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PALEONTOLOGY.—*Notes on Permian rhynchonellids.* Francis G. Stehli, California Institute of Technology, Pasadena, Calif.[1] (Communicated by David H. Dunkle.)

Attention has frequently been called to the intensive diversification of Jurassic rhynchonellids. Cooper and Williams (1952, p. 330) have pointed out, however, that this expansion is in part an artifact of the literature resulting from the contrast between the intensive splitting of Jurassic forms and a more conservative treatment of those of the Triassic. These investigators have also noted that the rhynchonellid deployment actually began at least as early as the Triassic. This observation is readily confirmed by a survey of literature on Triassic brachiopods, for it indicates the presence of a large number of still unrecognized rhynchonellid genera. The Mesozoic expansion may have resulted from reduced competition concomitant with the termination or severe reduction of many brachiopod lines at the close of the Paleozoic. Such a condition would have favored the rapid expansion of pre-adapted rhynchonellid phyla. Whether or not this was the case, the late Paleozoic, and particularly Permian rhynchonellid faunas, are of unusual significance for here are to be found the stocks ancestral to the Mesozoic diversification.

Rhynchonellids are not common in the Permian of North America. They are, however, more diverse than the present literature indicates. Recent collecting in the Wordian rocks of the Guadalupe Mountains, Tex., has revealed the presence of several new forms and allows increased detail in our knowledge of some previously described forms. Because of the unusual evolutionary interest attaching to Permian rhynchonellids, those forms represented by sufficiently abundant and perfect material are described below.

All the specimens studied are siliceous replacements prepared by acid etching of material collected in the upper part of the lower Getaway member of the Cherry Canyon formation. The collections were made near Pine Springs Camp, Tex., between U. S. Highway 62 and the Pasotex pipeline road on the west side of a road leading from U. S. 62 to the Airways Station.

[1] Publications of the Division of the Geological Sciences, California Institute of Technology, Pasadena, California. Contribution No. 702.

The best silicified material was found on the ridge crest south of the middle gully of a group of three running east-west and draining into the water course parallel to the road. All the easily accessible worthwhile material has been collected. The etched faunas are housed at the American Museum of Natural History in New York City, the United States National Museum in Washington, D. C., and at the California Institute of Technology, Pasadena, Calif.

The deposits from which the fossils were collected appear to represent a detrital fan adjacent to a small reef, though the latter has been largely removed by erosion. Some specimens are in position of growth, but much of the material is detrital. The locality is remarkable for the diversity of its fauna. Invertebrate groups represented in the approximate order of abundance are Brachiopoda, Fusulinidae, Bryozoa, Porifera, Gastropoda, Pelecypoda, Echinoidea, Tetracoralla, Crinoidea, Ammonoidea, Nautiloidea, Trilobita, Amphineura, and Scaphopoda. The rhynchonellid brachiopods are found largely in the detrital material about the reef, but occur sparingly in blocks in which much of the material is in position of growth.

The material here described and figured is housed in the paleontological collections of the American Museum of Natural History in New York City.

Superfamily RHYNCHONELLACEA Schuchert, 1896

? Family Camarotoechidae Schuchert, 1929

Genus **Fascicosta**[2] Stehli, n. gen.

Genotype.—*Rhynchonella ? longaeva* Girty.

Diagnosis.—Small impunctate uniplicate incipiently fascicostate Permian rhynchonellids ornamented with fine concentric lines; foramen small, subapical; deltidial plates large; pedicle interior with dental plates; brachial interior with hinge plate undivided and supported by a broad median ridge or low septum; teeth and sockets denticulate.

Range.—Wordian to Capitanian.

Discussion.—The incipiently fasciostate ribbing of this genus is very unusual for a rhynchonellid. Insofar as the writer is aware it is approached among upper Paleozoic members of the group only by *Allorhynchus ramosum* Bell from the Windsor group of Nova Scotia in which there is bifurcation of the costae. The form described by Bittner (1890, p. 192) as *Rhynchonellina juvavica* from the Triassic deposits in the Alps also exhibits fasciocostation but bears a divided hinge plate and is thus generically distinct.

The strong denticulation of the hinge teeth and sockets is not unusual in Permian rhynchonellids and has been noted in several genera by Cloud (1944, p. 55). Extensive and detailed studies will be necessary to determine its presence or absence in other genera and its taxonomic significance.

[2] Lat. *fascis*, bundle; Lat. *costa*, rib.

Fascicosta longaeva (Girty)

Figs. 1–17

Rhynchonella ? longaeva Girty, U. S. Geol. Surv. Prof. Pap. 58: 322–323, pl. 15, figs. 18–19. 1909.

Material.—This species is represented by two complete specimens, AMNH 27904:1 and AMNH 27904:2. In addition there are seven pedicle and four brachial valves, all of which are more or less complete, which collectively bear the designation AMNH 27904.

Diagnosis.—Small subpentagonal rhynchonelliform shells. Pedicle valve slightly convex; sulcus well developed, beginning near midlength and containing 2 to 4 costae on the floor of the valve, while each lateral margin usually bears a smaller one; beak long, little incurved; foramen small, subapical, limited by large conjunct deltidial plates. Brachial valve strongly convex; fold low with 3 to 5 costae on top and a smaller one at each side. Each valve ornamented with 15 to 25 fine high rounded costae extending to the beak and increasing toward the front by bifurcation and implantation; the entire shell surface bearing fine concentric lines.

Pedicle interior with small dental plates; position of the muscle insertions indeterminable. Brachial interior with a raised undivided hinge plate separated from the lateral shell walls by deep denticulate sockets; hinge plate bearing posteriorly a slight depression which received the diductor muscles; hinge plate supported by a low broad ridge or rarely by a low but well developed septum; crura not observed; anterior adductor scars depressed, elongate, located at either side of the ridge or septum near its anterior end; posterior adductor scars raised, located posterior to the other pair and anterolaterally directed.

Measurements in millimeters of two specimens are as follows:

Length	9.8	10.2
Width	10.2	11.2
Thickness	6.9	7.8

Range.—I have found this species in the lower part of the Getaway member of the Cherry Canyon formation. It has been reported by Girty (1909, p. 323) from the Capitan limestone on Capitan Peak and from several somewhat questionable localities in the vicinity. It is unknown outside the Guadalupe Mountains.

Discussion.—In his original description of the species Girty (1909, p. 322) expressed doubt as to its exact generic placement. He placed it questionably with *Rhynchonella*. It is so distinctive as to deserve a position as the genotype and only known species of a new genus.

Fascicosta longaeva (Girty)

Fig. 1.—Pedicle exterior showing fascicostation and prolongation of costae onto the umbo. AMNH 27904:1 (×2). Fig. 2.—Pedicle exterior showing increase of costae by bifurcation. AMNH. 27904:2 (×2). Fig. 3.—Exterior of brachial valve showing the fine concentric ornamentation characteristic of the species. AMNH 27904:1 (×7). Fig. 4.—Brachial exterior showing increase of costae by implantation and the extension of costation onto the umbo. AMNH 27904:1 (×2). Fig. 5.—Brachial exterior showing extension of costae onto the umbo and the small pedicle foramen and large deltidial plates of the pedicle beak. AMNH 27904:2 (×2). Fig. 6.—Brachial interior showing the reflection of the external ornamentation and also the undivided hinge plate. AMNH 27904:3 (×2). Fig. 7.—Profile showing the strong convexity of the brachial valve and the lesser convexity of the pedicle valve. AMNH 27904:1 (×2). Fig. 8.—Posterior showing extension of costation onto the umbo, pedicle valve slightly broken. AMNH 27904:2 (×2). Fig. 9.—Posterior view showing the increase anteriorly of the costae. AMNH 27904:1 (×2). Fig. 10.—Anterior showing irregular lamination of the valves near the front and the nature of the fold and sulcus. AMNH 27904:2 (×2). Fig. 11.—Profile showing unequal convexity of the two valves. AMNH 27904:2 (×2). Fig. 12.—Anterior showing irregular laminae and the nature of the fold and sulcus. AMNH 27904:1 (×2). Fig. 13.—Pedicle interior showing hinge teeth and dental plates and unusual plate partly shutting off the rostral cavity. AMNH 27904:4 (×2). Fig. 14.—Brachial interior of a specimen with a small median septum, showing the undivided hinge plate. AMNH 27904:7 (×2). Fig. 15.—Hinge plate showing denticulation of dental socket. AMNH 27904:6 (×5). Fig. 16.—Pedicle interior showing the small pedicle foramen and large deltidial plates and the adductor and diductor muscle scars. AMNH 27904:4 (×2). Fig. 17.—Brachial interior of a specimen without a median septum showing the undivided hinge plate and depressed posterior adductor scars and raised anterior adductor scars. AMNH. 27904:5 (×2).

Allorhynchus ? permianus Stehli, n. sp.

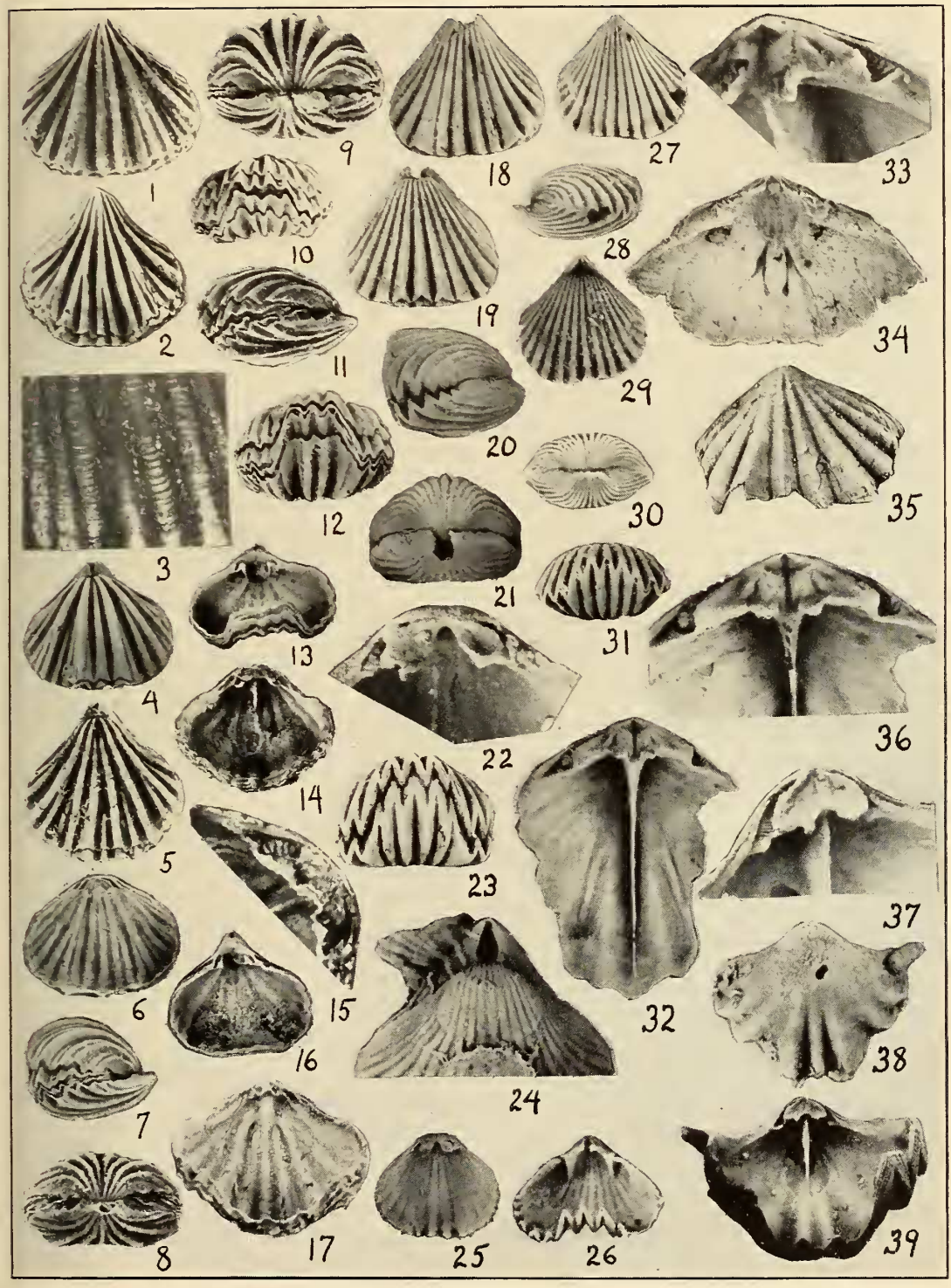
Fig. 18.—Pedicle exterior of a specimen with the pedicle beak missing but paucicostate ornamentation evident. AMNH 27905:1 (×2). Fig. 19.—Brachial exterior showing paucicostate ornamentation. AMNH 27905:1 (×2). Fig. 20.—Profile of specimen with the pedicle beak missing and the two valves gaping slightly. AMNH 27905:1 (×2). Fig. 21.—Posterior showing the extension of paucicostation onto the umbo. AMNH 27905:1 (×2). Fig. 22.—Hinge plate showing its divided nature and at the left the teeth in the denticulate hinge socket. AMNH 27905:2 (×7). Fig. 23.—Anterior view showing the nature of the fold and sulcus. AMNH 27905:1 (×2). Fig. 24.—Umbo of the brachial valve and underside of the beak of the pedicle valve showing the large pedicle foramen and the very small deltidial plates, which fail to close above the brachial valve. AMNH 27905:3 (×5). Fig. 25.—Brachial interior showing the divided hinge plate and the internal reflection of costation. AMNH 27905:2 (×2). Fig. 26.—Pedicle interior showing the well developed dental plates. AMNH 27905:4 (×2). Fig. 27.—Pedicle exterior showing paucicostate ornamentation extending onto the umbo. The holotype, AMNH 27905:5 (x2). Fig. 28.—Profile showing the unequal convexity of the valves. The holotype AMNH 27905:5 (×2). Fig. 29.—Brachial exterior showing paucicostate ornament and the large almost unrestricted pedicle foramen. The holotype AMNH 27905:5 (×2). Fig. 30.—Posterior view showing extension of costation onto the umbones. The holotype AMNH 27905:5 (×2). Fig. 31.—Anterior view showing the nature of the fold and sulcus. The holotype AMNH 27905:5 (×2).

Leiorhynchoidea cloudi Cooper

Fig. 32.—Brachial interior showing hinge plate and median septum as well as adductor muscle scars. AMNH 27906:3 (×2). Fig. 33.—Hinge plate and dental socket showing denticulation. AMNH 27906:1 (×5). Fig. 34.—Interior of beak region of the pedicle valve showing the central raised adductor scars, the depressed diductor scars and in the rostral cavity the tracks and scars of the median pedicle muscles. Note also the absolescence of dental plates. AMNH 27906:2 (×2). Fig. 35.—Pedicle exterior showing the strong paucicostate ornamentation and its obsolescence at the umbo. AMNH 27906:4 (×1). Fig. 36.—Detail of the hinge region of the brachial valve showing the medial trough, the median septum, the insertions of the brachial pedicle muscles and the special triangular insertions of the diductor muscles. AMNH 27906:3 (×5).

Wellerella ? sp.

Fig. 37.—Hinge plate and dental socket showing fine denticulation. AMNH 27907:1 (×5). Fig. 38.—Brachial interior showing entire hinge plate, and strong median septum. The floor of the valve shows the adductor scars. AMNH 27907:1 (×2). Fig. 39.—Exterior of brachial valve showing the relatively few costae and their obsolescence on the umbo. AMNH 27907:1 (×2).



Figs. 1–39.—(See opposite page for explanation).

Genus **Allorhynchus** Weller, 1910

Discussion.—Means for distinguishing this genus from other Mississipian rhynchonellids have been pointed out by Weller (1914, p. 197). There are few known Pennsylvanian or Permian genera with which *Allorhynchus* might be confused. It most nearly approaches *Terebratuloidea* from which it is distinguished by the presence of dental plates. It bears some resemblance to *Uncinunellina ? pulchra* Cooper from the middle Permian of Sonora, Mexico, but differs in the absence of concentric surface ornament and a brachial median septum.

Allorhynchus ? permianus Stehli, n. sp.
Figs. 18–31

Material.—This species is known from 15 more or less complete specimens and from 9 brachial and 11 pedicle valves.

Holotype, AMNH 27905:5. Paratypes, AMNH 27905.

Diagnosis.—Small subpentagonal rhynchonelliform shells. Pedicle valve slightly convex; sulcus shallow, arising near midlength and containing 3 through 4 costae; lateral slopes bearing 5 through 8 costae; beak long, not incurved; delthyrium mostly open, deltidial plates reduced to small triangular projections which may or may not meet above the brachial beak. Brachial valve moderately convex; fold generally low with 4 through 5 costae; beak short and hidden beneath that of the other valves. Both valves paucicostate with 15 to 20 fine angular costae extending to the beak; no other surface ornamentation is present.

Pedicle interior with dental plates and large flat topped denticulate hinge teeth; position of muscle insertions uncertain. Brachial interior with a deeply divided hinge plate; median septum absent; crura long and recurved; sockets denticulate; position of muscle insertions uncertain.

Measurements in millimeters of seven specimens are as follows:

Length	9.1	11.2	10.6	11.0	11.4	9.3	8.4
Width	10.3	11.3	10.7	11.3	10.9	9.5	7.6
Thickness	6.8	7.0	6.6	8.4	5.7	5.6	5.5

Range:—Lower Getaway member of the Cherry Canyon formation (Wordian).

Discussion:—The generic reference of this species is made with some reservations for *Allorhynchus* is unknown in the Pennsylvanian, and in addition there are noteworthy differences between *A. ? permianus* and Mississippian species placed in the genus. Among these is the absence in *A. ? permianus* of concentric striae on the shell surface and the presence of well developed dental plates and strong hinge teeth. In addition, some details of the morphology of the genotype are unknown and make comparison difficult. It is unknown, for instance, whether or not the teeth and sockets of *A. heteropsis* are denticulate. Should they prove not to be, *A. ? permianus* represents a new genus.

MORPHOLOGY OF OTHER PERMIAN RHYNCHONELLIDS

Leiorhynchoidea cloudi was described by Cooper (1953, p. 44) from the middle Permian of Sonora, Mexico. Additional material is present in the Getaway member of the Cherry Canyon formation in the Guadalupe Mountains, and though largely fragmentary shows excellent detail. The sockets in Cooper's material did not show denticulation, but it is clearly present in the material at hand. Its absence in the Mexican specimens is probably due to poor preservation. Cooper noted that the dental plates were greatly reduced in his specimens. In the Guadalupe Mountains specimens they are united in adults with the wall of the rostral cavity. In addition to the muscle scars noted by Cloud (1944, p. 57) in *Leiorhynchoidea*, Guadalupe Mountains material shows in the rostral cavity the pair of small median pedicle muscle scars characteristic of modern rhynchonellids.

The examination of a large number of specimens of various rhynchonellid species currently assigned to *Wellerella* and taken from various Permian horizons has shown that the teeth and sockets are denticulate. Insofar as I am aware, the nature of the teeth and sockets has not been ascertained for the genotype, *W. tetrahedra*, and the question deserves further study in the interests of achievement of a natural classification.

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