EARLY PERMIAN FUSULINIDS FROM MACUSANI, SOUTHERN PERU

by CHARLES A. ROSS

ABSTRACT. *Triticites patulus* Dunbar and Newell and *Schwagerina adamsi* sp. nov. from the early Wolfcampian (Permian) part of the Copacabana Group near Macusani, southern Peru, show morphological features that add new data concerning the evolution of the genera *Schwagerina* and *Pseudoschwagerina* from lineages arising within the genus *Triticites* near the close of the Pennsylvanian.

ONE of the greatest diversification of species within the family Fusulinidae took place in the latest part of the Pennsylvanian and the earliest part of the Permian. The two species described here are from the southern part of Peru and represent part of this diverse fusulinid fauna. *Triticites patulus* Dunbar and Newell is a member of one of the lineages within the genus *Triticites* that evolved during this time and *Schwagerina adamsi* sp. nov. is an early species of the genus *Schwagerina* which became abundant and widespread during the Wolfcampian and early part of the Leonardian Epochs of the Permian. The two species occur in a single block of light-grey limestone (biomicrosparite) from a bed of the Copacabana Group at the summit of the highest hill, 1 kilometre north-west of Macusani, Carabaya Province, Department of Puno, in southern Peru (text-fig. 1). The material was collected by Dr. A. J. Charig in June 1959.

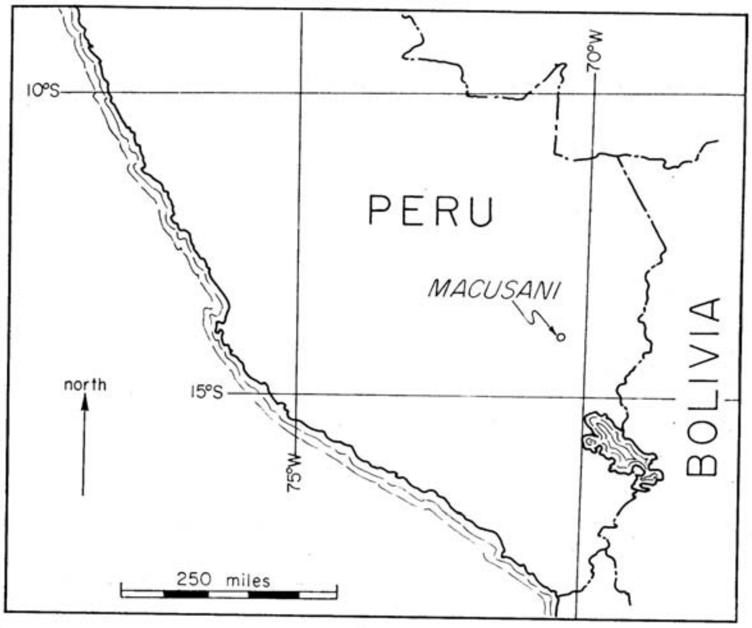
Triticites patulus was described by Dunbar and Newell (1946) and Roberts (*in* Newell, Chronic, and Roberts 1953) from the Copacabana Group in southern Peru and western Bolivia. In its internal features *T. patulus* shows a striking divergence from the larger species of late Pennsylvanian and early Permian *Triticites* in having high chambers in which the lower half of the septa are strongly folded and the upper half are nearly planar, and in having true chomata in the first two or three volutions which gradually pass into pseudochomata and into other secondary deposits in later volutions. In most features *T. patulus* bridges the morphological gaps between the genus *Triticites* and early species of *Pseudoschwagerina* such as *P. beedei* Dunbar and Skinner (1937).

Schwagerina adamsi sp. nov. belongs to an early lineage of species of *Schwagerina* that are small in size, including *S. campa* Thompson (1954), *S. turki* (Skinner) (1931), *S. jewetti* Thompson (1954), and *S. emaciata* (Beede) (1916). It has low, inconspicuous chomata in its early volutions which pass into pseudochomata that thicken the base of the septa near the tunnel in later volutions. The pseudochomata pass into secondary deposits which fill the septal folds adjacent to the tunnel in the later volutions.

The evolution of the genus *Pseudoschwagerina* has been discussed in its broader aspects by Ross (1962). The species of *Pseudoschwagerina* that are found in Peru and Bolivia are part of the early history of the genus and their probable phylogenetic

[Palaeontology, Vol. 5, Part 4, 1962, pp. 817–23, pl. 119.]

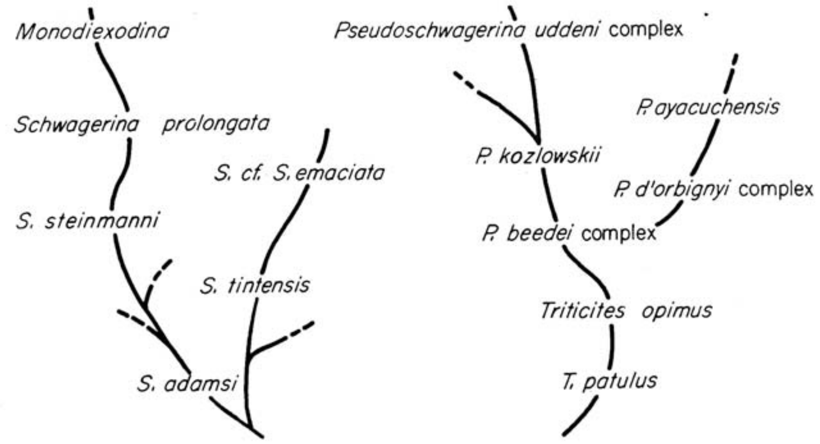
relations are indicated in text-fig. 2. *Triticites patulus* is apparently ancestral to *T. opimus* Dunbar and Newell, which has inflated chambers and strong septal folds in its outer volutions. Most of the morphological features of *T. opimus* would suggest its assignment to the genus *Pseudoschwagerina*; however, the species has low chomata extending into the outer volutions, a diagnostic feature of *Triticites*.



TEXT-FIG. 1. Map of the southern part of Peru showing the location of Macusani.

The *Pseudoschwagerina beebei* complex apparently evolved from *T. opimus*; it retained the strong chomata in the juvenarium, but lost the chomata in the inflated volutions. *P. kozlowskii* Dunbar and Newell is typical of this complex in having the upper part of the septa nearly planar and the lower part folded into narrow projections that have a semicircular cross-section. The *P. uddeni* complex appears to have evolved from the *P. beedei* complex by greatly increasing the height of its inflated chambers to give the test a subglobose shape. In the *P. d'orbignyi* complex further reduction of the chomata even in the juvenarium suggests that it was an offshoot from the *P. beedei* complex (text-fig. 2). Because the members of the *P. d'orbignyi* complex retain strong septal folds throughout their volutions, as in *Triticites opimus*, this complex probably arose shortly after the differentiation of the *P. beedei* complex. *P. ayacuchensis* Roberts is an advanced species in the *P. d'orbignyi* complex, in which there is a particularly sharp change from the juvenarium into the inflated volutions.

Schwagerina adamsi is apparently an early representative of a lineage in which the tests gradually became more elongate and evolved to form such species as *S. steinmanni* Dunbar and Newell and *S. prolongata* (Berry). *S. prolongata* is a transitional species connecting this lineage with *Monodiexodina*, which has well-developed cuniculi (openings at the points of contact of the septal folds of adjacent septa). Another related lineage consists of *S. tintensis* Roberts and *Schwagerina* cf. *S. emaciata* (Beede) (text-fig. 2).



TEXT-FIG. 2. Phylogeny of two lineages of early Permian fusulinids from southern Peru and Bolivia.

The stratigraphic ranges of many of these species apparently overlap and text-fig. 2 shows only their inferred phylogenetic relations. The stages of evolution of the two species, *Triticites patulus* and *Schwagerina adamsi*, and the reported association of *T. patulus* with *Pseudoschwagerina* elsewhere in the region by Dunbar and Newell (1946, pp. 400–1) and Newell, Chronic, and Roberts (1953, p. 24) suggest that this rock sample from near Macusani is from strata equivalent in age to the early Wolfcampian Neal Ranch Formation in the Glass Mountains, Texas (Ross 1959).

Acknowledgements. It is a pleasure to thank Dr. Charles G. Adams, British Museum (Natural History), who located and kindly loaned the collection for this study. I am also indebted to Dr. June Phillips Ross, Illinois State Geological Survey, for helpful discussions and suggestions on some of the philosophical problems during the preparation of this paper.

Repositories. The illustrated material and most of the rock sample are housed in the British Museum (Natural History). Additional thin sections and a part of the rock sample are deposited in the U.S. National Museum.

SYSTEMATIC DESCRIPTIONS

Genus TRITICITES Girty 1904

Triticites patulus Dunbar and Skinner

Plate 119, figs. 11–17

1946 *Triticites patulus*; Dunbar and Newell, p. 478, pl. 10, figs. 1–10.
1933 *Fusulina peruana* Berry [non Meyer], p. 269, pl. 22, figs. 4, 8, 9, 12.

Description. This species has thickly fusiform tests with bluntly rounded poles that reach 6 to 6·5 mm. in length and 2·5 mm. in diameter in five to six volutions. The proloculi are 0·15 to 0·25 mm. in diameter and the first 1½ volutions are low and thickly fusiform. Succeeding volutions increase markedly in height and length maintaining the general thickly fusiform shape of the test. The chambers are high and are loosely coiled about the axis (Pl. 119, figs. 11, 14, 15).

The wall is composed of a tectum and keriotheca clearly displaying alveoli (Pl. 119, fig. 15). It thins gradually from the midplane of the test to the poles. The septa are thin and are strongly folded only along their lower half, the upper half being nearly planar (Pl. 119, figs. 11–15). Chomata are conspicuous in the first two volutions and pseudochomata and secondary filling of the septal folds adjacent to the tunnel are common in the succeeding volutions (Pl. 119, figs. 15, 17).

Remarks. The rapid expansion of the chambers, the thick secondary deposits adjacent to the tunnel forming the pseudochomata, and the mode of septal folding separate *Triticites patulus* from most other species of this genus. The lineage of *Triticites* including *T. meeki* (Möller) and *T. ventricosus* (Meek and Hayden) have more elongate tests with much less strongly folded septa and lower chambers. *T. californicus* Thompson and Hazzard has heavier and more persistent chomata throughout its subglobose test.

Occurrence. Dunbar and Newell (1946) found *Triticites patulus* in many of their collections from Bolivia and Peru in the Lake Titicaca region, where it is commonly associated with *Pseudoschwagerina* and *Schwagerina*. The specimens illustrated here are from the Copacabana Group, bed at top of hill, 1 kilometre north-west of Macusani, Peru.

EXPLANATION OF PLATE 119

Figs. 1–10, *Schwagerina adamsi* sp. nov., Copacabana Group, 1 kilometre north-west of Macusani, Peru. 1, 2, Axial sections of holotype, ×10 and ×20, B.M.(N.H.) P42647. 3, 4, 5, 8, Axial sections, B.M.(N.H.) P42648, P42649, P42650, and P42651, ×10. 6, 9, Sagittal sections, B.M.(N.H.) P42652, P42653, ×10. 7, 10, Tangential sections showing nearly planar septa in the upper part of the chambers and closely folded septa in the lower part, B.M.(N.H.) P42660, P42661, ×10.

Figs. 11–17, *Triticites patulus* Dunbar and Skinner, Copacabana Group, 1 kilometre north-west of Macusani, Peru. 11, Axial section, B.M.(N.H.) P42654, ×10. 12, 13, Tangential sections showing the thick secondary deposits on the septa near the tunnel that form chomata and pseudochomata, B.M.(N.H.) P42655, P42656, ×10. 14, 15, Axial sections showing dense infilling of the septal loops near the tunnel to form chomata and pseudochomata, B.M.(N.H.) P42657, ×10 and ×20. 16, Axial section of an aberrant specimen, B.M.(N.H.) P42658, ×10. 17, Sagittal section showing marked variation in the chomata and pseudochomata, B.M.(N.H.) P42659, ×10.

Measurements of *Triticites patulus* B.M.(N.H.) specimens

	Volution	P42654	P42657	P42659	No. of septa
Radius vector (mm.)	0	0·08	0·09	0·09	
	1	0·17	0·15	0·20	
	2	0·30	0·25	0·35	
	3	0·55	0·40	0·55	
	4	0·85	0·75	0·80	
	5	..	1·10	1·20	
Half-length (mm.)	1	0·30	0·30		12
	2	0·70	0·55		16
	3	1·20	0·90		21
	4	1·60	1·50		27
	5	..	2·50		22
Form ratio	1	1·8	2·0		
	2	2·3	2·2		
	3	2·1	2·2		
	4	1·9	2·0		
	5	..	2·3		
Wall thickness (mm.)	0	0·02	0·02		
	1	0·03	0·02		
	2	0·03	0·03		
	3	0·04	0·03		
	4	0·06	0·06		
	5	..	0·08		
Tunnel angle (°)	1	20	25		
	2	20	25		
	3	15	25		
	4	20	35		
	5	..	..		

Genus SCHWAGERINA Möller 1877 (emend. Dunbar and Skinner 1936)

Schwagerina adamsi sp. nov.

Plate 119, figs. 1–10

Description. This species has small, elongate fusiform tests of 5 to $5\frac{1}{2}$ volutions that reach 5·5 to 6·5 mm. in length and 1·5 to 2·0 mm. in diameter. The proloculi are about 0·10 to 0·20 mm. in diameter and the first volution is subglobose in outline. Succeeding volutions rapidly increase in length along the axis of coiling, giving the test a progressively elongated shape (Pl. 119, fig. 2).

The wall is formed of a tectum and a thick keriotheca clearly displaying alveoli (Pl. 119, fig. 2). The thickness of the wall gradually increases from 0·01 mm. in the proloculus to 0·07 mm. in the fifth volution. The septa are folded into regularly spaced septal folds that reach nearly to the top of the chambers (Pl. 119, figs. 1–5, 7, 10).

Chomata are small and inconspicuous in the first one to two volutions and grade into pseudochomata in later volutions. Secondary deposits commonly fill the septal folds adjacent to the tunnel (Pl. 119, fig. 2). Axial deposits heavily coat the septa in the polar regions of the volutions.

Measurements of *Schwagerina adamsi* B.M.(N.H.) specimens

	Volution	P42647	P42648	P42650	P42649	P42653
Radius vector (mm.)	0	0·07	?	0·12	0·07	0·07
	1	0·20	0·15	0·20	0·15	0·15
	2	0·25	0·25	0·25	0·25	0·25
	3	0·40	0·35	0·40	0·35	0·35
	4	0·55	0·50	0·60	0·50	0·50
	5	0·80	0·70	0·85	0·70	0·70
	6	..	1·00	..	1·00	..
Half-length (mm.)	1	0·30	0·15	0·25	0·20	No. of septa: 9
	2	0·55	0·55	0·55	0·35	18
	3	0·90	0·80	0·90	0·70	23
	4	1·80	1·55	1·60	1·30	25
	5	2·90	2·50	2·70	2·20	23
	6	..	3·40	..	3·00	..
Form ratio	1	1·5	1·0	1·2	1·3	
	2	2·2	2·2	2·2	1·4	
	3	2·2	2·3	2·2	2·0	
	4	3·3	3·1	2·7	2·6	
	5	3·6	3·6	3·2	3·1	
	6	..	3·4	..	3·0	
Wall thickness (mm.)	0	0·01	?	0·01	0·01	
	1	0·02	0·02	0·02	0·01	
	2	0·02	0·03	0·03	0·02	
	3	0·03	0·04	0·04	0·03	
	4	0·04	0·06	0·06	0·03	
	5	0·08	0·08	0·07	0·05	
	6	..	0·10	..	0·08	
Tunnel angle (°)	1	20	35	25	25	
	2	35	40	30	25	
	3	50	35	30	25	
	4	50	40	30	30	
	5	50	..	40	35	
	6	..	..	..	..	

Remarks. *Schwagerina adamsi* is similar to a number of species of *Schwagerina* having a small size and rudimentary or inconspicuous chomata in their early volutions. *S. campa* Thompson (1954) lacks prominent secondary deposits; *S. jewetti* Thompson (1954) has higher septal folds that have steeper sides and it has higher chambers; *S. emaciata* (Beede) (1916) has more pointed poles and irregularly folded septa; and *S. turki* (Skinner) (1931) is larger and has irregularly folded septa. *Dunbarinella mantaroensis* Roberts is less slender and *S. steinmanni* Dunbar and Newell is much larger and lacks the prominent secondary deposits.

This species is named after Dr. C. G. Adams, Department of Zoology, British Museum (Natural History).

Occurrence. Copacabana Group, bed at top of hill, 1 kilometre north-west of Macusani, Peru. Holotype B.M.(N.H.) P42647, shown in Pl. 119, figs. 1, 2.

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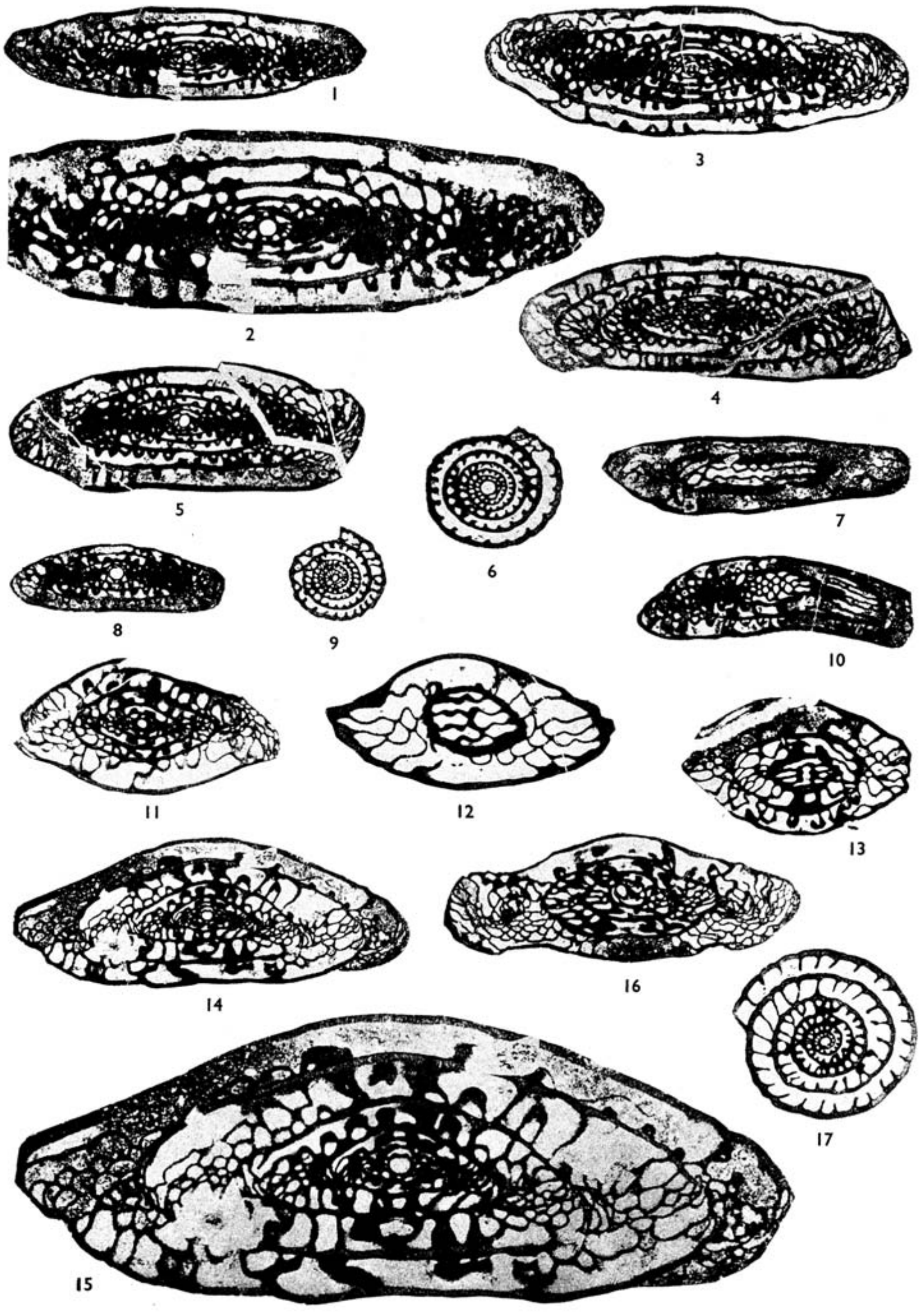
Manuscript received 6 February 1962



ROSS, Permian fusulinids from Peru