

Other material examined.—Nine cephala (in field collections).

Occurrence.—Montenegro Member of the Campito Formation in the northern Montezuma Range (section MN-f 199; section MN-h 193, 246.5; section MS 288).

Discussion.—This is a small species of *Esmeraldina*, average cephalic length for 12 specimens is 9.5 mm, range 5–15 mm, easily distinguished from all other species of *Esmeraldina* by the lack of an occipital spine and a thorax that is widest at T5. This species is rare (about 3% of the holmiid cephala) in collections from MS 211 to MS 278 (see Fig. 5). Furthermore, this species differs from *Esmeraldina rowei* in having a strongly rounded posterolateral margin, narrower glabella, and strongly advanced genal spines. It is distinguished from *Palmettaspis lidensis* (Fritz, 1995), in lacking the preglabellar field of the latter. Fritz's specimens of *P. lidensis* have about the same cephalic length, 7–12 mm, as the key specimens of this form, thus the absence of a preglabellar field is not ontogenetic. The advanced genal spines of this species are similar to *Palmettaspis consorta*, but the glabella is wider, there is no preglabellar field, the genal spines are wider and often more advanced, and the cephalon is finely granular.

Genus PALMETTASPIS Fritz, 1995

Palmettaspis FRITZ, 1995, p. 718, 720; PALMER AND REPINA, 1997, p. 416; LIEBERMAN, 1998, p. 65; 1999, p. 83–84.

Type species.—*Palmettaspis consorta* Fritz, 1995.

Included species.—*Esmeraldina lidensis* Fritz, 1995, not *Palmettaspis parallela* Fritz, 1995.

Occurrence.—Middle Montezuman in Esmeralda County, Nevada.

Discussion.—The notable differences between *Palmettaspis* and *Esmeraldina* are the presence of a preglabellar field and genal spines with a relatively narrow base on *Palmettaspis*. The thoraxes of the two species assigned by Fritz (1995) to *Palmettaspis*, *P. consorta*, and *P. parallela*, are substantially different. *Palmettaspis consorta* has distinctly thornlike pleural spines which are similar to those on the thorax of *Esmeraldina*. The thorax tentatively assigned to *P. parallela* by Fritz (1995) has sentate pleural spines, and new articulated material of this species confirms that assignment. These thoracic differences are the major reason to assign *P. parallela* to the new genus *Montezumaspis* (see *Discussion of Montezumaspis parallela* n. sp. for additional differences). Considering most of the features of the two species assigned to or retained in *Palmettaspis* herein, both could comfortably be placed within *Esmeraldina* (Lieberman, 1999). The strongest justification to maintain *Palmettaspis* separate from *Esmeraldina* is the presence of the preglabellar field. Ontogenetic studies (Palmer, 1957; Webster, 2003) show that with increased age, the glabella becomes relatively longer, thus the preglabellar field becomes progressively shorter. The preglabellar field is absent on small (about 10 mm cephalic length) specimens of *Esmeraldina*, so this criterion is valid even for small cephalata.

PALMETTASPIS CONSORTA Fritz, 1995

Palmettaspis consorta FRITZ, 1995, p. 720, figs. 5.4, 8.1–8.6, 10.1, 10.2; PALMER AND REPINA, 1997, p. 416, fig. 262.5; LIEBERMAN, 1999, p. 76–77 (coded), 83–84, fig. 15.2.

Material examined.—Three cephalata ranging in length from 7 to 16 mm in a collection from the Montenegro Member at Stewart's Mill (section RR 32), not illustrated.

Discussion.—New material of this species is limited and nothing useful can be added to the original diagnosis and description. This species is not particularly common in the original 1f collection with only 23 specimens (7% of trilobite cephalata) (Fritz, 1995). That large collection was made by F. B. Weeks from the

lowest unit of the Barrel Spring section located three miles (4.8 km) northeast of Barrel Spring, 16 miles (26 km) south of the town of Silver Peak (Walcott, 1908, 1910, 1912b). Unfortunately the exact source of this early collection has not been found, nor has any other locality been found that contains the same mix of species (Fritz, 1995).

A single 5.9 mm long cephalon (Fig. 9.10) of *Palmettaspis consorta*? was found in a large collection (section MN-f 163) in the Montezuma Range. It differs from the *P. consorta* of the 1f collection in having a nearly circular cephalon with genal spine outward-directed, initially at an angle of 55° to the sagittal axis, compared with 30° on the holotype. The glabella expands slightly forward, and is not parallel-sided. The anterior border and border furrows are subtle, and the preglabellar field is practically absent. The extraocular area is about equal to the interocular area, compared with nearly twice as wide on the holotype. The occipital spine is broken but does not appear to emanate from a ridge on the occipital ring as stated for the type material. This cephalon may represent an earlier species but, lacking adequate material, it is now questionably assigned to *P. consorta*.

PALMETTASPIS LIDENSIS (Fritz, 1995)

Figure 9.11

Esmeraldina lidensis FRITZ, 1995, p. 716, figs. 5.2, 7.4?, 7.5–7.9. *Palmettaspis lidensis* (FRITZ, 1995). LIEBERMAN, 1999, p. 76–77 (coded), 84–85.

Material examined.—One cephalon, 3.6 mm in length, from the Montenegro Member in the Montezuma Range (section MN-h 214–216).

Discussion.—This species is relatively common in Walcott's 1f collection (Fritz, 1995), where it comprises 16% of trilobite cephalata. Lieberman (1999) transferred this species to *Palmettaspis*, citing the short preglabellar field; his other criterion refers to the advancement of the genal spines which in this study is found to vary widely within *Esmeraldina*. The genal spines are narrow, but the glabellar configuration more closely resembles that of *Esmeraldina*.

Genus GRANDINASUS new genus

Type species.—*Olenellus? argentus* Walcott, 1910.

Included species.—*Grandinasus auricampus* n. sp., *G. patulus* n. sp., *G. sp. A*.

Diagnosis.—Holmiid with LA impinging on the anterior border. Lateral cephalic border wide, one-third to over two-thirds width (tr.) of L0. S3 furrow faint or obsolete, and L3 incorporated in dorsally inflated LA. Glabella wider at LA than at L0 and constricted at S1. L0 expands posteriorly into stout spine. Ocular lobes short with posterior tips opposite anterior of L1 or posterior of L2. Extraocular area one to one and one-half times width (tr.) of interocular area. Intergenal spine located closer to axial furrow than to genal angle. Dorsal surface granular. Thorax of 17 segments, pygidium unknown.

Etymology.—Latin, *grandis*, great, large; *nasus*, nose, noting the bulbous LA of the glabella.

Occurrence.—Uppermost middle through middle upper Montezuman Stage. Known occurrences are from Esmeralda County, Nevada, and Inyo County, California, and a single specimen from Stevens County, Washington.

Discussion.—In this genus, the S3 furrow is virtually obsolete, although it may be present on the ventral surface, and the L3 lobe is drastically modified by incorporation into the dorsally inflated LA. In most other respects it is similar to *Esmeraldina*. The curvature of the S3 furrow and modifications of L3 are important

characters of the Holmiidae (Ahlberg et al., 1986), thus the distinctive modifications on this form are considered to be diagnostic generic features.

GRANDINASUS ARGENTUS (Walcott, 1910)

Figure 12.1–12.9

Olenellus? argentus WALCOTT, 1910, p. 314–315, pl. 40, figs. 12, 13, 15, 16, non fig. 14.

Mesonacis argentus (WALCOTT, 1910). BELL, 1931, p. 12, 18, 20.

Olenellus argentus WALCOTT, 1910. HARRINGTON, 1956, p. 56.

Esmeraldina? argenta (WALCOTT, 1910). RAW, 1957, p. 170.

Esmeraldina argenta (WALCOTT, 1910). SHAW, 1962, p. 333.

Holmia? argenta (WALCOTT, 1910). FRITZ, 1972, p. 12, 13, 25; 1991, p. 15.

Holmia argenta (WALCOTT, 1910). POULSEN, 1974, p. 87.

Description.—Cephalon semicircular, width about twice length. Genal spines slightly outward-directed at base becoming parallel to the sagittal axis distally. Posterior margin transverse to genal angle. Intergenal spine long, distinct, two-fifths to one-half the distance from axial furrow to genal angle. Lateral border (tr.) somewhat less than half width (tr.) of L0; anterior border reduced to one-third width of lateral border due to expanded LA; posterior border two-thirds maximum width of lateral border. Border furrow becomes more distinct anteriorly. Glabella constricted at S1, expanding rapidly anteriorly to middle of LA which is about one-third wider (tr.) than L0 (tr.). LA width (tr.) and length (sag., including incorporated L3) both about two-thirds sagittal length of glabella. Preglabellar field absent. Axial furrow deep, distinct anteriorly, shallower adjacent to L0 and L1. S0 short deep, transverse, absent at glabellar axis, S1 similar but inclined slightly back; S2 shallower, nearly transverse; S3 very faint or absent. L3 incorporated in expanded LA. L2 slightly wider (tr.) than L1. L0 longer (sag.) medially by half than at axial furrow with narrow, upward-directed occipital spine from posterior margin. Ocular lobe narrow, slightly curved, clearly separated from LA by deep axial furrow; posterior tip opposite middle of L1, laterally spaced from axial furrow by interocular area one-fourth width (tr.) L0. Width of cephalon between distal margins of ocular lobes equal to length of glabella. Interocular area marked by longitudinal swelling or ridge. Extraocular area about equal to or slightly wider (tr.) than interocular area, with swelling parallel to border furrow. Dorsal surface of larger cephalata granular.

Thorax of 17 segments, expanding in width from T1 to T4, tapering rapidly behind T8. At T4, thoracic axis slightly less than one-third thoracic width (tr.), each inner portion of pleurae one-fourth thoracic width. Axial rings of at least T1 through T4 have prominent dorsally directed spines; spine length shown by isolated segments to be two-fifths width (tr.) of axial ring (USNM 520958). Pleural segments with sharp anterior band and short triangular pleural furrows; length of furrows (tr.) decreases uniformly from T1 to T17. Pleural spines sentate (although unclear for T1 through T3), outward-directed to backward-directed posteriorly; pleural spines of T12 through T17 are thornlike and backward-directed. Hypostome and pygidium unknown.

Late meraspid cephalata (Fig. 12.4–12.6) with cephalic lengths of 2.4 and 2.2 mm have a glabella which expands steadily forward to an enlarged LA that incorporates L3 as in holaspides. LA reaches border furrow but border width (sag.) is not diminished ahead of LA. Intergenal spine about as thick as genal spine but somewhat shorter. Genal spines are advanced to align with L1; posterior margin beyond intergenal spine angled forward, not transverse as on holaspides of *G. argentus* nor curved forward near genal angle as on holaspides of *G. auricampus* n. gen. and sp.

Type.—Lectotype cephalon (USNM 56812d) figured by Walcott (1910, pl. 40, fig. 15) as designated by Harrington (1956, p.

56). The specimen was collected by F. B. Weeks at locality 1v, three miles (4.8 km) north of Valcalda Spring, and four miles (6.4 km) west-northwest of the Drinkwater Mine, Silver Peak Quadrangle, Esmeralda County (Walcott, 1910, p. 415; 1912b, p. 161). Walcott's statement (1910, p. 315) attributing this material to "Lower Cambrian: (1v) shales of No. 3 of the Silver Peak Group, Barrel Spring section" was presumably intended to define the stratigraphic position of the collection, not the locality. The writer recollected this locality from the middle shale unit of the lower member of the Poleta Formation on the crest of Mineral Ridge 11.4 km northwest of the town of Silver Peak.

Other material examined.—Thirty more or less complete adult cephalata, one with attached thorax, and five meraspid cephalata, from field collections. Replica of lectotype cephalon (ICS 3255).

Occurrence.—From the shale unit in the middle of the lower member of the Poleta Formation at the Montezuma Range (section MS 386–411, 390–410; section IS 45, 134; IS-W 15), at Mineral Ridge (locality 1574, 1672, topotypes?), at the Fish Lake Valley (sections FLVS 183–188, 186–196, 193, 209; FLVS-N 231, 251), and east of Mount Jackson (locality 1721). An incomplete cephalon was found by M. B. McCollum from the Addy Quartzite at the type locality of *Nevadia addyensis* Okulich, 1951, on the southern end of the hill west of Addy, Washington.

Discussion.—This is a relatively small species; 29 cephalata from various collections average 9.3 mm in cephalic length and range from 3.3 to 21.3 mm, but one fragmentary specimen suggests a cephalic length of 40 mm. The features that combine to differentiate this species from other *Grandinasus* species are: the LA reduces the anterior border to a third the lateral border width, the glabella is constricted at S1, the posterior border is transverse, and the genal spine is not advanced. It is readily distinguished from *Esmeraldina rowei* by the general shape of the cephalon and glabella, the bulbous LA, and the absence of S3 with L3 incorporated in the LA. The bulbous LA and the severely reduced anterior border ahead of the LA are features that resemble '*Holmia? zimmermanni*' (Schwarzbach, 1939), but that species has a normal L3 and prominent S3 furrow (see Ahlberg et al., 1986, fig. 4; and see Geyer and Elicki, 1995, for an extended discussion of this species). The shape of the thorax of *G. argentus*, widest at T4, resembles the thorax of *Esmeraldina elliptica* n. sp.

GRANDINASUS AURICAMPUS new species

Figure 12.10–12.14, ?12.15–12.17

Diagnosis.—Glabella parallel-sided from L0 through L2. Posterior margin angled back from axial furrow to intergenal spine, then distinctly curved forward to genal angle. Genal spine moderately advanced, aligning with mid-L0 to S0, and initially slightly outward-directed curving to straight back.

Description.—Cephalon parabolic, width nearly twice length, wider in larger specimens. Genal spines initially directed outward at 30° from sagittal axis, curving nearly parallel sagittal axis, behind posterior margin of cephalon. Posterior margin angled slightly back from axial furrow to intergenal spine; from intergenal spine, posterior margin curves gently forward with a sharper curve at proximal margin of genal spine. Genal angle aligns with middle of L0 to S0. Intergenal spine is nearly as long as L0 (sag), and located distal of lateral margins of ocular lobes; on small cephalata intergenal spine aligns with lateral margins of ocular lobes. Lateral border width (tr.) about equal to sagittal length of L0. Anterior border ahead of LA reduced to less than half lateral border. Border convex in cross section near border furrow becoming nearly flat toward outer margins, posterior border one-half width (tr.) of lateral border. Border furrow broad, shallow except from middle of genal spine forward to LA. Glabella narrow and parallel-sided to S2 then expanded forward to middle of LA. LA incorporates L3. LA about two-fifths wider (tr.) than L0; length

(sag.) half length of glabella. Preglabellar field absent. Axial furrow broad, shallow, deeper adjacent to LA. S0 short, transverse, S1 similar; S2 shallower and longer, S3 absent or very faint and convex forward. L0 and L1 slightly longer (exsag.) than L2. Posterior margin of L0 slightly curved posteriorly, and distinctly elevated dorsally with stout occipital spine arising from posterior half; spine is angled upward. Ocular lobe narrow (tr.), one-sixth width (tr.) of L0, broadly curved, separated from LA by furrow; line from anterior to posterior tip of ocular lobe nearly parallels sagittal axis; posterior tip of ocular lobe aligns with L1. Width of cephalon between distal margins of ocular lobes slightly less than length (sag.) of glabella. Interocular area essentially flat. Extraocular area varies in width (tr.) from less than interocular area to about one-fifth greater, with a slight swelling parallel to border furrow. Dorsal surface granular. Thorax, pygidium, and hypostome unknown.

Etymology.—Latin, *aurium*, gold, and *campus*, field, reflecting the proximity of the type locality to the Goldfield mining district.

Types.—Holotype cephalon, slightly distorted external mold, USNM 520990, and two paratypes from the uppermost beds of the Montenegro Member of the Campito Formation in the northern Montezuma Range. Additional paratype cephalon, USNM 520989, from the lower member of the Poleta Formation in the Gold Point area, Esmeralda County, Nevada.

Other material examined.—Thirty-eight cephalons and cephalic fragments (in field collections).

Occurrence.—Near the top of the Montenegro Member of the Campito Formation in the northern Montezuma Range (section MN-h 323, 326, 330–331, 332, and 337–338; section MS 326.5, 330.5, 337.5, and 338), in a nodular limestone bed near the top of the Montenegro Member in the Gold Point area (section GP-N 0), and in the basal, ribbon limestone of the Poleta Formation in the Gold Point area (locality 1473).

Cephalons collected by A. R. Palmer from limestone at the top of the lower member of the Poleta in the Gold Point area (locality ICS 1053) (Fig. 12.15–12.17) have a sharp ridge in the interocular area, but otherwise fall within the concept of *Grandinasus auricampus*.

Discussion.—The specimens of this species from the Montenegro Member are compacted with some distortion. These cephalons range in length from 5.6 to 28.8 mm averaging 12.2 mm and lack a distinct longitudinal ridge in the interocular area. Weakly silicified cephalons were found on limestone surfaces in the basal Poleta Formation near Gold Point; 10 cephalons range in length from 3.3 to 8.6 mm, averaging 5.9 mm and have a longitudinal swelling in the interocular area. There are questionably assigned, poorly preserved, late-stage meraspid cephalons occurring in the same interval. Many of these fragile sclerites were lost during bulk acid digestion.

GRANDINASUS PATULUS new species
Figure 13.4–13.7, 13.9, 13.10

Diagnosis.—Cephalon unusually wide. Lateral border widens and merges with widening posterior border to form wide flat area at base of genal spine which is outward directed. Ocular lobes somewhat outward-directed.

Description.—Cephalon broadly curved at front, width well over twice cephalic length (sag.). Genal spine broad, outward-directed. Posterior margin transverse to intergenal spine then angled moderately forward. Intergenal spine distinct, located distal of exsagittal margin of ocular lobe, and slightly less than halfway on posterior margin from axial furrow to genal angle. Genal angle approximately opposite S0 to L1. Anterior border narrowed ahead of LA, width (exsag.) at point aligned ahead of distal lateral margin of ocular lobe about one-third width (tr.) L0, cross section slightly convex. Posterior border furrow very shallow laterally.

Border furrow broad, shallow, deepest ahead of glabella. LA width (tr.) three-fourths length (sag.) of glabella and wider than L0 by one-fifth, glabella constricted at S1. Axial furrow, shallow; practically obsolete adjacent to L1 and L0. LA elevated dorsally above rest of glabella, length (sag.) about two-thirds length of glabella. S0, S1, and S2 similar, shallow but distinct, angled posteriorly, not connected across glabellar axis. S3 furrow virtually obsolete, L3 incorporated in dorsally inflated LA. L0 expands posteriorly into broad-based spine at least one-fifth the glabellar length. Ocular lobes narrow, one-tenth width (tr.) L0, separated from LA by broad axial furrow, angle of line from posterior tip of ocular lobe to posterior point where ocular lobe meets LA averages about 20° from sagittal axis. Width of cephalon between distal margins of ocular lobes one-eighth more than length of glabella. Interocular area slightly convex dorsally. Extraocular area 1.4 times width (tr.) of interocular area, with convex elevation close to and paralleling margin of eye and extending forward to axial furrow at LA. Dorsal surface uniformly granular. One specimen, USNM 520965, shows that thoracic axial rings of segments T1 and T2 have stout medial spines similar to occipital spine, which are elevated at base, free portion of these spines parallels dorsal surface. Pygidium and hypostome unknown.

Etymology.—Latin, *patulus*, spreading, referring to the wide arrangement of the genal spines.

Types.—Holotype cephalon, USNM 520991, and one paratype cephalon from the Montezuma Range; one paratype cephalon from the Gold Point area, and a paratype cephalon, ICS 3760, from Stewart's Mill, all from the upper beds of the Montenegro Member of the Campito Formation.

Other material examined.—Sixteen cephalons and cephalic fragments (in field collections).

Occurrence.—Upper beds of the Montenegro Member of the Campito Formation in the northern Montezuma Range (section MN-h 326, 330–331, 332, and 334; section MS 330.5 and 338), in the Gold Point area (section GP-N 0), in Fish Lake Valley (section FLVS 97–113), at Alcatraz Island (locality 1223), and Stewart's Mill (ICS 1045).

Discussion.—This is a large, wide trilobite; available cephalons range from 10 to 40 mm in length. It is distinguished from *Grandinasus argentus* by the anterior border which is not completely eliminated by the advancement of the LA. It resembles *Esmeraldina rowei*, especially the wide variant, but L3 is incorporated in the dorsally inflated LA. It also resembles *Kjerulfia? palpebra* Ahlberg (1984, fig. 6a, b) in having a wide, relatively flat border but the ocular lobes are much narrower and the genal spines are outward-directed.

GRANDINASUS species A
Figure 13.1–13.3

Description.—Cephalon subtriangular, width one-half greater than length. Genal spines directed slightly outward then straight backward, length about three-fifths cephalic length. Posterior margin straight, distal point at genal angle slightly behind L0. Intergenal spine long, approximately equal to length of L0 (sag.), located slightly distal of lateral margin of ocular lobe. Lateral border convex dorsally near anterior, becoming flat and outward-sloping laterally, widens from anterior to genal angle where it is twice exsagittal length of L0. Anterior border severely reduced ahead of LA. Lateral border furrow distinct, rounded in cross section with nearly vertical outer margin, deeper near genal angle. Posterior border furrow shallow. Glabella constricted at S1, expanding anteriorly to middle of LA which is about one-fifth wider (tr.) than L0 (tr.); LA width one-half sagittal length of glabella. S3 very faint at axial furrow; L3 incorporated into LA which is over one-half total length (sag.) of glabella. Axial furrow shallower adjacent to L1 and L2. L2 slightly shorter (exsag.) than L1.