

## DISTRIBUTION OF SELECTED ORDOVICIAN CHITINOZOAN ASSEMBLAGES AND SPECIES IN NORTHERN EUROPE AND THEIR STRATIGRAPHICAL EVALUATION

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### Résumé

La répartition de certaines espèces de Chitinozoaires (*Lagenochitina esthonica*, *Pterochitina retracta*, *Eremochitina dalbyensis*, *Cyathochitina dispar*, *Acanthochitina barbata*, etc.) est discutée. La plupart de ces espèces ont une répartition verticale restreinte et leurs zones peuvent être suivies sur des longues distances, dans certains cas du Shropshire à l'Ouest jusqu'à la partie centrale du syneclyse de Moscou. Il semble que l'utilisation de certaines espèces de Chitinozoaires puisse permettre de préciser les limites inférieure et supérieure des zones à *Nemagraptus gracilis* et *Pleurograptus linearis* ainsi que d'autres niveaux stratigraphiques.

### Резюме

Рассматривается распространение определенных представителей хитинозой (*Lagenochitina esthonica*, *Pterochitina retracta*, *Eremochitina dalbyensis*, *Cyathochitina dispar*, *Acanthochitina barbata* и др.), имеющих наиболее важное значение для корреляции ордовикских отложений Северной Европы. Большинство из таких форм образуют четкие зоны, прослеживаемые на значительные расстояния, отчасти от Шропшира на западе до центральных районов Московской синеклизы на востоке. Предполагается, что при помощи хитинозой можно прослеживать границы граптолитовых зон *Nemagraptus gracilis* и *Pleurograptus linearis*, а также некоторые другие маркирующие стратиграфические уровни.

К статье «Силурийская система в Казахстане»

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The first results of a systematic study of the chitinozoans of the Ordovician in Shropshire [JENKINS, 1967], Dalarna [LAUFELD, 1967] and the Moscow syneclyse [UMNOVA, 1969] and the most recent data concerning their distribution in the bedrock sequence of the East Baltic area allow us to consider the problems of the distribution of chitinozoans and their correlational significance, now already on the scale of Northern Europa. Of course, the yet insufficient level of our knowledge of chitinozoan taxonomy in general and their distribution in different sequences of the given region in particular enables us to deal with those problems in a tentative manner, at the time being. Much work has yet to be done on the study of chitinozoans, especially on their zonal and geographical distribution, since the data connected with those problems are only in the preliminary stage of accumulation.

The present report deals with the distribution of merely a few species of chitinozoans whose occurrence has been stated in some regions of Northern Europe and which, according to the author's opinion, are more or less useful for the Ordovician stratigraphy of that area. The material is presented in a stratigraphical order, from the Arenigian to the Ashgillian, with special regard to the Caradocian.

The Arenigian assemblage of chitinozoans has up to now been only studied in the eastern regions of Northern Europe, and in an insufficient degree, as yet. Here belong, above all, the chitinozoan fauna of the Latorp (B<sub>I</sub>), Volkhov (B<sub>II</sub>) and, probably partially, also of the Kunda Stage (B<sub>III</sub>) of the Moscow syneclyse [UMNOVA, 1969], of B<sub>II</sub> of Northern Estonia [EISENACK, 1958] and of B<sub>III</sub>α of Sweden [EISENACK, 1955]. In the above-mentioned regions we may meet a number of chitinozoan species in common (*Cyathochitina calix*, *C. regnelli*, *Rhabdochitina magna*, *Conochitina? simplex*, and others), but it is, as yet, difficult to point to definite forms having any particular bearing upon the stratigraphy and correlations. In the

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Moscow syncline a particularly clear faunistic boundary is to be observed at the border between the assemblages Kunda 1 and Kunda 2 [UMNOVA, 1969], characterized by the appearance of a dwarf form of *Cyathochitina calix* (*C. granulata*, according to UMNOVA). In the sequence of North Estonia (Jägala) this form is evidently strictly restricted to the Voka Member ( $B_{III}\beta V$ ) and the lower half of the Pakri Member ( $B_{III}\beta P_1$ ); immediately below the above-mentioned members, in the oölitic limestone of the Pada Member (of a thickness of 0.07 m at Jägala, only), a peculiar assemblage of chitinozoans occurs, containing *Cyathochitina regnelli*, *C. campanulaeformis*, *Lagenochitina tumida*, and others, of those three species, the first one is met here for the first time, whereas the others are probably restricted in Estonia to this limestone (when concerning Arenigian and Lower Llanvirnian only). On the basis of the distribution of the dwarf form of *C. calix*, the above mentioned assemblages 2 and 3 may be correlated with  $B_{III}\beta V + B_{III}\beta P_1$  of North Estonia, and, on the analogy of the sequence of Oland [cf. SKERVINGTON, 1965], with the zone of *Didymograptus bifidus*. The age of the assemblage 1, as well as the age of the Pada limestone remains uncertain, as yet; it is possible that they both correspond to the zone of *Asaphus expansus* and belong to Arenigian.

It is a striking fact that in all the three mentioned assemblages of the Kunda Stage of the Moscow syncline, *Desmochitina* is missing, like in the whole Llanvirnian of Shropshire. Besides, the Llanvirnian assemblage of chitinozoans in Shropshire is characterized by the presence of *Siphonochitina*, which is entirely missing in the eastern regions of Northern Europe.

In the Llanvirnian of Shropshire, the presence of two eastern elements — *Lagenochitina esthonica* and *Pterochitina* is quite striking. The former occurs there in the *Didymograptus bifidus* zone, which is in no contradiction with its range in Northern Estonia — from  $B_{II}S$  (Upper Arenigian) to  $B_{III}\gamma V$  (Lower Llanvirnian). In the Moscow syncline, *L. esthonica* has been found by us, up to now, only in  $B_{III}\beta$  and  $B_{III}\gamma$  (Rostov boring, depth 1584-1699 m). In the Ordovician of North Estonia and Moscow syncline, the genus *Pterochitina* has been met with only in the interval between the lower part of the Lasnamägi Stage ( $C_1b$ ) to the middle of Kukruse Stage ( $C_{II}$ ), in other words, not lower than the zone of *Didymograptus murchisoni*. This allows us to assume that the transitional strata between Stapeley Shales and Weston Beds of Shropshire, which contain *Pterochitina*, ought to be classified as basal Weston Beds and, together with them, correlated with the zone of *Didymograptus murchisoni*.

The three upper chitinozoan assemblages of the Moscow syncline (Kunda 4, Tallinn 1, 2), as asserted by N. UMNOVA, are very similar to each other and almost miss such index forms which would allow to compare them with western assemblages. It is only of significance that *Cyathochitina calix* is absent in the uppermost assemblage, being replaced by *C. campanulaeformis*. In Northern Estonia, the latter is first met with (if not to consider its presence in the Pada member) at the lower boundary of the stage  $C_1b$  (where *C. regnelli* disappears), which stage accordingly ought to be correlated with the assemblage of Tallinn 2. If this correlation is correct, the similarity of the three uppermost assemblages of the Moscow syncline could be explained by their belonging to one and the same graptolite zone (the zone of *D. murchisoni*).

Apparently, the beginning of the Llandeilian in the development of the chitinozoan fauna of Northern Europe reveals no particular traits, if not to consider the absence of *Siphonochitina* and the appearance of *Desmochitina* in the Llandeilian of Shropshire, as a whole [JENKINS, 1967]. In North Estonia and in Leningrad district, the boundary beds between the Upper Llanvirnian stage  $C_1b$  and the Llandeilian stage  $C_1c$  which were especially studied by us on the distribution of chitinozoans, a distinct chitinozoan assemblage (*Conochitina clavaherculi*, *Cyathochitina striata*, *Pterochitina retracta*, *Conochitina* cf. *cactacea*) occurs in a practically unchanged manner, both in the stage  $C_1b$  as well as in the lower part of the stage  $C_1c$  (in the zone of *Gymnograptus linnaeensis*). Geographically, that assemblage may be traced, at least, from Oland up to the eastern part of the Leningrad district.

The stage  $C_1c$  of North Estonia, according to available data, does not contain any index species of chitinozoans, but it is characterized by the first appearance of *Cyathochitina stentor* and *Conochitina tuberculata*.

The base of stage  $C_{II}$  (= the base of Caradocian) in North Estonia is marked by the appearance of certain new forms of chitinozoans — *Cyathochitina kuckersiana*, *Conochitina elegans*, *C. oelandica*, *C. aff. tuba* — most of which have a wide distribution. Furthermore, the appearance of the two first above-mentioned species in the Costonian of Shropshire confirms the correlation of  $C_{II}$  with the lowermost Caradocian. It is of interest to note that *Cyathochitina kuckersiana* and *Conochitina elegans* seem to occur, both in Shropshire and North Estonia, almost in the whole sequence of the Caradocian, whereas in the Caradocian of Sweden they are practically unknown.

The upper part of  $C_{II}$  in North Estonia and the corresponding beds of the Dalby Formation of Dalarna contain strikingly similar chitinozoan assemblages, which include *Cyathochitina campanulaeformis*, *C. stentor*, *Conochitina suecica*, *C. dolosa*, *Desmochitina lecaniella*, and others. The contemporaneity of the beds containing those assemblages is further evidenced by the presence of the zone of *Eremochitina dalbyensis*, which occurs in the lower part of the Idavere Stage ( $C_{III}$ ) and is well defined in both regions. This zone seems to have a particular significance for correlations and will probably be established in other regions as well.

In Baltoscandia and Shropshire, an higher level, probably corresponding to a certain part of the zone of *Diplograptus multidentis* is marked by the first appearance of *Spinachitina*. In Estonia it corresponds to the base of the Jõhvi Stage ( $D_1$ ), where the first finds of *Spinachitina cervicornis* and *S. multiradiata* have been made. In Dalarna, these species are typical of the Skagen Limestone, which is either correlated with  $D_1$  [JAANUSSON, 1960] or  $D_{II}$  [MANNIL, 1966]. In Shropshire, the first

representative of *Spinachitina* (*S. bulmani*) is known from the Glenburrell Beds (Lower Soudleyan). Higher up in the sequence the range of *S. alaticornis* begins; this species is either identical with *S. cervicornis* or very closely related to it.

*S. cervicornis* evidently disappeared from the East Baltic area earlier (at the upper boundary of the Oandu Stage, D<sub>111</sub>) than *S. alaticornis* in Shropshire (basal Acton Scott Beds), since the latter species has been encountered together with *Hoegisphaera complanata*, which is in the East Baltic area a well-known chitinozoan of the Osteokalk [EISENACK, 1965] and has probably a range of uppermost F<sub>1a</sub> — lowermost F<sub>1b</sub>. The interval of the Caradocian sequence, lying between the level of the disappearance of *Spinachitina* in Baltoscandia (the upper boundary of D<sub>111</sub>) and the base of the zone of *Acanthochitina barbata* (see below), i.e. the stages E, F<sub>1a</sub> and the lower part of F<sub>1b</sub> of Estonia, may be correlated with the interval between the Marshbrookian and the Lower Onnian of Shropshire. The corresponding part of the Caradocian, both in Shropshire and in Dalarna, is rather poor in chitinozoans and devoid of index forms in common. In the East Baltic that interval shows an abundant development of the chitinozoans of the *Conochitina micracantha* group and the appearance of definitely exotic forms (in Shropshire, of *Hercochitina downiei*), of which *Cyathochitina dispar* is probably of particular importance. That species forms a well-defined zone in the East Baltic area, which is represented by limestones at the base of F<sub>1a</sub> in North Estonia, and by marls and limestones lying between the Mossen (zone of *Dicranograptus clingani*) and Fjäckå shales (= zone of *Pleurograptus linearis*) in the Central East Baltic. Besides the mentioned districts, the above zone has also been established on the territory of Lithuania (Pajavonys boring) and Eastern Poland (Mielnik boring).

One of the best-outlined chitinozoan zones of the Ordovician of Northern Europe, and, may be, of the entire Ordovician, is the zone of *Acanthochitina barbata*, which is situated at the boundary of the Caradocian and Ashgillian. In Baltoscandia, it has been up to the present time established in Dalarna [LAUFELD, 1967], Estonia, and also in the central and southern districts of the East Baltic. In Dalarna and in the central East Baltic, *Acanthochitina barbata* (together with the associated *Tanuchitina bergstroemi* and *Lagenochitina prussica*) has been stated in the upper clayey beds of Fjäckå Shales which contain graptolites of the zone of *Pleurograptus linearis* [cf. SKOGLUND, 1963]. In Northern Estonia and Lithuania (Ukmerge boring), the given zone attains a thickness, respectively, of 1, 5-2, 0 and 6,7 m, lying at the boundary of F<sub>1b</sub> and F<sub>1c</sub>.

In Shropshire, the zone of *Acanthochitina barbata* is proper to the upper part of the Onnia Stage, where it is ca. 25 m thick. It is most probable, that *Acanthochitina barbata* has in Shropshire exactly the same stratigraphic range which it has in the East Baltic area. If it is really so, then the overlying Pushgill Stage ought to be classified with the Ashgillian.

The Ashgillian chitinozoan assemblages, as far as we may judge by the materials of the East Baltic, are rather poor. They are best known by the chitinozoans of the erratics of Ojle mur, Gotland, where A. EISENACK [1968] established 9 species, including the Ojle mur index species *Conochitina taugourdeui*. The latter is evidently of a zonal value, being of significance, at least in some districts of the East Baltic, for drawing the upper boundary of the Ordovician. On Estonian territory it has been established, together with its associated forms (*Ancyrochitina ancyrea*, *Cyathochitina kuckersiana*, and others), in the uppermost part of F<sub>11</sub> in the Ohesaare, Kingissepa and Pärnu borings. The thickness of the zone of *Conochitina taugourdeui* amounts here up to 5 m. The basal beds of the Silurian in that region are characterized by the absence of such characteristic Ordovician species, as *Rhabdochitina magna*, *Conochitina minnesotensis* and forms of the group of *Conochitina micracantha*, all of them being still present in the uppermost Ashgillian.

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