Two new Rhynchonellid (Brachiopod) species from the Frasnian Shetienchiao (I) Formation of central Hunan, China

by Paul SARTENAER and XU Han-kui

Abstract

Two new species, one of them the type species of a new genus, *Parvaitissimarostrum*, are described from the Frasnian Shetienchiao Formation of central Hunan Province, China. *Navalicria rectangularis* n.sp. of middle-late Frasnian age is found in the highest part of the middle member and in the lower part of the upper member of the formation, and is associated with other brachiopods. *Parvaitissimarostrum minimum* n.gen., n.sp. of late Frasnian age derives from the upper member of the same formation, which contains also numerous corals and other brachiopods.

Key-words: rhynchonellids – brachiopods – Devonian – Hunan – systematics – stratigraphy

Introduction

The Shetienchiao Formation is the only formation recognized in the Frasnian of the central part of Hunan Province. Many of its rhynchonellids, and, more generally, of its brachiopods, have not been described so far or are in need of reassessment. Much work is needed. It is only by defining clear and restricted biostratigraphical units based on brachiopods that correlation will prove to be possible with similar subdivisions of the Frasnian Stage in various other parts of the world.

This paper represents a contribution to the collective endeavour undertaken in this direction.

*Navalicria rectangularis* n.sp.

(Plate 1, Figures 1-10; Text-figure 1)

REMARKS

The fine radial striation observed in the new species is a character that must be added to the definition of the genus *Navalicria* SARTENAER, 1989; recrystallization of the shell is the plausible explanation for the absence of this striation on the numerous specimens of the type species, *N. compacta* SARTENAER, 1989. The new species also indicates that the front margin described as unipli cate, and exceptionally parasulcate, when the genus was established, may also be sulciplicate.

SYNONYMY


DERIVATIO NOMINIS

*Rectangularis*, is, e (Latin, adjective) = rectangular. The name has been chosen to draw attention to the characteristic shape of the shell.

TYPES

The figured and measured type specimens are deposited in the Nanjing Institute of Geology and Palaeontology. Holotype, 110731 (Pl. 1, Figs. 1-5); Paratypes A, 110732 (Pl. 1, Figs. 6-10), B, 112784, C, 112785, D,
112799 (Text-fig. 1). Marl and calcareous mudstones in the top of the middle member of the Shetienchiao Formation of Frasnian age in the Tianmashan section, Xinhua County, central part of Hunan Province, China, loc. ADS-781. Collector: XU Han-kui, 1977.

Plaster casts of the types have been made and are deposited in the Royal Institute of Natural Sciences of Belgium in Brussels under the number I.G.27714. A plaster cast of paratype D was made before grinding and is joined to the remainder of the specimen.

LOCUS TYPICUS
Tianmashan, 27°80'N, 111°20'E, Xinhua County, central part of Hunan Province, China.

STRATUM TYPICUM
Twenty metres of marls and calcareous mudstones in the central part of Hunan Province. Eight specimens, including six specimens from the upper member of the Shetienchiao Formation) than the seven specimens higher (ADS-792, in the lower part of the upper member of the Shetienchiao Formation) are in a satisfactory state of preservation; the remainder are fragmentary.

DIAGNOSTIC CHARACTERS
Transversely subrectangular to subquadratic. Ventral flanks tending to become flat to slightly concave in their postero-lateral parts. Almost constant number of well marked costae.

DESCRIPTION
General external characters
Medium sized. Thick-set, but never inflated. Inequivalve, the thickness of the pedicle valve being about one third the thickness of the shell. Front margin sulciplicate, exceptionally uniplicate or parasulcate. Transversely subrectangular to subquadratic in ventral and dorsal views, with rounded angles and lateral borders shaped as parentheses; as these parentheses seldom correspond to each other, the contour of the shell is generally asymmetrical. In cardinal view, contour of shell is a half-ellipse in longitudinal and transverse median sections. Postero-lateral parts of flanks tend to become flat, and are even exceptionally slightly concave; therefore, the ventral umbonal region stands out clearly, although it is not particularly inflated. Elsewhere, with the exception of the apical region, flanks slope gently. Well marked sulcus, clearly separated from the flanks, wide at front, beginning more or less imperceptibly at about one third the length of the shell. Sulcus is moderately deep, rarely deep. Bottom of sulcus divided into two concave parts by a median swelling (costa). Sulcus widens rapidly, and reaches its greatest width (60 to 66% of the width of the shell) at the junction of the frontal and lateral commissures. In its anterior part the sulcus passes to the flanks through hog-backed edges. Tongue trapezoidal, moderately high to high with sharp borders, standing out clearly. The top of the tongue is clearly depressed by the furrow separating the two lobes (costae) of the fold. Crest of tongue tends to become vertical; its median swelling (costa) extends sometimes beyond the borders of the tongue, which are commonly recurved posteriorly. Beak small, wide, slightly incurved, sometimes overhanging the cardinal line, but seldom in contact with the dorsal umbonal region. Beak resorbed by a small circular foramen. Interarea ill-defined, composed of two "lunules" separated from the flanks by blunt beak ridges, which fade out rapidly laterally. Short deltidial plates observed in transverse serial sections.

Brachial valve
Moderately high, rarely high. Curve of the valve is one quarter of an ellipse in longitudinal median sections, and a dome in transverse median sections; the dome is deformed by the fold. Greatest thickness reached in the anterior half of the shell; from this point the valve curves gently toward the commissure. Slope of flanks generally abrupt. Well marked fold, clearly separated from the flanks, moderately high, wide at front, beginning more or less abruptly at some distance from the beak.

Ornament
Of the ten specimens on which costae could be counted, nine have 2/1, and one has 3/2, median costae. Neither parietal nor lateral costae have been observed. Fold of two wide, moderately high (sometimes high), subequal

Fig. 1. - Navalicria rectangularis n.sp. Camera lucida drawings of serial transverse sections; figures are distances in mm of the section forward of the crest of the ventral umbo. Paratype D, 112799. Measurements: 1 = 23.1 mm; w = (26.8) mm; t = 17.7 mm.
lobes (costae) separated by a wide and deep furrow corresponding to a moderately high swelling (costa) in the sulcus; in the specimen with 3/2 median costae, one lobe of the fold is divided by a narrow and shallow furrow to which corresponds an intercalated costa in the sulcus. Costae start about on a level with sulcus and fold. A faint radial striation is present as observed in three specimens, including the holotype.

**Comparisons**

Navalicia rectangularis n.sp. may be distinguished from *N. compacta* SARTENAER, 1989 by the following external features: somewhat smaller thickness of the brachial valve; frontal margin commonly sulciplicate; transverse contour, in ventral and dorsal views, almost exclusively subrectangular, and more systematically asymmetrical; dorsal umbonal region generally tangential to a vertical plane, and extending only exceptionally beyond the pedicle beak; ventral flanks tending to become flat, and even exceptionally slightly concave, in their postero-lateral parts; sulcus and fold usually better marked in their posterior part and starting commonly nearer to the beaks; well marked median lobes and median swelling (costae), and furrows; tongue always trapezoidal; crest of tongue exceptionally tangential to a vertical plane; ventral beak rarely in contact with the dorsal umbonal region; generally moderately high brachial valve; curve of the brachial valve less variable in longitudinal median sections; less variable number of costae; length of shell relatively larger as indicated by the l/w and t/l ratios. See Remarks (above, p. 123) for the fine radial striation.

**Dimensions**

Measurements of four specimens:

<table>
<thead>
<tr>
<th></th>
<th>Paratype C</th>
<th>Paratype A</th>
<th>Holotype</th>
<th>Paratype B</th>
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<tbody>
<tr>
<td>l</td>
<td>23.8</td>
<td>21.5</td>
<td>20.6</td>
<td></td>
</tr>
<tr>
<td>w</td>
<td>28.3</td>
<td>26.8</td>
<td>25.7</td>
<td>(25.5)</td>
</tr>
<tr>
<td>tpv unrolled</td>
<td>36</td>
<td>31.5</td>
<td>31</td>
<td>?</td>
</tr>
<tr>
<td>t</td>
<td>19.7</td>
<td>17.3</td>
<td>17.2</td>
<td>(17.6)</td>
</tr>
<tr>
<td>tpv</td>
<td>7.5</td>
<td>5.7</td>
<td>4.9</td>
<td>4.8</td>
</tr>
<tr>
<td>tbv</td>
<td>12.2</td>
<td>11.6</td>
<td>12.3</td>
<td>(12.8)</td>
</tr>
<tr>
<td>t/w</td>
<td>0.84</td>
<td>0.8</td>
<td>0.8</td>
<td>?</td>
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<tr>
<td>t/l</td>
<td>0.70</td>
<td>0.65</td>
<td>0.67</td>
<td>0.69</td>
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<tr>
<td>apical angle</td>
<td>141°</td>
<td>(150°)</td>
<td>160°</td>
<td>143°</td>
</tr>
<tr>
<td>angle of the</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cardinal</td>
<td>152°</td>
<td>?</td>
<td>165°</td>
<td>149°</td>
</tr>
<tr>
<td>commissure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The abbreviations used are: l = length; w = width; t = thickness; pv = pedicle valve; bv = brachial valve. Measurements shown in parentheses indicate a reasonable estimate of a damaged specimen.

The first column refers to the largest specimen at our disposal. Highest part of pedicle valve is located between 28 and 33% of the length of the shell. Greatest thickness of the shell is located in the anterior part of the shell at a variable point posterior to the frontal commissure; from this point the brachial valve curves gently toward this commissure. Width is always the largest dimension. Maximum width of shell occurs at a point between 46 and 53% of the length of the shell anterior to the ventral beak. The apical angle varies from 140° to 160°, and the angle of the cardinal commissure from 148° to 165°.

**Internal characters**

The following internal characters of the genus are easily observed in transverse serial sections: shell thick in the apical region; dental plates thick to very thick maintained as stout spurs anteriorly; reduced umbonal cavities; strong and short teeth; well developed denticula; closely joined valves; blade-shaped septum, thin except in its posterior part; short divided hinge plate; low to moderately deep crural trough; inconspicuous crural bases; long crura remaining close to each other.

**Comparisons**

*Navalicia rectangularis* n.sp. may be distinguished from *N. compacta* SARTENAER, 1989 by the following external...
ta (Hinde, 1879), Polygnathus webbi Stauffer, 1938, P. aequisus Klapper & Lane, 1985, P. pacificus Savage & Funai, 1980, etc. Unfortunately, the exact position of the beds in which samples have been taken is not known.

In the Qiziqiao section (see Text-fig. 3, p. 94 in Yu & al., 1990), which is described below, Navalicria rectangula n.s.p. is also found in the upper part of the middle member of the Shetenchiao Formation. In view of the lack of precision of these preliminary data it is useful to note the stratigraphical distribution of Navalicria compactsa Sartenaer, 1989, the type species of the genus Navalicria Sartenaer, 1989: i.e. in the Ancyronagnostus triangularis Zone and, possibly, according to not yet substantiated information found in the literature, the Lower and Upper Palmaolepis gigas Zones.

Parvalissimarostrum n.gen.

DERIVATIO NOMINIS
Parvus, a, um (Latin, adjective) = small; altissimus, a, um = adjective in the superlative of altus, a, um (Latin) = high; rostrum (Latin, neuter) = beak. The name has been chosen to draw attention to the small size and to the thickness of the shell.

TYPE SPECIES
Parvalissimarostrum minimum n.gen., n.sp.

SPECIES ATTRIBUTED TO THE GENUS
Only the type species is attributed to the genus.

DIAGNOSIS

DESCRIPTION
Shell very small with irregular hexahedral shape. Acuminate. Strongly inequivalve, the brachial valve being five to eleven times — generally six to ten times — thicker than the pedicle valve. Frontal margin uniplicate. Subpentagonal in ventral view, the pentagon being irregular and more or less transversely stretched. Generally lateral sides of pentagon are convex and asymmetrical, base is slightly to strongly concave, and angles rounded, with the exception of the top angle; otherwise the ventral beak is less projecting, and the top angle is also rounded. In dorsal view the dorsal umbalonal region modifies this contour in a pentagonal-elliptical shape. Contour of shell like a Celtic helmet in cardinal view. Dorsal umbalonal region mostly projected posteriorly, otherwise tangential to a vertical plane. Sometimes the dorsal umbalonal region extends beyond the ventral beak, sometimes not. Commissure sharp. At the lateral commissures, which are located very low in the shell, flanks join at an angle higher than 90°. Postero-lateral margins concave near the commissure. Cardinal line nearly straight.

Very shallow pedicle valve. Sulcus and tongue cannot be differentiated — we consider henceforth the whole as the tongue — and excavate the anterior half of the valve. The other half is the flanks and the umbalonal region, which, together, have the shape of a boomerang in ventral view; when the tongue starts nearer to the beak, flanks are shaped like the wings of flies. From the pronounced umbalonal region, flanks slope first abruptly, and then gently, towards the lateral commissures and, sometimes, become flat or even slightly concave near these commissures; in the cardinal region flanks slope always abruptly towards the cardinal commissure where the valve becomes concave. Prominent tongue starting imperceptibly at some distance from the beak, widening and deepening rapidly and strongly; tongue very wide at front. Antero-dorsal end of tongue at the front margin tends to narrow to a sharply acuminate — generally ogival — crest, which is the highest point of the valve. Crest of tongue tends to become vertical or is recurved posteriorly. The sharp borders of the tongue are always recurved posteriorly, but, sometimes, the curve is modified in its upper half. Tongue moderately deep to deep. Bottom of tongue generally concave, sometimes flat at front. Beak small, stout, straight or nearly straight or suberect. Wide and high interarea with beak ridges only clearly marked in the beak area. Discrete narrow deltoidal plates. Foram-en large and rounded.

Brachial valve very high and acuminate, highest point at anterior commissure in median line. From the umbalonal region, which is sometimes tangential to a vertical plane, and sometimes projected posteriorly, the valve rises abruptly, in median longitudinal sections, to the highest point at anterior commissure; in many specimens there is an inflexion at a point variably located — it may be near the frontal commissure — between the umbalonal region and the frontal commissure. Very high acuminate fold rising up abruptly well above the flanks and wide at front. Fold starts imperceptibly in the umbalonal region at some distance from the beak, and is then separated from the lateral slopes of the shell by a slight but clear deflection. Flanks are less steep than the sides of the fold and become concave postero-laterally. Top of fold angular to angular-rounded. Most shells are costate. Few simple, wide, very low angular to angular-rounded costae. Only the costa or the two costae at the crest of the fold and of the tongue can be considered median with certainty, while the others must be described as parietal on account of the acuminate shape of both fold and tongue; in the present case
this distinction is however arbitrary, and, therefore, all
costae on fold and tongue are considered as median.
Commissure is indented by the costae, but the indenta-
tion of the external median costae and of the lateral
costae is slight; it is even exceptionally absent for the
latter. The most external median costa exceptionally
does not indent the commissure as is often the case with
the most internal of the two most internal lateral costae;
these costae are called adventitious. In some rare cases
lateral costae are so weak that they give the impression
of close-set, flattened costellae. Median costae, with
the exception of the central or the two central ones, are
asymmetrical. External median, and lateral costae, are
sometimes so evanescent that they are almost indiscerni-able. The external lateral costa is generally a mere inden-
tation of the commissure. Median costae and internal
lateral costae start posterior to mid-unrolled length of
valves in the specimens in which they have been best
observed.

Width is the greatest dimension, and length the small-
est. Thickness is only exceptionally close to width.
Greatest width forward of mid-length. Top of shell at
frontal commissure, where the extremity of the central
costa(e) is sometimes slightly deflected towards the com-
missure. The borders of the tongue being always recurv-
ed posteriorly, the top of the shell is located at a point
posterior to the frontal extremity of the shell. Wide
apical angle and angle of the cardinal commissure.

Robust internal structures for a very small and delicate
genus. Dental plates divergent to subparallel posteriorly,
becoming slightly convergent anteriorly; they are widely
spaced and support the teeth to plane of articulation.
Umboval cavities wide. Teeth widely spaced, short, wide
and very stout, entering more or less perpendicularly into
the dental sockets in transverse serial sections. Well
marked denticula. Long and lamellar septum supporting
a deep and more or less narrow septalium, and becoming
marked denticula. Long and lamellar septum, supporting
a deep and more or less narrow septalium, and becoming
attached from the septalial plates very near to the beak.
Short and stout outer hinge plates characteristically slop-
ing towards each other. Anterior part of septalium covered
by delicate inner hinge plates which can become contiguous or even overlap without ever merging to form a
connectivum. Short and wide dental sockets. Crural
bases result from the progressive shortening of the outer
hinge plates. Short delicate crura becoming not much
apart anteriorly, and slightly curved at distal ends; they
are roughly subtriangular in transverse serial sections.

COMPARISONS
The following characteristic features, considered separa-
ately or combined, make it easy to distinguish the new
genus from genera, which, by their external shape, are
close to it or somewhat similar such as Ladogioides
McLaren, 1961 of late Givetian-early Frasnian age,
Ladogia Nalivkin, 1941 of early Frasnian age, Coelote-
rorhynchus Sartenaer, 1966 of middle-late Frasnian
age, Cavatisinarostrum Sartenaer, 1972 and Zilimia
Nalivkin, 1947 of early Famennian age, and Physetor-
hynchia Sartenaer & Rozman, 1968 of middle-late
Famennian age: very small size, lack of fine radial
striation, length of costae, long and lamellar septum,
narrow and deep septalium covered in its anterior part
by delicate inner hinge plates which may become contig-
uous or even overlap.

Parvaltissimarostrum minimum n.gen., n.sp.  
(Plate 1, Figures 11-40; Text-figure 2)

SYNONYMY
1983 Ladogia sp. – Xu & Liu in Yu et al., p. 270;
1987 Ladogia sp. – Liu, p. 465;
1990 Ladogia sp. – Xu & Liu in Yu et al., text-fig. 3, p. 94, p. 96.

DERIVATIO NOMINIS

Minimus, a, um = adjective in the superlative of parvus,
a, um (Latin) = small. The name has been chosen to
draw attention to the very small size of the species.

TYPES
The figured and measured type specimens are deposited
in the Nanjing Institute of Geology and Palaeontology.
Holotype, 112786 (Pl. 1, Figs. 11-15); Paratypes A,
B, 112787 (Pl. 1, Figs. 16-20), B, 112788 (Pl. 1, Figs. 21-
25), C, 112789 (Pl. 1, Figs. 26-30), D, 112790 (Pl. 1,
Figs. 31-35), E, 112791 (Pl. 1, Figs. 36-40), F, 112792,
G, 112793, H, 112794, I, 112795, J, 112796 (Text-
fig. 2A), K, 112797 (Text-fig. 2B), L, 112798 (Text-
fig. 2C). Thin-bedded limestone, nodular limestone,
marls and calcareous mudstones of the upper member of
the Shetienchiao Formation of Frasnian age in the Qizi-
qiao section, Xiangxiang County, central part of Hunan
Province, China, loc.ADS-855. Collector: Xu Han-kui,
1977.

Plaster casts of these primary types have been made
and are deposited in the Royal Institute of Natural
Sciences of Belgium in Brussels under the number
I.G.27712.

Plaster casts of paratypes J and L were made before
grinding and are joined to the remainder of the speci-
mens.

Fig. 2. – Parvaltissimarostrum minimum n.gen., n.sp. Camera lucida drawings of serial transverse sections; figures are distances
in mm of the section forward of the crest of the ventral umbo.
A, Paratype J, 112796; measurements: 1 = 6.8 mm; w = 9.3 mm; t = 7.4 mm;
B, Paratype K, 112797; measurements: 1 = 7 mm; w = 9 mm; t = 7.9 mm;
C, Paratype L, 112798; measurements: 1 = 6.7 mm; w = 9.3 mm; t = 8.5 mm.
LOCUS TYPICUS
Qiziqiao, 27°75′N, 112°20′E, Xiangxiang County, central part of Hunan Province, China.

STRATUM TYPICUM

MATERIAL. STATE OF PRESERVATION
One hundred and twelve specimens. In the locus typicus one specimen has been collected just below (ADS-854) and one just above (ADS-856) the stratum typicum, from which one hundred and five specimens derive. Five specimens have been collected in the Shetienchiao Formation in the Shetianqiao section (HC 26-16), also in the central part of Hunan Province. Fifty seven specimens are in good state of preservation, twenty nine in satisfactory state of preservation, twelve in poor state of preservation. Fourteen specimens are fragmental.

DESCRIPTION
As for the genus. Additional details are as follows. In 83% of the specimens, lateral sides of the pentagon, in ventral view, are convex and asymmetrical, base is slightly to strongly concave, and angles rounded with the exception of the top angle; in the other specimens, i.e. 17%, the ventral beak is less projecting, and the top angle is also rounded. Dorsal umbonal region projected posteriorly in 66%, and tangential to a vertical plane in 34% of specimens. In half the specimens – this obviously includes specimens with dorsal umbonal region tangential to a vertical plane – the dorsal umbonal region does not extend beyond the pedicle beak; it does in the other half. In a quarter of the specimens the ventral flanks become flat or even slightly concave near the lateral commissures. Tongue starts at a point from the beak between 29 and 48% of the length of the shell – most values are between 35 and 42% – or around 20% of the unrolled length of the valve. Width of tongue at front is between 70 and 90% of the width of the shell. Antero-dorsal end of tongue at the front margin is an equilateral ogive in 23% of the specimens, an obtuse ogive in 70% of the specimens, and spatula-shaped in 7% of the specimens. Crest of tongue tends to become vertical in 38% of the specimens, and is recurved posteriorly in 62% of the specimens. The curve of the borders of the tongue, which are always recurved posteriorly, is modified in its upper part in 15% of the specimens. Bottom of tongue generally concave at front, but flat in 15% of the specimens. Ventral interarea 38 to 45% the width of the shell. In half the specimens there is an inflexion of the brachial valve, in median longitudinal sections, between the umbonal region and the frontal commissure.

The general costal formula is $\frac{4}{3} - \frac{7}{6} - \frac{0}{4} - \frac{3}{6} - \frac{6}{5} - \frac{5}{4}$. The ratios of the median (+ parietal) and lateral costae are distributed as follows:

<table>
<thead>
<tr>
<th>Median (and parietal)</th>
<th>Lateral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults only</td>
<td>Adults + juveniles</td>
</tr>
<tr>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>2/1</td>
<td>1</td>
</tr>
<tr>
<td>3/2</td>
<td>1</td>
</tr>
<tr>
<td>4/3</td>
<td>8</td>
</tr>
<tr>
<td>5/4</td>
<td>11</td>
</tr>
<tr>
<td>6/5</td>
<td>13</td>
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<tr>
<td>7/6</td>
<td>10</td>
</tr>
<tr>
<td>8/7</td>
<td>4</td>
</tr>
</tbody>
</table>

Juvenile specimens are costate as in adults, but we have counted the costae separately, because the general costal formula is a grouping of at least 75% of adult specimens in the categories median, parietal, and lateral.

Measurements of ten specimens:
New middle-late Frasnian rhynchonellids from Hunan 131

<table>
<thead>
<tr>
<th>in mm</th>
<th>Paratype D</th>
<th>Holotype</th>
<th>Paratype B</th>
<th>Paratype C</th>
<th>Paratype E</th>
<th>Paratype A</th>
<th>Paratype F</th>
<th>Paratype G</th>
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<tbody>
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<td>l</td>
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<td>6.6</td>
<td>6.5</td>
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</tr>
<tr>
<td>w</td>
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<td>8.6</td>
<td>8.7</td>
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<td>7.</td>
<td>6.9</td>
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<td>11.5</td>
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<td>(11.)</td>
<td>10.7</td>
<td>9.8</td>
<td>7.2</td>
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<tr>
<td>t</td>
<td>7.6</td>
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<td>8.3</td>
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<td>1.</td>
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<td>(0.67)</td>
<td>0.87</td>
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<td>0.97</td>
<td>0.80</td>
<td>0.82</td>
<td>0.89</td>
<td>0.95</td>
<td>(0.86)</td>
<td>0.83</td>
<td>0.51</td>
</tr>
<tr>
<td>t/l</td>
<td>1.15</td>
<td>1.35</td>
<td>1.25</td>
<td>1.15</td>
<td>1.1</td>
<td>1.3</td>
<td>1.25</td>
<td>1.25</td>
<td>0.95</td>
<td>0.6</td>
</tr>
<tr>
<td>apical angle</td>
<td>(115°)</td>
<td>129°</td>
<td>(120°)</td>
<td>125°</td>
<td>127°</td>
<td>124°</td>
<td>?</td>
<td>115°</td>
<td>108°</td>
<td>112°</td>
</tr>
<tr>
<td>angle of the cardinal commissure</td>
<td>?</td>
<td>135°</td>
<td>?</td>
<td>129°</td>
<td>132°</td>
<td>129°</td>
<td>?</td>
<td>119°</td>
<td>113°</td>
<td>117°</td>
</tr>
</tbody>
</table>

The abbreviations used are: l = length; w = width; t = thickness; pv = pedicle valve; bv = brachial valve. Measurements shown in parentheses indicate a reasonable estimate on a damaged specimen.

The first six columns refer to the photographed specimens, the last two to immature specimens. Greatest width forward of mid-length between 53 and 68% - most values between 60 and 64% - of the length of the shell. The borders of the tongue being always recurved posteriorly, the top of the shell is located at a point between 14 and 49% posterior to the frontal extremity of the shell.

**GEOGRAPHIC LOCATION AND STRATIGRAPHIC POSITION**

In the Qiziqiao section (see Text-fig. 3, p. 94 in Yu & al., 1990) of Xiangxiang County (27°75'N, 112°20'E) in the central part of Hunan Province, from which the bulk of the collection of Parvaltissimamarostrum minimum n.gen., n.sp. derives, the Shetienchiao Formation is subdivided into: (1) a lower member, 218 m thick, composed of medium- to thick-bedded sandstone, and argillaceous siltstone with a few intercalated marly beds; (2) a middle member, 135 m thick, composed of medium- to thick-bedded limestone; (3) an upper member, 97 m thick, composed of thin-bedded limestone, nodular limestone, marls and calcareous mudstone.

The lower member is richer in brachiopods [Atrypa (Planatrypa) sp., A. (Hyponeatrypa) sp., Spinatrypa sp., Cyrtospirifer sinensis (Grabau, 1931), C. sp.] and corals (Sinodisphyllum variabile SUN, 1958, S. simplex SUN, 1958). The middle member contains only abundant corals: Hexagonaria schuchertii (Smith, 1945), H. orientalis (Sun, 1958), H. philomena Glinski, 1955, Disphyl­llum caespitosum cylindricum Jiang, 1982, D. irregularis Yoh, 1957, "Peneckiella" sp., and Wapitiphyllum sp. The upper member, in which abundant Parvaltissimamaros­trum minimum n.gen., n.sp. have been collected in bed 11, 44.8m thick and bed 12, 4m thick (see p.270 in Yu & al., 1983, p. 96 in Yu & al., 1990; see also bed 8, p. 465 in Liu, 1987), contains abundant other brachiopods ['Ptychomaletaectia' shetienchiaoensis (Tien, 1938), Hypothyridina sp., Atrypa sp., Spinatrypa sp., Tenticos­pifir vilis (Grabau, 1931), T. tenticulum (de Verneuil, 1845), T. cf. gortanii (Pellizzari, 1913)], and corals [Pseudozaphrentis difficilis Sun, 1955, Disphyl­llum geinitzi Lang & Smith, 1935, Micophyllum gigan­teum Sun, 1955, Phillipsastraea macouni Smith, 1945, Hunanophrentis uniformis Sun, 1958, Hexagonaria bompasi (Smith, 1945), and Wapitiphyllum sp.]; the upper member is considered late Frasnian in age.

The position in the Shetienchiao Formation of the specimens collected in the Shetianqiao section is unknown.

**References**


PLATE I

a = ventral view; b = dorsal view; c = frontal view; d = apical view; e = lateral view

Navalicria rectangularis n.sp.
Figures are x1

Figs. 1-5. - Holotype, 110731. Costal formula: \( \frac{2}{1} \).

Figs. 6-10. - Paratype A, 110732. Costal formula: \( \frac{2}{1} \).

Parvaltissimarostrum minimum n.gen., n.sp.
Figures are x3

Figs. 11-15. - Holotype, 112786. Costal formula: \( \frac{8}{7} \).

Figs. 16-20. - Paratype A, 112787. Costal formula: \( \frac{0}{0} \).

Figs. 21-25. - Paratype B, 112788. Costal formula: \( \frac{5}{2} \).

Figs. 26-30. - Paratype C, 112789. Costal formula: \( \frac{0}{0} \).

Figs. 31-35. - Paratype D, 112790. Costal formula: \( \frac{3}{3} \).

Figs. 36-40. - Paratype E, 112791. Costal formula: \( \frac{3}{3} \).