nearly horizontally, comprising lower margin of hinge, continuing for about a third of the distance to posterior extremity of hinge margin; anterior lateral shorter and less well developed but joining lunule margin. Right-valve dentition not observed.

Remarks.—External and internal morphology permit confident assignment to the genus *Tutcheria* as defined by Cox (1946). Although the material is somewhat smaller than the original type specimens of this species from Peru (Körner, 1937), the specimens from the Taylor Mountains quadrangle exhibit similar shape, external morphology, and hinge features. With the examination of additional material, Cox (1949) transferred Körner’s type from the Norian of southern Peru to this genus. They also appear to be identical to those illustrated from the Wallowa terrane, Oreg., by Newton and others (1987).

Illustrated specimens.—UAM Nos. 2607 through 2609 (pl. 2, figs. 1–6).

Superfamily CRASSATELLACEA Férussac, 1822

Family ASTARTIDAE d'Orbigny, 1844

Genus ASTARTE J. Sowerby, 1815–21

***Astarte* sp.**
(pl. 2, figs. 7, 8)

Material.—The collection consists of three articulated valve pairs and a single right valve. All specimens are from locality 1 (fig. 2).

Description.—Shells small (mean height, 5.2 mm, mean length, 4.9), moderately compressed, subtrigonal in outline, beak slightly anterior. Surface ornamented with five or six commarginal concentric folds more conspicuous in beak and becoming weaker later in ontogeny; one specimen (pl. 2, fig. 7) exhibits very faint radial sculpture. Valve interiors not observed.

Remarks.—Although valve interiors are not observable on any of the specimens, their small size, shape, and distinctive commarginal ornament permit assignment to *Astarte*. Small sample size and absence of valve interior preclude specific designation. This genus is common through out much of the marine Triassic. Newton and others (1987) described externally similar species from the Wallowa terrane, Oreg.

Illustrated specimens.—UAM Nos. 2610 and 2611 (pl. 2, figs. 7, 8).

Superfamily CARDIACEA Lamarck, 1809

Family CARDIIDAE Lamarck, 1809

Genus SEPTOCARDIA Hall and Whitfield, 1877

***Septocardia* cf. *S. peruviana* (Cox, 1949)**
(pl. 2, figs. 5–14)

Pascoella peruviana Cox, 1949. p. 35, pl. 1, figs. 9, 12a, 13, 14, *non* pl. 2, fig. 5.

?*Septocardia* sp. Newton and others, 1987, p. 77, fig. 60.

Material.—The collection consists of five left valves and four right valves, and numerous fragments from at least 21 individuals. All specimens are from locality 1 (fig. 2).

Description.—Valves moderately large (mean height, 18.8; mean length, 19.3 mm) and moderately convex (mean valve inflation, 7.8 mm), equivalved and nearly equilateral, with beaks positioned only slightly anterior (see table 4). Shell exterior sculpted by numerous angular ribs radiating from beak. Number of ribs varies (19–24, mean 21), yet they do not divide or intercalate with interrib spaces. Radial ribs are crossed by numerous fine, evenly spaced commarginal sculpture. Hinge sloping from beak; dorsal region consists of flattened ligamental groove bordered by nymphs; dentition consists of trigonal, centrally located, cardinal tooth in right valve and corresponding socket in left valve. Lateral dentition consists of a single, sloping anterior lateral tooth in right valve and two anterior laterals in left valve. Posterior lateral dentition well developed. Anterior (and ventral) to lateral dentition is deep circular anterior-adductor scar positioned immediately ventral to hinge margin; anterior scar is separated from rest of valve interior by septum present in both valves. Interior margins crenulated for first 2 or 3 mm from valve margin, corresponding to exterior radial ribs.

Table 4. Measurements on *Septocardia* cf. *S. peruviana* (Cox).

Valve	Length (mm)	Height (mm)	Inflation (mm)	Umbonal angle (°)	Rib number
Right	19.4	17.6	8.3	111	24
Right	18	16.8	7.6	108	22
Left	15.7	16	6.3	93	21
Left	23.5	23.3	8.5	120	19
?	– –	– –	8.1	111	21
Left	19.7	20.1	8.2	98	20

Remarks.—Specimens attributed to *Septocardia* from locality 1 (fig. 2) appear to be most similar to those from the Norian of Peru (originally named *Pascoella peruviana* by Cox, 1949). Some distinct differences exist between the Taylor Mountains specimens and the genotype *S. typica* named by Hall and Whitfield (1877) from Nevada. Although the type locality and horizon of this Nevada material are unclear, further examination of the specimens led L.R. Cox to accept them as a possible senior synonym of his Peruvian species (see Silberling, 1959, p. 60). Other specimens from Nevada, such as those that Silberling illustrated of *Septocardia* sp., appear to be similar in size and external morphology; however, their valve interiors remain unknown. Similar specimens are also known from the Wallowa terrane, Oreg. (Newton and others, 1987). This species shows several differences in both shape and interior characteristics from those from Alaska that were illustrated by Keen (1969, p. N586, fig. E85, 1d, 1e). The locality of Keen's specimen was never reported, but it probably came from a silicified Norian fauna from Keku Strait, Alaska (N.J. Silberling, written commun., 2001). These specimens may be from the same locality as those reported from Keku Strait by Newton (1983), who, using the name "*S. pascoensis* (Cox)," noted that they are thicker shelled than other *Septocardia* from North America. Although other occurrences of *Septocardia* from Alaska are known (see Newton, 1983; Blodgett and others, 2000), they have not been described or illustrated. Additionally, as pointed out by Newton and others (1987), the relation between *Septocardia* and *Palaeocardita* remains unclear at best. For example, specimens reported as *Palaeocardita globiformis* by Vu Khuc (1991) may likely be transferred to *Septocardia* once internal structures become known.

Two of the specimens (pl. 2, figs. 9, 13) exhibit small (~3 mm diam) circular holes that are centrally positioned on the umbo, approximately 4.5 mm from beak, which may represent predatory drill holes similar to those produced by naticid gastropods.

Illustrated specimens.—UAM Nos. 2612 through 2614 (pl. 2, fig. 9–14).

Class GASTROPODA Cuvier, 1797

[Materials for this class were prepared by R.B. Blodgett]

Discussion.—Many silicified gastropods are present in the fossil collection from locality 1 (fig. 2). Altogether, 11 species appear to be present (table 5); however, the state of preservation is so poor and incomplete that several of the taxa remain generically indeterminate. The following forms can be identified with some degree of confidence: *Neritaria nuetzeli* n.sp. (pl. 2, figs. 16–19), *Zygopleura*? sp. (pl. 3, fig. 15), *Chulitnacula alaskana* (Smith, 1927) (pl. 2, fig. 15), *Andangularia wilsoni* n.sp. (pl. 3, figs. 1, 2), *Cryptaulax* aff. *C. tilarniocensis* Haas, 1953 (pl. 3, figs. 3–9), *Coelostylina* cf. *C. cylindrata* Haas, 1953 (pl. 3, fig. 12), *Omphaloptycha* aff. *O. jenksi* Haas, 1953 (pl. 3, figs. 13, 14), *Omphaloptycha*? sp. (pl. 3, figs. 10, 11), and *Toxoconcha* cf. *T. gracilis* Haas, 1953 (pl. 3, figs. 20, 21). No gastropods were recovered from locality 2 (fig. 2).

Table 5. Gastropod taxa recognized at locality 1 (fig. 2).

Taxon	Number of specimens
Andangularia wilsoni n.sp	2
Chulitnacula alaskana (Smith)	8
Coelostylina cf. *C. cylindrata* Haas	3
Cryptaulax aff. *C. tilarniocensis* Haas	8
Genus and species indeterminate 1 (high spired)	1
Genus and species indeterminate 2 (low spired)	1
Katosira sp	9
Neritaria nuetzeli n.sp	17
Omphaloptycha aff. *O. jenksi* Haas	1
Omphaloptycha? sp	1
Toxoconcha cf. *T. gracilis* Haas	3

Subclass NERITOMORPHA Golikov & Starobogatov, 1975

Superfamily NERITOIDEA Rafinesque, 1815

Family NERITIDAE Rafinesque, 1815

Subfamily NERITINAE Rafinesque, 1815

Genus NERITARIA Koken, 1892

Neritaria nuetzeli n.sp. (pl. 2, figs. 16–19)

Material.—A total of 17 specimens from locality 1 (fig. 2).

Etymology.—The species name is in honor of the gastropod worker Alexander Nützel of Erlangen, Germany.

Diagnosis—Globose species of *Neritaria* with narrow, subpyriform aperture and strongly thickened inner and outer lips.

Description.—Small, strongly globose, smooth naticiform shell; spire low, rounded, not protruding, number of whorls uncertain due to sutures not being impressed, but probably few in number, protoconch not preserved; aperture subpyriform, narrow for genus; parietal lip with wide bandlike callus bearing a strong, rounded swelling on lower part just above its juncture with inner lip, which is strongly thickened; outer lip also thick but less so than inner lip; base seemingly anomphalous or cryptomphalous. Dimensions of holotype: height, 4.1 mm; width, 3.8 mm.

Remarks.—The strongly globose shell shape of *Neritaria nuetzeli* n.sp. with its nonprotruding spire readily distinguishes it from most species attributed to this genus. It differs from the type species, *N. similis* Koken [=*N. plicatilis* (Klipstein)], from the Raibler Schichten of the southern Alps in being more rounded, lower spired, and lacking subsutural ribs developed on the spiral whorls. Among the species of this genus described by Haas (1953) from Norian strata of Peru, it most closely approaches *N. dicosmoides* Haas, in that both species are rather globose. Nevertheless, it is easily distinguished by its much more rounded shell shape, narrower aperture, and much thicker outer lip. It differs from *N. hologyroides* Haas in lacking teeth on its inner lip and in being much lower spired, and from *N. ninacacana* Haas in being much more globose, in lacking the well-impressed sutures of *N. ninacacana* Haas, and in having a much more markedly thickened outer lip. It differs from *N. obliqua* Haas in having a more globose, distinctly lower spired shell shape, and from *N. distincta* Haas in being more globose, less high spired, and lacking the well-developed growth striae exhibited by this species.

Illustrated specimens.—Holotype, UAM No. 2616 (pl. 2, figs. 16, 17); paratype, UAM No. 2617 (pl. 2, figs. 18, 19).

Subclass CAENOGASTROPODA Cox, 1960

Order PTENOGLOSSA Gray, 1853

Family PROTORCULIDAE Bandel, 1991

Genus CHULITNACULA Frýda & Blodgett, 2001

Chulitnacula alaskana (Smith, 1927) (pl. 2, fig. 15)

Protorcula alaskana Smith, 1927, p. 109, pl. 103, figs. 9, 10.

Chulitnacula alaskana (Smith, 1927) new combination, Frýda and Blodgett, 2001, p. 217, figs. 2.1–2.4, 3.1–3.3.

Material.—Nine poorly preserved specimens from locality 1 (fig. 2).

Remarks.—*Chulitnacula alaskana* is represented here by nine specimens that represent the largest gastropod species in the collection. The teleoconch of this species closely resembles that of gastropods from the Chulitna terrane in general shape; however, the coarsely silicified characteristics of gastropods from the Farewell terrane did not allow for preservation of the finer spiral elements of ornamentation.

This species also is very abundant in late Norian strata of the Chulitna terrane of south-central Alaska (Blodgett and Clautice, 2000; Frýda and Blodgett, 2001). The type material of *Chulitnacula alaskana* (Smith, 1927), which is from the Chulitna terrane of south-central Alaska, was collected on

July 15, 1917, by S.R. Capps of the U.S. Geological Survey (USGS), who was leading a USGS geologic field-mapping party in the upper Chulitna region. The locality cited by Smith (1927, p. 109) is USGS Mesozoic locality 10093, which is noted as "Copeland Creek at Camp July 14." This locality, consisting of stream gravels along Copeland Creek, is in the Healy A–6 1:63,360-scale quadrangle. Further information on this locality was reported by Martin (1926, p. 44), who cited it as a "stream bar of Copeland Creek." Subsequently, Smith named the species *Protorcula alaskana* on the basis of material collected by Capps at USGS Mesozoic locality 10093, and indicated it to be of probable Carnian age. Two specimens were illustrated by Smith (1927, pl. 103, figs. 9, 10), with the holotype designated as the specimen shown in his figure 9. Additional specimens of this species were discovered at three localities (118, 120, and 151 of Blodgett and Clautice, 2000) during the 1997–98 field-mapping effort by the Alaska Division of Geological and Geophysical Surveys in the Healy A–6 1:63,360-scale quadrangle of south-central Alaska.

Chulitnacula alaskana (Smith) also is present in the Alexander terrane of southeastern Alaska (Blodgett and Frýda, 2001; Frýda and Blodgett, 2001; Sandy and others, 2001), where it is known from USGS Mesozoic locality M1912, collected by N.J. Silberling and L.J.P. Muffler in 1963. The locality is in limestone beds of late Norian age within the Hound Island Volcanics on Kuiu Island in the Port Alexander D–1 1:63,360-scale quadrangle (Muffler, 1967, pl. 1, loc. 29). According to Muffler (1967, p. C43), this locality is on a cove 3 km north of the west end of Kadak Bay on Kuiu Island and is of late Norian age.

Illustrated specimen.—UAM No. 2615 (fig. 5.15).

Order CERITHOMORPHA Golikov & Starobogatov, 1975

Family PURPURINIDAE Zittel, 1881–95

Genus ANDANGULARIA Haas, 1953

***Andangularia wilsoni* n.sp.**
(pl. 3, figs. 1, 2)

Material.—One specimen from locality 1 (fig. 2).

Etymology.—This species is named in honor of Frederic H. ("Ric") Wilson of the USGS, Anchorage, Alaska.

Diagnosis.—*Andangularia* with a relatively short, squat shell and strong, transverse ribs that extend entire length of spiral whorl surface and more than half of final whorl surface.

Description.—Small (height, max 7.0 mm), high-spired, turreted shell of relatively squat appearance; as many as six whorls, protoconch not preserved, sutures weakly impressed; upper whorl surface flat, ramplike, delimited by conspicuous angulation with outer whorl surface; base elongate and rounded, anomphalous, strong transverse ribs developed, numbering about six per volution, extending full length of spiral whorls and more than half the length of final whorl, extending outward as pointed spikelike projections at their upper termination at angulation separating outer and upper whorl surfaces; inner lip rounded, characteristics of outer lip unknown.

Remarks.—The purpurinid gastropod genus *Andangularia* was previously known from only two species described from the Norian of Peru. *A. wilsoni* n.sp. differs from the Peruvian type species *A. armatus* (Jaworski, 1923) in having a slightly broader, squatter shell. In addition, its transverse ribs are much less numerous, more widely spaced, and extend much farther over the whorl surface. Another distinct Peruvian species of *Andangularia* was described and illustrated by Haas (1953) as *Andangularia* aff. *A. subarmatae* (Jaworski). This species also differs in having a narrower shell, but it more closely approaches the new Alaskan species in having more well-developed transverse ribs, although the ribs in Haas' species are more numerous and more closely spaced.

An undescribed new species of *Andanguaria* is also present in the late Norian or Rhaetian "Lewiston fauna" of Idaho (belonging to the Wallowa terrane). The gastropods of this fauna are currently being studied by Alex Nützel of Erlangen, Germany, who graciously sent photographs of the Idaho species. It differs from the Alaskan species in being much narrower, having relatively higher whorls, and having transverse ribs that are less continuous over the whorls.

Illustrated specimen.—Holotype, UAM No. 2620 (pl. 3, figs. 1, 2).

Biogeographic Remarks and Conclusions

Taxonomic composition and paleoecologic associations suggest similarities to other low-latitude accreted terranes of southern Alaska. At least for the bivalves, the greatest similarity appears to be with the Alexander terrane, whose fauna (listed by Newton, 1983) has not been adequately illustrated but includes *Cassianella*, *Septocardia*, *Gryphaea*, and *Minetrigonia*. Limited similarity in bivalve species exists with inboard island-arc terranes (for example, the Wrangellia composite terrane and the Wallowa terrane); however, except for the Wallow terrane, Oreg. (for example, Newton and others, 1987), too little is known about the Norian bivalve faunas of other terranes to make any meaningful comparison. Striking similarities also exist between the bivalve faunas from the Norian of Peru and those from the Taylor Mountains quadrangle. Most notable among the similarities is the cooccurrence of *Septocardia peruviana* (Cox), which is quite distinct from other species of North America *Septocardia* (see Newton, 1983). Except for some widespread species, such as *Gryphaea arcuataeformis* Kiparisova, there is very little similarity with craton-bound Norian strata in British Columbia, Canada, and para-allochthonous strata of the Great Basin (for example, the Luning and Gabbs Formations in Nevada).

The most obvious gastropod in the collection, *Chulitnacula alaskana* (Smith, 1927), is a common to dominant element in late Norian strata of three separate accreted terranes of southern Alaska: the Chulitna, Farewell, and Alexander terranes. The common presence of this taxon may indicate that these terranes were in close reproductive communication during Late Triassic time (Blodgett and Frýda, 2001; Frýda and Blodgett, 2001). We note that this species is not known from coeval strata of either the Wrangellia composite terrane or the Wallowa terrane. Much of the remaining gastropod fauna illustrated here includes several taxa that appear to be closely allied, if not conspecific, with Norian gastropods described from Peru by Haas (1953). None of these Norian gastropod species occurs in craton-bound Norian strata of Nevada (notably from the Clan Alpine Mountains) and Sonora (Jiri Frýda and R.B. Blodgett, unpub. data). The strong similarity of the gastropod fauna from the Farewell terrane to that of Peru is also supported by the features of the two new species established here, *Neritaria nuetzeli* and *Andangularia wilsoni*, both of which find their closest related forms among Norian species described from Peru.

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