Jb. Geol. B.-A.	ISSN 0016-7800	Band **135**	Heft 2	S. 425–465	Wien, Mai 1992

Ammonoids of the Shoshonensis Zone (Middle Anisian, Middle Triassic) from Northwestern Nevada (USA)*)

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With 28 Text-Figures and 11 Plates

USA
Nevada
Ammoniten
Trias
Anis
Taxonomie
Biostratigraphie
Korrelationen

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Zusammenfassung

Neue Untersuchungen im anisischen Fossil Hill Member (Favret- und Prida-Formationen, Star Peak-Gruppe) führten zur Unterscheidung von 4 Ammoniten-Subzonen in der Shoshonensis-Zone (höchstes Mittel-Anis). Es handelt sich dabei in aufsteigender Reihenfolge um die Rieberi-, Ransomei-, Wallacei- und Fergusoni-Subzonen. Drei Gattungen und 14 Arten werden neu beschrieben. Da für die Korrelation kritische Taxa üblicherweise in niedrigen Paläobreitengraden gut vertreten sind, fällt die Unterscheidung der Shoshonensis-Zone im ganzen Tethysraum relativ leicht. Eine Korrelation auf Subzonen-Ebene ist jedoch bisher nur für den obersten Teil der Shoshonensis-Zone erstellt worden, der durch das gleichzeitige Auftreten von *Balatonites, Bulogites, Acrochordiceras* (*Carolinae*-Gruppe), *Proteusites* und *Proarcestes* gekennzeichnet ist. Diese kurze Zeitspanne entspricht hauptsächlich der „Pelsonischen Unterstufe" in den Alpen, mit Ausnahme des älteren Rahnbauerkogel-Horizonts.

Ammonoidea der Shoshonensis-Zone (Mittleres Anis, Mitteltrias) aus dem nordwestlichen Nevada (USA)

Abstract

New investigations in the Fossil Hill Member (Favret and Prida Formations, Star Peak Group) lead to the recognition of four disctinct ammonoid subzones in the late middle Anisian Shoshonensis Zone. These are the Rieberi, Ransomei, Wallacei, and Fergusoni subzones, in ascending order. Three genera and 14 species are newly described. Critical taxa for correlations have an essentially low paleolatitude distribution, making recognition of the Shoshonensis Zone fairly easy throughout the Tethyan

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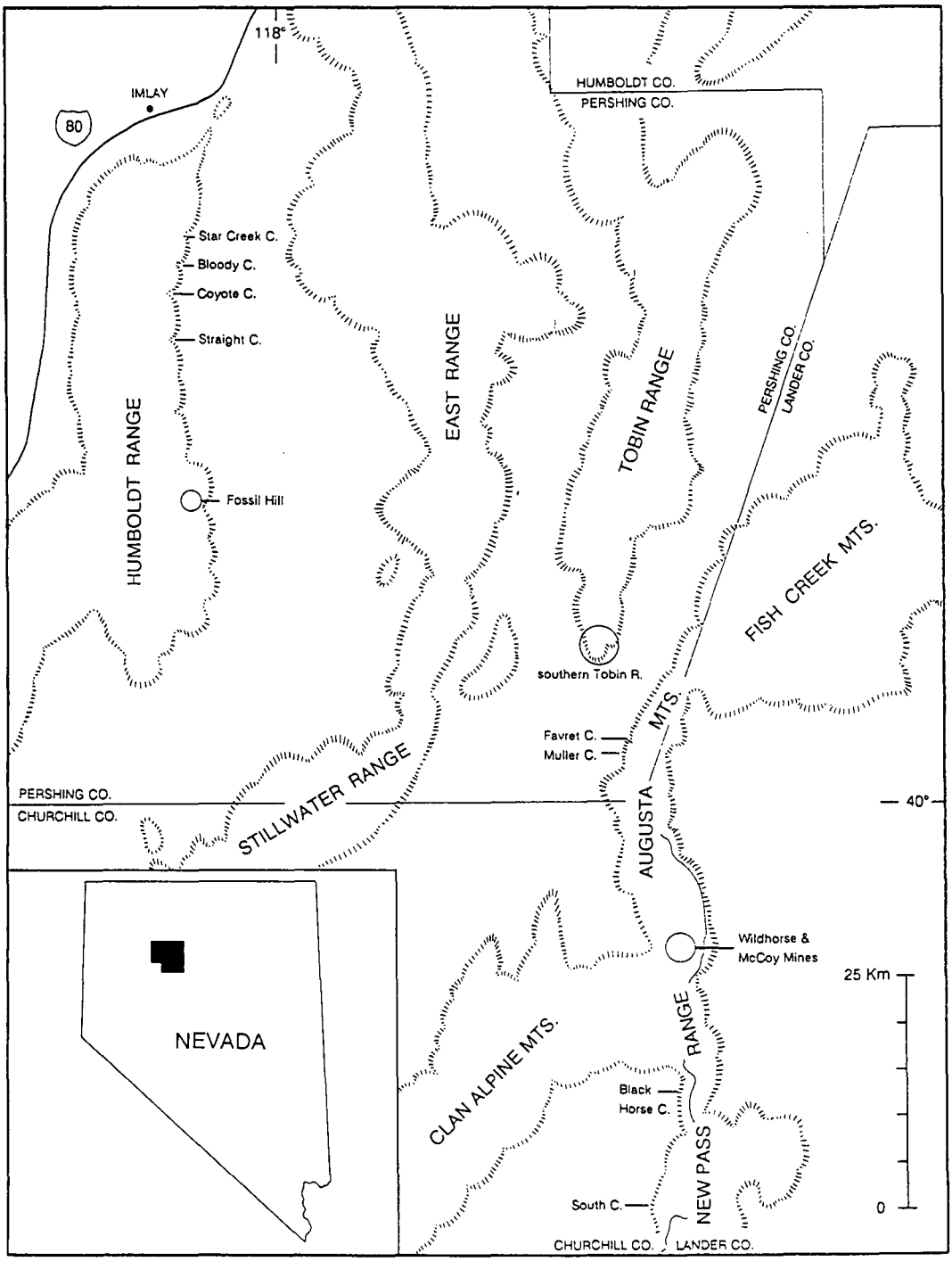
realm. However, suitable correlations at subzonal rank are only established for the latest part of the Shoshonensis Zone, which is characterized by the concurrent ranges of *Balatonites, Bulogites, Acrochordiceras* (*carolinae* group), *Proteusites*, and *Proarcestes*. This short time span corresponds to most of what is known as the „Pelsonian substage" in Alpine Europe, with the exception of the older Rahnbauerkogel horizon.

1. Introduction

This report updates the taxonomy and the biostratigraphic distribution of the ammonoids of the middle Anisian Shoshonensis Zone. Although the zonal index *Balatonites shoshonensis* was described long ago by HYATT & SMITH (1905) and SMITH (1914), the relative stratigraphic position of this fauna throughout the Anisian succession of the Fossil Hill Member (Favret and Prida Formations; NICHOLS & SILBERLING, 1977) was first established by SILBERLING & TOZER (1968). The Wildhorse mining district (Text-Fig. 1) was then designated as the type locality of the Shoshonensis Zone. Other occurrences of this zone were known from South Canyon in the New Pass Range and from the vicinity of Favret Canyon in the Augusta Mountains (Text-Fig. 1). By then, the Shoshonensis Zone was only known to occur below the Rotelliformis Zone, which is early upper Ani-



Text-Fig. 1.
Index map showing the location of sections relevant for the Shoshonensis Zone stratigraphy.

sian in age. Additional occurrences were subsequently discovered by SILBERLING (in BURKE, 1973) in the southern Tobin Range. SILBERLING & NICHOLS (1982) also showed that the Shoshonensis Zone occurs above the Hyatti Zone, as evidenced by the southern Tobin Range section.

Sections in the Augusta Mountains, southern Tobin Range, and northern Humboldt Range were recently documented by the author. This has led to the recognition of four subzones in the Shoshonensis Zone.

The Taylori Zone was discovered only recently and shown to be positioned between the Hyatti and Shoshonensis Zone (BUCHER, 1988). In ascending order, the middle Anisian substage is therefore divided into the Hyatti, Taylori and Shoshonensis zones. This confers a latest middle Anisian age to the Shoshonensis Zone in the Nevada succession.

2. Biostratigraphic Distribution of the Shoshonensis Zone Ammonoids

Index species: *Balatonites shoshonensis* HYATT & SMITH.

In addition to the zonal index, halobiid bivalves assigned to *Enteropleura* cf. *E. bittneri* KITTL provide a useful marker for the entire Shoshonensis Zone.

The scope of the Shoshonensis Zone is now enlarged to four distinct subzones (Rieberi, Ransomei, Wallacei and Fergusoni in ascending order, see Text-Fig. 2). In its original definition by SILBERLING & TOZER (1968), the Shoshonensis was based on a few localities from the vicinity of Wildhorse Mine in the New Pass Range (USGS Mesozoic loc. M501 and M635). It now appears that these localities are either of Wallacei or Fergusoni age. *Hollandites* sp. was listed from these two localities by SILBERLING & TOZER (1968). In fact, this form refers to the group of *Ceratites (Phillipites) ransomei* SMITH 1914 which is here transferred to the new genus *Favreticeras*. The original description of *Favreticeras ransomei* by SMITH from the vicinity of Wheeler Mine (between Cottonwood and Straight Canyons) shows that the Shoshonensis Zone was discovered in the northern Humboldt Range since the early twentieth century. The virtual presence of this zone between the Hyatti Zone and upper Anisian faunas in the northern Humboldt was anticipated by SILBERLING & WALLACE (1969). Ammonoids indicative of the Shoshonensis Zone were found again by the author in Straight, John Brown, and Congress Canyons, where they are bracketed between the Hyatti and Taylori Zones below and faunas of upper Anisian age above.

Except for the Fergusoni Subzone, which is only known in the vicinity of Wildhorse Mine (New Pass Range), the sequence including the three other subzones is best displayed in Favret and Muller Canyons (Augusta Mountains). Hence, Favret and Muller Canyons are preferred as the type area for the Shoshonensis Zone. Stratigraphic profiles are given in BUCHER (1988, Pl. 7), where the Rieberi, Ransomei, and Wallacei subzones were provisionally and unformally referred to as the lower, middle, and upper Shoshonensis Zone, respectively.

Biostratigraphic distribution of the Shoshonensis Zone ammonoids is summarized in Text-Fig. 2.

2.1. Rieberi Subzone

Index species: *Favreticeras rieberi* n.gen. n.sp.

Type locality: HB 166, Favret Canyon, Augusta Mountains.

SUBSTAGE		MIDDLE ANISIAN			
ZONE		SHOSHONENSIS			
Subzones		Rieberi	Ransomei	Wallacei	Fergusoni
Eogymnotoceras tuberculatum n. sp.	<-	**********			
Gymnotoceras praecursor n. sp.	<-	**********			
Ismidites cf. I. marmarense Arthaber	<-	**********			
Constrigymnites robersti n. gen n. sp.	<-	**********			
Nevadisculites smithi Bucher	<-	----------	**********		
Ussurites arthaberi (Welter)	<-	**********	**********	**********	
Epacrochordiceras cf. E. enode (Hauer)	<-	**********	**********	**********	**********
Intornites nevadanus (Hyatt and Smith)	<-	**********	**********	**********	**********
Acrochordiceras carolinae (Mojsisovics)	<-	**********	**********	**********	**********
Ptychites densistriatus n. sp.		**********			
Nevadisculites depressus n. sp.		**********			
Favreticeras rieberi n. gen. n. sp.		**********			
Amphipopanoceras cf. A. selwiny McLearn		**********			
Balatonites shoshonensis Hyatt and Smith		**********			
Favreticeras ransomei (Smith)			**********		
Platycuccoceras sp. indet.			**********		
Platycuccoceras cainense n. sp.			**********		
Gymnotoceras ginsburgi n. sp.				**********	
Guexites pacificus n. gen. n. sp.				**********	
Favreticeras wallacei n. gen. n. sp.				**********	**********
Ptychites gradinarui n. sp.				**********	**********
Balatonites whitneyi n. sp.				**********	**********
Proteusites weitschati n. sp.					**********
Proteusites fergusoni n. sp.					**********
Proarcestes cf. P. bramantei (Mojsisovics)					**********
Bulogites cf. B. mojsvari (Arthaber)					++++++++++++++

Text-Fig. 2.
Stratigraphic distribution of the ammonoids of the Shoshonensis Zone.

Occurrence: Loc. HB 117, 161, 167, 168, 173, 188, 190, 211, 230, Favret Canyon; loc. HB 198, Muller Canyon, Augusta Mountains (Fossil Hill Member, Favret Formation).

Balatonites shoshonensis, Ptychites densistriatus, Nevadisculites depressus, Amphipopanoceras selwyni and the subzonal index are presently known to occur exclusively in the Rieberi Subzone. *Favreticeras* typically has its oldest occurrence in the Rieberi Subzone.

HYATT & SMITH (1905) based their description of *Balatonites shoshonensis* on a single specimen from the Shoshone Mountains which was collected by the Whitney expedition. When the Shoshonensis Zone was introduced by SILBERLING & TOZER (1968), the first and by then unique proven stratigraphic occurrence of *Balatonites* became available for the Nevada record. Representatives of *Balatonites* were then assigned to *B. shoshonensis*. The newly refined subzonal scheme of the Shoshonensis Zone leads to establish specific distinctions between the various representatives of *Balatonites*. *Balatonites* identical to the *shoshonensis* holotype of HYATT & SMITH (1905) appears to be restricted to the Rieberi Subzone, whereas *Balatonites* ranging from the Wallacei up to the Fergusoni Subzone are assigned to *Balatonites whitneyi* n.sp.

2.2. Ransomei Subzone

Index species: *Favreticeras ransomei* (SMITH).

Type locality: Loc. HB 169, Favret Canyon, Augusta Mountains.

Occurrence: Loc. HB 35, North Fork of Straight Canyon; Wheeler Mine area (= Cottonwood Canyon of SMITH, 1914), northern Humboldt Range (Fossil Hill Member, Prida Formation). Loc. HB 172, 174, 177, 178, 186, 187, 198, 210, Favret Canyon, loc. HB 193, 254, Muller Canyon, Augusta Mountains. Loc. HB 158, McCoy Mine, New Pass Range (Fossil Hill Member, Favret Formation).

2.3. Wallacei Subzone

Index species: *Favreticeras wallacei* n.gen. n.sp.

Type locality: HB 191, Muller Canyon, Augusta Mountains.

Occurrence: Loc. HB 37, Congress Canyon, northern Humboldt Range (Fossil Hill Member, Prida Formation). Loc. HB 171, 220, Favret Canyon; loc. HB 192, 231, 233, Muller Canyon, Augusta Mountains. Loc. HB 111, 112, 155, 249, southern Tobin Range. USGS Mesozoic loc. M501, Wildhorse Mine, New Pass range (Fossil Hill Member, Favret Formation).

2.4. Fergusoni Subzone

Index species: *Proteusites fergusoni* n.sp.

Type locality: USGS Mesozoic loc. M2314, Wildhorse Mine, New Pass Range.

Occurrence: USGS Mesozoic loc. M501, SU 231 (Fossil Hill Member, Favret Formation).

At present, the superposition of the Fergusoni Subzone above the Wallacei Subzone still requires demonstration by field evidence. Representatives of *Proteusites* are stratigraphically limited to this subzone. *Proarcestes* also has its earliest occurrence in this subzone. The stratigraphic position of the Fergusoni Subzone, as presently anticipated, is only inferred from the concurrent ranges of *Balatonites, Favreticeras, Proteusites* and *Proarcestes*.

Unfortunately, the Fergusoni Subzone was not recognized in Favret and Muller Canyons. But there is ample room for the Fergusoni Subzone within the 20–25 m interval that separates the Wallacei Subzone from the lowest occurrence of *Daonellas* indicative of the Rotelliformis Zone. Moreover, this shaly interval with subordinate limestone yields abundant specimens of *Enteropleura* cf. *E. bittneri*, which unambiguously suggests a Shoshonensis age.

It is also worth mentioning that a single float specimen of *Bulogites* was collected about 5 m above beds indicative of the Wallacei Subzone, on the southern wall of Muller Canyon. This particular section has subhorizontal bedding and a limited vertical extent. Strata of upper Anisian age have been locally eroded away and only *Enteropleura* bearing shales crop out up to the top of the ridge. There is little doubt that this specimen is derived from strata representing the youngest part of the Shoshonensis Zone. It has a post-Wallacei and pre-Rotelliformis age, but cannot objectively be incorporated into the Fergusoni Subzone.

3. Correlatives of the Shoshonensis Zone

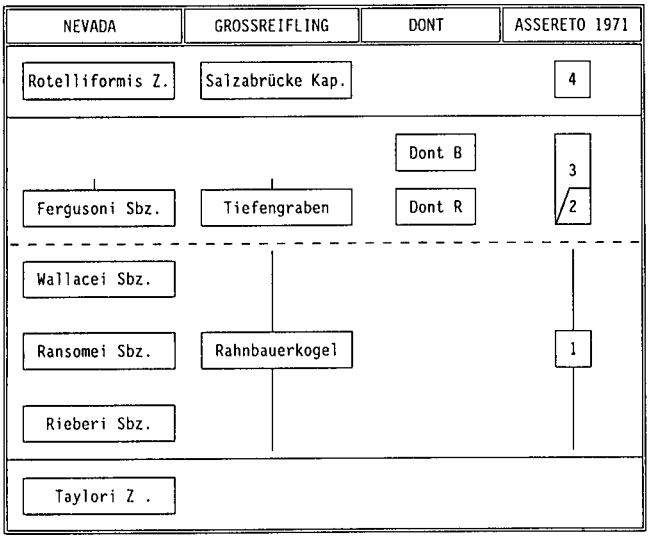
Balatonites is the most diagnostic genus of this time span. It appears essentially as a low paleolatitude marker (TOZER, 1982) and is known from North America, Europe and Asia.

Partial equivalents of the Shoshonensis Zone are well known in Mediterranean and Eastern Europe, where they are customarily grouped under the "Pelsonian substage" denomination. Although the original distinction between the Binodosus and Trinodosus Zones by MOJSISOVICS (1882) has been questioned by many authors, ASSERETO's reappraisal has demonstrated the valid status of Binodosus Zone (ASSERETO, 1971). And the European Trinodosus Zone has been shown to correlate with the Rotelliformis Zone, the oldest of the three upper Anisian Zones of Nevada. Because the index *"Paraceratites" binodosus* is only known to occur in the uppermost part of the Pelsonian, the Balatonicus Zone denomination is generally preferred by European workers for all of the faunas included in the Pelsonian substage.

Much confusion in the biostratigraphy of the Alpine Anisian arose from the scarcity of superpositional relationships and condensation problems related to the Hallstatt facies (Schreyer Alm, Han Bulog, etc...). As initially felt by ARTHABER (1912, p. 342), there is also compelling evidence that, without adequately documented superpositional relationships, the early development of several *"Ceratites"* lineages during the Pelsonian made distinction with younger Anisian faunas a difficult matter. Among these *"Ceratites"*, two groups of exclusively middle Anisian age are now recognized: the *Bulogites* group (inclusive of *Reiflingites* s.s.) and the *Favreticeras* group (inclusive of *Guexites*). Other

forms such as *"Paraceratites" binodosus* (HAUER), *"Paraceratites" cimeganus* (MOJSISOVICS), *"Ceratites" waageni* ARTHABER, *"C." planus* ARTHABER, *"C." glaber* ARTHABER (= *"C." semiornatus* ARTHABER), and *"C." falcifer* HAUER still need appropriate generic treatment, but they illustrate the early and diversified stock of late middle Anisian age, among which younger and keeled Paraceratininae SILBERLING (1962) may root into.

A main step in the biostratigraphic comprehension of the Alpine late middle Anisian substage was performed by ASSERETO (1971), and this contribution is used hereafter as a basis for comparisons with the Nevada succession (see Text-Fig. 3).



Text-Fig. 3.
Chart showing the current state of correlations of the Shoshonensis Zone with the Alpine Europe succession.
See text for other scattered partial correlatives.

Germanic lower Muschelkalk

Sporadic occurrences of Shoshonensis Zone correlatives are known from the Germanic lower Muschelkalk (Wellenkalk, see ULRICHS & MUNDLOS, 1985 for updated generic list). This correlation is based on the presence of *Acrochordiceras damesi* (NOETLING, 1880), a representative of the *A. carolinae* group, along with varied species of *Balatonites* (RASSMUSS, 1915). Furthermore, the presence of *Bulogites zoldianus* and *B. mirabilis* (ASSMANN, 1926, 1937) suggests that at least part of the Wellenkalk from Silesia may correlate with the latest Shoshonensis Zone.

Großreifling

The classic Anisian stratotype at Großreifling contains two distinct faunas (ARTHABER, 1896,a,b; ASSERETO, 1971; SUMMESBERGER & WAGNER, 1972; TATZREITER & VÖRÖS, 1991). The most discriminative forms of the upper fauna (Tiefengraben) for correlation with Nevada are *Balatonites* and *Bulogites* of the *B. mojsvari* group. Further evidence for correlation of Tiefengraben with the latest Shoshonenis Zone is the recent discovery of *Proarcestes* by TATZREITER (in TATZREITER & VÖRÖS, 1991).

As stressed by TATZREITER & VÖRÖS (1991), none of the Tiefengraben *"Ceratites"* figured by ARTHABER (1896a) can be referred to the upper Anisian *Paraceratites*, the latter having a distinctly keeled venter.

Association of *Balatonites, Bulogites* and *Proarcestes* indicates that the Tiefengraben fauna correlates with the post-Wallacei and pre-Rotelliformis interval of the Nevada succession.

The older Rahnbauerkogel fauna (ARTHABER, 1896b) has no diagnostic elements that would permit precise correlation with the Rieberi, Ransomei or Wallacei subzones.

Remark on *Bulogites* and *Reiflingites*

Following ASSERETO (1963, p. 13), *Bulogites* and *Reiflingites*, whose typical stratigraphic occurrences are found at Tiefengraben, are phyllogenetically very closely allied. Examination of ARTHABER's collection from Tiefengraben leads us to conclude that the innermost whorls of these two genera are hardly distinguishable. Moreover, their immature morphology bear no evidence that would justify lumping them with danubitids (see SPATH, 1951, p. 14, and KUMMEL, 1957), nor with balatonitids (see TOZER, 1981a, p. 92). Accompanying the distinctive evolute trend of outer whorls of *Reiflingites*, ribbing changes into a more distant pattern. The adoral rib branching from the lateral node in *Bulogites* tends to separate as a true intercalatory rib in *Reiflingites*, with the lateral and umbilical nodes being placed on the primary rib only. This concomittant change in outer whorl geometry and ornamentation is well illustrated by the following morphological sequence: *Bulogites mojsvari* (ARTHABER) → *Bulogites reiflingensis* (ARTHABER) → *Reiflingites eugeniae* ARTHABER → *R. torosus* ARTHABER. Adjunction of a thread-like keel is also regarded as a distinctive feature of *Reiflingites*.

Hungary

The Aszófö section was recently re-investigated by VÖRÖS (1987), thus making available the first detailed bedrock-controlled succession for the classic Balaton area. VÖRÖS identified most of ASSERETO's subdivisions, with the exception of Fauna 2 (Mt. Rite). This is not surprising because the content of Fauna 2 is very similar to that of Fauna 3 (ASSERETO, 1971, p. 24). *Bulogites, Acrochordiceras* (*carolinae* group), and multinodose *Balatonites* (*transfuga-gemmatus* group, see RIEDEL, 1949) from Mt. Rite also occur in the younger Fauna 3 (i.e. Dont R, see ASSERETO, 1971, p. 11; Tiefengraben, see ARTHABER, 1896a). Until Fauna 2 is more accurately defined, it is suggested that it should be lumped with Fauna 3.

More importantly, VÖRÖS (1987) showed that *Bulogites* is restricted to the upper part of the Balatonicus Zone, a stratigraphic range which is consistent with those from Grossreifling and Nevada.

Northern Italy

The Judicary sequence was shown by GAETANI (1969) to include two distinct assemblages. The lower fauna is characterized by *Bulogites* (*zoldianus* group), *Balatonites, "Paraceratites"* (*cimeganus* group), *Beyrichites cadoricus* and *Proavites*, and may possibly correlate with the latest Shoshonensis Zone. The upper fauna, which contains *Judicarites, Semiornites* and *Paraceratites trinodosus*, was unambiguously referred to the Trinodosus Zone.

As demonstrated by the common occcurrence of *Daonella sturi* (BENECKE), all of the localities from Val Camonica documented by ASSERETO (1963) are clearly upper Anisian in age. Moreover, all of these localities belong to a single fauna as stated by ASSERETO himself. Therefore, assignment of several species to *Bulogites* and *Reiflingites* by ASSERETO (1963, 1969) would provide the unique occurrence of these two genera in the

upper Anisian substage. But, from illustrations in ASSERETO (1963), there is no convincing evidence that *Bulogites* is represented in Val Camonica. Specimens referred to as *"B." gosaviensis* and *"B." camunus* do show obvious affinities with *Reiflingites*, an opinion also expressed by GAETANI & BALINI (in KOVÁCS et al., 1990, p. 181 and Text-Fig. 12). Thus, *Bulogites* is apparently restricted to the late Balatonicus Zone, whereas involute derivatives of *Reiflingites* may possibly range into the younger Trinodosus Zone.

Regardless of the controversial generic assignment of *"Paraceratites" binodosus* (see TOZER, 1981b; FANTINI SESTINI, 1988; VÖRÖS, 1987; TATZREITER & VÖRÖS, 1991), age assignment of the upper Dont fauna (= Dont B, field guide-book of the ASSERETO-Pisa symposium 1979) remains equivocal. Critical forms listed by ASSERETO (1971) from Dont B include: *Balatonites, Judicarites* and *"P." binodosus*. *Balatonites* and *Judicarites* are generally known to occur in the Balatonicus and Trinodosus Zones, respectively. The Dont B horizon would so far provide the unique concurrent range of these two genera. Consequently, it should be placed above the Balatonicus Zone and below the Trinodosus Zone.

The lower Dont fauna (Dont R) is characterized by the co-occurrence of *Balatonites* and *Bulogites* (*zoldianus* group), which permits correlation with the post-Wallacei and pre-Rotelliformis time interval of the Nevada sequence.

Bosnian Muschelkalk

The Bosnian Muschelkalk (HAUER, 1887, 1892, 1896) evidently includes faunas of latest middle and upper Anisian age. Despite of the lack of recent data on the stratigraphic distribution of its ammonoids, it is worth noting that KITTL (1903) already stated that occurrences of *Balatonites* and *Proteusites* were restricted to the lowermost part of the Bulog Limestone. The presence of *Acrochordiceras* (*carolinae* group), *Balatonites, Bulogites*, and *Proteusites* permits correlation with the Fergusoni Subzone and the post-Wallacei pre-Rotelliformis interval.

Although *Phillipites* does not occur in Nevada, this genus may also well characterize the uppermost part of the Alpine European Balatonicus Zone. As noticed by SPATH (1934), *Phillipites* is known from Tiefengraben as well as from the Bulog Limestone.

Czechoslovakia and Rumania

Sporadic occurrences of ammonoids diagnostic of late middle Anisian age are recorded from the Choc Nappe in the western Carpathians (RAKÚS, 1986) and from the Mnt. Persani Klippe in the eastern Carpathians (PATRULIUS, 1967). Another small fauna with *Balatonites* (*egregius* group) and *Enteropleura bittneri* was discovered by GRADINARU (unpubl. data) near Brasov.

Greece, Turkey, and Iran

Balatonites and *Acrochordiceras* (*carolinae* group) were first recorded from the Hallstatt facies limestone at Epidauros by RENZ (1910). Recent work by KRYSTYN & MARIOLAKOS (1975) and KRYSTYN (1983) established the exact occurrence of the Balatonicus Zone at the stratigraphic base of the Hallstatt limestone exotic block.

The faunal list established by RENZ (1931) from the Hallstatt limestone of Hydra Island also encompasses ammonoids of different ages. The largest part of the RENZ collection represents the Trinodosus Zone, but occurrences of *Balatonites, Proteusites*, and *Bulogites* permit recognition of a late Shoshonensis Zone correlative. Examination of the collection from Hagios Irene confirms the early designation of *"Ceratites"* (= *Bulogites*) *reiflingensis* by RENZ (1931); and to the addition of *Acrochordiceras* (*carolinae* group) to the Hagios Irene composite fauna.

The Balatonicus Zone is represented at Gebze (Turkey) by a small fauna in stratigraphic succession with the Osmani, Ismidicus and Trinodosus Zone (TOULA, 1896; ARTHABER, 1915; ASSERETO, 1972; FANTINI SESTINI, 1988).

Sample 123 of the Allam Formation in central Iran (TOZER, 1972, p. 32) is also regarded as a possible equivalent of the Shoshonensis Zone. As already noticed by SILBERLING & NICHOLS (1982), *Acrochordiceras* sp. aff. *A. hyatti* from bed 123 (TOZER, 1972, Pl. 10, Figs. 11–13) refers to the *A. carolinae* group, which is consistent with a probable Shoshonensis age assignment.

Himalayan Upper Muschelkalk

Although *Balatonites* is not recorded from the Himalayan "Upper Muschelkalk", the presence of *Proteusites* in the "*Ptychites* layers" from Kashmir (MIDDLEMISS, 1910; DIENER, 1913) suggests that at least part of the "*Ptychites* layers" may correlate with the Fergusoni Subzone of the Shoshonensis Zone. *Favreticeras kuvera* (originally described as *"Ceratites"* by DIENER, 1895, Pl. 5, Fig. 2) has obvious affinities with *F. rieberi* n.gen. n.sp. and would support recognition of the Shoshonensis Zone in the Spiti area.

"Ceratites" thuilleri OPPEL was assigned to *Paraceratites* by SPATH (1934), but the general shape and sculpture of its phragmocone agree in plan with that of *Bulogites*. However, *"C." thuilleri* retains some beyrichitian characteristics such as a subammonitic suture line with deeply indented lobes as well as a *Hollandites*-type of body chamber. These characters are significant differences that separate *"C." thuilleri* from typical *Bulogites*, but it is speculated here that *Bulogites* may root in the supposedly older *"C." thuilleri* group.

China

A Shoshonensis Zone correlative was described by GU, HE & WANG (1980) from northern Tibet, in the Chaqupu Formation at Dequen (see also WANG & HE 1980, p. 1214). First, the association of *Balatonites, Reiflingites, Acrochordiceras* (*carolinae* group) indicates a middle Anisian age; not upper as stated by GU et al. (1980). Next, specimens identified as *Paraceratites trinodosus, P. elegans* and *P. brembanus* by these authors may probably be referred to as *Bulogites*. This is another indication that most of the Dequen fauna probably correlates with the Tiefengraben fauna, and hence with the latest Shoshonensis Zone.

Specimens identified as *"Parakellnerites"* by GU et al. (1980) pose some problems with their generic assignment, and therefore with age significance. They clearly differ from *Parakellnerites* (see RIEBER, 1973) and from the very closely allied *Paraceratites* by their strongly compressed, discoidal, and involute shell shape; also by absence of marginal spiny tubercules and denser, falcoid ribbing. Although these keeled specimens from Denquen do not show any trace of a papillate ornamentation, their general shape and ornamentation suggest some affinities with *Eutomoceras* which is upper Anisian in age (see SILBERLING & NICHOLS, 1982). Whatever genera these specimens should be referred to,

they undoubtedly resemble true Paraceratitinae, which are thought to be exclusively upper Anisian in age. Consequently, this would cast some doubt on the synchronous character of the Denquen fauna, which is said to have been collected from a single, 15 cm thick limestone bed. Alternatively, if one admits the natural character of the whole fauna, this would indicate that Paraceratitinae already occur in the latest middle Anisian substage, an hypothesis that still needs substantiation.

Other occurrences of lesser importance are to be found in ZHAO & WANG (1974), who described *Balatonites gracilis* ARTHABER & *Bulogites multicostatum* ZHAO & WANG from southwest China; in WANG & HE (1981) from Xizang (*Balatonites xizangensis* WANG & HE); in GUO (1983) from Yunnan (*Guleites* GUO = *Balatonites*).

Vietnam, Thailand, Japan and Primorie

Scarce occurrences of *Balatonites*, that permit correlation with the Shoshonensis Zone without further precision, are known from the middle part of the Dongtrau Suite in Vietnam (VU KHUC, 1984), the Doi Chang shale and sandstone in Thailand (KUMMEL, 1960), and from the "*Hollandites* Zone" in Japan (BANDO, 1964, 1967).

Generic assignment of *Balatonites vladivostokensis* by ZAKHAROV (1968) remains equivocal, for the Primorie species does not show any ventral tuberculation that would permit distinction with *Platycuccoceras* from the older Hyatti and Taylori zones (BUCHER, 1988).

Concluding remarks

Correlatives of the Shoshonensis Zone have an essentially low paleolatitude distribution. However, scarcity of comprehensive successions throughout the Alpine and Himalayan domains, and problems attending the Hallstatt limestone stratigraphy allow only limited correlations at the subzone rank. Only the latest Shoshonensis Zone (Fergusoni Subzone and post-Wallacei pre-Rotelliformis time interval) can be adequately correlated with the late Balatonicus Zone, for which the concurrent ranges of *Balatonites, Bulogites, Proteusites, Proarcestes*, and *Acrochordiceras* (*carolinae* group) are significant. Older faunas of the Balatonicus Zone are very scarce (i.e. Rahnbauerkogel and its equivalent from the Balaton area) and cannot be precisely correlated with any of the Rieberi, Ransomei or Wallacei Subzones from Nevada.

Accuracy of correlations also decreases when comparing the Nevada sequence with the mid paleolatitude record of northeastern British Columbia. The latest Varium Zone (TOZER, 1971, 1974) correlates with the sum of the Taylori and Shoshonensis zones. Common forms are early representatives of *Ptychites* and *Proarcestes, Intornites* of the *nevadanus* group, *Anagymnotoceras spivaki, Nicholsites* of the *tozeri* group, and *Amphipopanoceras selwini*.

4. Systematic Descriptions

The systematic descriptions follow the classification by TOZER (1981a). Repository of figured specimens is abbreviated USNM (National Museum of Natural History, Washington D.C.).
SU = Stanford University; D = diameter; H = whorl height; W = whorl width; U = umbilical diameter.

Order: Ceratitida HYATT 1884
Superfamily: Dinaritaceae MOJSISOVICS 1882
Family: Dinaritidae MOJSISOVICS 1882
Subfamily: Khvalinitinae SHEVYREV 1968
Genus: *Ismidites* ARTHABER 1915

Ismidites cf. *I. marmarensis* ARTHABER

(Plate 10, Figures 5–6)

1915 cf. *Ismidites marmarensis* ARTHABER, p. 185, Pl. 15, Fig. 10. – SILBERLING & NICHOLS 1982, p. 20, Pl. 28, Figs. 19–20; BUCHER 1988, p. 726, Fig. 2.

Description: discoidal, relatively compressed, with an evenly arched and strigate venter that grades into the slowly converging flanks with indistinct ventral shoulders. Umbilical edge very abrupt, nearly acute, with slightly overhanging, high umbilical wall. There is some suggestion of very thin and sinuous ribs, gradually coarsening and projected on outer flanks, but fading on venter. At D = 26 mm (plesiotype USNM 448275), H = 46 %, W = 35 %, and U = 19 %. The suture line conforms to that described by SILBERLING & NICHOLS (1982, Fig. 10).

Discussion: The few available specimens from the Rieberi Subzone indicate that *Ismidites* cf. *I. marmarensis* ranges without any significant change in morphology from the Hadleyi Subzone (Hyatti Zone) up to the Rieberi Subzone (Shoshonensis Zone).

Figured specimen: Plesiotype USNM 448275.

Occurrence: HB 190 (3), Favret Canyon, Augusta Mountains. Rieberi Subzone, Shoshonensis Zone, middle Anisian (other occurrences in the Hyatti and Taylori Zones not listed here).

Superfamily: Megaphyllitaceae MOJSISOVICS 1896
Family: Parapopanoceratidae TOZER 1971
Genus: *Amphipopanoceras* VOINOVA 1947

Amphipopanoceras selwyni (McLEARN)

(Plate 7, Figures 10–11; Text-Fig. 4)

1948 *Parapopanoceras selwyni* McLEARN, p. 1, Pl. 9, Figs. 7–9.
1969 *Parapopanoceras testa* McLEARN, p. 46, Pl. 9, Figs. 1–2 (only).
non 1982 *Amphipopanoceras* cf. *A. selwyni* (McLEARN). – SILBERLING & NICHOLS, p. 20, Pl. 6, Fig. 15–16.

Description: Phragmocone sphaerocone, narrowly umbilicated. Last whorl represents the excentrumbilicate body chamber. Beginning and ultimate part of the body chamber broadly arched; intermediate part flattened by differential compaction. At D = 31 mm, H = 48 %, W = 45 %, and U = 14 %; at D = 50 mm, H = 40 %, W = 33 %, and U = 28 %.

Discussion: Scarce specimens of *Amphipopanoceras* occur in the Rieberi Subzone. They are easily distinguished from those restricted to the Hadleyi Subzone (Hyatti Zone) by lacking any acute stage on venter (BUCHER, in press). They resemble very closely *A. selwyni* which is known from the late Varium Zone of northeast British Columbia.

Text-Fig. 4.
Ultimate suture line (x3) of *Amphipopanoceras selwyni* McLEARN at D = 52 mm.
Plesiotype USNM 448257.

Figured specimen: Plesiotype USNM 448257.

Occurrence: Varium Zone, British Columbia. Loc. HB 190 (2), 211 (2), Favret Canyon, Augusta Mountains. Rieberi Subzone, Shoshonensis Zone, middle Anisian.

Superfamily: Ceratitaceae MOJSISOVICS 1879
Family: Balatonitidae SPATH 1951
Genus: *Platycuccoceras* BUCHER 1988

Platycuccoceras cainense n.sp.
(Plate 6, Figures 18–21)

Description: Delicately ribbed, small sized *Platycuccoceras* with numerous constrictions. Lateral tuberculation absent. Venter low arched on phragmocone, tabulate on body chamber. Both ribs and constrictions moderately projected on venter. Umbilical and marginal nodes very weak, but increasing in strength on the body chamber. Transition to mature body chamber enhanced by approximated constrictions. At D = 30 mm (holotype), H = 33 %, W = 18 %, and U = 40 %.
Suture line not known.

Discussion: *P. cainense* is obviously closely allied to the stratigraphically older *P. favretense* BUCHER. It is however distinguished from the latter in being more finely ribbed and in having more numerous constrictions per whorl. *P. cainense*, together with *P.* sp. indet., record the youngest occurrence of the genus in the Nevada sequence. It also demonstrates that the stratigraphic ranges of *Platycuccoceras* and *Balatonites* partially overlap.

Etymology: Species name derived from Cain Summit, Augusta Mountains.

Figured specimens: Holotype USNM 448255, plesiotype USNM 448254.

Occurrence: Loc. HB 187 (1), Favret Canyon; Loc. HB 254 (1), Muller Canyon, Augusta Mountains. Ransomei Subzone, Shoshonensis Zone, middle Anisian.

Platycuccoceras sp. indet.
(Plate 6, Figures 22–23)

Description and discussion: A single fragment from the Ransomei Subzone comes into this denomination. Absence of both lateral and ventral tuberculation makes attribution to *Platycuccoceras* more likely than to *Balatonites*. It differs from the co-occurring *P. cainense* n.sp. by its much coarser ribbing and more widely spaced constriction; from *P. favretense* BUCHER by its chevron-shaped ventral ribbing.

Figured specimen: USNM 448256.

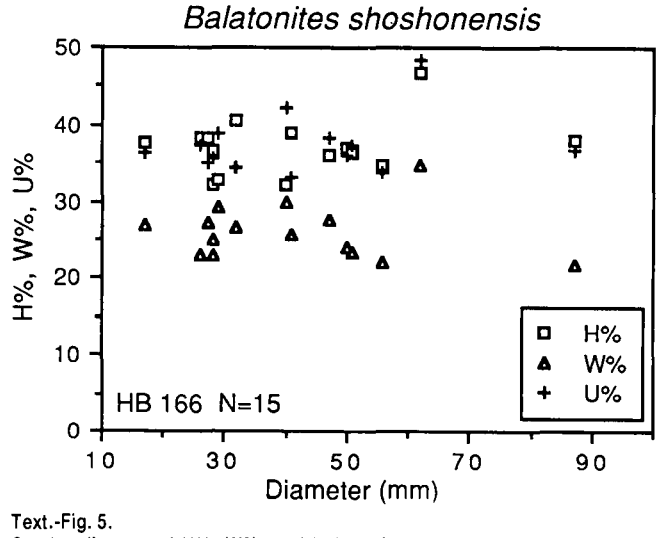
Occurrence: Loc. HB 186 (1), Favret Canyon, Augusta Mountains. Ransomei Subzone, Shoshonensis Zone, middle Anisian.

Genus: *Balatonites* MOJSISOVICS 1879

Balatonites shoshonensis HYATT & SMITH
(Plate 1, Figures 1–19;
Plate 6, Figure 24; Text-Fig. 6)

1905 Balatonites shoshonensis HYATT & SMITH, p. 167, Pl. 23, Figs. 12–13. – SMITH, 1914, p. 120. Pl. 6, Figs. 12–13; [not] SILBERLING & TOZER, 1968, p. 37.

Description: *Balatonites* with umbilical, lateral, marginal, and ventral tuberculation. Lateral and ventral tubercles develop beyond 1.5 cm in diameter, whereas umbilical and marginal tubercles are already densely and regularly spaced on earliest whorls. Lateral tubercles enlarge into spines when placed on ribs bordering the apicad side of constrictions. Associated marginal and ventral tubercles tend to be clavate on coarse variants. Intercalated ribs bear comparatively smaller tubercles or knots, and corresponding marginal tubercles rarely develop into clavi. Transition to mature stage shows decreasing strength of tuberculation with simultaneous approximation of ribbing. On mature body chamber, nontuberculate chevron-shaped ribs cross the low, angular venter. H %, W %, and U % plotted on Text-Fig. 5.
The suture line shows an elongated second lateral saddle, higher than the first and third saddles.



Text.-Fig. 5.
Scatter diagram of H%, W%, and U% against corresponding diameter for 15 specimens of *Balatonites shoshonensis* HYATT & SMITH from locality HB 166 in the Rieberi Subzone (Shoshonensis Zone), Favret Canyon.

Text-Fig. 6.
Suture line (×3) of *Balatonites shoshonensis* HYATT & SMITH at D = 40 mm. Plesiotype USNM 448200.

Discussion: Specimens here referred to as *B. shoshonensis* appear to be stratigraphically restricted to the Rieberi Subzone. They differ from the younger *B. whitneyi* n.sp. by the irregular strength of the lateral tuberculation and by the loss of ventral spines on the mature body chamber. Although the ventral view of the holotype as given by HYATT & SMITH (1905) is somewhat simplistic, the diagnostic pattern of the lateral tuberculation permits recognition of the species.

Figured specimens: Plesiotypes USNM 448200 to 448208.

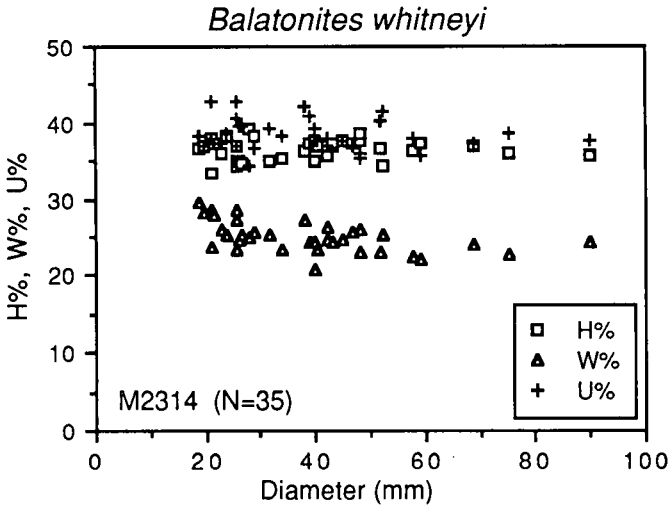
Occurrence: Loc. HB 161 (4), 166 (72), 167 (11), 168 (3), 188 (10), 230 (3), Favret Canyon, Augusta Mountains. Rieberi Subzone, Shoshonensis Zone, middle Anisian.

Balatonites whitneyi n.sp.

(Plate 2, Figures 1–19; Text-Fig. 8)

1968 *Balatonites shoshonensis* HYATT & SMITH, SILBERLING & TOZER, 1968, p. 37.

Description: *Balatonites* with clavate ventral tuberculation extending to all ontogenetic stages, inclusive



Text-Fig. 7.
Scatter diagram of H%, W%, and U% against corresponding diameter for 35 specimens of *Balatonites whitneyi* n.sp. from USGS Mesozoic locality M2314 in the Fergusoni Subzone (Shoshonensis Zone), Wildhorse Mine.

Text-Fig. 8.
Suture line (×3) of *Balatonites whitneyi* n.sp. at D = 70 mm. Holotype USNM 448216.

of the mature body chamber. Lateral tubercles develop beyond approximately 1.5 cm in diameter, with tendency in having a nearly uniform strength on average variants. However, only the coarsest variants do show the greater strength of lateral spines bordering the apicad side of constrictions. In such specimens, intermediate lateral spines may even be obliterated. Umbilical tubercles spiny, evenly and densely spaced. Marginal tuberculation commonly clavate. Transition to mature body chamber enhanced by decreasing strength of umbilical tuberculation and approximation of ornamentation. H %, W %, and U % plotted on Text-Fig. 7.

Suture line with first and second lateral saddles of approximately equal height.

Etymology: Species named in honor of J.D. WHITNEY.

Discussion: Distinguished from the stratigraphically older *B. shoshonensis* HYATT & SMITH by the preponderant clavate shape of ventral tuberculation which extends to the mature body chamber; also by the more uniform strength of lateral tuberculation.

Figured specimens: Holotype USNM 448216; paratypes USNM 448209 to 448215.

Occurrence: Loc. HB 171 (4), Favret Canyon; loc. HB 231 (5), 233 (6), Muller Canyon, Augusta Mountains. Loc. HB 111 (17), 112 (1), 155 (14), 249 (3), southern Tobin Range. Loc. HB 123, South Canyon, New Pass Range. Wallacei Subzone. USGS Mesozoic locality M2314 (43), Wildhorse Mine, New Pass Range. Fergusoni Subzone, Shoshonensis Zone, middle Anisian.

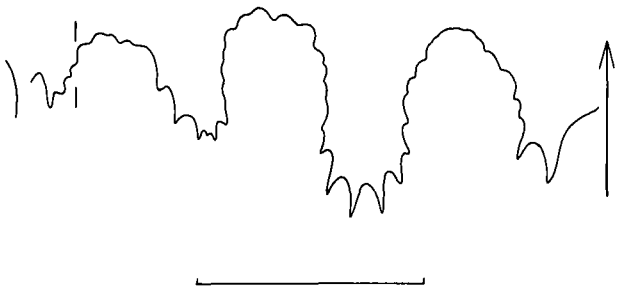
Family: Ceratitidae MOJSISOVICS 1879
Subfamily: Beyrichitinae SPATH 1934
Genus: *Eogymnotoceras* BUCHER 1988

Eogymnotoceras tuberculatum n.sp.

(Plate 3, Figures 1–12; Plate 4, Figures 13–14; Text-Fig. 9)

1988 *Eogymnotoceras* sp. A, BUCHER, p. 738.

Description: Widely umbilicated *Eogymnotoceras* with closely spaced, prominent and rounded umbilical tubercles, and pronounced carination that may extend to the end of mature phragmocone. Ribbing falcoid to very sinuous, with sharp projection on ventral shoulders. At D = 58 mm (holotype), H = 40 %, W = 33 %, and U = 29 %.



Text-Fig. 9.
Suture line (×3) of *Eogymnotoceras tuberculatum* n.sp. at H = 25 mm.
Plesiotype USNM 452811.

Suture line subammonitic, conforming to that of the genus.

Discussion: Ranges of variability of *E. tuberculatum* and *E. thompsoni* BUCHER partially overlap, but *E. tuberculatum* distinctly includes robust forms with dense, high, and rounded umbilical tuberculation.

Etymology: Species name refers to the strong umbilical tuberculation.

Figured specimens: Holotype USNM 448217, paratypes USNM 448218 to 448220, plesiotypes USNM 452810 and 452811.

Occurrence: Loc. HB 166 (8), Favret Canyon; loc. HB 234 (12), Muller Canyon, Augusta Mountains. Tozeri Subzone (Taylori Zone) and Rieberi Subzone (Shoshonensis Zone), middle Anisian.

Genus: *Gymnotoceras* HYATT 1877

Gymnotoceras praecursor n.sp.

(Plate 4, Figures 1–7; Text-Fig. 10)

Description: Strongly discoidal, compressed and involute *Gymnotoceras*. Ribbing very weak, subfalcate, persisting on mature body chamber. Bluntly rounded keel extends to about 6 cm in diameter. Venter first acutely rounded, grading into a broader, low rounded outline on the egressive mature body chamber. At D = 81 mm (holotype, end of phragmocone), H = 51 %, W = 28 %, and U = 12 %.

Suture line subammonitic, with first lateral deeply indented. First and second lateral saddles elongated, with sides densely crenellated.

Discussion: Differs from *G. ginsburgi* n.sp., *G. rotelliformis* MEEK and *G. blakei* (GABB) by its strongly discoidal, compressed and weakly ribbed phragmocone; also by absence of umbilical tuberculation and subfalcate ribbing pattern occurring precociously on early immature stages. *G. praecursor* may be regarded as a palingenetic derivative of *Eogymnotoceras transiens* BUCHER which is late Taylori Zone in age.

Text-Fig. 10.
Suture line (×3) of *Gymnotoceras praecursor* n.sp. at D = 39 mm.
Paratype USNM 448226.

Etymology: Species name refers to the oldest known occurrence of the genus.

Figured specimens: Holotype USNM 448227, paratypes USNM 448226 and 448228.

Occurrence: Loc. HB 166 (15), 168 (1), 188 (2), 228 (3), 232 (2), Favret Canyon. Loc. HB 234 (1), Muller Canyon, Augusta Mountains. Praebalatonensis and Tozeri Subzones, Taylori Zone; Rieberi Subzone, Shoshonensis Zone, middle Anisian.

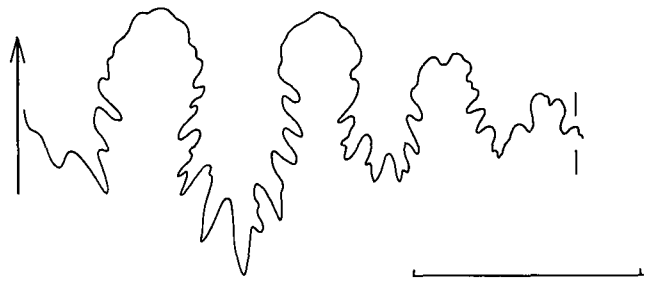
Gymnotoceras ginsburgi n.sp.

(Plate 3, Figures 13–23; Text-Fig. 11)

Description: Inner whorls with non-tuberculate, uniform, and strongly sinuous ribbing. Ribs slightly swollen on inner flanks and projected on outer flanks and venter. Whorl section high, strongly compressed with subparallel flanks and rounded venter. Keel low and rounded, barely visible. With further increase in shell size, whorl section gradually changes into a thicker, slightly discoidal shape. Ribbing fades concomittantly and briefly acquires a moderate falcate pattern at the end of phragmocone. Mature body chamber smooth, with growth striae only. Complete full grown specimens attain an estimated diameter of about 150 mm. At D = 71 mm (holotype), H = 53 %, W = 34 %, and U = 15 %.

Subadult suture line with a relatively narrow, deeply indented first lateral lobe. First and second lateral saddles markedly elongated.

Discussion: Distinguished from *G. praecursor* n.sp., *G. rotelliformis* MEEK and *G. blakei* (GABB) by its strongly compressed, subrectangular inner whorls; also in having an evenly, sinuous and non-tuberculate ribbing and a very weak keel on immature stages. *G. ginsburgi* also attains a larger adult size than other representatives of the genus.



Text-Fig. 11.
Suture line (×3) of *Gymnotoceras ginsburgi* n.sp. at H = 21 mm.
Holotype USNM 448225.

Etymology: Species named for L. GINSBURG of the Institut de Paléontologie, Muséum national d'Histoire naturelle, Paris.

Figured specimens: Holotype USNM 448225, paratypes USNM 448222 to 448224.

Occurrence: Loc. HB 233 (6), Muller Canyon, Augusta Mountains. Wallacei Subzone, Shoshonensis Zone.

Genus: *Favreticeras* n.gen.

Type species: *Favreticeras rieberi* n.sp.

Description: Moderately evolute, non-carinate shell with a subrectangular or trapezoidal whorl section. Weakly to strongly tuberculated, umbilical, lateral and marginal tuberculation being dissociated throughout ontogenetic development. Two main stages are evident: a first stage is characterized by a high, subrectangular whorl section, a low arched to subtabulate venter, and faint ribs branching from umbilical nodes; a second stage shows a trapezoidal whorl section associated with thick, distant ribs branching from bullate to spinose lateral tubercles, and projected, nearly clavate marginal tubercles. Umbilical tuberculation absent in this second stage. Length mature body chamber of about two thirds of a whorl, and markedly egressive. Suture line ceratitic to subammonitic.

Composition of the genus: *Favreticeras rieberi* n.sp., *Favreticeras ransomei* (SMITH), *Favreticeras wallacei* n.sp., and *Favreticeras kuvera* (DIENER).

Discussion: Species presently referred to this new genus may include either one or both of the ontogenetic stages as described above. Shell shape and presence of a well developed lateral spinose stage exclude generic assignment to any other known beyrichitid. It is also worth noting that megastriae (BUCHER & GUEX, 1990), a widespread growth feature among beyrichitids, have not been observed in *Favreticeras*. On the other hand, absence of both carination and true trituberculation precludes comparison with typical paraceratitids. *Favreticeras* apparently displays affinities with both beyrichitids and paraceratitids, but embodies a combination of characters quite unlike any representative of these two subfamilies. Whether or not *Favreticeras* and its derivative (*Guexites* n.gen.) should be assigned to a distinct subfamily is a somewhat premature question, but such an alternative would have the merit of faithfully reflecting their intermediate characters between beyrichitids and paraceratitids. Provisionally, they are still classified with Beyrichitinae.

Favreticeras, which is one of the most salient genus of the Shoshonensis Zone, has no apparent close ancestor in the mid-Anisian record of Nevada and is consequently regarded as a migrant. The conspicuous proterogenetic transformation resulting in the loss of spinose stage and concomitant extension of weakly ornamented stage at maturity (e.g. transition from *F. rieberi* n.sp. to *F. ransomei* (SMITH) and to *F. wallacei* n.sp.) suggests that a potential ancestor may have possessed lateral tubercles at immature stages. This is met by *"Ceratites" kuvera* DIENER, which agrees perfectly well in whorl shape and ornamentation with the mature restricted, spinose stage of *Favreticeras rieberi* n.sp.. *F. kuvera* (DIENER) is recorded from the Himalayan "Upper Muschelkalk" at Byans (DIENER, 1895, Pl. 5, Fig. 2; DIENER, 1907, Pl. 4, Fig. 5) and possibly from the "*Ptychites* layers" in Kashmir (DIENER, 1913, Pl. 7, Fig. 4).

"Ceratites" evolvens (HAUER, 1887, p. 26, Pl. 6, Fig. 4) has some superficial similarity with *Favreticeras rieberi* n.sp. in ontogenetic transformation of the sculpture and egression of outer whorls. However, HAUER's species undoubtedly differs from *F. rieberi* in having a carinate venter.

In its general shape, *"C." falcifer* (HAUER, 1896, p. 22, Pl. 7, Figs. 5–6) may possibly be compared with representatives of *Favreticeras* such as *F. wallacei* n.sp., but the Bosnian form differs in having small marginal tubercles and simple, regularly spaced ribs of greater strength.

Favreticeras differs from *Phillipites* DIENER (type species *"Ceratites" erasmi*, see MOJSISOVICS, 1882, Pl. 40, Figs. 13) in having a well defined ribbing with lateral and marginal tuberculation, also in having a conspicuously egressive umbilicus.

F. ransomei (SMITH) was previously assigned to *Hollandites* sp. by SILBERLING & TOZER (1968, p. 37), thus following a suggestion by SPATH (1934, p. 419). Indeed, *Favreticeras* and *Hollandites* may have some superficial similarities but *Favreticeras* is definitely distinguished by its early low arched to subtabulate venter, angular ventral shoulders, occasional marginal and spinose lateral tuberculation, and more finely indented saddles. Moreover, the Fossil Hill record clearly demonstrates that *Hollandites* is stratigraphically restricted to the Mctaggarti Subzone of the Hyatti Zone (BUCHER, in press), whereas *Favreticeras* typically ranges throughout the much younger Shoshonensis Zone.

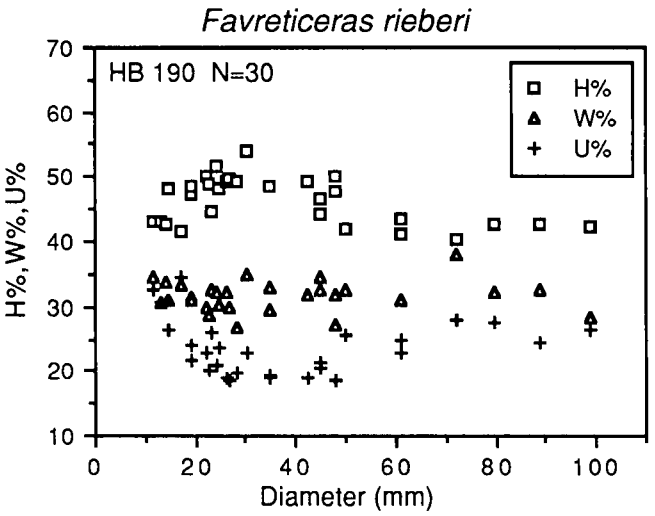
Etymology: Genus named after Favret Canyon.

Occurrence: Shoshonensis Zone, middle Anisian, Nevada. Himalayan "Upper Muschelkalk", Byans, and (?) "*Ptychites* layers", Kashmir, India. (?) "Upper Muschelkalk", Bulogkalke, Yugoslavia.

Favreticeras rieberi n.sp.

(Plate 5, Figures 1–24; Plate 7, Figures 8–9; Text-Fig. 13)

Description: *Favreticeras* with subrectangular, faintly ribbed inner whorls and trapezoidal, strongly tuberculated end of phragmocone and body chamber. At D < 15–20 mm, the shell is widely umbilicated, with a broadly arched venter. Ornamentation consists of distant and sinuous single ribs rising from small umbilical nodes. At 15–20 < D < 30–40 mm, whorl height increases significantly and the whorl section is typically subrectangular and highly involute. Flanks very gently converge toward the low arched venter, which is bordered by subangular, smooth ventral shoulders. The umbilical edge is abrupt, and the umbilical wall short and nearly perpendicular. Primary ribs rise from the persistent umbilical nodes, and intercalated ribs may develop on upper flanks. With further increase in diameter, the shell becomes more loosely coiled. Simultaneously, primary ribs become more distant, thicker, and attain their greater elevation just below mid-flanks where they transform into radially elongated bullae. Secondary ribs branch from bullae, and are slightly projected on outer flanks. They develop into faint marginal tubercles on ventral shoulders, but do not cross the low arched venter. Only projected growth striae do cross the venter. Umbilical nodes gradually fade, and the umbilical edge becomes smooth and sharply rounded. Concomitantly, the slightly overhanging umbilical wall noticeably increases in height. The transition to final stage on end

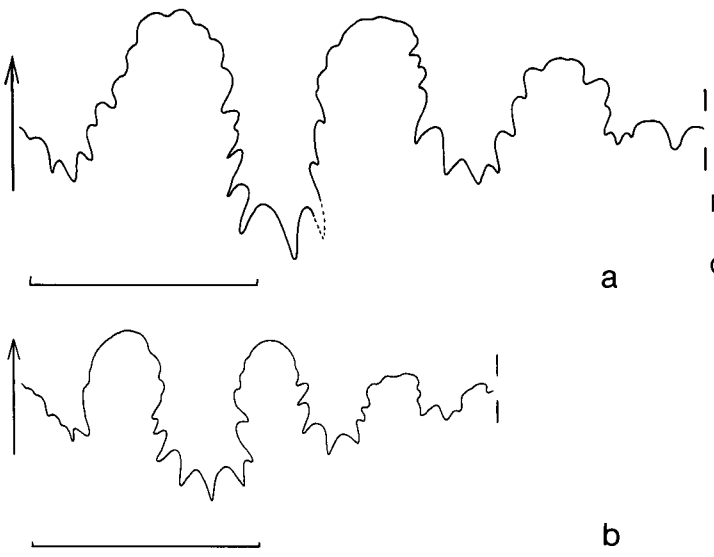


Text-Fig. 12.
Scatter diagram of H%, W%, and U% against corresponding diameter for 30 specimens of *Favreticeras rieberi* n.gen. n.sp. from locality HB 190 in the Rieberi Subzone (Shoshonensis Zone), Favret Canyon.

of phragmocone and mature body chamber is enhanced by the spinose shape of former lateral bullae, the nearly clavate pattern of marginal tubercles, and the even more pronounced egression. Venter becomes subtabulate, and crossed by angular, slender ribs that merge the lateral tubercles. H %, W %, and U % plotted on Text-Figure 12.
Adult suture line subammonitic.

Discussion: Distinguished from *F. kuvera* DIENER by the late ontogenetic development of tuberculated stage and concomitant trapezoidal whorl section; from *F. ransomei* SMITH and *F. wallacei* n.sp. in retaining the tuberculated stage at submature and mature stages.

Etymology: Species named for H. RIEBER of the Institute of Paleontology, University of Zürich.



Text-Fig. 13.
Suture lines (×3) of *Favreticeras rieberi* n.gen. n.sp.
a) At H = 28 mm.
Paratype USNM 448239.
b) At D = 44 mm.
Plesiotype USNM 448238.

Figured specimens: Holotype USNM 448232, paratypes USNM 448231, USNM 448233 to 448239.

Occurrence: Loc. HB 117 (4), 161 (31), 166 (49), 167 (19), 168 (8), 173 (11), 188 (12), 190 (37), 230 (9), Favret Canyon. Loc. HB 198 (2), Muller Canyon, Augusta Mountains. Rieberi Subzone, Shoshonensis Zone, middle Anisian.

Favreticeras ransomei (SMITH)

(Plate 6, Figures 1–17; Text-Fig. 14)

1914 *Phillipites ransomei* SMITH, p. 108, Pl. 99, Figs. 1–4.

Description: Slightly discoidal, non-spinose *Favreticeras*. Submature stage commonly shows thickened ribs, somewhat bullate below mid-flanks but never enlarging into spines. Gently projected ribs cross the low arched venter in loosing most of their strength. Lateral bullae invariably fade but ribbing subsists on mature body chamber (for further details, see also description by SMITH 1914, p. 108). At D = 72 mm (plesiotype USNM 448240), H = 44 %, W = 29 %, and U = 24 %.
The suture line, here illustrated for the first time, conforms to that of the type species.

Discussion: Distinguished from *F. rieberi* n.sp. by lack of spinose stage; from *F. wallacei* by its less tabulate venter, smaller mature size, and coarser ribbing at submature stage. Immature stages of *F. ransomei* and *F. rieberi* are identical. SMITH's holotype comes from the Wheeler Mine area in the northern Humboldt Range and is the oldest historical evidence for the presence of the Shoshonensis Zone in that range. Occurrence of the Shoshonensis Zone in that part of the northern Humboldt Range is not surprising for the basal beds of the Fossil Hill Member that crop out at the nearby Fourth of July Flat are of Hyatti age (see BUCHER, in press). Additional occurrence in the northern Humboldt is presently reported from North Fork of Straight Canyon and John Brown Canyon, where the Shoshonensis Zone is in close stratigraphic succession with the Hyatti, Taylori, and Rotelliformis Zones. However, stratigraphic occurrence of *F. ransomei* is by far best displayed in the Augusta Mountains.

Figured specimens: Plesiotypes USNM 448240 to 448245.

Occurrence: Wheeler Mine (see SMITH 1914), loc. HB 35 (29), North Fork of Straight Canyon; loc. HB 16 (4), John Brown Canyon, northern Humboldt Range; loc. HB 169 (89), 172 (11), 174 (65), 177 (9), 186 (31), 187 (54), 198 (6), 203 (8), 210 (1), Favret

Text-Fig. 14.
Suture line (×3) of *Favreticeras ransomei* (SMITH) at D = 52 mm.
Plesiotype USNM 448240.

Canyon, Augusta Mountains. Ransomei Subzone, Shoshonensis Zone, middle Anisian.

Favreticeras wallacei n.sp.

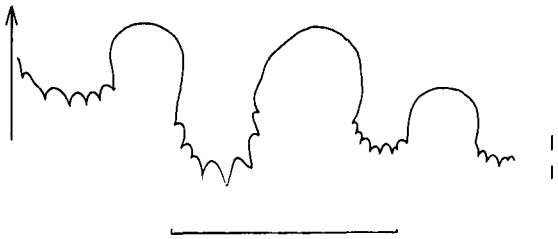
(Plate 7, Figures 1–7; Plate 8, Figures 4–5; Text-Fig. 15)

Description: Discoidal, large size *Favreticeras* with noticeably reduced tuberculation. Immature stages involute, with strongly compressed whorl section, subtabulate venter, faint sinuous ribbing and subtle umbilical tuberculation. Initiation of pronounced egression starts at late immature stage. Submature stage shows thickened ribs branching from elongated, low bullae just below mid-flanks, ending with weak, gently projected marginal tubercles on ventral shoulders. Mature stage characterized by evolute coiling, extension of former weak lateral bullae to inner flanks and loss of lateral tubercles. Pairs of branched ribs then rapidly thin out on outer flanks with concomitant development of closely spaced, projected and thin intercalated ribs. At this ultimate stage, the subtabulate venter broadens and is crossed by moderately projected growth lines. At D = 80 mm (submature holotype), H = 44 %, W = 29 %, and U = 22 %.

Suture line conforms to that of the genus.

Discussion: Differs from *F. ransomei* (SMITH) by its lower venter, weaker ribbing and larger mature size.

Etymology: Species named for R.E. WALLACE.



Text-Fig. 15.
Suture line (×3) of *Favreticeras wallacei* n.gen. n.sp. at H = 26 mm. Paratype USNM 448248.

Figured specimens: Holotype USNM 448246, paratypes USNM 448247 and 448248, plesiotype USNM 448249.

Occurrence: Loc. HB 171 (4), Favret Canyon; loc. HB 191 (4), 192 (1), 193 (9), 231 (2), 233 (4), Muller Canyon, Augusta Mountains. Loc. HB 111 (13), 112 (3), 155 (2), 249 (1), southern Tobin Range. USGS Mesozoic locality M2314 (10), Wildhorse Mine, New Pass Range. Wallacei and Fergusoni Subzones, Shoshonensis Zone, middle Anisian.

Genus: *Guexites* n.gen.

Type species: *Guexites pacificus* n.sp.

Description: Evolute, thick discoidal, densely and finely ribbed beyrichitid. Umbilical nodes present at immature and submature stages, absent at mature stage. Lateral and marginal tuberculation absent, at least at submature and mature stages. At submature stage, whorl section is high and subtriangular. Umbilical wall steep, but not perpendicular, umbilical margin smooth and angular. Evenly converging flanks grade into the rounded venter without appreciable ventral shoulders. Ribbing sinuous to subfalcate. Some ribs may branch either on inner or at mid-flanks, and are gently projected on outer flanks. They cross the venter with slightly increasing strength. On beginning of body chamber, whorl section becomes somewhat inflated and attains its greater width just below mid-flanks. The marked umbilical egression initiates at this stage. Ribs become stout on inner flanks, but weaken on outer flanks and on the broadly arched venter. The last stage as preserved on the ultimate fourth of whorl of the holotype shows that ribs become more sinuos, fade on innermost flanks, and progressively attain their greater elevation on mid-flanks. At D = 103 mm (holotype), H = 46 %, W = 32 %, and U = 20 %.

Adult suture line ceratitic, with relatively short elements. Ventral and first lateral lobe broad, with regular and shallow indentations.

Discussion: *Guexites* differs from *Favreticeras* by its narrower and rounded venter, and more discoidal whorl shape; also by absence of both lateral and marginal tuberculation. Additional difference is shown by the suture line, which has more robust elements. However, the style of ribbing, the umbilical nodes and the marked excentrumbilication lead to regard *Guexites* as a probable derivative of *Favreticeras*.

Etymology: Genus named for J. GUEX, Institute of Geology and Paleontology, University of Lausanne.

Composition of the genus: *Guexites pacificus* n.sp.

Occurrence: Wallacei Subzone, Shoshonensis Zone, middle Anisian.

Guexites pacificus n.sp.

(Plate 8, Figures 1–3; Text-Fig. 16)

Description and discussion: As for the genus.

Figured specimen: Holotype USNM 448250.

Occurrence: Loc. HB 171 (1), Favret Canyon, Augusta Mountains. Wallacei Subzone, Shoshonensis Zone, middle Anisian.

Text-Fig. 16.
Suture line (×1.5) of *Guexites pacificus* n.gen. n.sp. at D = 73 mm. Holotype USNM 448250.

Subfamily: Paraceratitinae SILBERLING 1962
Genus: *Bulogites* ARTHABER 1912

Bulogites cf. *B. mojsvari* (ARTHABER)

(Text-Figures 17,18)

1896 *Ceratites mojsvari* ARTHABER, p. 50, Pl. 4, Fig. 6.

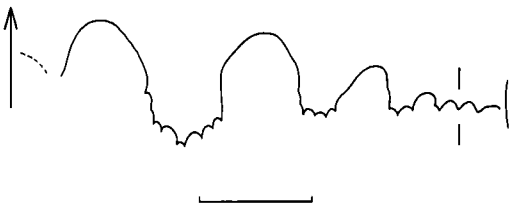
Description: A single mature specimen comes into this provisional denomination. The last half volution

of the phragmocone shows a high quadrangular whorl section, with a rounded and moderately high venter. The umbilical wall is very steep and is bordered by a narrow, angular umbilical shoulder. The conch is characteristically trituberculate (umbilical, lateral and marginal). The umbilical row is generally defined by blunt nodes only, whereas lateral and marginal rows are more prominent. The lateral row of nodes is placed just below midline of flanks and the marginal row consists of clavate tubercles. The ribbing is dense and regularly spaced. On inner flanks slightly prorsiradiate, nearly straight simple ribs raise from umbilical tubercles and merge the lateral tubercules. On outer flanks, a pair of thicker and sinuous ribs stem from the lateral tubercules. Every rib ends up in a marginal clavate tubercle. The ribs attain their greater strength halfway between the lateral and marginal tuberculations. On the last half volution of the phragmocone, there is some suggestion of one or two intercalated ribs only. These do not bear lateral, nor umbilical tubercles. V-shaped blunt ribs tend to cross the venter. The last fourth of whorl corresponds to the beginning of the mature body chamber. From then on, the ribbing becomes coarser and less regularly spaced. At D = 82 mm, H = 43 %, and U = 26 %.

Mature suture line ceratitic, with crudely indented lobes.

Discussion: Whorl shape and sculpture of this single specimen permit distinction with all representatives of *Favreticeras* and *Paraceratites* known from the Fossil Hill Member. It unambiguously shows strong affinities with European representatives of *Bulogites*. *Bulogites mojsvari* (ARTHABER) appears as its closest European counterpart. Both share a mainly bifurcate, moderately sinuous ribbing which sets them slightly aside from the type species *B. multinodosus* (HAUER), which has a straighter and slightly prorsiradiate ribbing, an additional outer lateral row of radially elongated nodes, and a more robust whorl shape.

The stratigraphic position of the Nevada specimen is not accurately known. From field evidence, one can only state that its age is post-Wallacei Subzone and pre-Rotelliformis Zone. Its superpositional relationship with the Fergusoni Subzone remains undeterminate.



Text-Fig. 18.
Suture line (×1.5) of *Bulogites* cf. *B. mojsvari* (ARTHABER) at D = 70 mm.
USNM 45280.

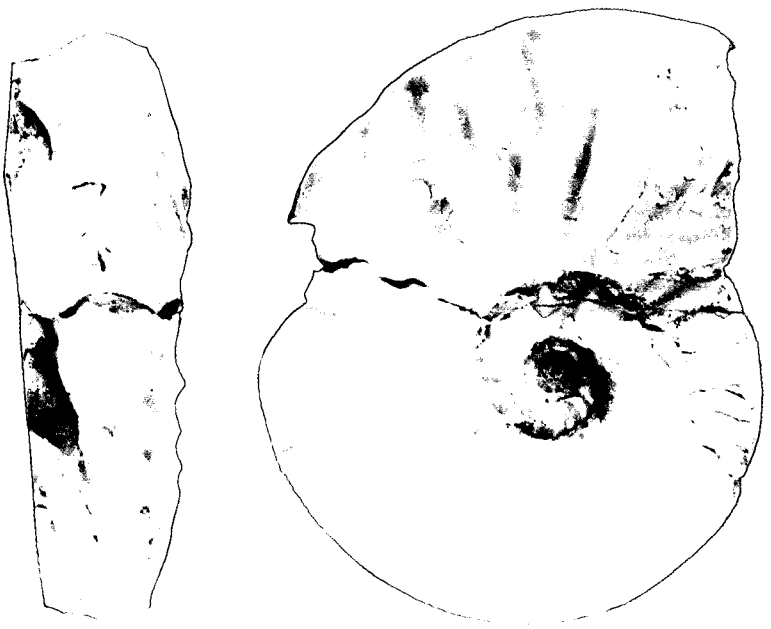
Figured specimens: Plesiotype USNM 452800.

Occurrence: One float specimen from the southern wall of Muller Canyon, Augusta Mountains. Latest Shoshonensis Zone, middle Anisian.

Superfamily: Pinacocerataceae MOJSISOVICS 1879
Family: Gymnitidae WAAGEN 1895
Genus: *Constrigymnites* n.gen.

Type species: *Constrigymnites robertsi* n.sp.

Description: Serpenticone gymnitid with compressed, ovoid whorl section, and four or five constrictions to a whorl, visible on internal mold only. Umbilical margin very low and steep on phragmocone, grading into evenly divergent inner flanks on body chamber. Venter first narrowly rounded, broadening on body chamber. Outer shell smooth, with only thick and sinuous growth striae. Slightly biconcave constrictions wider and deeper with shell size increase. Adoral side of constriction marked by a thickened ridge, forming a bumpy narrow sinus on siphonal line. Ventral sinus develop on later constrictions only. At D = 73 mm (paratype USNM 448229), H = 31 %, W = 18 %, and U = 44 %.



Text-Fig. 17.
Bulogites cf. *B. mojsvari* (ARTHABER).
Single float specimen from rocks of post-Wallacei and pre-Rotelliformis age (latest Shoshonensis Zone).
USNM 452800.
Southern wall of Muller Canyon, Augusta Mountains.

Suture line with relatively low elements. First lateral saddle bifid and of about same height than the second lateral saddle. Suspensive lobe short, with few auxiliaries external to the umbilical seam.

Composition of the genus: *Constrigymnites robertsi* n.sp.

Discussion: Introduction of a new generic name is justified by the presence of constrictions, a feature hitherto not known among gymnitids. Shell shape and suture line otherwise suggest derivation from *Gymnites*.

Etymology: Genus name refers to the presence of constrictions.

Occurrence: Praebalatonensis and Tozeri Subzones, Taylori Zone; Rieberi Subzone, Shoshonensis Zone, middle Anisian.

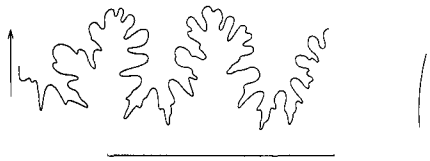
Constrigymnites robertsi n.sp.

(Plate 4, Figures 8–12; Text-Fig. 19)

1988 *Epigymnites* sp. A, BUCHER, Fig. 2.

Description and discussion: See definition of the genus.

Etymology: Species named in honor of R.J. ROBERTS.



Text-Fig. 19.
Suture line (×3) of *Constrigymnites robertsi* n.gen. n.sp. at D = 44 mm.
Paratype USNM 448276 (specimen not figured).
Loc. HB 166, Rieberi Subzone, Shoshonensis Zone; Favret Canyon, Augusta Mountains.

Figured specimens: Holotype USNM 448230, paratype USNM 448229.

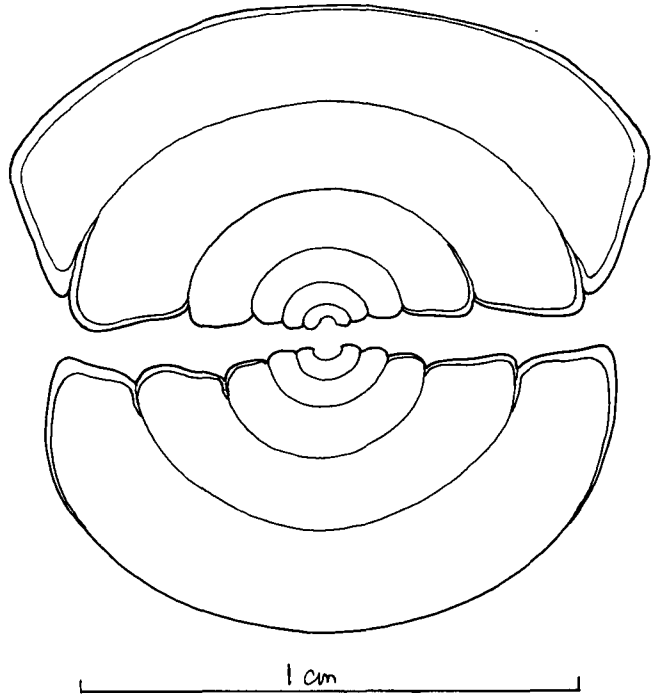
Occurrence: Loc. HB 162 (19), 161 (2), 166 (32), 167 (5), 168 (4), 188 (5), Favret Canyon; loc. HB 232 (2), 234 (9), Muller Canyon, Augusta Mountains. Praebalatonensis and Tozeri Subzones, Taylori Zone; Rieberi Subzone, Shoshonensis Zone, middle Anisian.

Family: Isculitidae SPATH 1951
Genus: *Nevadisculites* BUCHER 1988

Nevadisculites depressus n.sp.

(Plate 5, Figures 25–27; Plate 9, Figures 13–17; Text-Fig. 20)

Description: Relatively small sized *Nevadisculites* with strongly depressed body chamber. Umbilicus extremely narrow but not occluded. Last half whorl of adult body chamber egressive, with a very wide, low arched to subtabulate venter and low, diverging umbilical walls. End of body chamber bears a deep apertural collar on internal mold. A short siphonal groove may occur on the internal mold of the beginning of the body chamber. It obviously corresponds



Text-Fig. 20.
Section (×4) of a complete mature specimen of *Nevadisculites depressus* n.sp.
Plesiotype USNM 448277 (specimen not figured).
Loc. HB 188, Rieberi Subzone, Shoshonensis Zone; Favret Canyon, Augusta Mountains.

to a siphonal ridge on the inner surface of the outer shell. Such a siphonal ridge is interpreted as a support for the forward prolongation of the siphonal tube into the preseptal cavity. At D = 12 mm (holotype, measured before egression), H = 53 %, and W = 108 %.

Adult suture line too poorly preserved to be drawn, but reaching a stage comparable to that of *N. smithi* BUCHER.

Discussion: *N. depressus* differs from other congeneric species by its extremely depressed whorl section. Presence of a siphonal ridge is not restricted to this species but is a feature shared by some representatives of both *Isculites* and *Nevadisculites*.

Etymology: Species name refers to the depressed whorl section.

Figured specimens: Holotype USNM 448251, paratypes USNM 448252 and 448253.

Occurrence: Loc. HB 166 (7), 188 (3), Favret Canyon, Augusta Mountains. Rieberi Subzone, Shoshonensis Zone, middle Anisian.

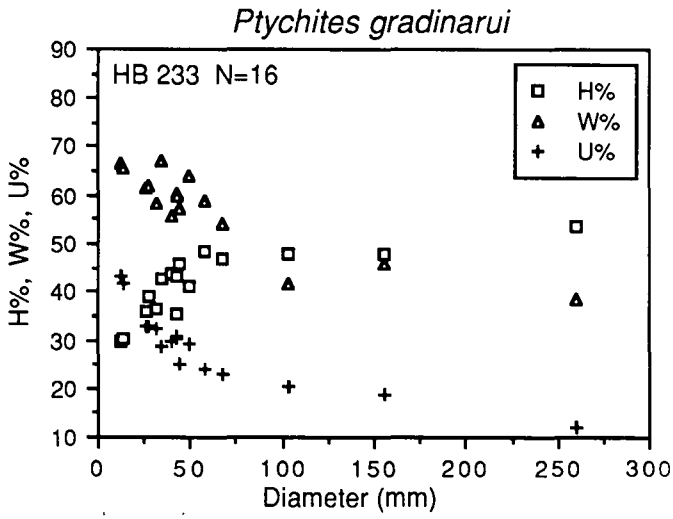
Family: Ptychitidae MOJSISOVICS 1882
Genus: *Ptychites* MOJSISOVICS 1875

Ptychites gradinarui n.sp.

(Plate 9, Figures 11–12; Plate 10, Figures 1–4; Plate 11, Figures 21–26; Text-Fig. 22)

1968 *Ptychites* cf. *P. domatus* (HAUER), SILBERLING & TOZER, p. 37.

Description: Ontogenetic transformations of the geometry that are essential to the definition are illus-



Text-Fig. 21.
Scatter diagram of H%, W%, and U% against corresponding diameter for 16 specimens of *Ptychites gradinarui* n.sp. from locality HB 166 in the Wallacei Subzone (Shoshonensis Zone), Muller Canyon.

trated in Text-Fig. 21. Early stage widely umbilicated and depressed, smooth, with broad and low arched venter. Umbilical shoulder narrowly rounded, and umbilical wall steep, slightly convex. At D>2 cm, venter gradually changes into a semi-circular outline. Concomitantly, the umbilical wall proportionally increases in height and slopes evenly from the umbilical edge to the umbilical seam. At this stage, distant, shallow, convex and prorsiradiate constrictions encircle both flanks and venter. These are only visible on the internal mold. At D>3 cm, whorl section rapidly changes into a low, subtriangular shape with convex flanks converging toward the rounded venter. Irregular convex folds develop at this stage. Their strength is greater on innermost flanks, and they completely fade before reaching the venter. Shallow constrictions and weak folds may occur simultaneously up to 7 cm in diameter. Then constrictions disappear and only nearly straight, blunt radial folds subsist to about 20 cm in diameter. Whorl height considerably increases while the funnel-shaped umbilicus remains comparatively narrow. The full grown holotype shows that the now discoidal phragmocone ends at an estimated diameter of about 29 cm. The mature body chamber is smooth, without folds, and markedly egressive. The partially preserved ultimate part of the umbilical wall indicates that umbilical width is of about 8 cm at this latest stage.

The suture line is subject to considerable transformations until it reaches maturity. The most conspicuous change is shown by the external saddle. It is initially very small and slender, nearly degenerated, but enlarged into a prominent shape at mature stage. However, it remains typically smaller that the first lateral saddle. The second and third lateral saddle are bifid, the internal part of the third one being placed at the umbilical shoulder.

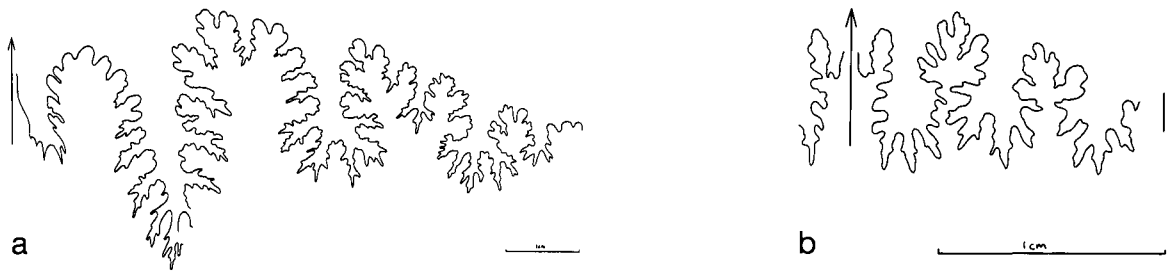
Discussion: Among the wealth of the species assigned to *Ptychites*, *P. gradinarui* n.sp. shows patent affinities with the *Ptychites megalodisci* group of DIENER. The compressed, discoidal mature shape of *P. gradinarui* resembles that of *Pt. barclayi* (see DIENER, 1913, Pl. 9, Figs. 1–2), but such a shape is acquired at smaller diameter by *Pt. barclayi* than by *P. gradinarui*. *Ptychites sahadeva* (see DIENER, 1895, Pl. 25, Fig. 1–2) appears as the closest Himalayan ally of *P. gradinarui*, with regard to both shell shape, ornamentation and suture line, but differs in lacking constrictions at immature stages. *Ptychites gradinarui* differs from *P. wrighti* (see MCLEARN, 1969, Pl. 10, Fig. 1) in being less inflated at comparable size, and by presence of shallow constrictions.

Older representatives of *Ptychites* that occur in the Taylori Zone (i.e. *Ptychites* sp. A and *Ptychites* sp. B, see BUCHER 1988, Fig. 2) are distinctly regarded as members of the *P. rugifer* group of DIENER.

Etymology: Species named for E. GRADINARU, University of Bucarest.

Figured specimens: Holotype USNM 448264, paratypes USNM 448262, USNM 448265 to 448267, plesiotype USNM 448263.

Occurrence: Loc. HB 37 (1), Congress Canyon, northern Humboldt Range. Loc. HB 112 (4), 155 (4), southern Tobin Range. Loc. HB 191 (2), 192 (1), 231 (1), 233 (18), Muller Canyon; one single specimen (USNM 448279) from talus block, Favret Canyon, Augusta Mountains. USGS Mesozoic locality M2314 (?), Wildhorse Mine, New Pass Range. Wallacei and Fergusoni Subzones, Shoshonensis Zone, middle Anisian.



Text-Fig. 22.
Ptychites gradinarui n.sp.
a) Suture line (×1) at an estimated height of about 80 mm.
Plesiotype USNM 448279 (specimen not figured).
Specimen collected from float originating from strata in the Wallacei Subzone, Shoshonensis Zone; Favret Canyon, Augusta Mountains.
b) Suture line (×3) at H = 12 mm.
Paratype USNM 448279 (specimen not figured).
Loc. HB 233, Wallacei Subzone, Shoshonensis Zone; Muller Canyon, Augusta Mountains.

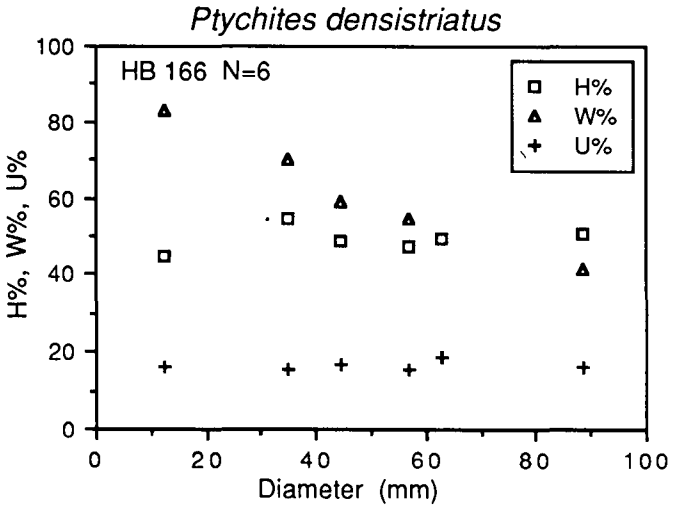
Ptychites densistriatus n.sp.

(Plate 9, Figures 1–10)

Description: Outer shell permanently smooth, with dense, regularly spaced, thick radial striae. Striae also visible on internal mold. Inner whorls involute, subglobose, with evenly rounded venter and flanks. Umbilical margin abruptly rounded, with high and steep umbilical wall. Outer whorl involute, ovoid, with flanks grading into the semi-circular venter. Umbilical edge more gently rounded, and umbilical wall less steep. Mature body chamber shows further increase in whorl height and is more laterally compressed. At the end of the body chamber, the internal mold bears a wide and shallow apertural collar. The largest, complete, and mature specimen has an estimated diameter of about 90 mm. H %, W %, and U % plotted on Text-Fig. 23.
Suture line not known.

Discussion: *Ptychites densistriatus* n.sp. differs from both *megalodisci* and *rugifer* groups of DIENER by its globose inner whorls, permanent sub-circular venter and narrow umbilicus, and lack of lateral folds. Whorl shape of immature stages compares with that of *P. drona* (see DIENER, 1895, Pl. 16, Fig. 3). Although the adult morphology of *P. drona* DIENER is not known, it differs only by having less closely spaced radial striae on inner whorls.

Etymology: Species name refers to the striate outer shells.



Text-Fig. 23.
Scatter diagram of H%, W%, and U% against corresponding diameter for 6 specimens of *Ptychites densistriatus* n.sp. from USGS Mesozoic locality HB 166 in the Rieberi Subzone (Shoshonensis Zone), Favret Canyon.

Figured specimens: Holotype USNM 448261, paratypes 448259 and 448260, plesiotype USNM 448258.

Occurrence: Loc. HB 161 (1), 166 (8), 167 (4), 168 (2), Favret Canyon, Augusta Mountains. Rieberi Subzone, Shoshonensis Zone, middle Anisian.

Superfamily: Nathorstitaceae SPATH 1951
Family: Proteusitidae SPATH 1951
Genus: *Proteusites* HAUER 1887

Proteusites fergusoni n.sp.

(Plate 11, Figures 4–14; Text-Fig. 25)

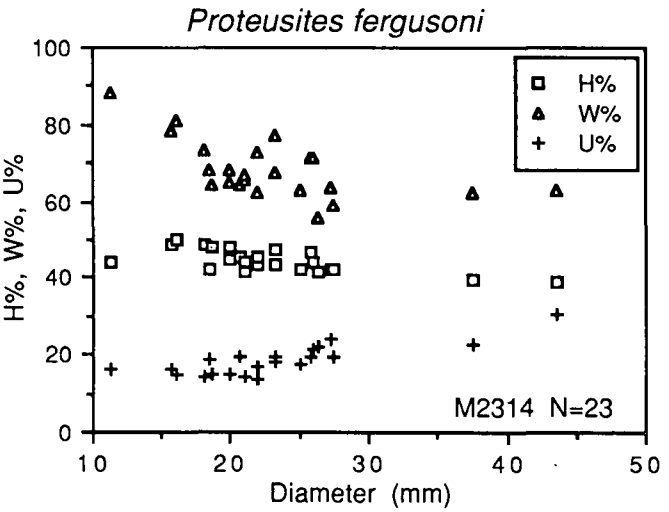
1968 [part] *Proteusites* cf. *P. kellneri* HAUER, SILBERLING & TOZER, p. 37.

Description: Innermost whorls (D<1.5 cm) globose and depressed, moderately evolute. Shell smooth, with radial to slightly prorsiradiate, distant, thick striae. Three or four shallow constrictions to a whorl are visible on internal mold only. At 1.5<D<3 cm, the shell shape gradually becomes ovoid and more compressed. Ribbing then develops into blunt, prorsiradiate, somewhat convex fold-like ribs which cross the venter. Early in that stage, constrictions combine with ribs and lose their individuality. Ribs gradually get thinner, more prorsiradiate and bundled. Gradual increase in umbilical width occurs simultaneously with this change in ornamentation. With transition to the mature body chamber, coiling becomes excentric, umbilical wall changes into a flared, concave slope, and the whorl section is slightly retracted. The former thin ribs merge into wavy folds that rise from narrow umbilical tubercles. H %, W %, and U % plotted on Text-Figure 24.
Suture line ceratitic, with short and rounded saddles. Lobe finely crenellated, with second lateral lobe broader and somewhat deeper than the first lateral lobe.

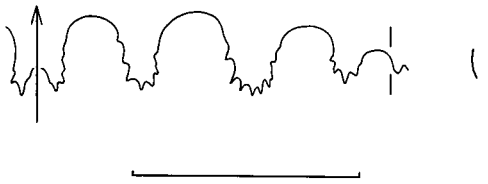
Discussion: *P. fergusoni* n.sp. differs from *P. kellneri* HAUER and other congeneric species described by HAUER (1887, 1892, 1896) and SALOPEK (1911) from the Han Bulog limestone by its prorsiradiate ribbing, as well as by its first tighter and then eccentric coiling. *P. fergusoni* more closely resembles *P. indicus* (see DIENER, 1913) in whorl proportions and style of ribbing, but is distinguished by its prorsiradiate ribbing again.

Etymology: Species named in honour vof H.G. FERGUSON.

Figured specimens: Holotype USNM 448271, paratypes USNM 448269 and 448270, USNM 448272.



Text-Fig. 24.
Scatter diagram of H%, W%, and U% against corresponding diameter for 23 specimens of *Proteusites fergusoni* n.sp. from locality M2314 in the Fergusoni Subzone (Shoshonensis Zone), Wildhorse Mine.



Text-Fig. 25.
Suture line (×3) of *Proteusites fergusoni* n.sp. at H = 14 mm.
Holotype USNM 448271.

Occurrence: USGS Mesozoic locality M2314 (19), Wildhorse Mine, New Pass Range. Fergusoni Subzone, Shoshonensis Zone, middle Anisian.

Proteusites weitschati n.sp.

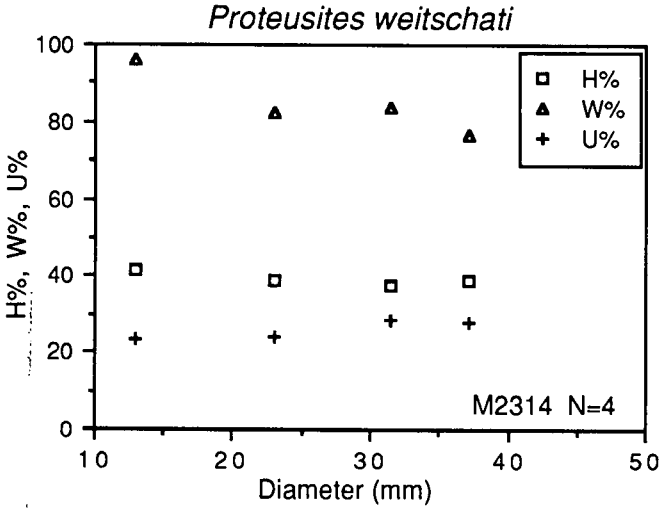
(Plate 41, Figures 1–3; Text-Fig. 27)

1968 [part] *Proteusites* cf. *P. kellneri* HAUER, SILBERLING & TOZER, p. 37.

Description: Cadicone *Proteusites*, with widely spaced, strongly prorsiradiate bullae at umbilical edge; outer shell otherwise smooth. Growth striae follow a convex path from umbilical bullae to siphonal line. The last half whorl of the holotype corresponds to the incomplete body chamber. Submature stage shows that bullae enlarge and get approximated, thus giving rise to wavy folds that cross the venter. Coiling concentric, at least until submature stage. H %, W %, and U % plotted on Text-Fig. 26.
Suture line with evenly rounded saddles, the first lateral saddle having a slightly phylloid outline.

Discussion: Distinguished from *P. fergusoni* n.sp. and other congeneric species by its cadicone shape and smooth immature stages; also in having strongly inflated umbilical bullae at submature stage.

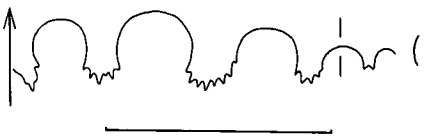
Etymology: Species named for W. WEITSCHAT of the University of Hamburg.



Text-Fig. 26.
Scatter diagram of H%, W%, and U% against corresponding diameter for 4 specimens of *Proteusites weitschati* n.sp. from USGS Mesozoic locality M2314 in the Fergusoni Subzone (Shoshonensis Zone), Wildhorse Mine.

Figured specimen: Holotype USNM 448268.

Occurrence: USGS Mesozoic locality M2314 (3), Wildhorse Mine, New Pass Range. Fergusoni Subzone, Shoshonensis Zone, middle Anisian.



Text-Fig. 27.
Suture line (×3) of *Proteusites weitschati* n.sp. at H = 11 mm.
Holotype USNM 448268.

Superfamily: Arcestaceae MOJSISOVICS 1875
Family: Arcestidae MOJSISOVICS 1875
Genus: *Proarcestes* MOJSISOVICS 1893

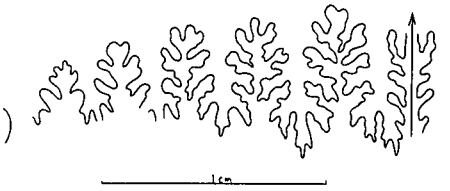
Proarcestes cf. *P. bramantei* (MOJSISOVICS)

(Plate 11, Figures 15–20; Text-Fig. 28)

1968 *Proarcestes* cf. *P. bramantei* (MOJSISOVICS), SILBERLING & TOZER, p. 37.

Description: Varices irregularly distributed, with a maximum of four to a whorl. Varices less sinuous but deeper on inner whorls than on outer whorls. Umbilicus narrow but permanently open. Inner whorl globose, somewhat more depressed than outer whorls. At D = 30 mm, 70 % < W < 80 %.
Suture line with very elongated external saddle, nearly as high as the symmetric first lateral saddle.

Discussion: Distinction at the species level is seriously complicated by the profusion of available names assigned to *Proarcestes*. This stratigraphically earliest representative of *Proarcestes* in the Fossil Hill sequence has nevertheless important biochronologic implications, because it occurs in the latest subdivision of the Shoshonensis Zone. Its suture line chiefly differs from that of the stratigraphically higher *P.* cf. *P. balfouri* and *P. gabbi* (MEEK) in having a more elongated external saddle and a symmetric first lateral saddle (see SILBERLING & NICHOLS, 1982, Figs. 42,43). Comparison with *P. bramantei* (MOJSISOVICS), as first suggested by SILBERLING & TOZER (1968), is also in accordance with the Binodosus Zone age assignment by MOJSISOVICS (1882, p. 316).



Text-Fig. 28.
Suture line (×3) of *Proarcestes* cf. *P. bramantei* (MOJSISOVICS) at D = 28 mm.
Plesiotype USNM 452800 (specimen not figured).
USGS Mesozoic loc. M2314, Fergusoni Subzone, (Shoshonensis Zone); Wildhorse Mine, New Pass Range.

Figured specimens: Plesiotypes USNM 448273 and 448274.

Occurrence: USGS Mesozoic locality M2314 (9), Wildhorse Mine, New Pass Range. Fergusoni Subzone, Shoshonensis Zone, middle Anisian.

Acknowledgements

E.T. TOZER, N.J. SILBERLING, F. TATZREITER, and J. GUEX provided valuable information and reviewed the manuscript. H. RIEBER lent comparative collections from northern Italy. Photographic illustrations were prepared by J.C. VIELLEFOND.

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Manuskript bei der Schriftleitung eingelangt am 11. Oktober 1991.

Plate 1

***Balatonites shoshonensis* HYATT & SMITH.**
Rieberi Subzone, Shoshonensis Zone.

Figs. 1– 3: Plesiotype, USNM 448200.
Loc. HB 166, Favret Canyon, Augusta Mountains.

Fig. 4: Plesiotype, USNM 448201.
Loc. HB 166, Favret Canyon, Augusta Mountains.

Figs. 5– 6: Plesiotype, USNM 448202.
Loc. HB 166, Favret Canyon, Augusta Mountains.

Figs. 7– 8: Plesiotype, USNM 448203.
Loc. HB 166, Favret Canyon, Augusta Mountains.

Figs. 9–11: Plesiotype, USNM 448204.
Loc. HB 166, Favret Canyon, Augusta Mountains.

Figs. 12–13: Plesiotype, USNM 448205.
Loc. HB 166, Favret Canyon, Augusta Mountains.

Figs. 14–16: Plesiotype, USNM 448206.
Loc. HB 166, Favret Canyon, Augusta Mountains.

Figs. 17–19: Plesiotype, USNM 448207.
Loc. HB 167, Favret Canyon, Augusta Mountains.

All figures natural size.

Plate 2

***Balatonites whitneyi* n.sp.**
Fergusoni Subzone, Shoshonensis Zone.

Figs. 1– 3: Paratype, USNM 448209.
USGS Mesozoic locality M2314, Wildhorse Mine, New Pass Range.

Figs. 4– 5: Paratype, USNM 448210.
USGS Mesozoic locality M2314, Wildhorse Mine, New Pass Range.

Figs. 6– 7: Paratype, USNM 448211.
USGS Mesozoic locality M2314, Wildhorse Mine, New Pass Range.

Figs. 8–10: Paratype, USNM 448212.
USGS Mesozoic locality M2314, Wildhorse Mine, New Pass Range.

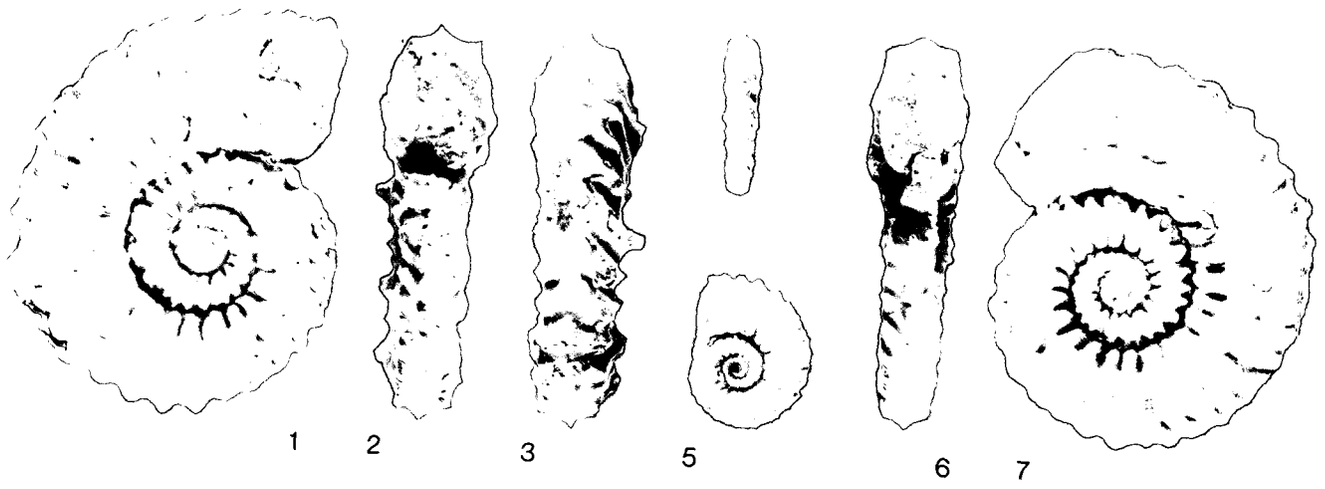
Figs. 11–12: Paratype, USNM 448213.
USGS Mesozoic locality M2314, Wildhorse Mine, New Pass Range.

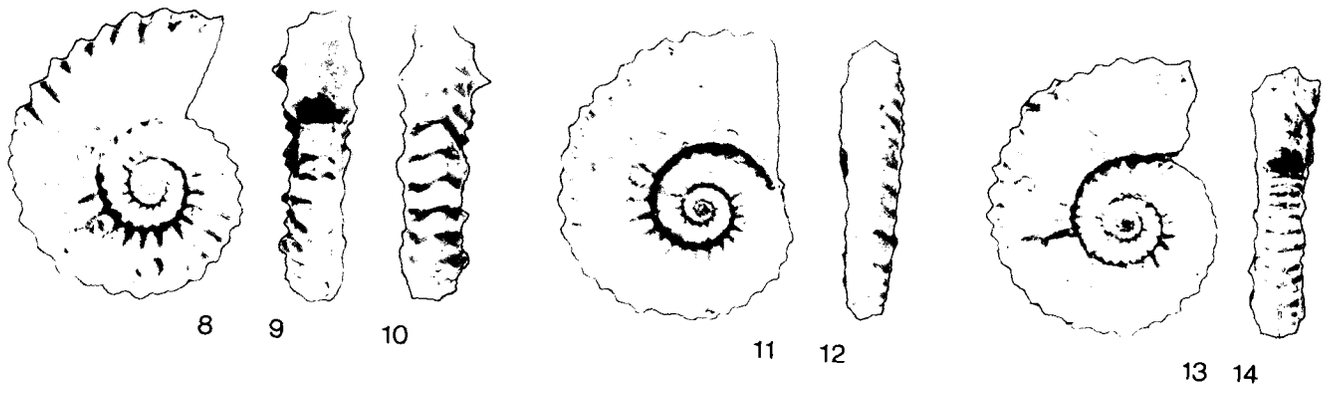
Figs. 13–14: Paratype, USNM 448214.
USGS Mesozoic locality M2314, Wildhorse Mine, New Pass Range.

Figs. 15–16: Paratype, USNM 448215.
USGS Mesozoic locality M2314, Wildhorse Mine, New Pass Range.

Figs. 17–19: Holotype, USNM 448216.
USGS Mesozoic locality M2314, Wildhorse Mine, New Pass Range.

All figures natural size.





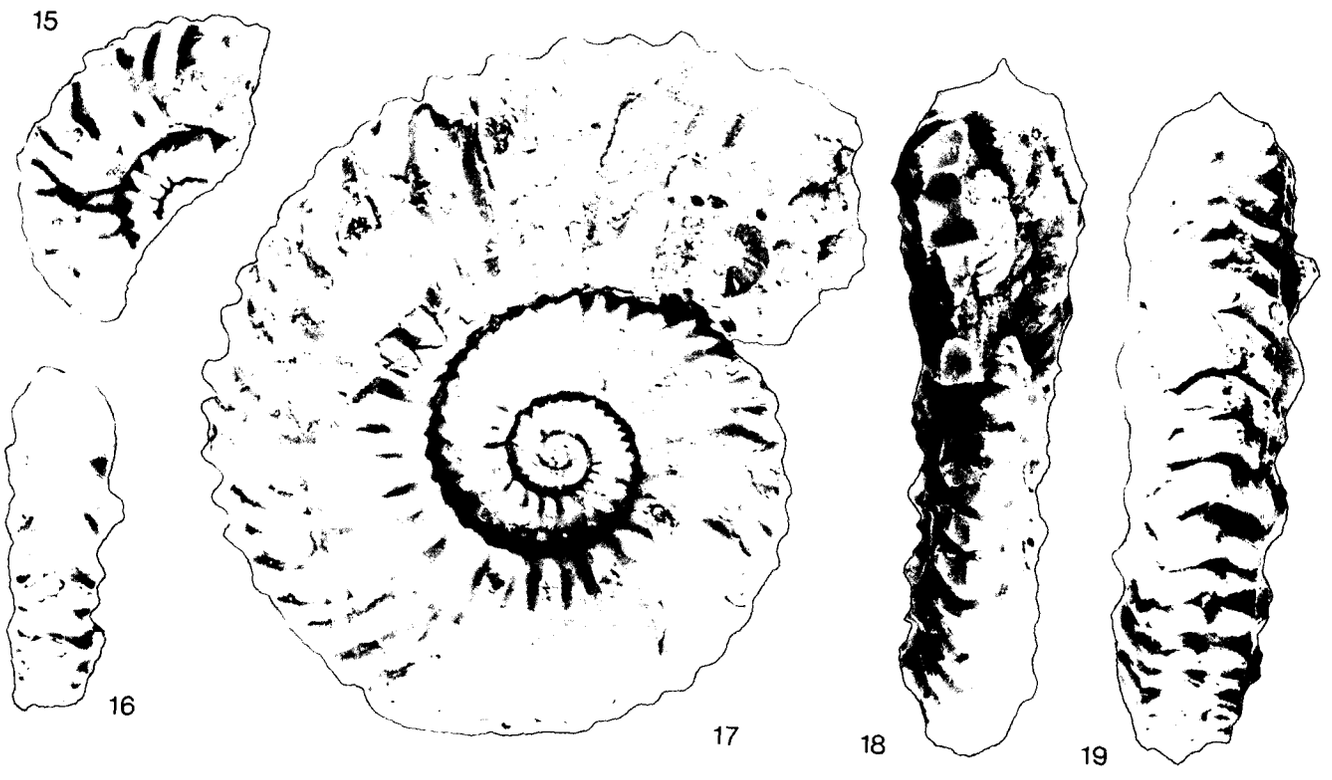


Plate 3

***Eogymnotoceras tuberculatum* n.sp.**
Rieberi Subzone, Shoshonensis Zone.

Figs. 1– 3: Holotype, USNM 448217.
Loc. HB 166, Favret Canyon, Augusta Mountains.

Figs. 4– 6: Paratype, USNM 448218.
Loc. HB 166, Favret Canyon, Augusta Mountains.

Figs. 7– 9: Paratype, USNM 448219.
Loc. HB 166, Favret Canyon, Augusta Mountains.

Figs. 10–12: Paratype, USNM 448220.
Loc. HB 166, Favret Canyon, Augusta Mountains.

***Gymnotoceras ginsburgi* n.sp.**
Wallacei Subzone, Shoshonensis Zone.

Figs. 13–15: Paratype, USNM 448222.
Loc. HB 233, Muller Canyon, Augusta Mountains.

Figs. 16–17: Paratype, USNM 448223.
Loc. HB 233, Muller Canyon, Augusta Mountains.

Figs. 18–20: Paratype, USNM 448224.
Loc. HB 233, Muller Canyon, Augusta Mountains.

Figs. 21–23: Holotype, USNM 448225.
Loc. HB 233, Muller Canyon, Augusta Mountains.

All figures natural size.

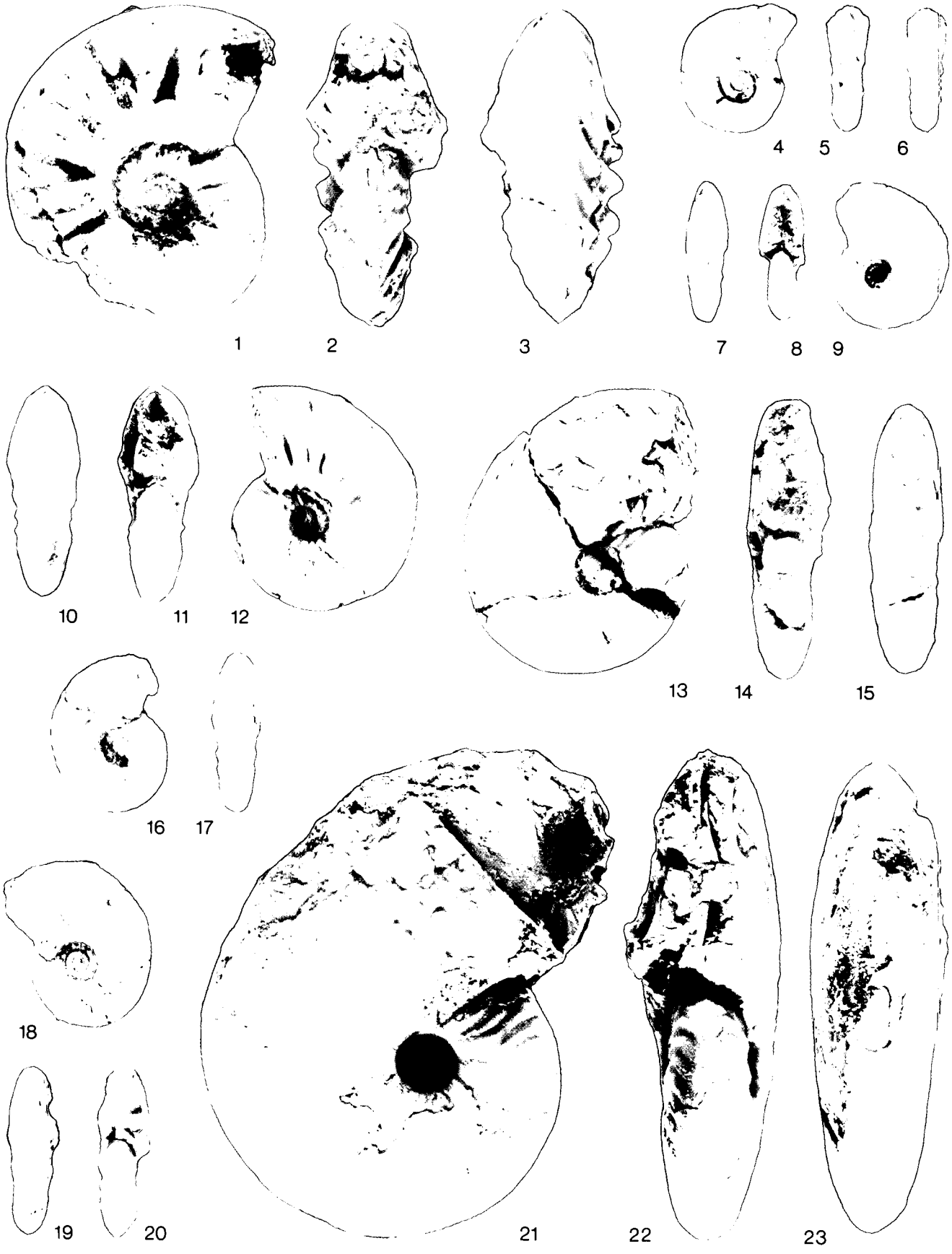


Plate 4

***Gymnotoceras praecursor* n.sp.**
Rieberi Subzone, Shoshonensis Zone.

Figs. 1– 2: Paratype, USNM 448226.
Loc. HB 166, Favret Canyon, Augusta Mountains.

Figs. 3– 4: Holotype, USNM 448227.
Loc. HB 166, Favret Canyon, Augusta Mountains.

Figs. 5– 7: Paratype, USNM 448228.
Loc. HB 166, Favret Canyon, Augusta Mountains.

***Constrigymnites robertsi* n.gen. n.sp.**
Rieberi Subzone, Shoshonensis Zone.

Figs. 8– 9: Paratype, USNM 448229.
Loc. HB 166, Favret Canyon, Augusta Mountains.

Figs. 10–12: Holotype, USNM 448230.
Loc. HB 166, Favret Canyon, Augusta Mountains.

***Eogymnotoceras tuberculatum* n.sp.**
Rieberi Subzone, Shoshonensis Zone.

Figs. 13–14: Paratype, USNM 448221.
Loc. HB 166, Favret Canyon, Augusta Mountains.

All figures natural size.

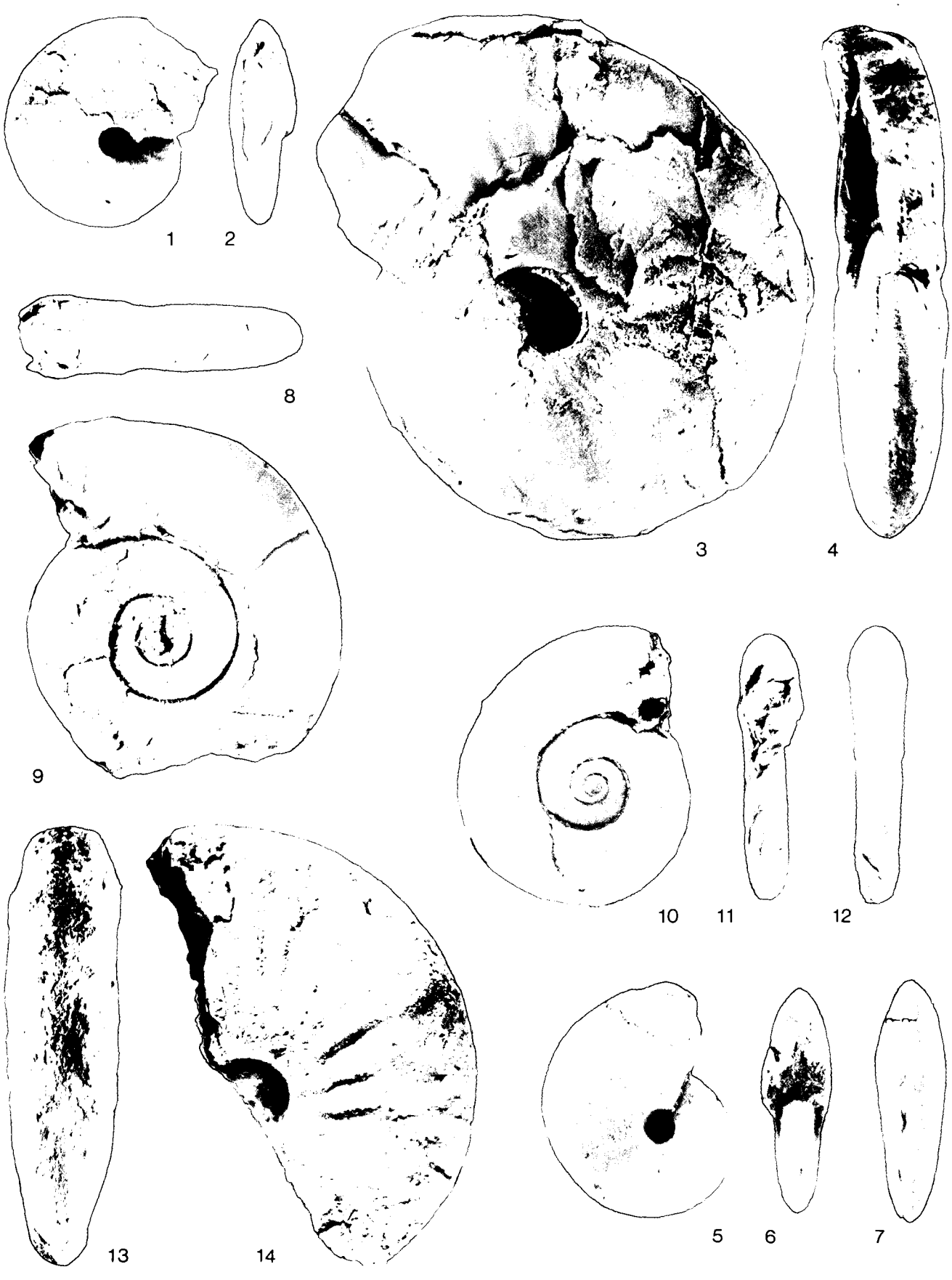


Plate 5

Favreticeras rieberi **n.gen. n.sp.**
Rieberi Subzone, Shoshonensis Zone.

Figs. 1– 3: Paratype, USNM 448231.
Loc. HB 190, Favret Canyon, Augusta Mountains.

Figs. 4– 6: Holotype, USNM 448232.
Loc. HB 190, Favret Canyon, Augusta Mountains.

Figs. 7– 9: Paratype, USNM 448233.
Loc. HB 190, Favret Canyon, Augusta Mountains.

Figs. 10–12: Paratype, USNM 448234.
Loc. HB 190, Favret Canyon, Augusta Mountains.

Figs. 13–15: Paratype, USNM 448235.
Loc. HB 190, Favret Canyon, Augusta Mountains.

Figs. 16–18: Paratype, USNM 448236.
Loc. HB 190, Favret Canyon, Augusta Mountains.

Figs. 19–21: Paratype, USNM 448237.
Loc. HB 190, Favret Canyon, Augusta Mountains.

Figs. 22–24: Plesiotype, USNM 448238.
Loc. HB 230, Favret Canyon, Augusta Mountains.

Nevadisculites depressus **n.sp.**
Rieberi Subzone, Shoshonensis Zone.

Figs. 25–27: Holotype, USNM 448251.
Loc. HB 166, Favret Canyon, Augusta Mountains.

All figures natural size.

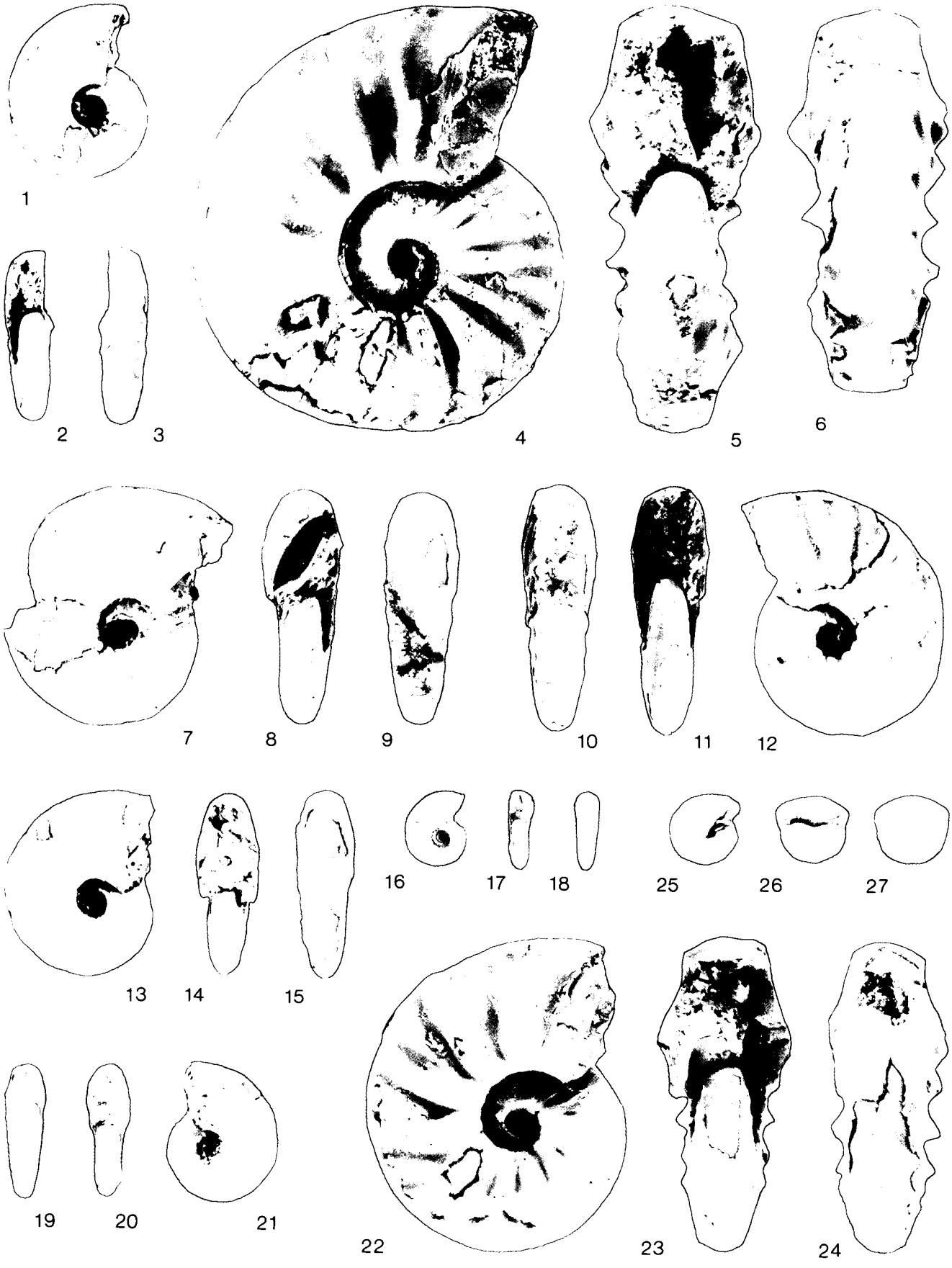


Plate 6

***Favreticeras ransomei* (SMITH).**
Ransomei Subzone, Shoshonensis Zone.

Figs. 1– 3: Plesiotype, USNM 448240.
Loc. HB 169, Favret Canyon, Augusta Mountains.

Figs. 4– 6: Plesiotype, USNM 448241.
Loc. HB 187, Favret Canyon, Augusta Mountains.

Figs. 7– 9: Plesiotype, USNM 448242.
Loc. HB 187, Favret Canyon, Augusta Mountains.

Figs. 10–12: Plesiotype, USNM 448243.
Loc. HB 187, Favret Canyon, Augusta Mountains.

Figs. 13–15: Plesiotype, USNM 448244.
Loc. HB 187, Favret Canyon, Augusta Mountains.

Figs. 16–17: Plesiotype, USNM 448245.
Loc. HB 187, Favret Canyon, Augusta Mountains.

***Platycuccoceras cainense* n.sp.**
Ransomei Subzone, Shoshonensis Zone.

Figs. 18–19: Plesiotype, USNM 448254.
Loc. HB 187, Favret Canyon, Augusta Mountains.

Figs. 20–21: Holotype, USNM 448255.
Loc. HB 254, Muller Canyon, Augusta Mountains.

***Platycuccoceras* sp. indet.**
Ransomei Subzone, Shoshonensis Zone.

Figs. 22–23: USNM 448256.
Loc. HB 186, Favret Canyon, Augusta Mountains.

***Balatonites shoshonensis* HYATT & SMITH.**
Rieberi Subzone, Shoshonensis Zone.

Fig. 24: Plesiotype USNM 448208.
Loc. HB 166, Favret Canyon, Augusta Mountains.

All figures natural size.

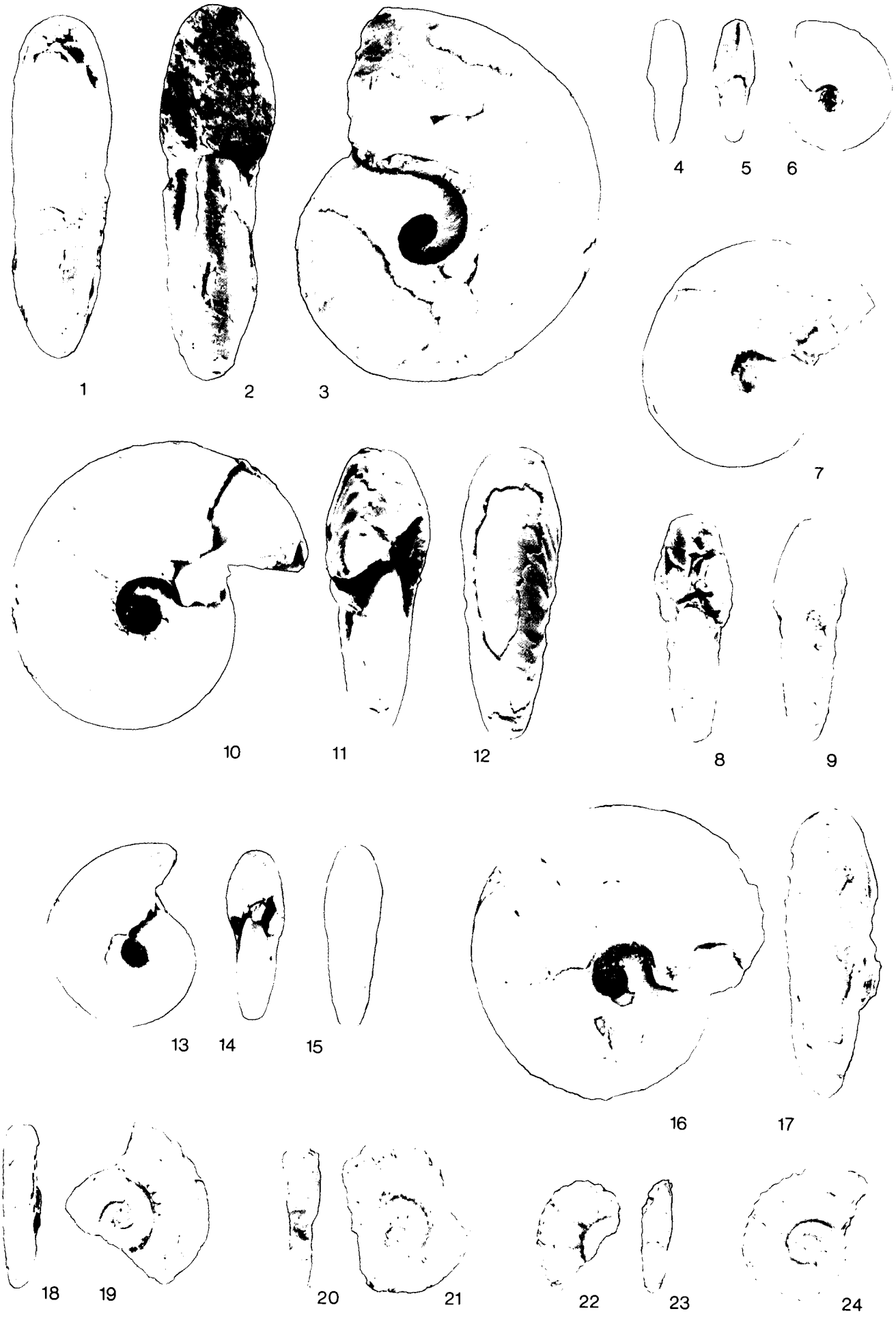


Plate 7

***Favreticeras wallacei* n.gen. n.sp.**
Wallacei Subzone, Shoshonensis Zone.

Figs. 1– 3: Holotype, USNM 448246.
Loc. HB 191, Muller Canyon, Augusta Mountains.

Figs. 4– 5: Paratype, USNM 448247.
Loc. HB 191, Muller Canyon, Augusta Mountains.

Figs. 6– 7: Paratype, USNM 448248.
Loc. HB 191, Muller Canyon, Augusta Mountains.

***Favreticeras rieberi* n.gen. n.sp.**
Rieberi Subzone, Shoshonensis Zone.

Figs. 8– 9: Paratype USNM 448239.
Loc. HB 190, Favret Canyon, Augusta Mountains.

***Amphipopanoceras selwyni* (McLEARN).**
Rieberi Subzone, Shoshonensis Zone.

Figs. 10–11: Plesiotype USNM 448257.
Loc. HB 190, Favret Canyon, Augusta Mountains.

All figures natural size.

Plate 8

***Guexites pacificus* n.gen n.sp.**
Wallacei Subzone, Shoshonensis Zone.

Figs. 1–3: Holotype, USNM 448250.
Loc. HB 171, Favret Canyon, Augusta Mountains.

***Favreticeras wallacei* n.gen. n.sp.**
Fergusoni Subzone, Shoshonensis Zone.

Figs. 4–5: Plesiotype, USNM 448249.
USGS Mesozoic locality M2314, Wildhorse Mine, New Pass Range.

All figures natural size.

Plate 9

***Ptychites densistriatus* n.sp.**
Rieberi Subzone, Shoshonensis Zone.

Figs. 1– 3: Plesiotype, USNM 448258.
Loc. HB 167, Favret Canyon, Augusta Mountains.

Figs. 4– 5: Paratype, USNM 448259.
Loc. HB 166, Favret Canyon, Augusta Mountains.

Figs. 6– 7: Paratype, USNM 448260.
Loc. HB 166, Favret Canyon, Augusta Mountains.

Figs. 8–10: Holotype, USNM 448261.
Loc. HB 166, Favret Canyon, Augusta Mountains.

***Ptychites gradinarui* n.sp.**
Wallacei Subzone, Shoshonensis Zone.

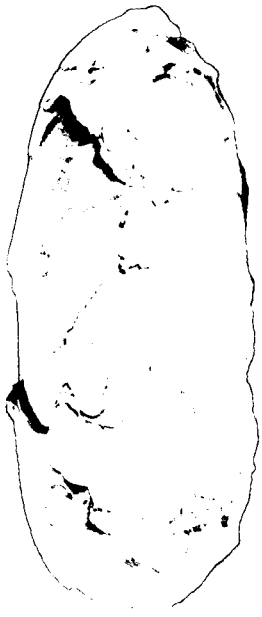
Figs. 11–12: Paratype USNM 448262.
Loc. HB 233, Muller Canyon, Augusta Mountains.

***Nevadisculites depressus* n.sp.**
Rieberi Subzone, Shoshonensis Zone.

Figs. 13–15: Paratype, USNM 448252.
Loc. HB 186, Favret Canyon, Augusta Mountains.

Figs. 16–17: Paratype, USNM 448253.
Loc. HB 186, Favret Canyon, Augusta Mountains.

All figures natural size.



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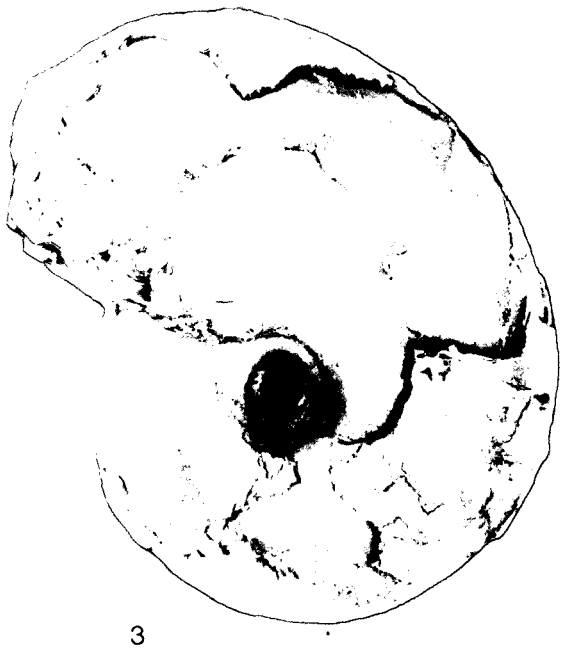

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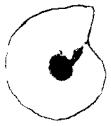

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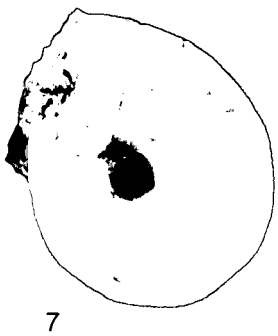

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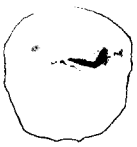

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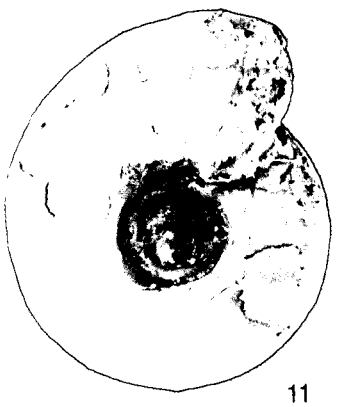

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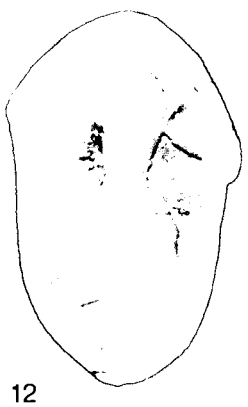

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Plate 10

***Ptychites gradinarui* n.sp.**
Wallacei Subzone, Shoshonensis Zone.

Figs. 1–2: Plesiotype, USNM 448263.
Loc. HB 155, southern Tobin Range.

Figs. 2–4: Holotype (×1/3), USNM 448264.
Loc. HB 233, Muller Canyon, Augusta Mountains.

***Ismidites* cf. *I. marmarensis* ARTHABER.**
Rieberi Subzone, Shoshonensis Zone.

Figs. 5–6: Plesiotype, USNM 448275.
Loc. HB 190, Favret Canyon, Augusta Mountains.

All figures natural size unless otherwise indicated.

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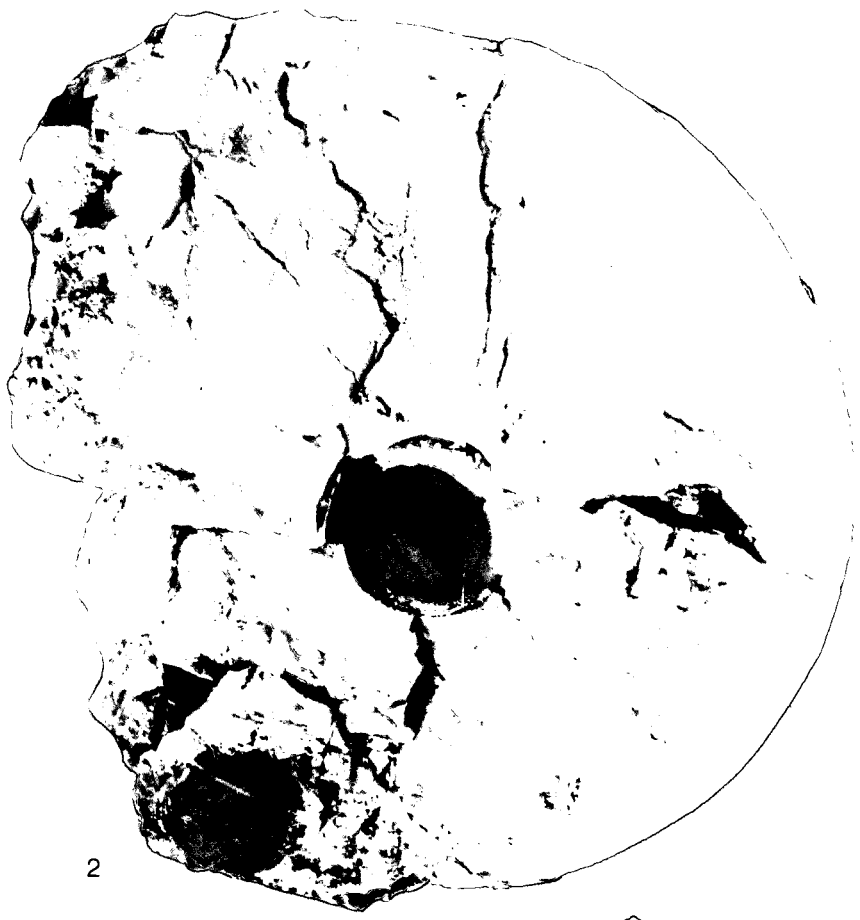

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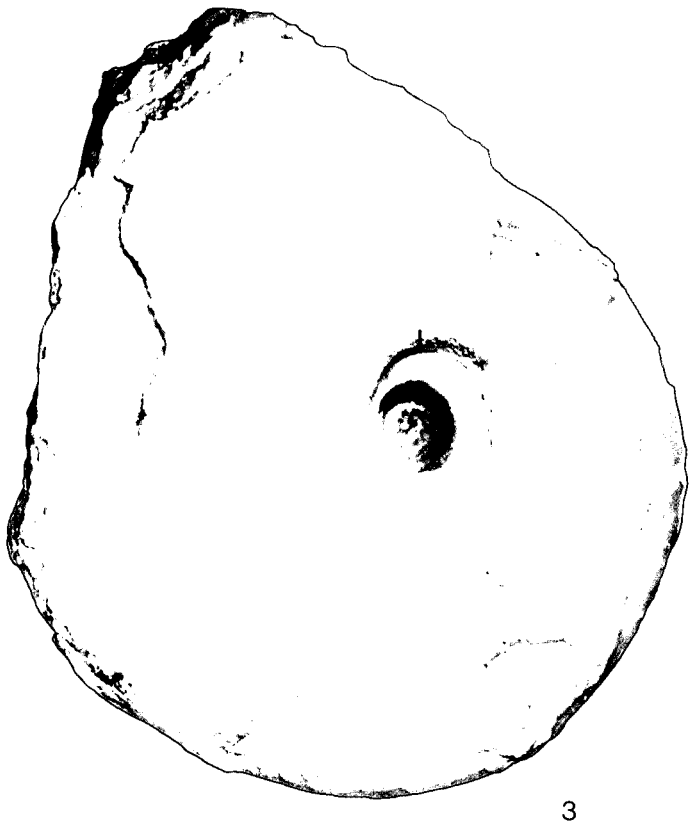

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Plate 11

***Proteusites weitschati* n.sp.**
Fergusoni Subzone, Shoshonensis Zone.

Figs. 1– 3: Holotype, USNM 448268.
USGS Mesozoic locality M2314, Wildhorse Mine, New Pass Range.

***Proteusites fergusoni* n.sp.**
Fergusoni Subzone, Shoshonensis Zone.

Figs. 4– 6: Paratype, USNM 448269.
USGS Mesozoic locality M2314, Wildhorse Mine, New Pass Range.

Figs. 7– 9: Paratype, USNM 448270.
USGS Mesozoic locality M2314, Wildhorse Mine, New Pass Range.

Figs. 10–12: Holotype, USNM 448271.
USGS Mesozoic locality M2314, Wildhorse Mine, New Pass Range.

Figs. 13–14: Paratype, USNM 448272.
USGS Mesozoic locality M2314, Wildhorse Mine, New Pass Range.

***Proarcestes* cf. *P. bramantei* (Mojsisovics).**
Fergusoni Subzone, Shoshonensis Zone.

Figs. 15–17: Plesiotype, USNM 448273.
USGS Mesozoic locality M2314, Wildhorse Mine, New Pass Range.

Figs. 18–20: Plesiotype, USNM 448274.
USGS Mesozoic locality M2314, Wildhorse Mine, New Pass Range.

***Ptychites gradinarui* n.sp.**
Wallacei Subzone, Shoshonensis Zone.

Figs. 21–22: Paratype, USNM 448265.
Loc. HB 233, Muller Canyon, Augusta Mountains.

Figs. 23–24: Paratype, USNM 448266.
Loc. HB 233, Muller Canyon, Augusta Mountains.

Figs. 25–26: Paratype, USNM 448267.
Loc. HB 233, Muller Canyon, Augusta Mountains.

All figures natural size.