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### STRATIGRAPHIC RANGE OF THE EARLY SILURIAN VIRGIANIINAE (BRACHIOPODA)

"*Pentamerus*" *borealis*, *Virgiana*, and *Platymerella* are the earliest Silurian representatives of the Subfamily *Virgianiinae* of the dominant Silurian Family *Pentameridae*. As such they are of particular interest in giving a foundation upon which to build a sound phylogenetic framework for the derivative taxa of the generic plexus now assigned to the Subfamily *Pentamerinae* of the *Pentameridae*. The specialized Ashgillian virgianid taxa *Holorhynchus*, *Eoconchidium* and "*Conchidium*" *münsteri* are so specialized as to do no more than indicate that the ancestry of the *Virgianiinae* must be sought for in the pre-Ashgillian. The Early Silurian virgianids are also of great stratigraphic interest because of their widespread distribution in North America, Europe and Asia. In all three continents beds containing Early Silurian virgianids occur in a stratigraphic position which can most easily be interpreted as Middle Llandovery (Berry and Boucot, in press).

In North America *Virgiana* and *Platymerella* occur in localities from Arctic Canada to west Texas, and Anticosti Island to Nevada beneath faunas dated by means of brachiopods, conodonts, and graptolites as of Late Llandovery age. In a few instances the Late Llandovery information is reliable enough to insure that a  $C_1$ — $C_2$  age i. e. very low in the Late Llandovery, should be assigned to these overlying strata. In a smaller number of occurrences brachiopods occurring beneath beds with *Virgiana* can be assigned an Early Llandovery age. Unfortunately, however, in none of the North American occurrences are graptolites of zonal value found in close conjunction with occurrences of either *Virgiana* or *Platymerella*. It must be admitted, therefore, that the North American occurrences of *Virgiana* and *Platymerella* can be assigned a maximum age span of "late" Early Llandovery through the Middle Llandovery and possibly into the lowest Late Llandovery.

In the Oslo region early representatives of "*Pentamerus*" *borealis* were reported by St. Joseph (1938) from Stage 6 c $\beta$ , which is considered to be Lower Llandoveryan, but the widespread occurrences of "*Pentamerus*" *borealis* may also be easily interpreted as of Middle Llandovery age as they occur in Stage 7a of the Oslo region which is sandwiched between the brachiopod-rich, Early Llandovery Stage 6, and the Late Llandovery Stage 7b. In Jämtland the Ede Quartzite brachiopod fauna (Boucot and Johnson, 1964) was interpreted to be of Early Llandovery age because of the great similarity of its taxa to those in Stage 6 of the Oslo region. However, recognition that the smooth virgianid (generically and



specifically unassigned by Boucot and Johnson) probably represents an occurrence of "*Pentamerus*" *borealis* raised a serious question about the possibility of a Middle Llandovery age for the Ede Quartzite. The abundant pentamerid of the overlying *Pentamerus* Limestone in Jämtland is probably also "*Pentamerus*" *borealis* but this does not help matters very much. Nowhere in the Oslo region or in Jämtland are zonable graptolites found in association with "*Pentamerus*" *borealis*.

The strata in Timan, Novaya Zemlya, and the west slope of the Urals north of the southern Urals have also yielded *Virgiana* and "*Pentamerus*" ex gr. *borealis* beneath brachiopod faunas of Late Llandovery age, but no graptolitic aids in correlation are available, nor definite Early Llandovery faunas beneath the strata containing virgianids.

On the west side and center of the Siberian Platform and to the north in the Taimyr Peninsula there are numerous occurrences of *Virgiana* above graptolitic beds of zone *Pristiograptus cyphus* to *Monograptus sedgwicki* i. e. late Early Llandovery through early Late Llandovery age, and below beds containing  $C_1$ — $C_2$  or younger Late Llandovery age brachiopods. The "*Pentamerus*" *borealis schmidtii* of this region appears to be a form intermediate between "*P.*" *borealis* and true *Pentamerus*; the stratigraphic information accompanying citations of "*P.*" *borealis schmidtii* are too vague, however, to allow one to decide whether the occurrences are well within the Late Llandovery or possibly earlier. Additional occurrences in Sette Daban and elsewhere are unassociated with the necessary stratigraphic information which might permit their precise position in the column to be ascertained.

The East Baltic area presents the most valuable information for defining the lower limit of the stratigraphic range of the Early Silurian *Virganiinae*, as here limestones with "*Pentamerus*" *borealis* are laterally replaced by graptolite-containing beds and are also overlain by strata well dated by graptolites.

The "*Pentamerus*" *borealis* beds, now considered as a local Tamsalu formation in the upper part of the Juuru stage (Нестор, Кала, 1968), are in Central Estonia laterally replaced by marls and argillaceous limestones of Varbola formation, containing *Stricklandia lens* (most probably subsp. *typica* or *prima*). In some cases "*Pentamerus*" *borealis* and *Stricklandia lens* were found together in the same sample. In North Estonia the last species occurs as often in the lower as in the upper part of the Juuru Stage, thus wholly "surrounding" the "*Pentamerus*" *borealis* bank.

In Central and South Estonia, in the Juuru Stage graptolites are rarely found. They are mostly species with a wide stratigraphic range, but the great percentage of climacograptids indicate a probable Early Llandovery age (Калъо, 1967). From topmost layers of Juuru Stage in Ikla boring (SW Estonia) the *Dimorphograptus confertus* Nich. is reported (Kaljo in Нестор, Кала, 1968), occurring in the standard section not higher than *Orthograptus vesiculosus* zone.

In Estonia, the Juuru Stage is overlain by cryptocrystalline limestones of Raikküla Stage, which in the lower part contains the graptolites *Pribylograptus atavus* (Jones), *Rhaphidograptus törnquisti* (E. & W.), *Diplograptus* cf. *modestus diminutus* E. & W., *Orthograptus* cf. *mutabilis* E. & W., *Pristiograptus sandersoni* (Lapw.) and in southern Estonia also *Pristiograptus cyphus* (Lapw.) and *P. incommodus* Törnq., showing that these strata can be easily correlated with the *Pristiograptus cyphus* zone of the graptolite succession (Калъо, 1967).



Above these strata in southernmost Estonia and in Latvia the *Demi-rastrites triangulatus* zone is well recognized by the presence of abundant zonal species.

All these data confirm that in Estonia the "*Pentamerus*" *borealis* limestone is without any doubt Early Llandoveryan in age and probably corresponds to the second and partly the third Silurian graptolite zones — that is *Orthograptus vesiculosus* and *Pristiograptus cyphus* or to some part of A<sub>2</sub>—A<sub>4</sub> Beds of Wales, dated by stricklandids.

Summary of the critical information regarding the three Early Silurian virganiid taxa permits us to state that in Estonia they occur only in a late Early Llandovery position well dated by means of graptolites, in North America and the Oslo region in a broad span which may be interpreted as late Early Llandovery through to C<sub>1</sub>—C<sub>2</sub> of the early Late Llandovery at maximum or Middle Llandovery at minimum, in Jämtland in an Early Llandovery and possibly in a still higher position, and on the Siberian Platform in a generalized late Early Llandovery through early Late Llandovery position. Considering the close evolutionary relationships existing between "*Pentamerus*" *borealis* and *Pentamerus* sensu stricto in conjunction with their known stratigraphic relations in the northern hemisphere it appears most likely that "*Pentamerus*" *borealis* should be interpreted to range from the late Early Llandovery through the Middle Llandovery, and possibly into the earliest Late Llandovery. It is reasonable to assume that the plicate analogs i. e. *Virgiana* and *Platymereella* will also have about the same stratigraphic range as "*P.*" *borealis* with the understanding that this assumption may be incorrect in detail.

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#### VARASILURI VIRGIANIINIDE (BRACHIOPODA) STRATIGRAAFILINE LEVIK

Põhja-Ameerikas, Euroopas ja Aasias laialdaselt levinud varasilurisse kuuluvate virgianiinide (*Virgiana*, *Platymereella*, «*Pentamerus*» *borealis*) esinemistaseks on siiani peetud kesklandovertit, kuna mitmetes regioonides lasuvad *Virgiana*'t sisaldavate kihtide peal kahtlemata hilislandovertisse kuuluvad graptoliitide või brahhiopoodide sisaldavad kihid.

Viimased Baltikumi alamsiluri stratigraafiat käsitlevad uurimused (Кальо, 1967; Нестор, Кала, 1968) aga näitavad, et selles regioonis lamavad «*Pentamerus*» *borealis*'ega kihid alamländoveri *Pristiograptus cyphus*'e tsooni all ja asenduvad lateraalselt (ka vertikaalselt) kihtidega, milles esineb *Stricklandia lens* (alamliik *typica* või *prima*). Seetõttu ei ole kahtlust, et «*Pentamerus*» *borealis*'e kehvel on Põhja-Baltikumis juba varaländoveri vanusega ja võib vastata *Pristiograptus cyphus*'e tsooni alumisele osale, tõenäolisemalt isegi osale *Orthograptus vesiculosus*'e tsoonist. Seega võib käsitletud virgianiinide stratigraafilise leviku ilmselt paigutada ajavahemikku varaländoveri teisest poolest kuni varajase hilislandovertini.



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### СТРАТИГРАФИЧЕСКОЕ РАСПРОСТРАНЕНИЕ РАННЕСИЛУРИЙСКИХ ВИРЖИАНИН (BRACHIOPODA)

Возраст раннесилурийских *Virganiinae* (*Virgiana*, *Platymereella*, «*Pentamerus borealis*»), широко распространенных в соответствующих отложениях Северной Америки, Европы и Азии, до сих пор датировался средним лlandoвери, поскольку в ряде регионов непосредственно над слоями с виржианинами были установлены граптолиты или раковинная фауна несомненно позднелlandoверийского позраста. О нижней границе биозоны силурийских виржианин точные данные отсутствовали.

Последние работы по стратиграфии и корреляции нижнесилурийских разрезов Северной и Средней Прибалтики (Кальо, 1967; Нестор, Кала, 1968), однако, показывают, что в этом регионе слок с «*Pentamerus borealis*» залегают ниже слоев с граптолитами зоны *Pristiograptus cyphus* и замещаются латерально (и вертикально) слоями, содержащими *Stricklandia lens typica* или *prima*. Таким образом, известняки с «*Pentamerus borealis*» в Северной Прибалтике несомненно являются раннелlandoверийскими и могут соответствовать низам граптолитовой зоны *Pristiograptus cyphus* или, скорее всего, определенной части зоны *Orthograptus vesiculosus*. Следовательно, распространение раннесилурийских виржианин можно датировать временем от второй половины раннего лlandoвери до начала позднего лlandoвери.