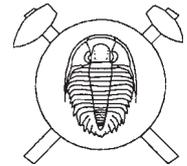


## Delphinulopsidae, a new neritopsoidean gastropod family from the Upper Triassic (upper Carnian or lower Norian) of the Wallowa terrane, northeastern Oregon



(3 figs)

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Three new neritopsoidean gastropods, *Paradelphinulopsis vallieri* gen. et sp. nov., *Spinidelphinulopsis whaleni* gen. et sp. nov., and *Wallowanerita newtonae* gen. et sp. nov., are described from the Martin Bridge Formation of northeastern Oregon. These species come from late Carnian or early Norian age strata of the Spring Creek locality in Hells Canyon. The new genera are placed in the new family Delphinulopsidae, belonging to the superfamily Neritopsoidea. This new family also includes the genera *Delphinulopsis* and *Seisia*. The Delphinulopsidae represents a distinctive Middle to Late Triassic group of neritopsoideans characterized by a rapidly expanding shell and a strongly developed plate-like septum extending into the aperture from the inner lip. The group is characteristic for warm tropical seaways of the Middle to Late Triassic, including the classical Tethyan regions of Europe, as well as southern China, Oregon, and southern Alaska. Close paleobiogeographic affinities are noted between the Late Triassic gastropod fauna of the Wallowa and Wrangellia terranes, including the sharing of two of the new species described here. On the basis of their closely similar faunas (60% of the Wrangellian species from Green Butte are also found in the coeval Spring Creek fauna), we believe that these two terranes were in close reproductive communication in the tropics of the Panthalassa Ocean.

**Key words:** Triassic, North America, Wallowa terrane, Wrangellia terrane, Gastropoda, Neritimorpha, new taxa

### Introduction

This short paper is our first contribution to systematics and the study of paleobiogeographic affinities of Late Triassic (late Carnian or early Norian) gastropods from the Martin Bridge Formation (Wallowa terrane) of northeastern Oregon. Our study is based on the highly diverse, silicified gastropod fauna from the well-known Spring Creek locality (USGS Mesozoic locality M2672) in Hells Canyon (Fig. 1). This paper provides the first systematic descriptions of gastropods from this locality. Newton et al. (1987, Fig. 5) illustrated a single gastropod which they identified as *?Kokenella* sp. On the basis of examination of topotypic material, we would reassign this species to a new genus closely allied to *Discohelix*. The locality also yields other molluscs, the bivalves having been previously published by Newton et al. (1987). This locality by far provides the best insight into Late Triassic gastropods of the Wallowa terrane in Oregon. Gastropods are known from other localities in the Wallowa Mountains, but typically occur only as cross-sections within weakly metamorphosed limestones. Several localities are known from the northern Wallows where silicified gastropods similar to those from the Spring Creek locality occur, but these collections are small in size and contain only a few taxa. The only other richly diverse Late Triassic gastropod fauna in the Wallowa terrane is the so-called Lewiston fauna, frequently mentioned by Haas (1953) in his study of Peruvian Late Triassic gastropods.

The Lewiston fauna at present remains unpublished, but should show some taxic differences due to being younger in age (late Norian) than the Spring Creek locality (late Carnian or early Norian).

All figured specimens are deposited in the University of Montana's Paleontology Museum (UMIP).

### Geologic Setting of the Martin Bridge Formation

The Martin Bridge Formation of northeastern Oregon and adjacent Idaho, contains diverse carbonate rock types that represent paleoenvironments including patch reefs, platform shoals, restricted peritidal basins, slope deposits, and basinal rocks. These were deposited within an island arc setting following the abrupt cessation of volcanism (Stanley 1986; Stanley – Senowbari-Daryan 1986; Whalen 1988; McRoberts 1993; Follo 1994). A diverse shallow-water invertebrate fauna of calcareous algae, sponges, spongiomorphs, corals, and bivalves were collected from silicified beds at Spring Creek (Newton 1986; Stanley 1986; Stanley – Senowbari-Daryan 1986; Newton et al. 1987; Senowbari-Daryan – Stanley 1988; Stanley – Whalen 1989). The associated lithofacies and faunas indicate a tropical setting that is corroborated by paleomagnetic results indicating Triassic paleolatitudes of 18°–24° (± 4°) north or south of the equator (Hillhouse et al. 1982; May – Butler 1986). Newton (1983) and Malmquist (1991) favored a paleoposition in the southern hemisphere while Stanley – Vallier (1992) support-

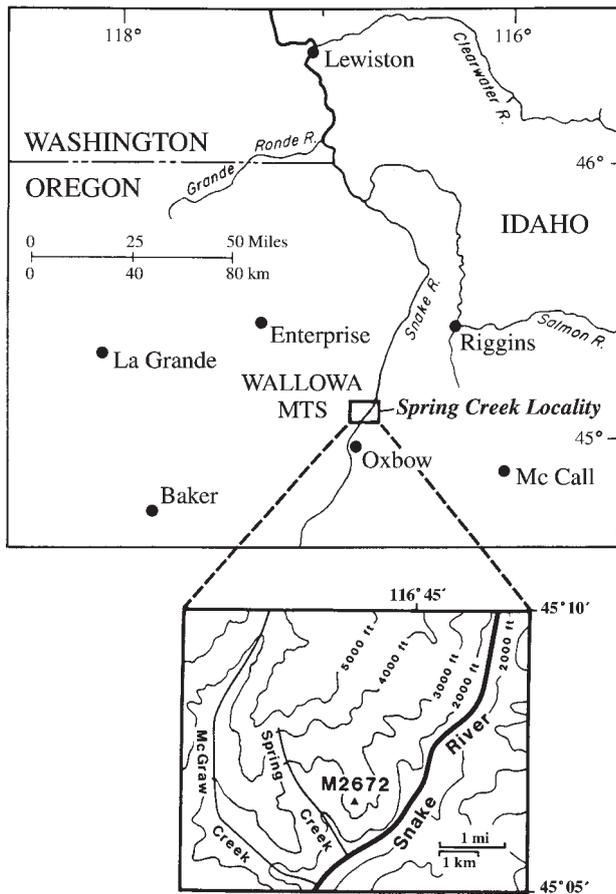


Fig. 1. Map showing location of Spring Creek locality of the Martin Bridge Formation, northeastern Oregon (from Senowbari-Daryan – Stanley 1988, Fig. 1).

ed a location in the northern hemisphere based on paleomagnetic investigations of Harbert et al. (1988). The Martin Bridge is well exposed on both sides of Hells Canyon north of Oxbow, Oregon (Vallier 1977). The depositional history of the Martin Bridge in Hells Canyon was reported by Whalen (1988). Structural complications exist on the west side of Hells Canyon at Spring Creek where the unit is tightly to isoclinally folded. These folds open into a broad synform on the east side of Hells Canyon where stratigraphic relationships are best deciphered. The Martin Bridge carbonate rocks were deposited above volcanoclastic Doyle Creek Formation of the Seven Devils Group (Vallier 1977). The basal contact of the Martin Bridge is not well exposed in Hells Canyon but intercalation of thin beds of volcanoclastic siltstone in the lower 25 meters indicates a gradational contact with the underlying volcanoclastics of the Doyle Creek Formation (Whalen 1988). This intercalation also appears similar to relationships observed near the Martin Bridge unit stratotype in the southern Wallowa Mountains (McRoberts 1993; Follo 1994). The onset of pure marine carbonate deposition indicates cessation of volcanic activity and a relatively abrupt shut down of terrigenous sediment supply (Whalen 1988). Detailed facies analysis of the Mar-

tin Bridge Formation (Whalen 1988) reveals a suite of shallow water platform carbonates deposited as an overall deepening upward sequence. The basal Martin Bridge facies (60 m thick) includes laminated and fenestral dolostones with gypsum casts and algal laminated intervals interbedded with mudstones and peloid wackestones. Supratidal to shallow intertidal conditions are indicated by algal laminated dolomudstones, gypsum casts, and fenestral textures. Interbedded mudstones and peloid wackestones were deposited in relatively quiet water peritidal settings. Peritidal facies are overlain by bioclast, intraclast, peloid wackestones and packstones, bioclast or ooid grainstones, and spongiomorph bafflestones (~150 m thick). The normal marine fauna and coarse-grained packstones and grainstones indicate deposition in shallow to deep subtidal, moderate to high energy environments.

Biostratigraphically useful fossils from Hells Canyon are rather scarce and restricted to only the reported occurrence of the ammonoid *Tropiceltites* cf. *T. columbianus* and an undescribed halobiid bivalve *Halobia austriaca*. Stanley (1986) and Newton et al. (1987) described silicified coral-spongiomorph and bivalve mollusc assemblages at Spring Creek, respectively. This was a site first described by Vallier (1977) and designated USGS Mesozoic locality M2672. It has been assigned to the early Norian *Kerri* Zone based on the above ammonoid (identified by N. J. Silberling and cited in Vallier 1977, p. 49). A rich fauna of bivalves reported by Newton et al. (1987) are temporally wide-ranging including both Carnian and Norian taxa correlatable with those of the Tethys. The corals relate most closely to Norian taxa. Many of the bivalve taxa are close if not conspecific with counterparts in the Cassian fauna from the Tethys. However, Stanley – Whalen (1989) pointed out the lack of similarity between the Spring Creek fauna and the Wrangell Mountains on the basis of the coral and spongiomorph faunas. The only non-endemic sponge from the Spring Creek fauna, *Amblysiphonella* cf. *A. steinmanni* (Senowbari-Daryan – Stanley 1988), is known from the Rhaetian age Zlambach Formation. Preliminary conodont sampling by Stanley – Shunxin Zhang (unpublished data) yielded an uppermost Carnian age for the silicified bed which has yielded most of the invertebrate faunas, suggesting that the silicified bed at Spring Creek is late Carnian rather than early Norian in age.

### Paleogeographic and paleobiogeographic implications

The Martin Bridge Formation is a distinctive Upper Triassic lithostratigraphic unit in the Wallowa terrane (Fig. 2) of northeastern Oregon, western Idaho, and extreme southeastern Washington. This terrane was formed in an island arc setting and during the late 1970's and early 1980's was considered to represent the southeastern terminus of the Wrangellia terrane, with which it shares strong gross lithostratigraphic similarities. This in-

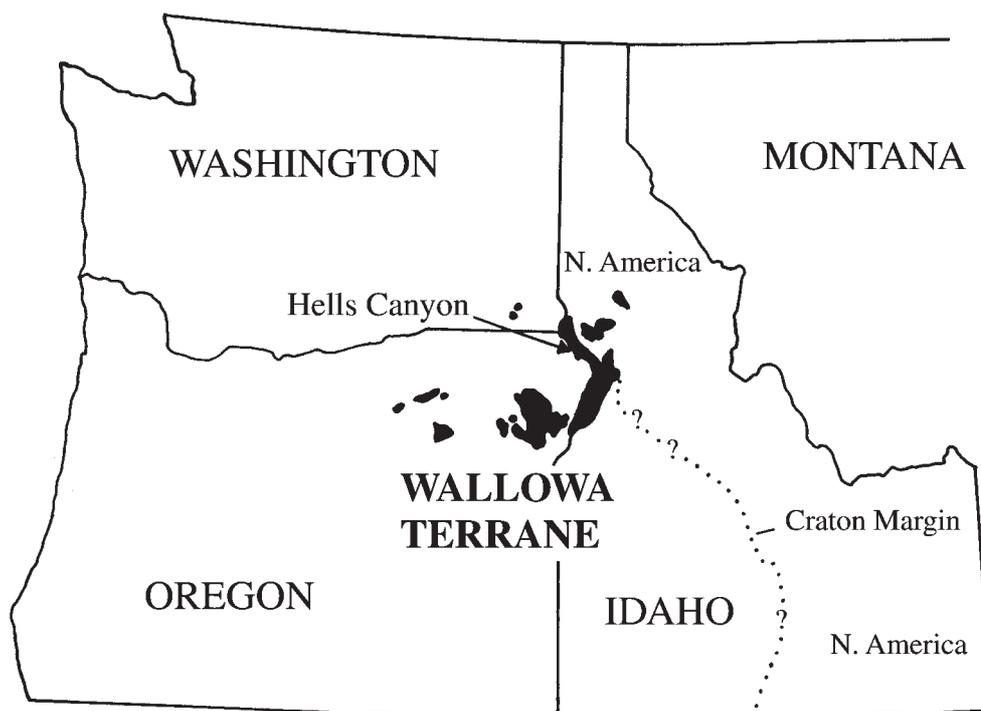


Fig. 2. Map showing extent of Wallowa terrane in Oregon, Idaho, and Washington (from Newton et al. 1987, Fig. 3).

terpretation was not supported by Sarewitz (1983), who suggested that petrologic evidence indicated these two terranes to be of distinctly differing origins. Stanley – Whalen (1989) concurred with Sarewitz on the basis of the cnidarian faunas, that there was little similarity with Wrangellia.

On the basis of preliminary analysis (by Blodgett – Frýda) of gastropod faunas from the Wallowa terrane (represented by the Spring Creek locality) and the Wrangellia terrane, we believe that these two terranes were in close reproductive communication with each other during Late Triassic time. A diverse silicified bed (USGS Mesozoic locality M1708), rich in bivalves and gastropods is known from Green Butte in the southern Wrangell Mountains of southern Alaska (Newton 1983). This locality (see Fig. 3 for location) in the uppermost beds of the Chitistone Limestone is considered to be of latest Carnian or earliest Norian age (Armstrong et al. 1969; Silberling – Tozer 1968) or early Norian age (Newton 1983). Our preliminary analysis (Blodgett – Frýda) of the Green Butte fauna as represented by the original collection made at M1708, as well as photographic plates made of this fauna by N. J. Silberling, indicates that it contains 31 gastropod species. Eighteen of these species (representing about 60% of the total gastropod fauna) also are found in the Spring Creek fauna. Such a large number of shared gastropod species suggests to us that the Wallowa – Wrangellia terranes were in close reproductive communication. Of the three delphinulopsid species established here from the Wallowa terrane, definitely one species, and probably a second, are also found in the Green Butte locality in the Wrangellia terrane. Many gastropod groups have proven to be useful for the fine delineation of low-level paleobiogeographic

units during the Paleozoic, due to the very restricted nature of larval distribution in many gastropod groups (Blodgett 1992; Blodgett et al. 1988, 1990; Blodgett – Frýda 1999; Frýda – Rohr 1999), and we conclude that they also have paleobiogeographic value in the Triassic. It is worthy to note that Newton (1983, p. 41), in her study of Green Butte bivalves, also stated that this faunal group was most similar to the Hells Canyon assemblage (Spring Creek locality). According to paleomagnetic studies, both terranes shared low paleolatitudes during the Late Triassic, in permissive agreement with the tropical character shown by their coeval gastropod faunas. The presence of spines in many species of the Delphinulopsidae is consistent with positioning these terrane in tropical regions. Spinose shells are typical of modern tropical molluscan faunas (Nicol 1967; Graus 1974; Vermeij 1978) as well as those of the past (i.e. Blodgett – Rohr 1989, and Blodgett et al. 1990, for examples in the Devonian). However, the dissimilarity noted between the cnidarian fauna of these two terranes (Stanley – Whalen 1989) requires further consideration.

Of special interest is the fact that the Upper Triassic shallow-marine gastropod fauna of the Wrangellia-Wallowa terranes is very dissimilar to that of other accreted terranes found in southern Alaska, notably the Chulitna, Farewell, and Alexander terranes (see Frýda – Blodgett 2001, this volume). The latter three terranes also are of tropical aspect and share closely similar faunas to one another. We suggest that they were also closely associated with each other in a tropical portion of the Panthalassa Ocean, but positioned at a biogeographically significant distance from both the tropical Wrangellia and Wallowa terranes.

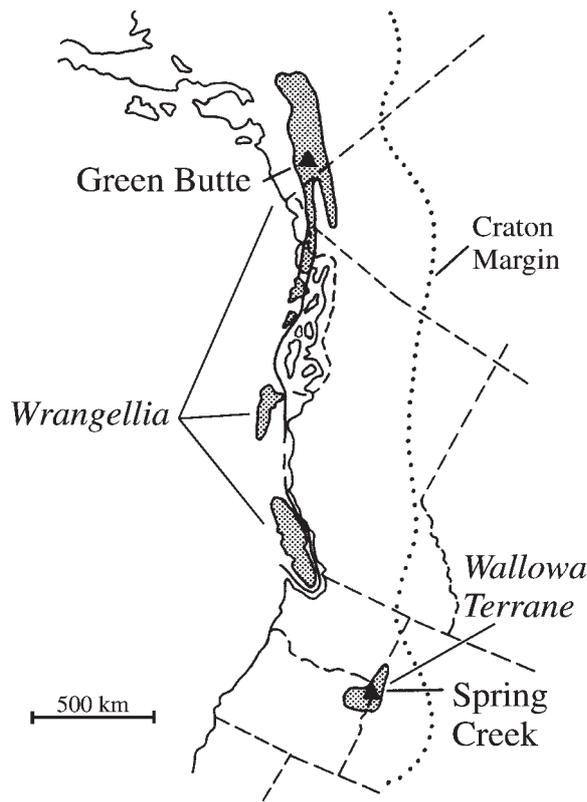


Fig. 3. Locality map showing position of the Spring Creek locality (Wallowa terrane) and Green Butte locality (Wrangellia terrane). Modified from Newton (1983, Fig. 1).

### Systematic paleontology

Subclass Neritimorpha Golikov et Starobogatov, 1975  
 Order Cycloneritimorpha Bandel et Frýda, 1999  
 Superfamily Neritopsoidea Gray, 1847

**Discussion:** The higher taxonomic positions of the superfamilies Neritoidea and Neritopsoidea have changed several times during this century. Both taxa have several anatomical characters that distinguish them very well from other gastropods (Fretter – Graham 1962; Sasaki 1998). On the other hand, their rhipidoglossate radula resembles that of the Archaeogastropoda which they have usually been placed (e.g., Wenz 1938). Knight et al. (1960) placed them in the suborder Neritopsina of the order Archaeogastropoda. The independent position of neritoideans was also recognized by Golikov – Starobogatov (1975) who established the superorder Neritimorpha uniting the superfamilies Neritoidea, Hydro-

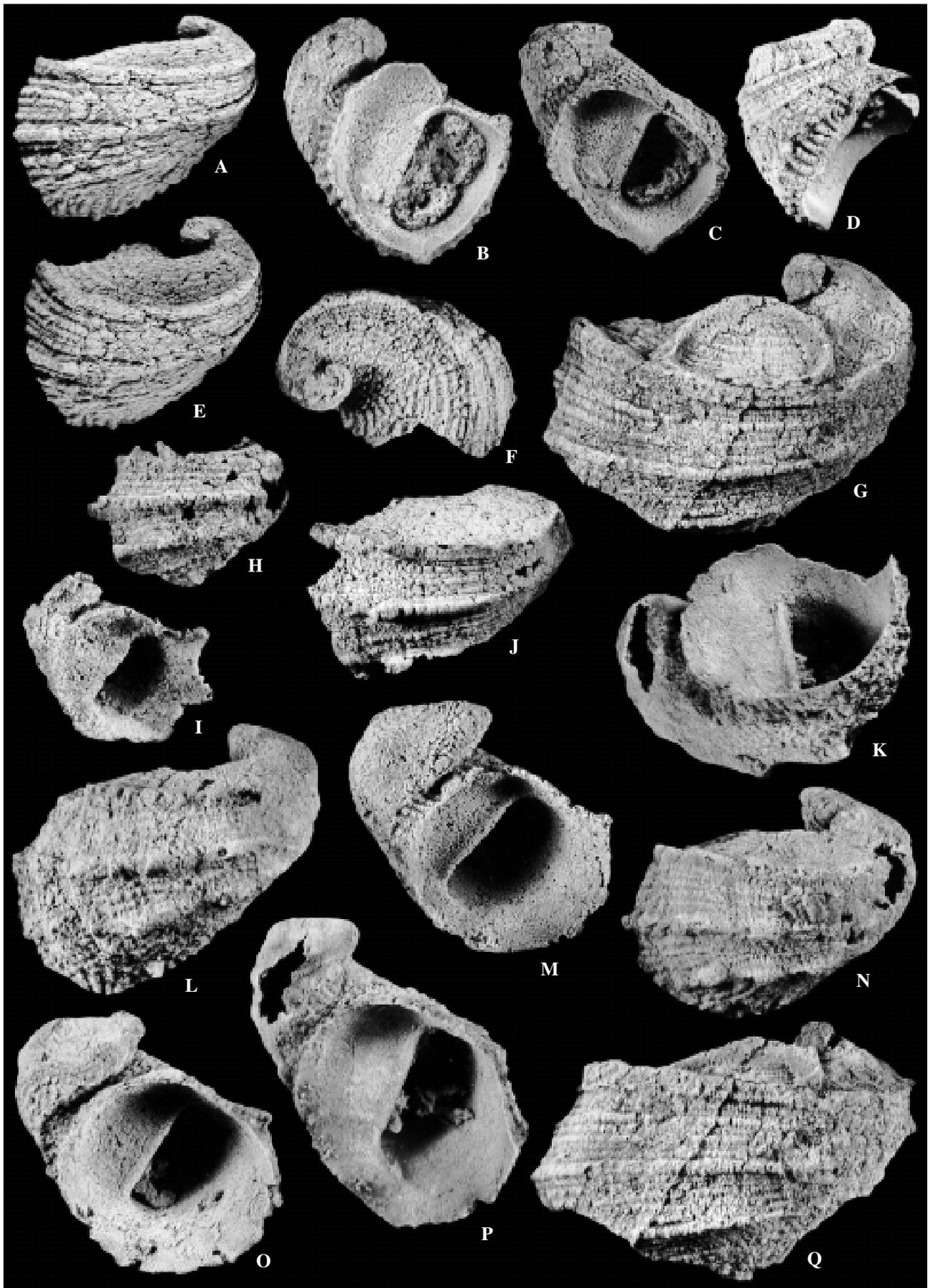
cenoidea, Titiscanoidea, and questionably also the Cocculinoidea. This concept was elaborated by Bandel (1992) who also considered the Neritimorpha to represent an independent gastropod subclass on the basis of their being characterized by a strongly convolute protoconch (Robertson 1971; Scheltema 1971; Bandel 1982). The independent position of the Neritimorpha was also noted by Biggelaar – Haszprunar (1996), who characterized this large gastropod taxon by its cleavage patterns. The results of their study suggest that the Neritimorpha forms a gastropod group which is far removed from the Docoglossa (=Patellogastropoda) and Vetigastropoda. Recently, Sasaki (1998) published a detailed study based on the comparative anatomy of Recent “Archaeogastropoda” in which he also summarized anatomical features of living Neritidae. The results of his cladistic analysis also strongly supported the robust monophyly of the Neritimorpha (= Neritopsina). Discoveries of well-preserved protoconchs in the presumed Paleozoic members of the subclass Neritimorpha show that this group unites gastropods with at least two protoconch types: 1.) a strongly convolute type and 2.) an openly coiled, fish hook-like type. Both of these types may be traced in the fossil record for more than 200 million years and the changes in their shape during this time were insignificant (Frýda 1998a–c 1999; Bandel – Frýda 1999). This character has been considered to have very high-level taxonomic significance and for this reason, the subclass Neritimorpha has been divided into two separate orders, the Cycloneritimorpha and Cyrtoneritimorpha (Frýda 1998a–c 1999; Bandel – Frýda 1999). Members of the order Cycloneritimorpha with a strongly convolute protoconch may be traced from the Recent back at least to the Carboniferous. The Cyrtoneritimorpha with openly coiled, fish hook-like protoconchs are hitherto known only from Paleozoic rocks and they may be traced from the Early Ordovician to the Late Permian. The modern Cycloneritimorpha unites the superfamilies Neritopsoidea, Neritoidea, Hydrocenoidea, and Helicinoidea. Bandel – Frýda (1999) included within Neritopsoidea three families: Neritopsidae Gray, 1847, Cortinellidae Bandel, 2000, and Pseudorthonychiidae Bandel and Frýda, 1999.

Family *Delphinulopsidae*, fam. nov.

**Diagnosis:** Neritopsoideans with rapidly expanding whorls (no more than three in number), an open-coiled teleoconch in adult forms, and a prominent, weakly con-



Fig. 4. A–Q – *Paradelphinulopsis vallieri* gen. et sp. nov.; A–F – holotype, UMIP 2.27180, abapertural, oblique apertural, apertural, lateral, oblique, and apical views, x3; G, Q – paratype B, UMIP 2.27182, oblique and lateral views, x3; H, I – paratype F, UMIP 2.27186, lateral and apertural views, x3; J – paratype E, UMIP 2.27185, lateral view, x3; K, L, P – paratype A, UMIP 2.27181, oblique apertural (to better show septum), abapertural, and apertural views, x3; M, N – paratype C, UMIP 2.27183, apertural and abapertural views, x3; O – paratype D, UMIP 2.27184, apertural view, x3. All specimens from Spring Creek locality (late Carnian of early Norian), Martin Bridge Formation, Wallowa terrane, northeastern Oregon.



cave plate-like septum extending from inner lip into and partially constricting the aperture; ornamentation dominantly spiral.

**Discussion:** The Delphinulopsidae fam. nov. comprises a compact group of neritopsoidean gastropods that existed from Middle Triassic (Anisian) to Late Triassic (Norian) time. Among the oldest representatives were forms illustrated by Yin – Yochelson (1983) from southern China. The type genus of the new family Delphinulopsidae, *Delphinulopsis* Laube, 1868, was placed within the family Neritidae by Wenz (1938) and this opinion was later followed by Knight et al. (1960). However, as noted by Yin – Yochelson (1983), the absence of resorption of the inner whorls in *Delphinulopsis* has been demonstrated repeatedly (Koken, 1892, p. 195; Böhm, 1895, p. 243; Kittl, 1899, p. 74). This character, together with the shape of the operculum, are considered to be important in distinguishing between the superfamilies Neritopsoidea and Neritoidea. Gastropods belonging to the Neritopsoidea do not resorb the inner whorls of the protoconch and the teleoconch as is observed in members of the Neritoidea. In addition, the calcareous operculum of the Neritopsoidea is not spirally arranged. On the other hand, the calcareous operculum in the Neritoidea is spiral and usually has a peg-like projection which inserts into the muscle of the snail. The lack of resorption of the inner whorls in *Delphinulopsis* places it in the Neritopsoidea, as noted by Yin – Yochelson (1983). This systematic position of *Delphinulopsis* is also followed here. All of the new genera established here, *Paradelphinulopsis* gen. nov., *Spinidelphinulopsis* gen. nov., and *Wallowanerita* gen. nov., do not resorb inner whorls of the teleoconch. Thus, the placement of the Delphinulopsidae into the superfamily Neritopsoidea fits well with its diagnosis. Unfortunately, opercula of the Delphinulopsidae (if any exist) that could be useful for testing this taxonomic position are not known. Recently, Bandel – Frýda (1999) included three families in the Neritopsoidea: Neritopsidae Gray, 1847, Cortinellidae Bandel, 1998, and Pseudorthonchiidae Bandel and Frýda, 1999. The latter two families, like the Delphinulopsidae, are known only from the Triassic. Members of the Delphinulopsidae differ from members of all three families by the presence of a prominent, weakly concave, plate-like septum extending from inner apertural lip and by their rapidly expanded teleoconch having an openly coiled gerontic whorl. In addition, the Delphinulopsidae differs from the Pseudorthonchiidae by its distinctly anisostrophically (dextrally) coiled teleoconch. The only known genus of the latter family, *Pseudorthonchia* Bandel – Frýda, 1999, has a cap-like teleoconch. On the other hand, the type genus of the Cortinellidae, *Cortinella* Bandel, 1989, is planispirally coiled (see Bandel 1993, Pl. 3, Figs 3, 5–6). No other taxa in the Neritopsoidea possess this prominent plate-like septum and rapidly expanded teleoconch having an openly coiled gerontic whorl. Similar plate-like septa are found in the Neritoidea, however, a signif-

icant stratigraphic gap exists between the last known representatives of the delphinulopsids and the first appearance of this feature in the latter group. In addition, the morphologic characters of the septal plate found in neritoideans (i.e. *Nerita*) appears to be different in detail from those found in the Delphinulopsidae.

The genus *Platytilina* Koken in Wöhrmann – Koken, 1892, which shows some similarity to some members of the Delphinulopsidae, can not belong to this new subfamily, because resorption of inner whorls has been noted (Koken 1892, p. 195; Böhm 1895, p. 243; Kittl 1899, p. 74). This feature places the latter genus in the family Neritidae (Yin – Yochelson 1983, p. 530). The genus *Fossariopsis* Laube, 1868, has been suppressed as a synonym of *Delphinulopsis* Laube, 1868, for some time, but Yin – Yochelson (1983) argued for reaffirming the distinctiveness of these two genera. We are uncertain at this time about the correct placement of *Fossariopsis*, and believe further study of the type species (*Naticella rugoso-carinata* Klipstein) is necessary to help resolve this issue. The type species of *Seisia* was designated by Kutassy (1934, p. 75) as *Platytilina wöhrmanni* Blaschke (non *Platytilina wöhrmanni* Koken, 1892). According to Kutassy, the specimens illustrated by Blaschke represent a different species (and genus) than those of Koken, and Kutassy proposed the name *Seisia blaschkei* for it. He also identified the latter species in his Norian age fauna from St. Anna in Hungary, however judging from his illustrations this species appears to differ from *S. blaschkei*. Unfortunately, neither paper illustrated the character of the aperture, so it is difficult at this time to be certain that *Seisia* belongs to the family Delphinulopsidae. However, an illustration of the shell base of *Seisia blaschkei* (Kutassy, 1934, Pl. 3, Fig. 7) shows shell ornamentation in the inner lip region that closely approaches that of *Paradelphinulopsis* gen. nov. (Fig. 4A–Q) For this reason, we tentatively place *Seisia* in the Delphinulopsidae, but feel further study is necessary of both the Austrian and Hungarian specimens attributed to the type species.

**Included genera:** *Delphinulopsis* Laube, 1868  
*Seisia* Kutassy, 1934  
*Paradelphinulopsis* gen. nov.  
*Spinidelphinulopsis* gen. nov.  
*Wallowanerita* gen. nov.

### **Genus *Paradelphinulopsis* gen. nov.**

**Type species:** *Paradelphinulopsis vallieri* sp. nov. by monotypy.  
**Etymology:** The name refers to the close relationship of the new genus to *Delphinulopsis* Laube, 1868.

**Diagnosis:** Delphinulopsid gastropods with well developed upper ramp, delimited by strong angulation; ornament composed of three prominent spiral carinae, the uppermost situated on angulation bordering upper ramp; ornamentation also includes numerous secondary spiral

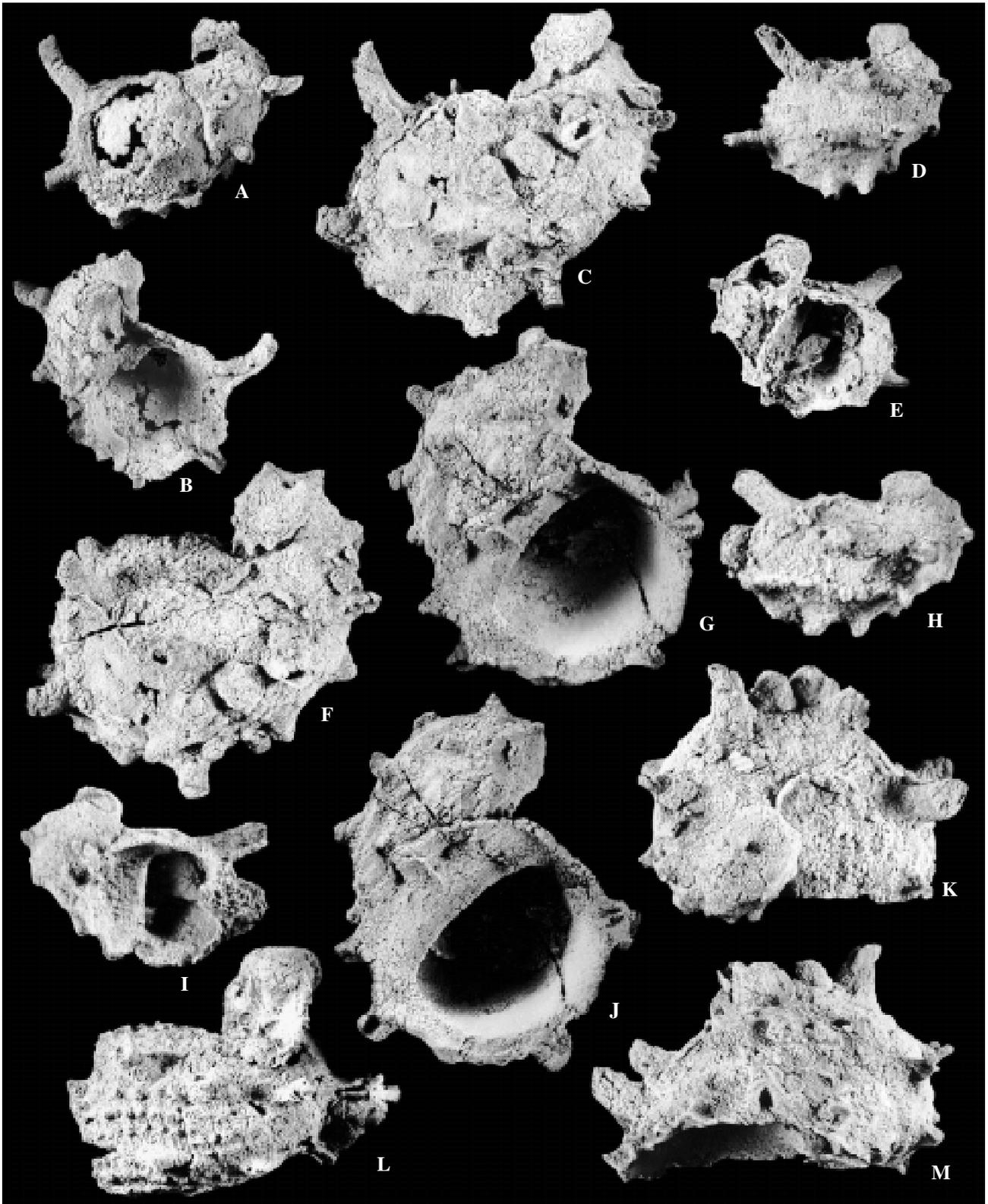


Fig. 5. A–M – *Spinidelphinulopsis whaleni* gen. et sp. nov.; A, B – paratype B, UMIP 2.27189, abapertural and apertural views, x2; C, F, G, J, K, M – holotype, UMIP 2.27187, lateral, oblique, apertural, oblique apertural, apical, and basal views, x2; D, E – paratype A, UMIP 2.27188, lateral and apertural views, x2; H, I – paratype D, UMIP 2.27191, lateral and apertural views, x4; L – paratype C, UMIP 2.27190, lateral view, x2. All specimens from Spring Creek locality (late Carnian or early Norian), Martin Bridge Formation, Wallowa terrane, northeastern Oregon.

cords developed between each carinae, on the upper ramp, and also on upper portion of basal whorl surface; short, hollow spines may be present on carinae, oriented at a low oblique angle to shell surface.

**Comparison:** The new genus differs from *Delphinulopsis* in the presence of numerous secondary spiral cords covering much of the shell surface, in having a wider, more horizontally inclined upper ramp, as well as being lower spired. It differs from *Seisia* Kutassy, 1934, in having a quite differing whorl profile, by the absence of prominent nodes, and by its possession of numerous secondary spiral cords. From *Spinidelphinulopsis* gen. nov. it differs in having an angular whorl profile, in its lack of long perpendicular spines, and the presence of numerous secondary spiral cords. It differs from *Wallowanerita* gen. nov. in having an angular whorl profile, in its possession of prominent carinae, and the absence of the distinctive shingled ornament typical for the latter genus. **Species assigned:** Only the type species is presently known.

#### ***Paradelphinulopsis vallieri* sp. nov.**

**Diagnosis:** By monotypy, same as genus.

**Etymology:** In honor of Tracy L. Vallier, who discovered the Spring Creek locality in 1964 and mapped the geology of Hells Canyon.

**Types:** Holotype, UMIP 2.27180 and paratypes A–F, UMIP 2.27181–2.27186.

**Description:** Medium-sized, dextral shell with rapidly expanding whorls, numbering up to 1.5 to 2 volutions; spire relatively low, protoconch not preserved, initial whorl smooth, approximately first 1.25 whorls conjunct, afterwards subsequent whorl becomes openly-coiled; whorl profile with well developed sharp, acute angulation bordering weakly inclined, almost horizontal upper ramp which is adaxially convex and abaxially concave; aperture holostomatous, weakly inclined with respect to shell axis, external outline of aperture rounded, internal outline semicircular; inner lip with strongly developed, weakly concave plate-like septum projecting into and partially constricting aperture, outer margin of septum straight; base anomphalous, weakly rounded; three prominent, strongly rounded spiral carinae present on shell, the uppermost of which is situated at the prominent angulation, the middle carinae situated at the periphery, which is at mid-whorl height, and the lower carinae situated lower on basal whorl surface; carinae commonly bear short, hollow spines, oriented at a low oblique angle to shell surface; shell weakly concave between each spiral carinae; much of shell exterior covered by secondary, weakly convex to flattened spiral cords, except for two portions of the shell: 1.) the region occupying the inner third of the upper ramp where the spiral cords are replaced by stronger, thicker cords which are concave-forward in form, initiating adaxially nearly perpendicular to inner margin and increasing in forward cur-

vature to abruptly merge with spiral cords situated abaxially (Fig. 4A–Q); and 2.) a narrow, weakly concave spiral band on the lowermost portion of the basal whorl surface where the spiral cords are replaced again by stronger, short convex-forward cords, oriented nearly perpendicular to spiral cords on overlying shell surface (Fig. 4A–Q of them).

**Other material examined:** 23 non-type specimens are known from the Spring Creek locality.

**Occurrence:** In addition to its occurrence at the Spring Creek locality of the Martin Bridge Formation in northeastern Oregon, this species also occurs at the Green Butte locality (USGS Mesozoic locality M1708) in the Wrangell Mountains of southern Alaska. This occurrence in the Wrangellia terrane is based on direct examination of fossil material from the latter locality.

#### **Genus *Spinidelphinulopsis* gen. nov.**

**Type species:** *Spinidelphinulopsis whaleni* sp. nov. by monotypy.

**Etymology:** The genus name refers both to the strongly spinose character of the shell and its resemblance to the genus *Delphinulopsis*.

**Diagnosis:** Delphinulopsid gastropods with rounded whorl profile and moderately high spire, ornament consists of strong, widely spaced, long hollow spines; the latter oriented perpendicular to shell surface, with suture between spine halves situated adaperturally.

**Comparison:** The new genus is easily distinguished from all other delphinulopsid genera by its widely spaced, long, hollow spines. In addition, the combination of otherwise relatively smooth shell surface and well rounded whorl profile also distinguish it. Spines are also present in *Paradelphinulopsis* gen. nov. and *Wallowanerita* gen. nov., but in both genera they are much shorter and oriented at a low oblique angle with respect to the shell surface. **Species assigned:** Only the type species is confidently assigned at present. However, several delphinulopsid species that may belong to *Spinidelphinulopsis* are *Fossariopsis palfyi* Kutassy, 1932 and *Seisia spinosa* Kutassy, 1937, both from the Upper Triassic of Hungary. The former species closely approaches the type species of *Spinidelphinulopsis*, but judging from Kutassy's description and illustrations, it appears to lack the long spines of the new genus. *Seisia spinosa* Kutassy is also similar in being relatively smooth, but differs in being much lower spired. Although spinose, their character is uncertain. Pending examination of specimens of these taxa, we reserve further judgment on their placement in *Spinidelphinulopsis*.

#### ***Spinidelphinulopsis whaleni* sp. nov.**

**Etymology:** In honor of Michael T. Whalen, Department of Geology and Geophysics, University of Alaska, Fairbanks.

**Types:** Holotype, UMIP 2.27187, and Paratypes A–D, UMIP 2.27188–2.27191.

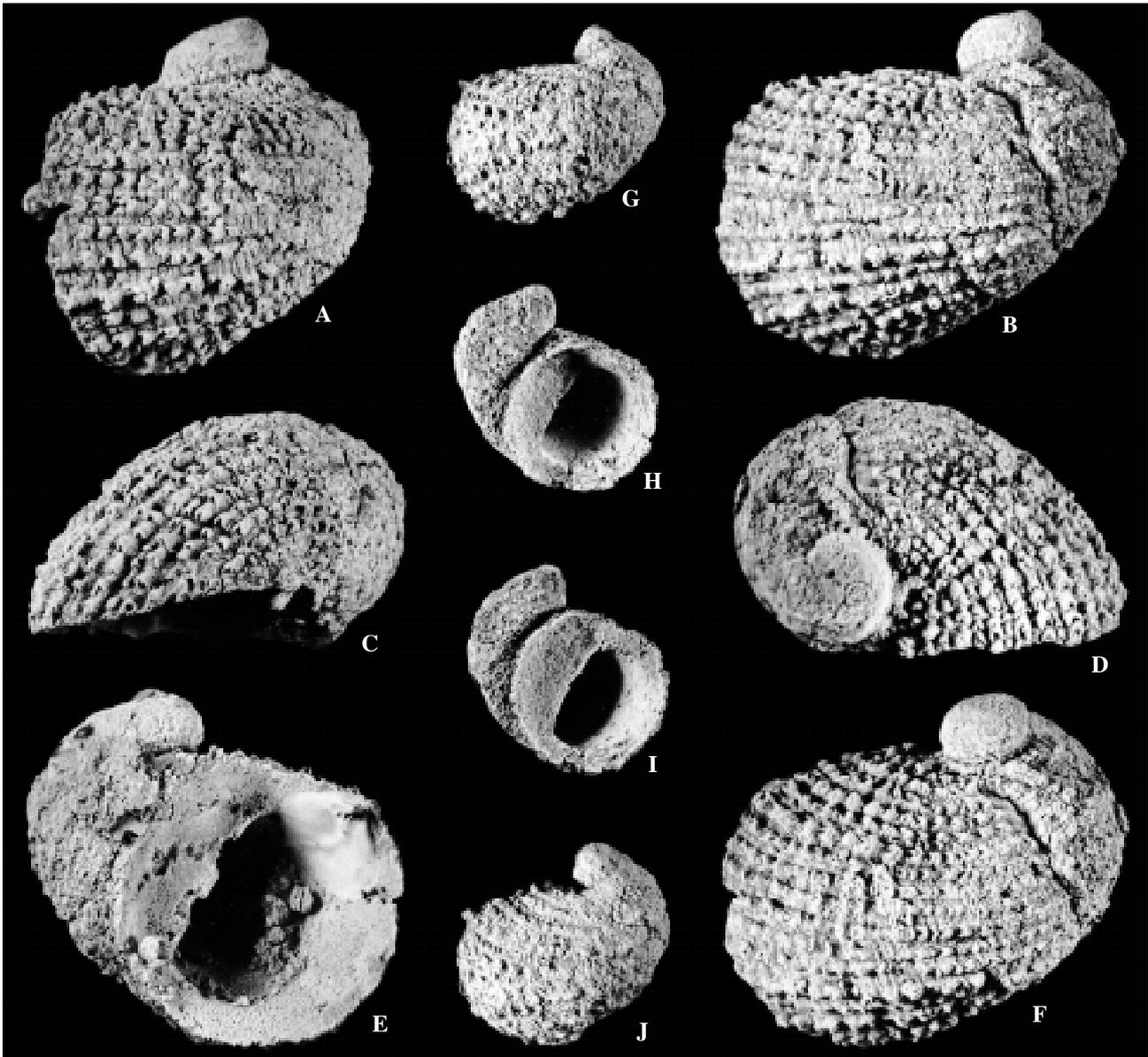


Fig. 6. A–J – *Wallowerita newtonae* gen. et sp. nov. from Spring Creek locality (late Carnian or Early Norvian), Martin Bridge Formation, Wallowa terrane, northeastern Oregon. A–F – holotype, UMIP 2.27192, lateral, oblique, basal, lateral, apertural, and apical views, x3; G–J – paratype A, UMIP 2.27193, oblique, oblique apertural, apertural, oblique abapertural views, x3.

**Diagnosis:** By monotypy, same as genus.

**Description:** Medium-sized, dextrally coiled, rapidly expanding shell composed of several whorls; spire relatively high, initial portion of shell closely coiled, final whorl disjunct; protoconch not preserved; whorl profile evenly rounded; aperture holostomatous, weakly inclined with respect to shell axis, height of aperture approximately half of shell height, external outline of aperture sub-rounded, internal outline semicircular; inner lip with strongly developed, weakly concave plate-like septum projecting into and partially constricting aperture; base anomphalous; ornament composed of widely spaced, long, hollow spines, directed perpendicular to shell surface, typically aligned in three spiral rows; spines with abaperturally situated sutures; minor secondary ornamentation (not present in all specimens) composed of minute

nodes which are spirally arranged (Fig. 5A–M). Dimensions of holotype (largest specimen): height, 3.05 mm; width 2.23 mm.

**Other material examined:** In addition to the types, two non-type specimens are known from the Spring Creek locality.

**Occurrence:** In addition to its occurrence at the Spring Creek locality of the Martin Bridge Formation in northeastern Oregon, a similar, probably conspecific form occurs at the Green Butte locality (USGS Mesozoic locality M1708) in the Wrangell Mountains of southern Alaska. This occurrence in the Wrangellia terrane is based on examination of several plates of gastropods provided by N. J. Silberling, who discovered the locality. Although probably conspecific, we withhold final judgment until we can examine the Alaskan material.

### Genus *Wallowanerita* gen. nov.

Type species: *Wallowanerita newtonae* sp. nov. by monotypy.

Etymology: Combination after the Wallowa Mountains of north-eastern Oregon and the gastropod genus *Nerita*.

Diagnosis: Delphinulopsid gastropods with rounded whorl profile, wholly lacking angulations; with numerous spiral carinae, which bear small, regularly spaced hollow spines which give the shell a distinctive shingled appearance; carinae separated by slightly narrower flattened interspaces; transverse ornament composed of closely spaced, nearly orthocone growth lamellae.

Comparison: The new genus differs from all other members of the Delphinulopsidae in its distinctive shingled ornamentation. In addition, it differs from *Delphinulopsis* in having a rounded whorl profile lacking prominent angulations. Similarly, the new genus differs from *Paradelphinulopsis* gen. nov. in having a more rounded whorl profile (lacking the distinctive upper ramp of the latter genus), and in total lack of spines; from *Spinidelphinulopsis* gen. nov. it also differs in having a much more rounded whorl profile and in its lack of prominent spines. The new genus differs from *Seisia* Kutassy, 1934, in having a rounded whorl profile and in its lack of prominent nodes.

Species assigned: Only the type species is presently known.

### *Wallowanerita newtonae* sp. nov.

Etymology: In honor of Cathy R. Newton, Department of Geology, Syracuse University, Syracuse, New York.

Types: Holotype, UMIP 2.27192 and Paratype, UMIP 2.27193.

Diagnosis: By monotypy, same as genus.

Description: Medium-sized, dextrally coiled, rapidly expanding shell, consisting of several whorls, sutures deeply incised; spire of moderate height, protoconch and initial shell not preserved; whorl profile rounded; aperture holostomatous, weakly inclined with respect to shell axis, external outline circular, internal outline semicircular; inner lip with prominent, weakly concave plate-like septum extending into and partially constricting aperture; base anomphalous; ornament consists of numerous (up to 30) spiral carinae, separated by slightly narrower flattened interspaces intersected by transverse ornament composed of closely spaced, nearly orthocone growth lamellae; spiral carinae bearing numerous, regularly spaced, extremely hollow short spines (Fig. 6A–J) which project at a low angle to give the shell a distinctive shingled appearance.

Dimensions of holotype: height, 18.8 mm; width, 17.8 mm.

Other material examined: One partial whorl fragment.

Occurrence: Known only from the Spring Creek locality of the Martin Bridge Formation.

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