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Some Permian Gastropoda from Eastern Arizona

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INTRODUCTION

The present paper is a preliminary study of an interesting silicified fauna from beds that have elements similar to those of the Kaibab formation. The fauna was discovered several years ago by H. Wesley Peirce of the Arizona Bureau of Mines at Tucson and reported on by Brady (1962, p. 62). Brady reported this predominantly molluscan fauna from four localities in eastern Arizona (see Locality List below), thus extending the known range of the Kaibab (Alpha) fauna eastward. Knowledge of this fauna is important, because it is becoming increasingly apparent that this fauna and others equivalent to it are quite widespread in the southwestern United States.

Of the species found at these localities, the most abundant are *Goniasma geminocarinata* Chronic, 1952; *Bradyospira johnsensis*, new genus and new species; and *Meekospira sulcata*, new species. A.M.N.H. 1067 (south of St. Johns, Arizona) has yielded by far the most material. In comparing these collections with those from other Permian formations, we can note a high degree of similarity with the Kaibab (Alpha) formation and in particular that described by Chronic (1952) from Walnut Canyon, Arizona. The gastropods indicate essential time equivalence. The present report is preliminary and concerned with a description of the gastropods, and no at-

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tempt is made here to elucidate the very complex stratigraphic problems involved in the correlation of Kaibab units with those farther east. Chronic has suggested that the Kaibab (Alpha) might be correlated with the San Andres and Word Limestone No. 1. Confirmation of such correlation must await further investigations, but the gastropods tend to support her statements.

There are several differences between our collections and those of Chronic; for example, *Bradyospira johnsensis* is unknown in northern Arizona (or elsewhere in the Permian, for that matter). The bellerophonitids, *Euconospira*, and the naticopsids, which are generally very common in all facies of the Permian, are absent from the eastern Arizona area. In short, the fauna is not so varied as that in northern Arizona. There are morphological differences within the species, such as those discussed under *Goniasma geminocarinata*.

The American Museum collections were made by N. D. Newell and G. R. Adlington with the generous help of Major L. F. Brady who accompanied them for several days. Thanks are due also to the Museum of Northern Arizona, which put a vehicle at their disposal and made available other facilities and fossil collections.

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LOCALITY LIST

A.M.N.H. 1067: Kaibab-San Andres limestone, about 75 feet below Moenkopi red beds. Calcitic limestone just above 6-foot marly shale. Probably equivalent to upper Kaibab (Alpha?) SE. $\frac{1}{4}$, sect. 15, and SW. $\frac{1}{4}$, sect. 14, T. 12 N., R. 28 E. Cedar Mesa Anticline, Little Colorado River canyon, $4\frac{1}{2}$ miles south of St. Johns, Arizona.

M.N.A. HOG WASH: Six miles from Show Low on road to Heber, about 30 feet above the creek on the right side.

M.N.A. FAUGHT RIDGE: Two miles west of Faught Ridge Lookout, on both sides of the road near main road through Apache Indian Reservation south of Show Low.

M.N.A. ST. JOHNS: About 6 miles south of town in canyon of the Little Colorado, sects. 14, 15, T. 28 N., R. 12 E. (best exposure just below ruin of stone shack on rim of canyon).

ABBREVIATIONS

A.M.N.H., the American Museum of Natural History

CBS, distance between lower selenizone margin and first basal cord

H, height of each whorl

H(t), height of entire shell

M.N.A., Museum of Northern Arizona, Flagstaff

N, size of sample

SA, spiral angle, measured at sutures

SS, distance between the upper margin of the selenizone and the suture

SW, width of the selenizone

W, width of each whorl

W(t), maximum width of shell

\bar{x} , sample mean

SYSTEMATIC PALEONTOLOGY

SUPERFAMILY EUOMPHALACEA DEKONINCK, 1881

FAMILY EUOMPHALIDAE DEKONINCK, 1881

Straparollus (Euomphalus) kaibabensis Chronic, 1952

Figures 1-3

Euomphalus kaibabensis CHRONIC, 1952, p. 126, pl. 4, figs. 15-16c.

DISCUSSION: This species is represented by two specimens, both of which are very well preserved. They differ in several respects from the descriptions and measurements of Chronic (1952) and Yochelson (1956). The chief difference is the relative height which is greater in these specimens compared to the Kaibab specimens of Chronic and most of Yochelson's material which ranges in age from Leonard through the Word (and equivalent beds). There are some exceptions, notably specimens from Word Limestone No. 1. It is realized that with two specimens no definite conclusions can be reached. Only more material will show the true relationship of these forms to the type material. These two specimens tend to have stronger nodes than do the other forms, possibly partly owing to their excellent preservation.

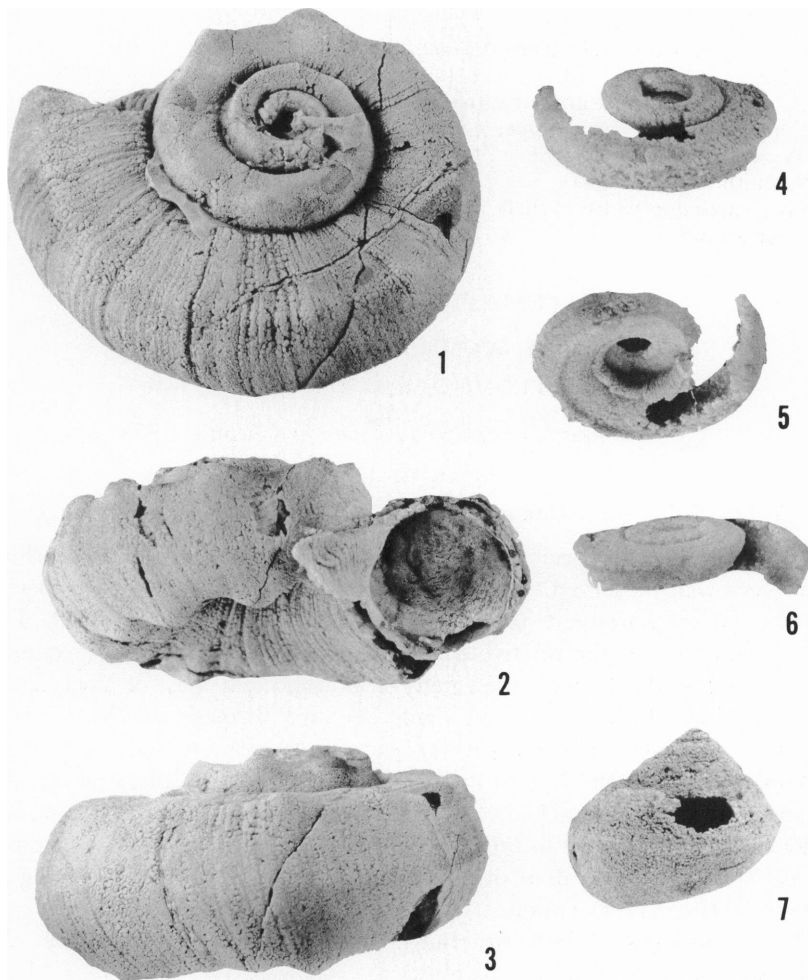
MEASUREMENTS: The width ranges from 27.5 mm. to 48.5 mm.; the height, from 15.5 mm. to 24.7 mm.

OCCURRENCE: M.N.A. Faught Ridge, two specimens.

Planotectus? sp.

Figures 4-6

DESCRIPTION: Discoidal shells with a rather sharp keel at the outer margin of the upper whorl surface. The upper whorl surface is apparently nearly flat and gently sloping to the suture. The outer whorl face is probably concave. There is a well-developed keel at the junction of the outer whorl face and the base. The base is slightly convex, especially near



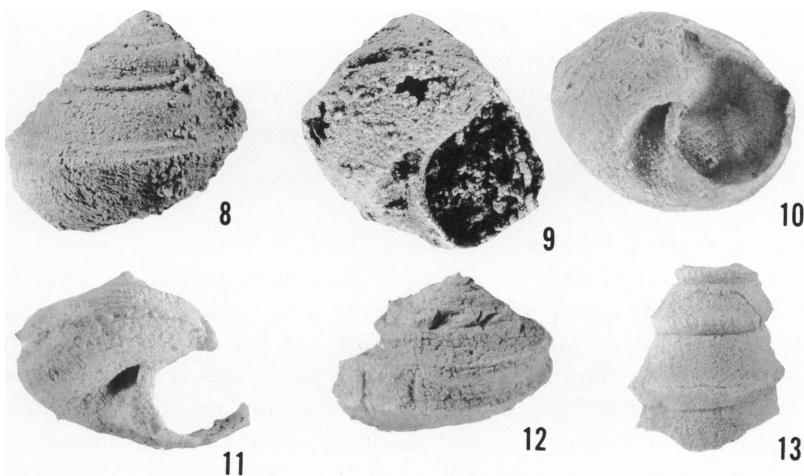
FIGS. 1-3. *Straparollus* (*Euomphalus*) *kaibabensis* Chronic, M.N.A. No. G27748. 1. Oblique top view. 2. Slightly oblique apertural view. 3. Side view. $\times 1.5$.

FIGS. 4-6. *Planotectus?* sp. A.M.N.H. No. 28357. 4. Oblique side view. 5. Oblique basal view. 6. Apertural view. $\times 3$.

FIG. 7. *Bradyospira johnsensis*, new genus and new species, M.N.A. No. G27749, paratype, side view. $\times 2$.

the umbilicus. The base is moderately phaneromphalous.

DISCUSSION: The specimens under consideration have all their outer shell layer removed, and absolute identification is impossible. Yochelson (1956, p. 214) has shown that there may be little relationship between the



FIGS. 8–10. *Bradyospira johnsensis*, new species. 8. Holotype, A.M.N.H. No. 28358, side view. 9. Holotype, A.M.N.H. No. 28358, oblique apertural view. 10. Paratype, A.M.N.H. No. 28359, oblique basal view. $\times 2$.

FIGS. 11, 12. *Glabrocingulum* (*Glabrocingulum*) *coronatum* Chronic, A.M.N.H. No. 28360. 11. Oblique basal view. 12. Side view. $\times 2$.

FIG. 13. *Goniasma geminocarinata* Chronic, A.M.N.H. No. 28361 /1, side view of broken specimen, showing noded selenizone and a fracture along the selenizone on the lowest whorl. $\times 2$.

surface of the outer whorl and the inner shell layer. Notwithstanding the above difficulties, these specimens do not fall within the range of any described genera of the Euomphalidae. The chief difference between species of *Straparollus* and this species is in the concave outer whorl face which tapers inward toward the base, the reverse of the condition found in *Straparollus*. *Planotectus* appears to be similar to these specimens in this characteristic, but has a rounded junction of the outer whorl face and the base. Another important difference is in the shape of the upper whorl surface between the two groups. In *Planotectus* the upper whorl face is convexo-concave and essentially horizontal, while in the St. Johns specimens this surface is flattened and slopes up to the suture, causing a higher-spired condition. *Planotectus* is known from a single species, *Planotectus cymbellatus* Yochelson, 1956, which ranges from the upper Leonard Formation through the middle Word Formation and equivalent beds. The material available for this study is too poor for the erection of a new category, so we must await better specimens.

MEASUREMENTS: The width ranges from 2.45 mm. to 3.37 mm.; the height, from 7.69 mm. to 11.06 mm.

SUPERFAMILY PLEUROTOMARIACEA SWAINSON, 1840

FAMILY EOTOMARIIDAE WENZ, 1938

SUBFAMILY EOTOMARIINAE WENZ, 1938

TRIBE PTYCHOMPHALIDES WENZ, 1938

BRADYOSPIRA, NEW GENUS

TYPE SPECIES: *Bradyospira johnsensis*, new species.

DESCRIPTION: Globose pleurotomarians with a peripheral selenizone at midwhorl. The early whorls are simple, with the selenizone beginning at the second or third whorl. The whorls are in contact just below the lower selenizone margin. The upper whorl face is convexo-concave down to the selenizone which is situated on a peripheral keel. The selenizone is concave, but not strongly so, and may have lunulae, and the margins are well developed. A weakly developed outer whorl face, beneath the selenizone, is concave and merges with the rounded base. The base is minutely phaneromphalous and has a very well-developed circum-umbilical ridge.

DISCUSSION: The genus is very distinct and thus far has not been observed from any other area in the world. *Pleurotomaria? carinifera* Girty, 1908, has a shell shape and selenizone position similar to those of this genus, but its preservation is too poor to be certain if it is related to *Bradyospira*. Chronic (1952) described *Pernotrochus arizonensis* as having a base quite similar to that of *Bradyospira* in possessing a circumumbilical ridge. However, *Bradyospira* is phaneromphalous, while *Pernotrochus* is not. In other characteristics, the two genera are quite distinct. The selenizone is wider, more strongly developed, and appears far earlier in *Bradyospira*. *Bradyospira* apparently has a deeper slit, indicated by the sharply swept-back growth lines as the selenizone is approached.

RANGE: Middle Permian.

Bradyospira johnsensis, new species

Figures 7-10

DESCRIPTION: Globose to trochiform shells, with about five whorls. The upper whorl face is gently convexo-concave to the selenizone or is strongly convex near the suture. Whorls embrace at or slightly below the lower selenizone margin. The spiral angle varies from about 88 degrees to 120 degrees. The upper whorl face has collabral ornament in the form of weakly developed threads, some specimens showing spiral threads as well. Both sets of ornament are relatively widely spaced. The peripheral keel is well developed and shows some variation in degree of develop-

ment. Just below the selenizone, the outer whorl face is strongly concave but rounds out until it merges with the base. The base shows no evidence of ornament. The height ranges from 10.50 mm. to 17.20 mm.; the width, from 11.82 mm. to 19.80 mm.

DISCUSSION: The preservation of all the specimens available is much too poor for the depth of the slit to be determined accurately or for identification of the type of ornament. Furthermore, nothing can be said about the parietal surface. The variation that can be observed is involved in the shape of the whorl surfaces both above and below the selenizone. In many cases there is a shortening of the whorl height and an exaggeration of the convexity and concavity of the upper whorl surface (see fig. 7). These appear to be due to pressure parallel to the axis, applied during diagenesis of the matrix. The variation in the degree of concavity of the selenizone appears to be independent of the secondary axial flattening described above.

OCCURRENCE: A.M.N.H. 1067, 49 specimens; M.N.A. Hog Wash, four specimens; M.N.A. Faught Ridge, three specimens.

TYPE MATERIAL: Holotype, A.M.N.H. No. 28358; figured paratypes, A.M.N.H. No. 28359, M.N.A. No. G27749.

TABLE 1
MEASUREMENTS (IN MILLIMETERS) OF *Bradyospira johnsensis*
FROM A.M.N.H. 1067

H(t)		W(t)	SA
	16.40	16.40	88°
	15.60	16.80	104°
	17.20	17.80	94°
	12.00	13.50	107°
	12.10	14.10	97°
	14.20	18.40	100°
	16.80	19.80	120°
	14.30	15.00	95°
	15.30	17.50	100°
	16.40	19.10	119°
	17.00	17.80	90°
	10.50	11.82	91°
	15.80	16.50	105°
	11.95	13.84	106°
	14.95	16.00	108°
	13.70	15.50	104°
N	16	16	16
\overline{x}	14.64	16.24	101.75°

TABLE 2
MEASUREMENTS (IN MILLIMETERS AND DEGREES) OF *Bradyospira johnsensis* FROM A.M.N.H.
1067 (A SMALL SAMPLE)

	Each Whorl					Whole Specimen		
	1	2	3	4	5	H	W	SA
H	0.48	0.673	1.44	2.93	5.19	17.00	17.80	90°
SW	—	—	—	—	0.96			
SS	—	—	—	—	3.56			
W	1.25	2.79	5.14	8.37	—			
H	0.19	0.48	0.72	1.73	3.46	10.50	11.82	91°
SW	—	—	0.14	0.24	0.39			
SS	—	—	0.43	1.15	2.69			
W	0.67	1.59	2.98	6.35	11.82			
H	0.14	0.29	1.49	2.69	5.38	15.80	16.50	105°
SW	—	—	0.19	0.39	0.67			
SS	—	—	1.06	2.50	4.13			
W	0.58	0.96	2.21	4.81	9.62			
H	0.43	0.91	2.07	4.04	—	11.95	13.84	106°
SW	—	0.14	0.24	0.38	—			
SS	—	0.58	1.63	3.08	—			
W	1.20	3.65	8.17	13.84	—			
H	0.38	0.43	1.20	2.36	4.42	14.95	16.00	108°
SW	—	0.14	0.24	0.34	0.67			
SS	—	0.19	0.67	1.68	3.46			
W	1.01	2.21	—	9.62	16.00			
H	0.19	0.38	1.44	2.40	4.33	13.70	15.50	104°
SW	—	—	0.19	0.29	0.58			
SS	—	—	0.96	2.07	3.46			
W	0.96	1.73	5.00	9.23	15.50			

TRIBE EOTOMARIIDES WENZ, 1938

Glabrocingulum (*Glabrocingulum*) *coronatum* Chronic, 1952

Figures 11, 12

Glabrocingulum? *coronatum* CHRONIC, 1952, p. 118, pl. 3, figs. 1–3A.

DISCUSSION: This is a highly distinctive species of *Glabrocingulum*, and the specimens from eastern Arizona fall well within the range of variation displayed within this group. I have compared the measurements of these specimens with the Kaibab (Alpha) fauna of Chronic and the Word (and Word equivalents) in New Mexico and Texas and find no significant difference in any of eight measurements. The details of ornament are almost identical with those seen in other populations. In the evolution of

TABLE 3
MEASUREMENTS (IN MILLIMETERS AND DEGREES) OF *Glabrocingulum* (*Glabrocingulum*)
coronatum FROM A.M.N.H. 1067

	Each Whorl						Whole Specimen		
	1	2	3	4	5	6	H	W	SA
H	—	—	—	—	—	—	8.13	9.97	103°
CBS	—	—	—	—	—	1.83			
SW	—	—	—	—	—	0.24			
SS	—	—	—	—	—	—			
W	—	—	—	—	—	9.97			
H	—	—	—	—	—	—	10.87	15.10	111°
CBS	—	—	—	—	—	2.12			
SW	—	—	—	—	—	—			
SS	—	—	—	—	—	—			
W	—	—	—	—	—	15.10			
H	0.144	0.29	0.58	1.11	1.92	—	7.50	9.04	103°
CBS	—	—	0.048	0.096	1.63	—			
SW	—	—	—	—	0.24	—			
SS	—	—	0.29	0.77	1.20	—			
W	0.77	1.35	2.50	4.86	9.04	—			
H	0.144	0.24	0.336	0.625	1.11	1.79	8.94±	10.10	105°
CBS	—	—	—	0.096	0.144	1.92			
SW	—	—	—	0.096	0.144	0.24			
SS	—	—	—	0.336	0.72	1.25			
W	0.336	0.82	1.44	2.74	5.38	10.10			
H	—	—	—	—	—	—	6.49	8.27	110°
CBS	—	—	—	—	—	1.73			
SW	—	—	—	—	—	0.336			
SS	—	—	—	—	—	—			
W	—	—	—	—	—	8.27			
H	—	—	—	—	—	—	7.40	9.13	112°
CBS	—	—	—	—	—	—			
SW	—	—	—	—	—	—			
SS	—	—	—	—	—	—			
W	—	—	—	—	—	9.13			

G. (G.) coronatum from the Texas Permian (where large numbers of specimens are known from Wolfcampian through mid-Guadalupian), there is a tendency for the base to become flattened and then finally rounded. In addition, there is a trend for a gradual increase in the height of the shell. Other trends can be found in the group. In a comparison of characters in the evolution of the group, the flattened base and relatively low height of the eastern Arizona specimens indicate that they would fall within the range of the Word No. 1 stage of development. Another point is that *G.*

(*G.*) *coronatum* is relatively rare below the Word No. 1 Limestone.

OCCURRENCE: A.M.N.H. 1067, eight specimens; M.N.A. Faught Ridge, three specimens; and M.N.A. Hog Wash, one specimen.

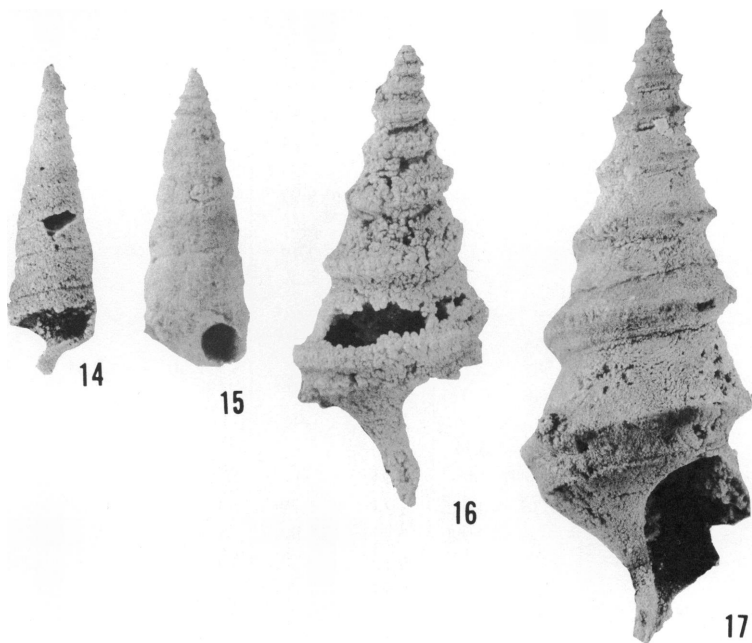


FIG. 14. *Orthonema* sp., Meek and Worthen, A.M.N.H. No. 28362, side view. $\times 3$.

FIG. 15. Genus and species indeterminate, A.M.N.H. No. 28363. Note angulate early whorls and flattened ephoebic whorls. $\times 3$.

FIGS. 16, 17. *Goniasma geminocarinata* Chronic. 16. A.M.N.H. No. 28361 /1:2, apertural view, showing a flat selenizone without nodes on the nine whorls preserved. $\times 3$. 17. A.M.N.H. No. 28361 /1:3, apertural view, showing canal. $\times 1/5$.

SUPERFAMILY CERITHIACEA FLEMING, 1822

FAMILY TURRITELLIDAE WOODWARD, 1851

Orthonema sp. Meek and Worthen, 1862

Figure 14

DISCUSSION: The principal characteristic for the recognition of genera within the family Turritellidae is the configuration of the growth lines. Whorl shapes and over-all shell shapes are generally considered to be specific characters. The specimens available for study are so badly pre-

served that the growth lines have been completely destroyed. The general appearance of the forms is that of *Orthonema*. No more can be done with them.

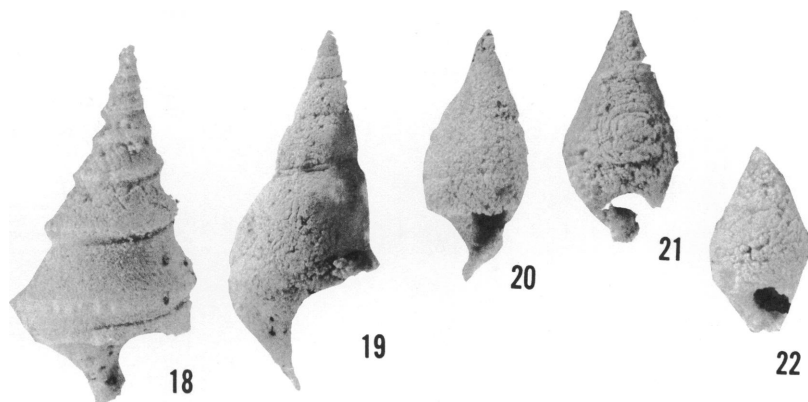


FIG. 18. *Goniasma geminocarinata* Chronic, A.M.N.H. No. 28361 /1:4, side view, showing well-developed nodes on the selenizone after the fifth whorl. $\times 2$.

FIG. 19. *Girtytspira* sp., A.M.N.H. No. 28366, apertural view of broken specimen. Note high spire and inflated whorls compared to the specimens of *Meekospira sulcata*. $\times 3$.

FIGS. 20–22. *Meekospira sulcata*, new species. 20. Holotype, A.M.N.H. No. 28364, apertural view. 21. Paratype, A.M.N.H. No. 28365 /1, apertural view. 22. Paratype, A.M.N.H. No. 28365 /2, apertural view. $\times 3$.

OCCURRENCE: A.M.N.H. 1067, nine specimens; and M.N.A. Faught Ridge, two specimens.

Genus and species indeterminate

Figure 15

DESCRIPTION: The first five to six of the 11 whorls have flat, steeply sloping outer whorl faces, culminating at the periphery in an angulation, beneath which is the next whorl. The angulation may be nodose, but poor preservation makes it impossible to be sure. This type of whorl shape is very similar to the type of variation seen in such species as *Stegocoelia* (*Taosia*) *crenulata* Girty, 1939. The next whorl under these early ones loses its angulation, and the upper whorl surface occupies most of the whorl and is somewhat convex. All other whorls are turreted and conspiral. The whorls are convex and very similar to those of some species of *Stegocoelia*, *sensu stricto*.

TABLE 4
MEASUREMENTS (IN MILLIMETERS AND DEGREES) OF *Goniasma geminicarinata* FROM A.M.N.H. 1067

	1	2	3	4	5	Each Whorl		7	8	9	10	11	Whole Specimen SA
H	—	—	1.25	1.75	2.21	3.37	4.81	—	—	—	—	—	34°
CBS	—	—	0.67	0.82	1.15	2.21	2.60	—	—	—	—	—	
SW	—	—	—	—	—	—	—	—	—	—	—	—	
SS	—	—	—	—	—	—	—	—	—	—	—	—	
W	—	—	2.95	4.38	5.87	8.08	9.42	—	—	—	—	—	31°
H	—	0.96	1.01	1.54	2.12	3.13	3.75	5.10	—	—	—	—	
CBS	—	—	—	—	—	—	0.63	0.96	—	—	—	—	
SW	—	—	—	—	—	0.38	0.48	0.48	—	—	—	—	
SS	—	—	—	0.67	1.06	1.54	2.12	3.37	—	—	—	—	32°
W	—	1.92	2.60	3.56	4.38	6.25	8.75	12.01	—	—	—	—	
H	0.63	1.11	1.30	1.92	2.40	3.46	4.81	—	—	—	—	—	
CBS	—	—	—	0.29	0.38	0.58	1.06	—	—	—	—	—	
SW	—	—	—	0.24	0.29	0.38	0.38	—	—	—	—	—	42°
SS	—	—	0.58	1.15	1.44	2.21	2.88	—	—	—	—	—	
W	—	2.21	2.98	4.33	6.15	7.88	10.77	—	—	—	—	—	
H	0.67	0.96	1.25	1.79	2.55	4.04	6.06	8.75	—	—	—	—	
CBS	—	—	0.19	0.29	0.29	0.53	0.96	0.96	—	—	—	—	26°
SW	—	—	0.24	0.24	0.29	0.38	0.62	0.77	—	—	—	—	
SS	—	—	0.96	0.96	1.73	2.98	4.90	6.54	—	—	—	—	
W	1.49	2.31	3.27	4.81	7.26	10.29	14.90	18.32	—	—	—	—	
H	0.67	0.77	1.06	1.25	2.02	2.98	3.56	4.52	5.96	8.65	10.77	10.77	26°
CBS	—	—	—	0.34	0.48	0.86	1.06	1.06	1.15	1.63	2.21	2.21	
SW	—	—	—	0.19	0.29	0.38	0.62	0.67	0.87	1.15	1.15	1.15	
SS	—	—	—	0.58	0.96	1.44	1.73	2.50	3.85	5.67	6.73	6.73	

TABLE 4—(Continued)

Each Whorl											Whole Specimen SA	
1	2	3	4	5	6	7	8	9	10	11		
W	1.15	1.54	2.21	3.08	4.42	5.82	7.60	10.50	14.40	19.40	24.10	34°
H	—	0.77	0.96	1.44	1.79	2.60	3.65	—	—	—	—	
CBS	—	—	0.19	0.29	0.29	0.48	0.67	—	—	—	—	
SW	—	—	0.19	0.29	0.29	0.34	0.48	—	—	—	—	
SS	—	—	0.48	0.77	1.06	1.73	2.40	—	—	—	—	
W	—	—	2.60	3.75	5.00	6.35	9.23	—	—	—	—	34°
H	—	0.77	0.96	1.35	1.79	2.40	3.65	—	—	—	—	
CBS	—	—	—	—	—	0.77	1.25	—	—	—	—	
SW	—	—	—	—	—	—	0.29	—	—	—	—	
SS	—	—	—	0.48	0.77	1.44	1.92	—	—	—	—	
W	—	1.54	2.12	2.88	4.23	5.96	7.88	—	—	—	—	31°
H	0.38	0.58	0.67	0.96	1.35	1.73	2.60	3.37	—	—	—	
CBS	—	—	—	—	—	—	—	—	—	—	—	
SW	—	—	—	—	—	—	—	—	—	—	—	
SS	—	—	—	0.38	0.67	0.86	1.59	2.12	—	—	—	
W	—	—	—	—	—	—	—	—	—	—	—	26°
H	—	0.96	1.25	1.63	2.21	3.08	3.94	5.29	—	—	—	
CBS	—	—	—	—	0.29	0.58	0.58	0.77	—	—	—	
SW	—	—	—	—	0.29	0.38	0.48	0.77	—	—	—	
SS	—	—	—	0.77	1.35	2.02	2.60	3.75	—	—	—	
W	—	1.92	2.50	3.46	4.62	5.96	7.98	10.60	—	—	—	32°
H	0.34	0.48	0.77	1.11	1.39	1.83	3.61	—	—	—	—	
CBS	—	—	—	—	0.38	0.48	0.67	—	—	—	—	
SW	—	—	—	—	0.34	0.48	0.48	—	—	—	—	
SS	—	—	—	—	1.06	1.44	2.31	—	—	—	—	
W	1.11	1.54	2.16	2.88	4.13	5.96	8.37	—	—	—	—	

DISCUSSION: Unfortunately no growth lines are preserved on the single specimen in the collection. Therefore, we can say nothing of its proper position within the family or of its relation to other genera. No other described form is even remotely similar to it.

OCCURRENCE: A.M.N.H. 1067, one specimen.

SUPERFAMILY MURCHISONIACEA KOKEN, 1896

FAMILY MURCHISONIIDAE KOKEN, 1896

Goniasma geminocarinata (Chronic), 1952

Figures 16–18

Murchisonia geminocarinata CHRONIC, 1952, p. 123, pl. 4, figs. 12–14.

DESCRIPTION: This species consists of high-spined forms with the selenizone low on the whorl, except in the early whorls where it is situated more nearly in the center. The upper whorl surface is either flat or concave. The selenizone is apparently concave or flat and is situated between two well-developed carinae. After the fourth to sixth whorl, strong elongated nodes form across the width of the selenizone and give it a convex appearance (see fig. 18). The alveozone (the concave area just under the selenizone) is well developed and lightly ornamented by spiral threads. The ornament on the upper whorl surface consists primarily of spiral threads, but there may be very light collabral elements as well. The nodes on the selenizone tend to be rather massive. The selenizone is developed after the first whorl.

DISCUSSION: Owing to the poor state of preservation of this material, the morphology cannot be critically examined. The reason for my transferring this species from *Murchisonia*, where Chronic placed it, to *Goniasma* is that the St. Johns specimens have the lower lip of the aperture preserved, so that the development of a siphonal canal can be seen (see fig. 17). Other characters more closely associated with those found in *Goniasma* are: the placement of the selenizone on the periphery; the ornamentation on the selenizone; the more flattened selenizone; and the over-all shape of the whorls. The St. Johns specimens differ from the Chronic specimens in that they are larger, the spiral angles appear to be somewhat greater (on an average of 32° against 24°), and the relative development of the selenizone nodes appears to be greater. This last difference may be due to the over-all larger size of the St. Johns specimens.

One of the more important observations made by Chronic is that the nodes on the selenizone in this species are ephoebic and do not appear until after the formation of the fourth to sixth whorl, which is true also of the St. Johns material, except for one specimen on which up to the ninth

and final whorl there is no evidence of nodding (see fig. 16).

OCCURRENCE: A.M.N.H. 1067, 62 specimens; M.N.H. St. Johns, six specimens; M.N.A. Hog Wash, three specimens; M.N.A. Faught Ridge, one specimen.

***Meekospira? sulcata*, new species**

Figures 20–22

DESCRIPTION: Fusiform specimens with flattened, regular shell shapes and with constant, rather tight coiling. The body whorl occupies about two-thirds of the shell. The whorls are very smooth, and no ornament has been observed. The aperture has a well-developed anterior siphonal notch.

DISCUSSION: This group would fall within the range of *Girtyspira?* sp. of Chronic. It is clearly within the species range of *Meekospira*, since it is without a ramp, one of the chief characteristics of *Girtyspira* Knight, 1936. The presence of an anterior siphonal notch in this species requires some caution in taxonomic interpretation. The Meekospiridae lack both internal columellar folds and an anterior siphonal notch. Careful study of the internal characteristics of this group shows that there is no columellar folding. Therefore it cannot certainly be assigned either to the Meekospiridae or to the next closest group, the Soleniscidae. Since *Girtyspira* was separated from *Meekospira* on the basis of a ramp on the final whorl, I cannot justify placement within that group. There are no published species of Permian age that are similar to *M.? sulcata*.

TYPE MATERIAL: Holotype, A.M.N.H. No. 28364; figured paratypes, A.M.N.H. Nos. 28365 /1, 28365 /2; all from A.M.N.H. 1067.

OCCURRENCE: A.M.N.H. 1067, 48 specimens; M.N.A. St. Johns, seven specimens; and M.N.A. Hog Wash, three specimens.

MEASUREMENTS (OF HOLOTYPE): Height, 11.15 mm.; width, 4.76 mm.; spiral angle, 45 degrees.

Girtyspira sp.

Figure 19

DESCRIPTION: Large subulate to fusiform specimens, with inflated whorls and a weakly developed ramp. The body whorl occupies about one-half of the shell. No ornament is present on the whorls. The aperture has a weakly developed, anterior, siphonal notch. The shell profile suggests that the rate of axial lengthening is not uniform.

DISCUSSION: This group appears far closer to *Girtyspira* than to *Meekospira sulcata*, because of the inflated whorls and more weakly formed siphonal notch. On the basis of the pleural angle, the general shape of the

shell, and the dimensions, these specimens seem very close to the illustrations of Chronic of *Meekospira?* sp. 1.

MEASUREMENTS: Spiral angle, 33 degrees; height, 23.86 mm.; width, (of largest specimen), 10.14 mm.

OCCURRENCE: A.M.N.H. 1067, three specimens.

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