Sapelnikoviella santuccii, a new gypidulinid brachiopod genus and species from the upper Silurian of Glacier Bay National Park & Preserve, Southeast Alaska

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A new late Silurian (Ludlow) gypidulinid genus and species, *Sapelnikoviella santuccii*, is established from carbonate mudstone interbeds within an algal reef tract in shoreline exposures of the Willoughby Limestone on the southwest side of Drake Island in Glacier Bay, Southeast Alaska. The new brachiopod co-occurs with smooth atrypid brachiopods (*Septatrypa*) and less abundant high-spired gastropods (murchisoniids and less common *Coelocaulus*) in small nest-like accumulations between the algal buildups. Recent field work in Glacier Bay indicates that the Tidal Formation, formerly considered to overlie the shallow-water platform carbonates of the Willoughby Limestone, is now recognised as a laterally equivalent, deeper water basinal unit. A similar platform to basin transition is recognised to the immediate south on the northeastern part of Chichagof Island.

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THE ALEXANDER TERRANE of southeastern Alaska is a major accreted block within the accretionary collage that comprises much of western North America (Berg *et al*. 1972, 1978; Coney *et al*. 1980; Monger & Berg 1987; Gehrels & Berg 1994; Blodgett *et al*. 2010; see Fig. 1 for location). It is widely recognised that the Alexander terrane has been transported and accreted from some distant source area, and previously suggested areas for its origin include the Klamath Mountains and northern Sierra Nevada Mountains of California, the Lachlan Fold Belt of eastern Australia and Baltica or the area of the Uralian geosyncline (see Blodgett *et al*. 2010, p. 326 for review of these models). More recently, Blodgett *et al*. (2010) suggested that the Alexander terrane most likely originated by rifting from northeastern Russia, based on palaeontological and stratigraphical similarities.

During the summer of 2011, two of the authors (Blodgett and Rohr) visited the Glacier Bay region (see Fig. 2A for many of the geographical features referred to in the text) in order to conduct a detailed palaeontological field survey of Palaeozoic rocks in this part of the Alexander terrane. A number of key areas in the region were visited (i.e., Willoughby Island, Drake Island, Tidal Inlet, North Marble Island, Sandy Cove), including several sites in the late Silurian Willoughby Limestone on Drake Island. One of these sites (locality 11RB16; Fig. 2B) has a well exposed stromatolitic algal reef tract with associated breccias. In several lime mudstone pockets within the reef framework a low-diversity assemblage of brachiopods was found, including the atrypid *Septatrypa* (the most abundant brachiopod found here), a gypidulinid and an undetermined athyrid. There were also numerous high-spired gastropods (murchisoniids and less common *Coelocaulus*) (Fig. 3). The material was relatively easy to prepare and during laboratory analysis yielded a large number of ‘crack-out’ specimens. The unique external and internal morphological characteristics of the gypidulinid brachiopod indicate that it represents a new genus and species, established here as *Sapelnikoviella santuccii*.

Further documentation of the Silurian brachiopod faunas of the Alexander terrane would be valuable as only a handful of taxonomic studies have been published (Kirk 1922, 1925, 1926; Kirk & Amsden 1952; Savage 1989; Boucot *et al*. 2012). Recent papers providing an overview of these faunas include Blodgett *et al*. (2002, 2010).

STRATIGRAPHIC FRAMEWORK

Glacier Bay in the northern part of Southeast Alaska contains a thick succession of middle Palaeozoic (Silurian and Devonian) strata which were geologically mapped in detail by Seitz (1959) and Rossman (1963). Biostratigraphic age support for these mapping efforts was rather spotty, with most of the age-diagnostic collections coming from either the late Silurian Willoughby Limestone or the Devonian Black Cap Limestone. The stratigraphic framework for the Palaeozoic succession was established by Rossman (1963), who formally named the formations, in ascending order (Fig. 4),

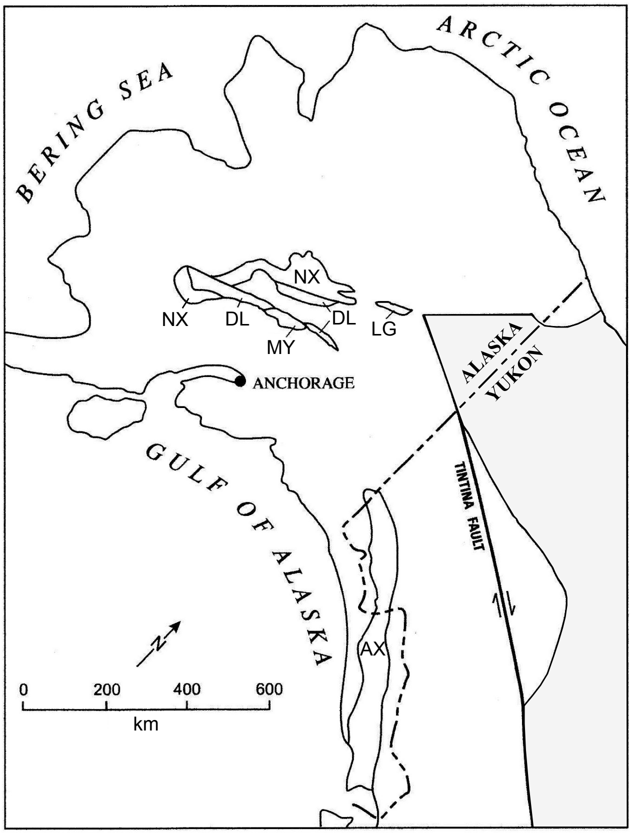

Figure 1. Tectonostratigraphic terranes and component subterranes in southern Alaska (from Blodgett *et al*. 2010). AX, Alexander terrane; LG, Livengood terrane. Subterranes of the Farewell terrane: DL, Dillinger; MY, Mystic; NX, Nixon Fork. Shaded area, North American autochthonous basement.

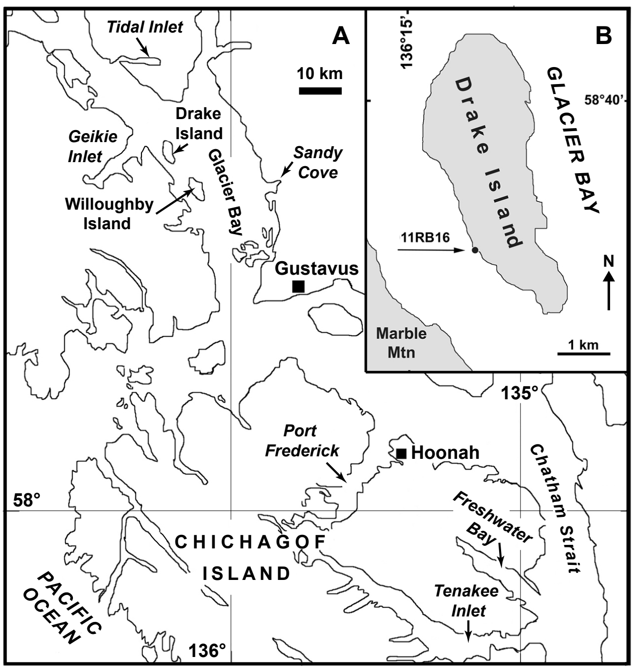

Figure 2. **A,** Index map of the northern part of Southeast Alaska showing the location of some of the geographic features referred to in the text. **B,** Map of Drake Island showing position of locality 11RB16 on its southwestern shore.

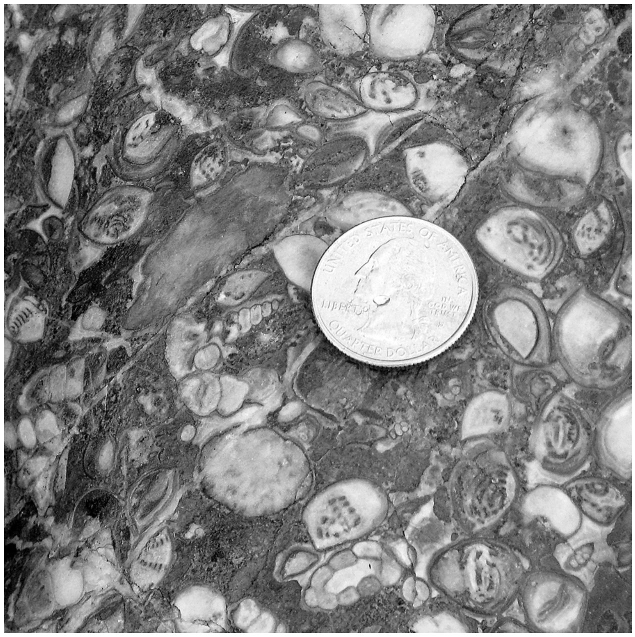

Figure 3. View of pocket-like accumulation of brachiopods (*Septatrypa*, *Sapelnikoviella santuccii* gen. et sp. nov) and high-spired murchisoniid gastropods at locality 11RB16 on the southwest shore of Drake Island. Note presence of spiralia in *Septatrypa*. Diameter of coin is 24 mm.

as: Willoughby Limestone (late Silurian); Tidal Formation (late Silurian); Pyramid Peak Limestone (unfossiliferous, age unknown); Rendu Formation (unfossiliferous, age unknown); and Black Cap Limestone (Middle Devonian according to Rossman, but now known to contain an Early Devonian fauna as well). Later field mapping by the US Geological Survey in the mid 1960s revealed that an unnamed Permian limestone unit is also present on the east side of Glacier Bay (Brew *et al.* 1978). This unit contains a brachiopod fauna having many species in common with the early Permian Pybus Formation of Admiralty and Kuiu islands further to the southeast (Blodgett *et al*. 2012).

The Willoughby Limestone, which yielded the brachiopod that is the focus of the present study, was estimated by Rossman (1963) to be at least 5,000 ft (1,524 m) thick and to consist of bedded limestones, with exposures on Willoughby Island representing the most typical section. Seitz (1959) had earlier used the name Willoughby Limestone for Silurian exposures in a small area of Geikie Inlet, but he did not establish it as a formal stratigraphic name. Nearly all of the illustrated or formally described fossils from the Glacier Bay area came from the Willoughby, including specimens of the large late Silurian lagoonal bivalve genus *Pycinodesma* (Kirk 1927a, b; Kříž *et al.* in preparation) and associated large gastropods belonging to *Bathmopterus*, *Kirkospira* and *Coelocaulus* (Kirk 1928; Rohr & Blodgett 2003; Rohr *et al*. 2003). All of these specimens were collected from restricted lagoonal limestones exposed on a small satellite island lying off the northeast coast (Johnson Cove area) of Willoughby Island. Soja *et al*. (2000) reported the presence of stromatolite reefs and associated lithofacies in exposures of the Willoughby Limestone on the southwest and east sides of Drake Island.

Rossman (1963, p. K12) did not recognise the contact of the Willoughby Limestone with the Tidal Formation, which he considered to overlie it (Fig. 4). However, our

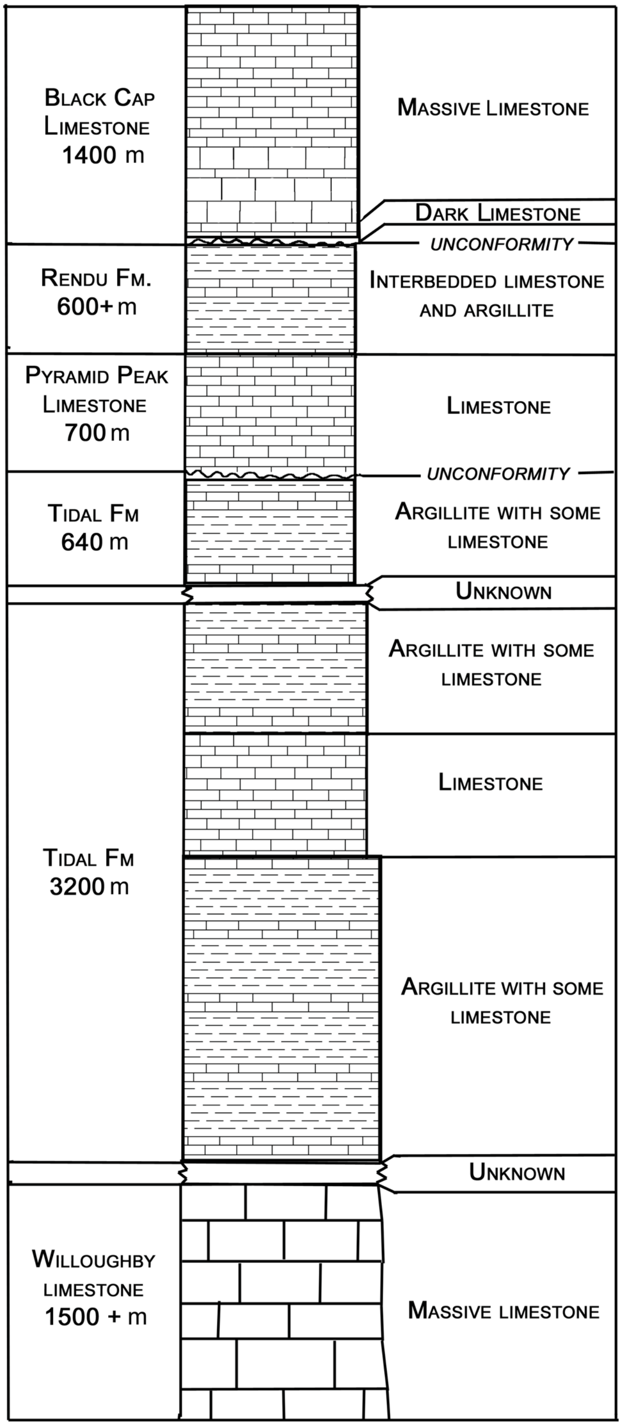

Figure 4. Generalised columnar section of Palaeozoic rocks in Glacier Bay (modified from Rossman 1963, fig. 2).

reconnaissance field study indicates that the thick succession of argillites comprising the Tidal Formation instead represents a coeval deeper-water (basinal) facies equivalent of the carbonate platform succession of the Willoughby. This interpretation is in accord with the spatial distribution of outcrop belts of the Willoughby Limestone and the Tidal Formation, the Willoughby being primarily restricted to the west side of Glacier Bay and to Gloomy Knob on the east side of Glacier Bay, whereas outcrops of the Tidal Formation are restricted to an area farther east on the east side of Glacier Bay. The rock types in the Tidal Formation are similar to those in a time-equivalent unnamed upper Silurian mixed siliciclastic and limestone succession on northeast Chichagof Island (Fig. 2A), in the vicinity of Hoonah (Kříž *et al*. 2011; Rohr *et al*. 2011; Boucot *et al*. 2012). The latter rocks appear to represent slightly deeper-water, basinal equivalents of shallow platform carbonates of the Kennel Creek Limestone of northeast Chichagof Island (also containing abundant remains of the bivalve *Pycinodesma*).

LOCALITY AND AGE

Field locality 11RB16 (Fig. 2B) which yielded the specimens of *Sapelnikoviella santuccii* is situated on a promontory on the southwest side of Drake Island, Glacier Bay, Southeast Alaska [SE1/4, NE1/4, SW1/4 Sec. 19, Mt Fairweather (C-1) 1:63,360 scale quadrangle map, 1948 edition (with minor revisions 1973)]. GPS coordinates for the locality are N 58°38.649’, W 136°13.89’ (NAD 27). This locality is approximately 300 m NE of triangulation station Just, situated on another prominent promontory. The collection was made on 26 July 2011 by Robert B. Blodgett, David M. Rohr and Vincent L. Santucci.

The strata at this locality consist primarily of stromatolitic algal/cyanobacterial reef buildups and associated breccia beds. The low-diversity brachiopod assemblage was recovered from several small, closely spaced lime mudstone pockets within the reef buildup. The most common brachiopod present, *Septatrypa*, has a stratigraphic range extending from the upper Silurian to the Lower Devonian, and the few others have yet to be identified; thus, the brachiopods do not provide a narrow age range. However, the presence of aphrosalpingid sponges in nearby strata at about the same stratigraphic level suggest a Ludlow age for this locality. A large, several kilogram sized sample of limestone from this locality was dissolved by Ladislav Slavík (Institute of Geology, Academy of Sciences of the Czech Republic, Prague) for recovery of conodonts, but the sample proved to be barren.

SYSTEMATIC PALAEONTOLOGY

The type specimens of *Sapelnikoviella santuccii* are deposited in the University of Alaska Museum Earth Science Collection, Fairbanks. Morphological terminology follows Boucot *et al*. (2002).

Order PENTAMERIDA Schuchert & Cooper, 1931
Superfamily GYPIDULOIDEA Schuchert & LeVene, 1929
Family GYPIDULIDAE Schuchert & LeVene, 1929
Subfamily GYPIDULINAE Schuchert & LeVene, 1929

Sapelnikoviella gen. nov.

Type species. *Sapelnikoviella santuccii* gen. et sp. nov. from the upper Silurian (Ludlow) of the Willoughby Limestone, Glacier Bay, Southeast Alaska.

Etymology. The generic name is in honor of Vadim P. Sapelnikov (1930-2004) of Ekaterinburg, Russia, a leading scholar of Ordovician-Devonian brachiopods, and an expert in particular on the Suborder Pentameridina

Diagnosis. Small, globose, ventribiconvex, plicate gypidulinid brachiopods with a well developed ventral and dorsal sulcus resulting in a unisulcate anterior commissure. Ventral median septum strongly reduced or absent.

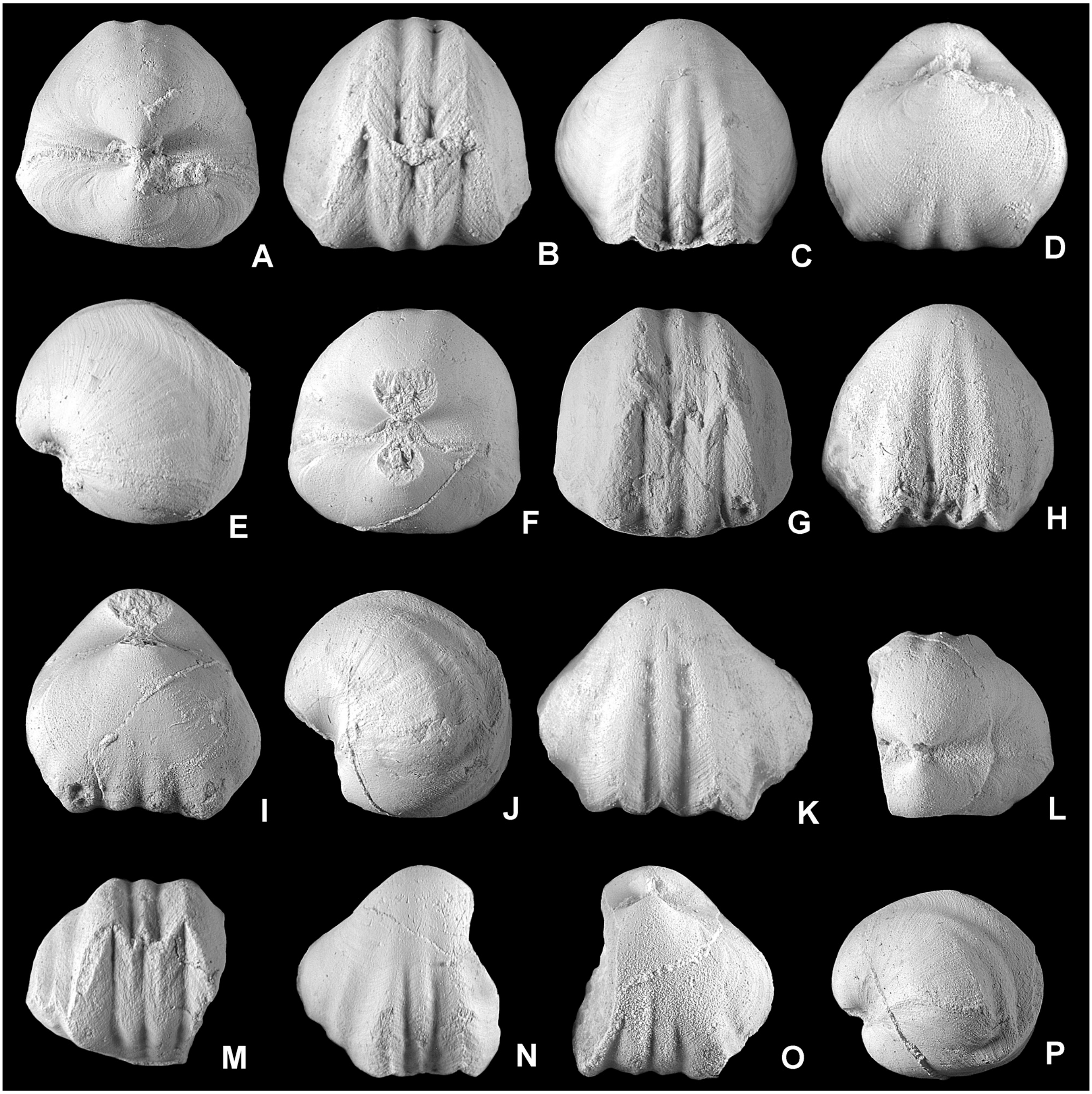

Figure 5. ***Sapelnikoviella santuccii*** gen. et sp. nov., Willoughby Limestone (Ludlow), locality 11RB16, Drake Island, Glacier Bay, Southeast Alaska. **A-E**, holotype, UAMES 23259, posterior, anterior, ventral, dorsal and lateral views, x 5. **F-J**, paratype (missing ventral and dorsal beaks), UAMES 23260, posterior, anterior, ventral, dorsal and lateral views x 5. **K**, paratype, UAMES 23261, ventral view, x 5. **L-P**, paratype, UAMES 23262, posterior, anterior, ventral, dorsal and lateral views, x 5.

Comparison. The combination of an absent to very short ventral median septum and its characteristic external features clearly distinguish *Sapelnikoviella* from all other Silurian genera of the subfamily Gypidulinae. The new genus differs from *Amsdenina* Boucot, 1975, in having strong, angular plicae, as opposed to numerous smaller costae which cover the entire shell surface; from *Ascanigypa* Havlíček, 1990 in being strongly plicate (rather than smooth), and in having inner hinge plates which do not converge medially; it differs from *Breviseptum* Sapelnikov, 1960 in lacking numerous costae covering the entire shell as well as in having a well developed fold and sulcus; and from *Caryogyps* Johnson, Boucot & Murphy, 1976, in being more globose and less squat, and in lacking strong plications on the shell flanks. The new genus is morphologically closest to *Cadudium* Havlíček, 1985, in its globose shape, but can be distinguished in having more numerous and strongly developed angular plicae on its fold and sulcus (as opposed to the broader, more rounded and weaker plications in *Cadudium*), as well as in having a much more reduced ventral median septum, and a brachidium which is not as strongly lyre-shaped with relatively longer inner hinge plates. This distinction applies both to the type species of *Cadudium*, *C. caducum* (Barrande, 1847) from the Požáry Formation (Přídolí) of Bohemia, and to other species from Bohemia, the Urals and Tian-Shan attributed to this genus by Havlíček (1990). *Sapelnikoviella* is easily distinguished from the type species of *Gypidula*, *G. typicalis* Amsden, 1953 from Givetian strata of the Cedar

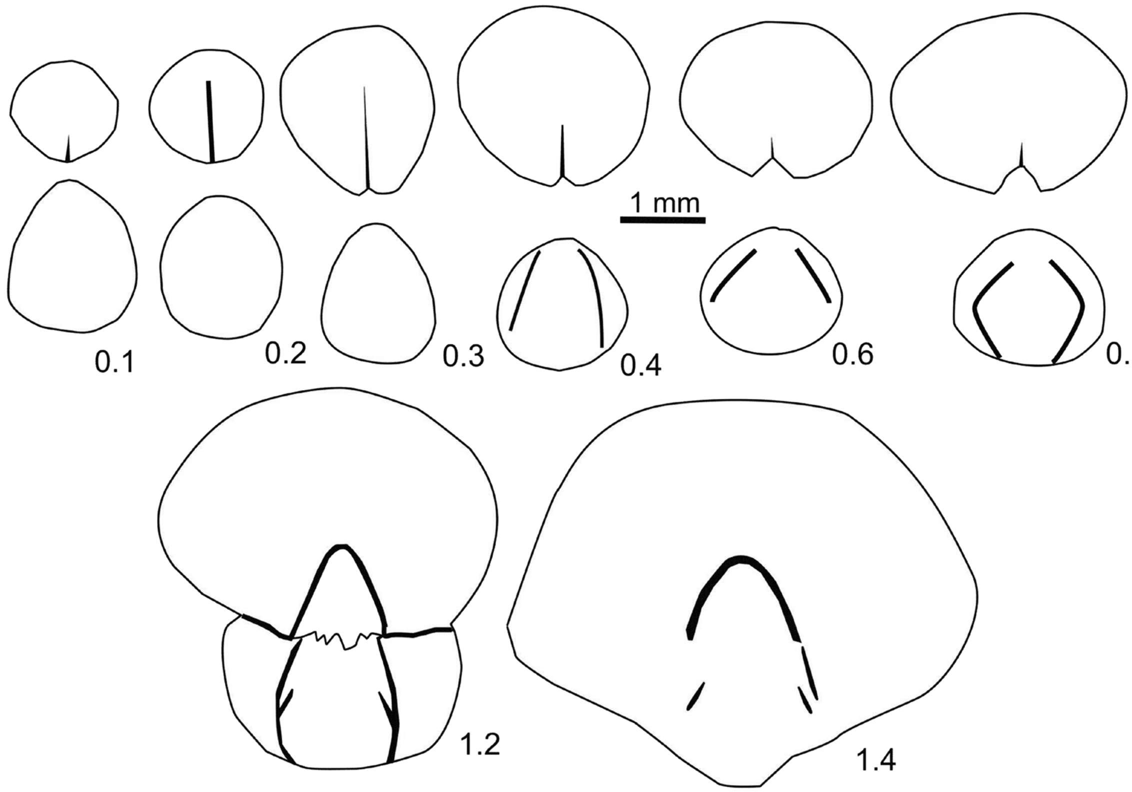

Figure 6. ***Sapelnikoviella santuccii*** gen. et sp. nov. Serial sections of paratype UAMES 23263; original length of shell 5.8 mm. Distances listed are those from the ventral beak; ventral valve is at top.

Valley Group of Iowa, in being much smaller, distinctly globose in shape, in having strong, angular costae developed medially, as well as in having only a rudimentary or absent ventral median septum.

Discussion. Silurian gypiduloid brachiopods are much more poorly documented than their Devonian descendants. As noted by Jin (2005, p. 48), who additionally cited Boucot (1999) and Sapelnikov *et al*. (1999), gypiduloid brachiopods occur 'primarily in level-bottom benthic shelly communities or in reef-dwelling brachiopod communities'. This observation is in accord with our general experience with both Silurian and Devonian gypiduloids.

Sapelnikoviella is notable for its very small size (see Table 1). This is in line with the overall relatively small size of Silurian articulate brachiopods as contrasted with their Early Devonian descendants, a fine example of Cope's Rule. Devonian gypiduloids are generally 3-4 times larger than *Sapelnikoviella*, as exemplified by the Middle Devonian genus *Zdimir*. When viewing Silurian articulate brachiopods as a group it is notable that the delthyrids are also relatively small, with *Howellella* as a good example, as contrasted with their Pragian and younger Devonian descendants. The same is true for stropheodontids, dalmanellids, chonetids, rhynchonellids and atrypids. However, in the case of pentamerinids, exemplified by genera such as *Kirkidium*, larger forms appeared earlier in the Silurian, culminating in the late Wenlock and Ludlow, and the *Costistricklandia* branch of the stricklandiids were largest in the very late Llandovery and earliest Wenlock. The evolutionary trend towards increased size in most groups began in the Lochkovian and is complete by Pragian time, following which 'large' forms were the rule. Notable too is that the earliest terebratuloids, such as *Podolella* and *Nanothyris* of the Lochkovian, gave rise to large sized genera in the later Early Devonian. The reasons for these Cope's Rule changes are elusive. About the best one can do is appeal to some form of unknown specialisation, since 'large' size accompanies some aspects of specialisation in some organism lineages.

Further systematic study and revision of Silurian gypiduloids seems highly desirable in order to understand better the origins and early evolution of the superfamily. Sapelnikov (1985) provided lengthy species lists, especially comprehensive for gypiduloid taxa described from Silurian and Devonian strata of the former Soviet Union. *Gypidula* is often cited as having a long stratigraphic range, from upper Llandovery to Frasnian, and is the gypiduloid genus with the largest number of attributed species. It seems probable that this genus has been overused as a 'catch-all' or 'ragbag' recipient, with many species that under closer scrutiny would be placed in other new or existing genera. The type species of *Gypidula*, *G. typicalis* Amsden, 1953 from Givetian strata of the Cedar Valley Group of Iowa, is typical of a plexus of species which seem be mostly restricted to the Eifelian-Frasnian. Nearly all stratigraphically older species attributed to *Gypidula* seem to belong in different genera.

Sapelnikoviella santuccii gen. et sp. nov. (Figs 5-7, Table 1)

Diagnosis. As for genus.

Description. Shells small, globose, strongly ventribiconvex, galeatiform. Ventral valve two to three times thicker than dorsal valve. Ventral fold and dorsal sulcus both strongly developed, resulting in a unisulcate anterior commissure. Plicae are strongly developed on both valves, limited

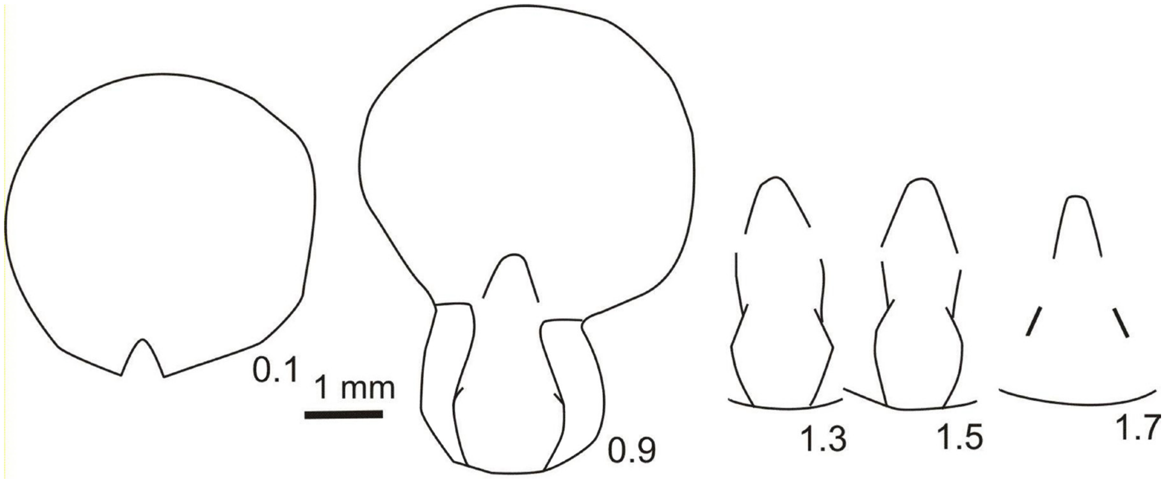

Figure 7. ***Sapelnikoviella santuccii*** gen. et sp. nov. Serial sections of paratype UAMES 23264; original length of shell 6.5 mm. Distances listed are those from the ventral beak; ventral valve is at top.

specimen	L	W	T
holotype UAMES 23259	9.0	9.4	8.8
paratype UAMES 23260	8.8	9.0	8.8

Table 1. ***Sapelnikoviella santuccii*** gen. et sp. nov.; measurements (in mm) of shell length (L), width (W) and thickness (T) of the holotype and a paratype.

primarily to the medial regions. Plicae are sharply angular and present on the anterior half to two-thirds of the shell length. Three plications are located on the ventral fold, with the outermost two forming its boundary and the central plica being slightly reduced in strength. Four plications are situated on the dorsal sulcus, the outermost two forming its lateral margins, with the medial pair of plicae being slightly reduced in strength. The flanks of both valves are commonly smooth, but one to two weakly developed plicae may be present on each flank. Umbones of both valves smooth. Ventral umbo strongly rounded, projecting beyond and overhanging the more weakly rounded dorsal umbo. Ventral median septum either strongly reduced or absent. Spondylium is unsupported for most of its length. The interior of the dorsal valve has discrete, relatively short, inner hinge plates which at their distal, ventral termination bear inward-projecting strong carinae. Carinae project ventromedially into the shell interior at their intersection with the outer hinge plates. In ontogenetically early shell stages, the outer and inner hinge plates are smoothly joined and form an evenly convex-outward bow. However, in later ontogeny the outer hinge plates appear separate and are almost vertically inclined, forming a generalised lyre-shaped brachidium typical for member of the subfamily Gypidulinae (see Fig. 7, intervals 1.3 mm and 1.5 mm distant from the dorsal umbo). Micro-ornament consists of closely spaced growth lines (Fig. 5E).

Discussion. Due to the paucity of complete articulated specimens and most of the material being fragmentary, no attempt is made here to provide a detailed biometrical analysis of the new genus and species. However, measurements can be given for the holotype and one of the paratypes, both of which are nearly completely preserved (Table 1).

Etymology. The species name is in honour of Vincent L. Santucci, geologist/palaeontologist with the US National Park Service, in recognition of his strong support for palaeontological work being conducted on National Park Service lands and for being the 'father' of National Fossil Day.

Types. Holotype, UAMES 23259; five paratypes, UAMES 23260 to 23264; all from locality 11RB16.

Other material. Twenty-two articulated shells (many fragmentary), 12 ventral valves, and 2 dorsal valves.

Occurrence. *Sapelnikoviella santuccii* gen. et sp. nov. is known only from a single locality, 11RB16, in strata of the late Silurian Willoughby Formation on the west side of Drake Island, Glacier Bay, Southeast Alaska.

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