

# Brachiopods of the Family Ambocoeliidae (Spiriferida) from the Givetian of Southern Verkhoyansk Region (Northeastern Russia)

V. V. Baranov and T. S. Alkhovik<sup>†</sup>

Diamond and Precious Metal Geology Institute, Siberian Division, Russian Academy of Sciences,  
pr. Lenina 39, Yakutsk, 677891 Sakha Republic, Russia  
e-mail: vbaranov@diamond.ysn.ru

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**Abstract**—Four new ambocoeliid species, *Ambocoelia ectypa* sp. nov., *Echinocoelia tikhiensis* sp. nov., *Emanuella takwanensis* (Kayser), and *Ladjia sita* sp. nov., from the Givetian of the southern Verkhoyansk Region are described (northeastern Russia).

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**Key words:** brachiopods, spiriferids, ambocoeliids, septal plates, Middle Devonian, Givetian, South Verkhoyansk Region, northeastern Russia.

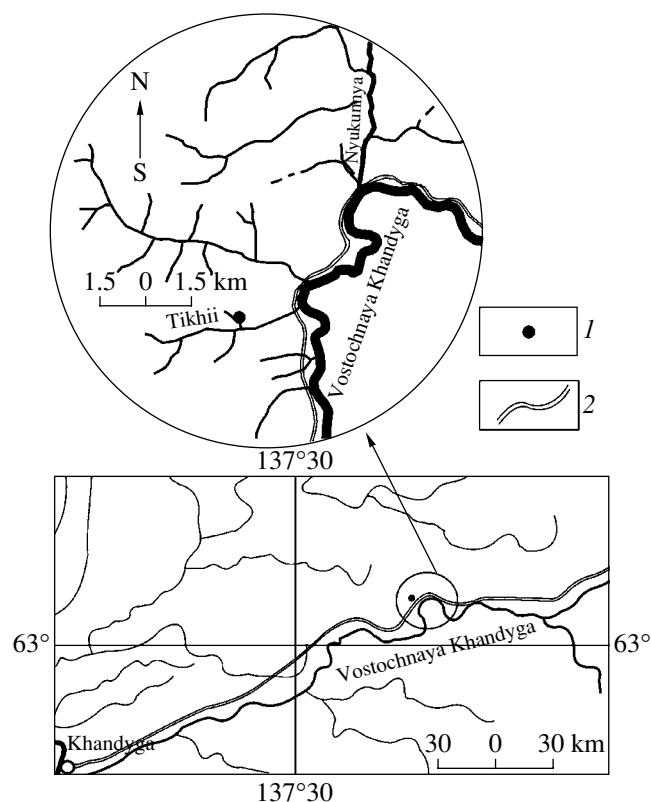
## INTRODUCTION

Ambocoeliids are widespread in the Givetian of many continents. However, only one ambocoeliid species, *Emanuella takwanensis* (Kayser), was described from the Givetian of the southern Verkhoyansk Region (Alekseeva *et al.*, 1996). In this study, additional data on the microornamentation and inner structures of this species are discussed (Pl. 7, figs. 10–12; Fig. 3). In addition to *E. takwanensis*, we found representatives of three other ambocoeliid genera in the Givetian of the southern Verkhoyansk Region, i.e., *Ambocoelia ectypa* sp. nov., *Echinocoelia tikhiensis* sp. nov., and *Ladjia sita* sp. nov. This spiriferid assemblage was dated Givetian based on the co-occurrence with conodonts of the *varcus* Zone (Figs. 1, 2).

*A. ectypa* sp. nov. is assigned to *Ambocoelia* based on its smooth shell with strongly convex ventral valve and slightly convex dorsal valve, the sinusoidal depression on the ventral valve, bilobed cardinal process, cruralium, and dorsal muscle field which closely approaches the anterior margin. The presence of growth lamellae with thin spines on the valve surface, the cone-shaped cardinal process, triangular crural plates, and low medial septum in the dorsal valve are evidence for the assignment of *E. tikhiensis* sp. nov. to *Echinocoelia*. The smooth shell, hatched cardinal process, and cruralium with riblike outgrowths on the inner side testify to the assignment of *L. sita* sp. nov. to *Ladjia*.

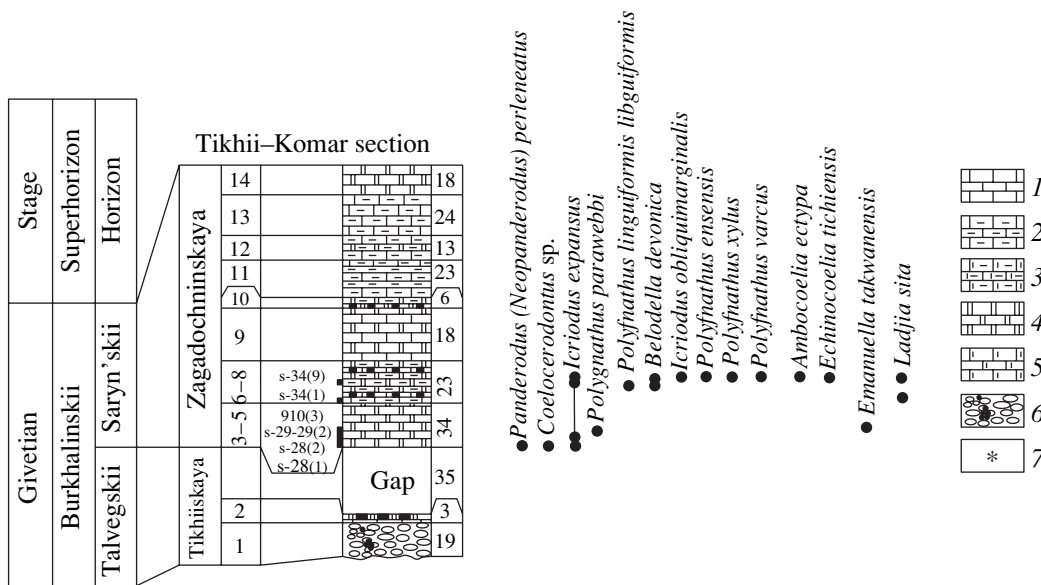
In the taxonomic descriptions of spiriferids, the structure of the cardinalia is of great significance. Schuchert (1897) gave the name *crural plates* to the plates growing from the inner socket ridges. If these

plates are joined to the valve floor, they are designated as septalike (Rzhonsnitskaya, 1952), basal (Havliček, 1959), dorsal adminiculum, or tabellae (Waterhouse,



**Fig. 1.** Schematic map of localities with spiriferids. Designations: (1) Tikhii-Komar section and (2) Khandyga-Magadan highway.

<sup>†</sup>Deceased.



**Fig. 2.** Stratigraphical column of the Givetian Stage showing distribution of conodont assemblages that accompany the spiriferids discussed. Designations: (1) limestone, (2) clayey limestone, (3) aleurite limestone, (4) dolomite, (5) calcareous dolomite, (6) conglomerate, and (7) speckled deposits.

1968). The cruralium is formed by the fusion of these plates. Some researchers (Ivanova, 1971; Carter *et al.*, 1994) supposed the crural and septal plates to be a single morphological structure. Pavlova (1969) and Sapel'nikov *et al.* (1987) recognized the crural plates and the septal plates supporting them. These authors believed that the crural and septal plates are separated by the crural bases. We also suppose these plates to be different structures, especially since the structures corresponding to the crural and septal plates of spiriferids are known in other brachiopod orders; these are the outer hinge and septal plates of rynchonellids and brachial and septal plates of pentamerids.

The crural and septal plates of the ambocoeliids described below were studied in thin cross sections and in the prepared dorsal valves. In the cross sections of *E. takwanensis*, the crural and septal plates are separated by the crural bases, which are marked out with dark color (Fig. 3). These structures of *A. ectypa* sp. nov., *E. tichiensis* sp. nov., and *L. sita* sp. nov., are described below.

The material examined is currently housed in the Geological Museum of the Diamond and Precious Metal Geology Institute of the Siberian Division of the Russian Academy of Sciences, Yakutsk (GM IGABM), collection no. 184.

## SYSTEMATIC PALEONTOLOGY

Order Spiriferida

Suborder Spiriferidina

Family Ambocoeliidae George, 1931

### Subfamily Ambocoeliinae George, 1931

#### Genus *Ambocoelia* Hall, 1860

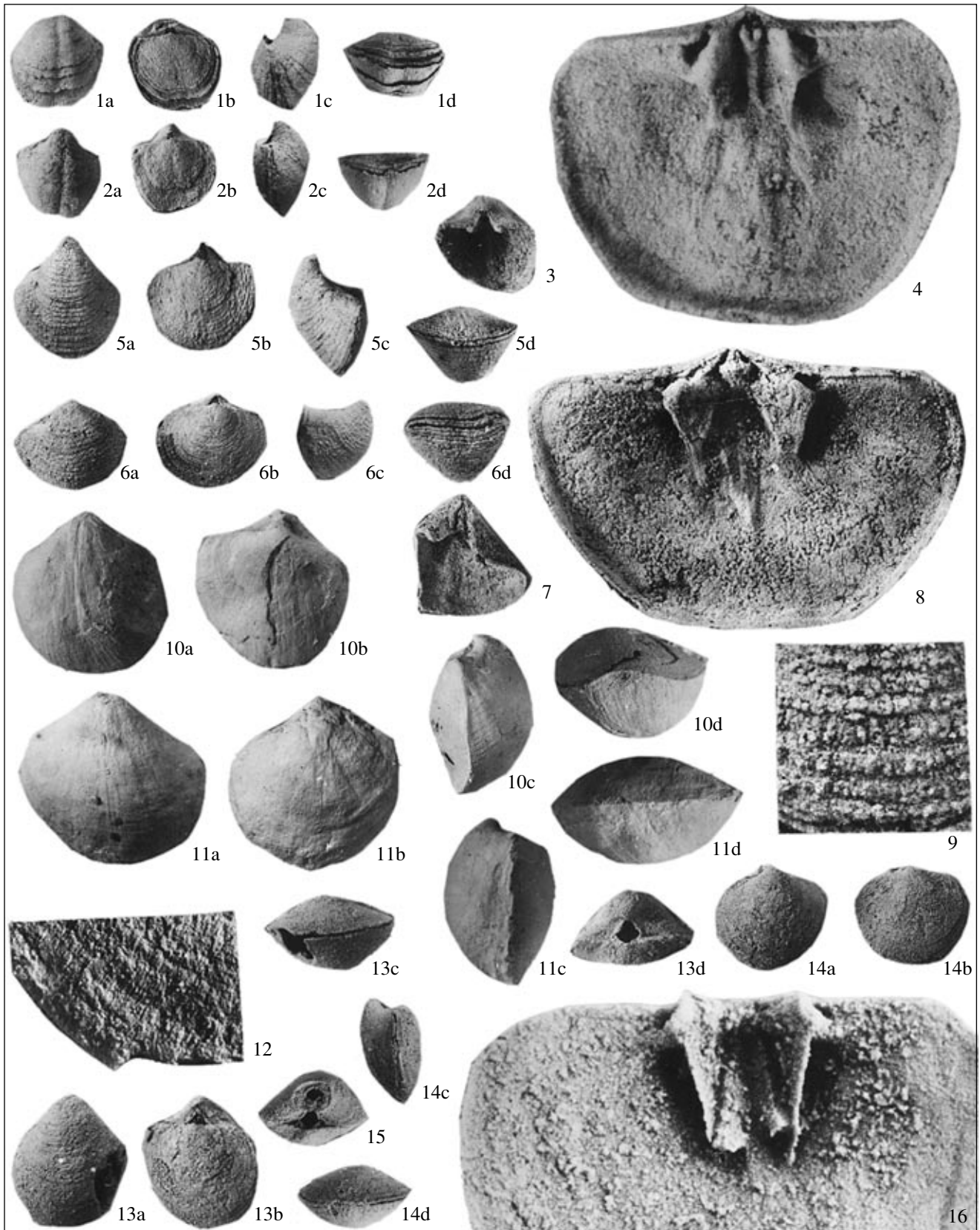
*Ambocoelia ectypa* Baranov et Alkhovik, sp. nov.

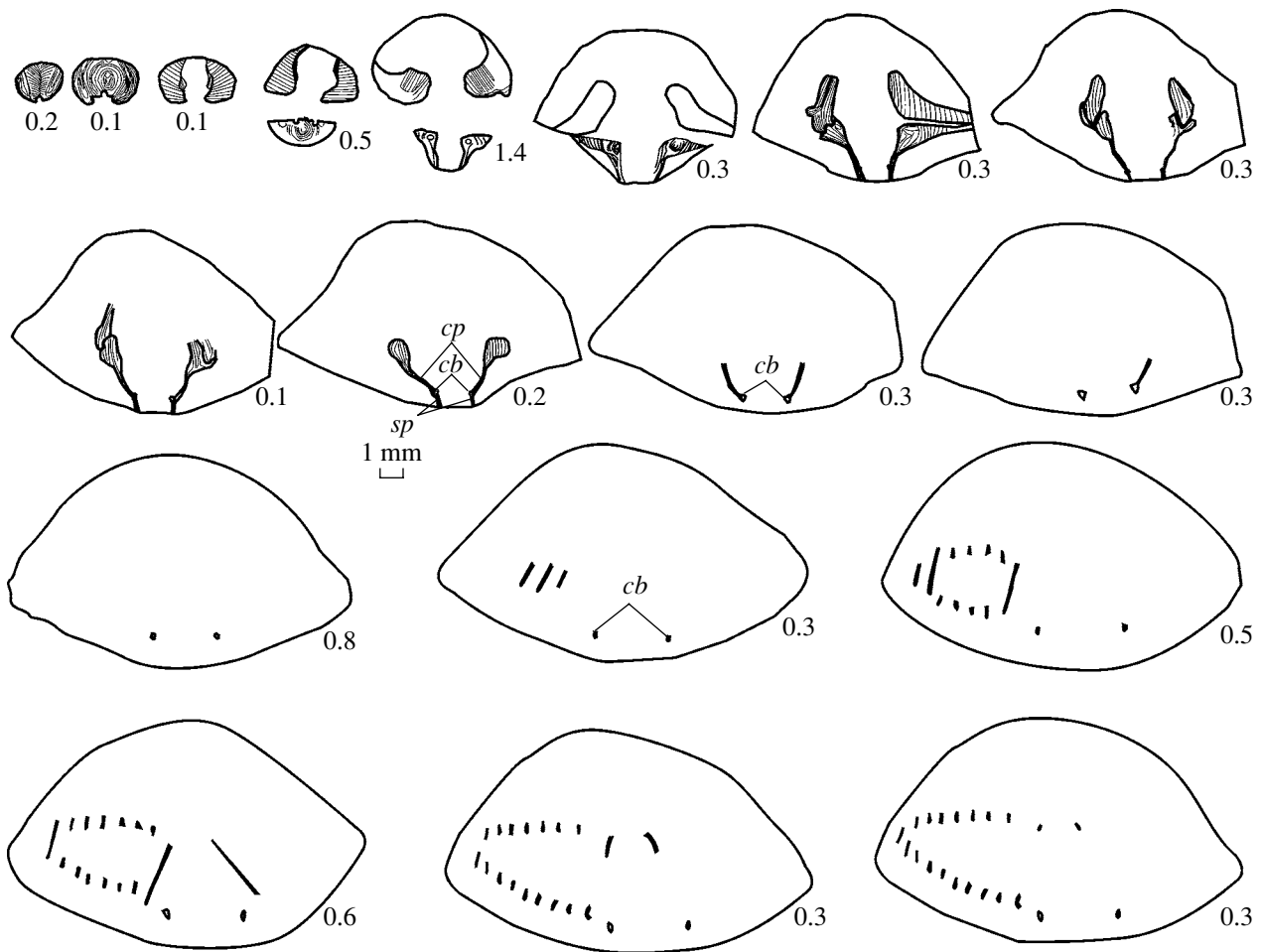
Plate 7, figs. 1–4

**E t y m o l o g y.** From the Latin *ectypus* (convex).

**H o l o t y p e.** GM IGABM, no. 184/2, complete shell; southern Verkhoyansk Region, eastern slope of the Sette-Daban Mountain Ridge, right bank of the Vostochnaya Khandyga River, Komar Creek, left tributary of the Tikhii Creek; Middle Devonian, Givetian Stage, Saryn' Horizon, Middle Zagadochninskaya Subformation, *varcus* Zone.

**D e s c r i p t i o n.** The shell is small, with rounded cardinal angles and a rectimarginate commissure. The maximum width and maximum thickness are in the posterior part of the shell, close to the midlength. The ventral valve is strongly convex, with the maximum thickness within the posterior part. The umbo is high and straight. The area is anacline, triangular, and concave. The delthyrium is triangular and open. A narrow sinusoidal groove extends from the umbo to the anterior margin. The dorsal valve is slightly evenly convex, flattened anteriorly, with the maximum thickness at the midlength of the valve. The umbo is low and straight. The area is narrow. The notothyrium is open. The shell surface is smooth, with sharp projections, which were caused by periods of delay in the shell growth. Thin spines are arranged in concentric rows on the surface of the projections.





**Fig. 3.** *Emanuella takwanensis* (Kayser); specimen GM IGABM, no. 184/26, serial sections through the shell. Designations: (c) crura, (cb) crural bases, (cp) crural plates, and (sp) septal plates.

Dimensions in mm and ratios:

| Specimen<br>GM IGABM,<br>no. | L   | W   | T   | L/W  | L/T  |
|------------------------------|-----|-----|-----|------|------|
| 184/1                        | 5.4 | 4.9 | 3.4 | 1.1  | 1.58 |
| Holotype 184/2               | 5.3 | 4.5 | 3.4 | 1.17 | 1.55 |

*Shell interior* (Pl. 7, fig. 4; Fig. 4). Dental plates are absent. The teeth are club-shaped. The cardinal process

is bilobed. The septal plates fuse to form the cruralium. The euseptoidium runs along the cruralium bottom. The muscle field is represented by large, oval posterior adductors located along the lateral sides of the anterior adductors, which are extended anteriorly and almost reach the anterior margin.

**Comparison.** The new species differs from the type species *Orthis umbonata* Conrad, 1842 (Pitrat, 1965, p. H672, text-fig. 546.1) in the smaller shell and more convex dorsal valve. It differs from *A. operulifera*

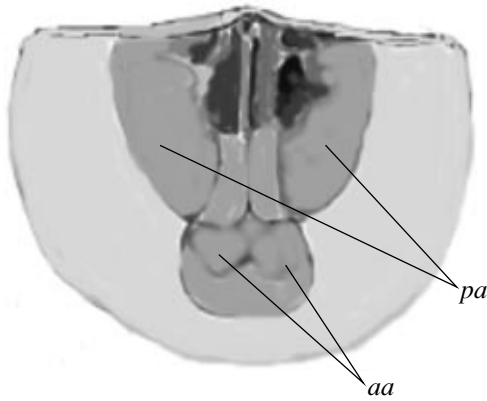
Explanation of Plate 7

**Figs. 1–4.** *Ambocoelia ectypa*, sp. nov.: (1a–1d) specimen GM IGABM, no. 184/1,  $\times 3$ ; (2a–2d) holotype GM IGABM, no. 184/2,  $\times 3$ ; (3) GM IGABM, no. 184/5, structure of the apical part of the ventral valve,  $\times 3$ ; and (4) GM IGABM, no. 184/6, interior of the dorsal valve,  $\times 10$ .

**Figs. 5–9.** *Echinocoelia tikhiensis* Baranov et Alkhovik, sp. nov.: (5a–5d) holotype GM IGABM, no. 184/10,  $\times 3$ ; (6a–6d) GM IGABM, no. 184/11,  $\times 3$ ; (7) GM IGABM, no. 184/13, interior of the dorsal valve,  $\times 10$ ; (8) and (9) GM IGABM, no. 184/14: (8) interior of the ventral valve,  $\times 4$ ; and (9) microornamentation,  $\times 13$ .

**Figs. 10–12.** *Emanuella takwanensis* (Kayser): (10a–10d) GM IGABM, no. 184/20,  $\times 1.5$ ; (11a–11d) GM IGABM, no. 184/21,  $\times 1.5$ ; and (12) GM IGABM, no. 184/25, microornamentation,  $\times 10$ .

**Figs. 13–16.** *Ladjia sita* Baranov et Alkhovik, sp. nov.: (13a–13d) GM IGABM, no. 184/30,  $\times 3$ ; (14a–14d) holotype GM IGABM, no. 184/31,  $\times 3$ ; (15) GM IGABM, no. 184/35, section of the apical part of the ventral valve,  $\times 3$ ; and (16) GM IGABM, no. 184/36, interior of the apical part of the dorsal valve,  $\times 10$ .



**Fig. 4.** *Ambocoelia actypta* sp. nov.; specimen GM IGABM, no. 184/6, dorsal muscle field,  $\times 8$ . Designations: (aa) anterior adductors and (pa) posterior adductors.

Havliček (Havliček, 1959, p. 172, pl. 27, figs. 7, 8) and *A. mesodevonica* Havliček (Havliček, 1959, p. 173, pl. 27, figs. 9, 10) in the maximum shell thickness located closer to the midlength of the shell, the thinner shell, and the lower ventral area.

**Material.** Sixty-seven well-preserved specimens from sample S-34 (9).

## Genus *Echinocoelia* Cooper et Williams, 1935

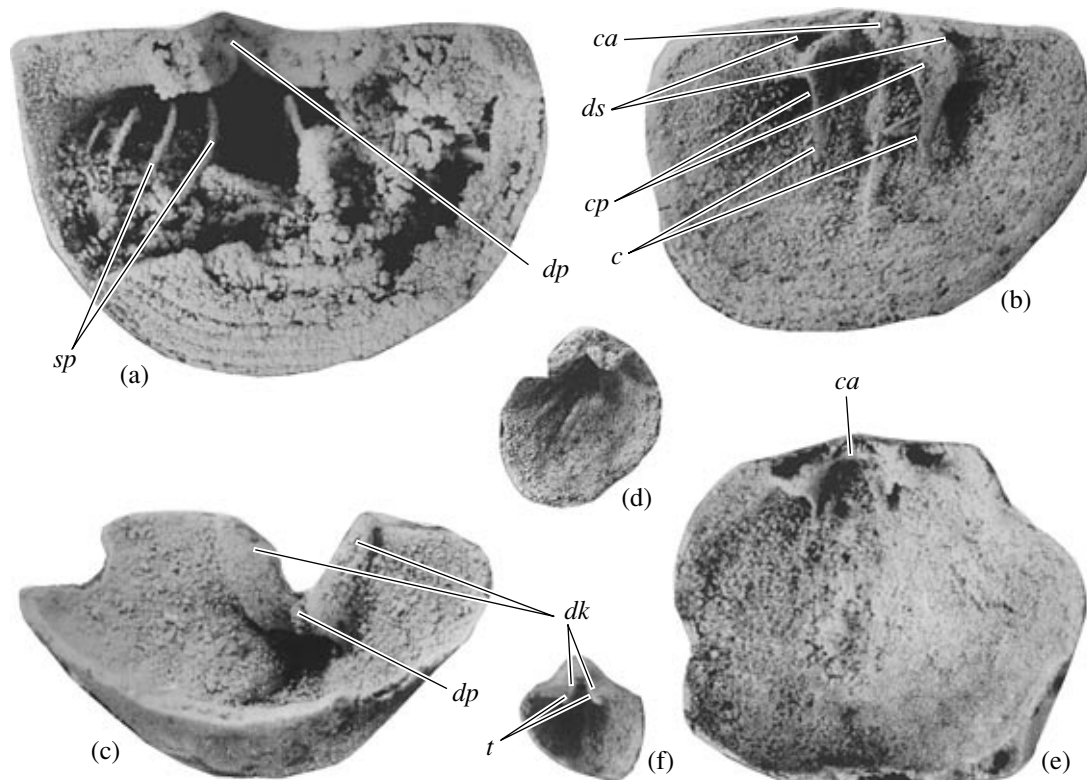
*Echinocoelia tikhiensis* Baranov et Alkhovik, sp. nov.

Plate 7, figs. 5-9

**Etymology.** From the Tikhii Creek.

**Holotype.** GM IGABM, no. 184/10, complete shell; southern Verkhoyansk Region, eastern slope of the Sette-Daban Mountain Ridge, right bank of the Vostochnaya Khandyga River, Komar Creek, left tributary of the Tikhii Creek; Middle Devonian, Givetian Stage, Saryn' Horizon, Middle Zagadochninskaya Subformation, *varcus* Zone.

**Description.** The shell is relatively small, with a straight or slightly ventrally curved anterior margin and rounded cardinal angles. The maximum width is at the midlength of the shell. The maximum thickness is at the hinge line. The ventral valve is pyramidal. The umbo is straight. The area is apsacline, high, triangular, and concave. The upper part of the delthyrium is covered by a slightly convex deltidial plate. The dorsal valve is slightly evenly convex; anteriorly, it is oval and flattened. The umbo is small and protruding. The area is narrow. The valves bear concentric growth plates covered with thin spines.



**Fig. 5.** (a-c) *Echinocoelia tikhiensis* sp. nov.: (a) specimen GM IGABM, no. 184/14, dorsal view,  $\times 10$ ; (b) specimen GM IGABM, no. 184/15, interior of the dorsal valve,  $\times 10$ ; and (c) specimen GM IGABM, no. 184/16, anterior view of the ventral valve,  $\times 10$ ; (d, e) *Ladjia sita* sp. nov.: (d) specimen GM IGABM, no. 184/37, ventral valve,  $\times 5$ ; and (e) specimen GM IGABM, no. 184/38, interior of the dorsal valve,  $\times 10$ ; (f) *Ambocoelia ectypa* sp. nov., specimen GM IGABM, no. 184/5, ventral valve,  $\times 10$ . Designations: (c) crura, (ca) cardinal process, (cp) crural plates, (dk) delthyrial keels, (dp) deltidial plate, (ds) dental sockets, (sp) septal plates, and (t) teeth.

## Dimensions in mm and ratios:

|          | Specimen<br>GM IGABM,<br>no. | L   | W   | T   | L/W | L/T  |
|----------|------------------------------|-----|-----|-----|-----|------|
| Holotype | 184/10                       | 7.2 | 6.5 | 5.4 | 1.1 | 1.2  |
|          | 184/11                       | 5.5 | 6.8 | 4.5 | 0.8 | 1.2  |
|          | 184/12                       | 5.0 | 6.1 | 4.7 | 0.8 | 1.06 |
|          | 184/13                       | 7.6 | 11  | 4.7 | —   | —    |

*Shell interior* (Pl. 7, fig. 8; Figs. 5a–5c). Dental plates are absent. The teeth are club-shaped. The cardinal process is cone-shaped and hatched. A low euseptoidum extends from the cardinal process to the middle of the valve. The crural plates are triangular and wide in the posterior part, becoming narrower anteriorly. The primary lamellae of the spires, with four whorls in the cone, deviate anteroventrally from the crural plates.

**Comparison.** The new species differs from the type species *E. ambocoelioides* Cooper et Williams, 1935 (Pitrat, 1965, p. H672, text-fig. 547.5) and *E. denayensis* Johnson (Johnson *et al.*, 1981, pl. 1, figs. 14–17) in the smaller shell and the presence of the deltidial plate. In addition, it differs from the type species in the cone-shaped, hatched cardinal process.

**Material.** Twenty-three well-preserved specimens from sample S–34 (9).

**Subfamily Rhynchospiriferinae Paulus, 1957****Genus *Ladjia* Veevers, 1959***Ladjia sita* Baranov et Alkhovik, sp. nov.

Plate 7, figs. 13–16

**Etymology.** From the Latin *situs* (lying).

**Holotype.** GM IGABM, no. 184/31, complete shell; southern Verkhojansk Region, eastern slope of the Sette-Daban Mountain Ridge, right bank of the Vostochnaya Khandyga River, Komar Creek, left tributary of the Tikhii Creek; Middle Devonian, Givetian Stage, Saryn' Horizon, Middle Zagadochninskaya Subformation, *varcus* Zone.

**Description.** The shell is relatively small, almost equivalvate, with a straight anterior margin and rounded cardinal angles. The maximum width and maximum thickness are at the midlength of the shell. The valves are approximately equal in convexity. The ventral umbo is low and slightly curved. The area is relatively low, wide, triangular, and concave. The delthyrium is triangular, narrow, and closed at the top by a relatively small deltidial plate. The dorsal valve is uniformly convex, with low, small, and curved umbo. No microornamentation has been recorded.

## Dimensions in mm and ratios:

|          | Specimen<br>GM IGABM,<br>no. | L   | W   | T   | L/W  | L/T  |
|----------|------------------------------|-----|-----|-----|------|------|
| Holotype | 184/30                       | 7.2 | 7.5 | 5.0 | 0.96 | 1.44 |
|          | 184/31                       | 6.3 | 6.6 | 3.8 | 0.95 | 1.65 |
|          | 184/32                       | 5.8 | 6.1 | 3.7 | 0.95 | 1.56 |
|          | 184/33                       | 5.3 | 6.0 | 3.2 | 0.8  | 1.06 |
|          | 184/34                       | 9.0 | —   | —   | —    | —    |

*Shell interior* (Pl. 7, fig. 16; Figs. 5d, 5e). Dental plates are absent. The teeth are club-shaped. The cardinal process is hatched. The crural plates are wide in the posterior part of the valve and are supported by the septal plates, which fuse to form the cruralium. On the inner side of the crural plates, the crural bases are rib-like. The crural plates become narrower anteriorly. The crura deviate from the dorsal ends of the crural plates.

**Comparison.** The new species differs from the type species *L. saltica* Veevers, 1959 (Pitrat, 1965, p. H674, text-fig. 547.6) in the smaller shell, the absence of the sinusoidal depression in the ventral valve, the straight hinge line, and the presence of the deltidial plate.

**Material.** Three hundred and fifty-four well-preserved specimens from sample S–34 (1); and 40 well-preserved specimens from sample S–34 (9).

## ACKNOWLEDGMENTS

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