



SVERIGES GEOLOGISKA UNDERSÖKNING  
Rapporter och meddelanden nr 25

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Sven Laufeld [Ed.]

# Proceedings of Project Ecostratigraphy Plenary Meeting, Gotland, 1981

Uppsala 1981



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ISBN 91-7158-241-X

ISSN 0349-2176

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PROCEEDINGS OF PROJECT ECOSTRATIGRAPHY  
PLENARY MEETING, GOTLAND, 1981



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#### COVER PICTURE

*Kodonophyllum truncatum* (Linnaeus) from the Silurian of Gotland.

The first published pictures of pre-Quaternary fossils from Sweden are those of a small paper from 1715 by Lars Roberg. In 1717 Emanuel Swedenborg published drawings of two fossils — *Calymene* and *Atrypa reticularis* — which were probably collected on Gotland.

It was not until 1728, however, that pictures of fossils undisputedly from the Silurian of Gotland were published by Magnus von Bromell in his "Lithografia Svecana". The cover picture is a facsimile — enlarged 3 x — from page 465 of "Lithografia Svecana".

## INTRODUCTION

When the Swedish National Committee for the International Geological Correlation Program submitted the proposal on Project Ecostratigraphy to Unesco in 1973 it was formalizing the work of the Baltic-Scanian Silurian Project which had its geological roots on Gotland. So it may well be said that Project Ecostratigraphy was launched on Gotland. Hence, the Swedish group of Project Ecostratigraphy felt it appropriate to invite to a fully international Project Ecostratigraphy Plenary Meeting on Gotland. The indoor parts of the Plenary Meeting will take place at Allekvia - the geological research station east of Visby operated by the national Ecostratigraphy group and sponsored by the Swedish Natural Science Research Council, the Gotland Commune and the Geological Survey of Sweden. The indoor scientific program will be followed by four days in the field.

The indoor scientific program has four main topics:

- (1) Crossing the boundaries of the facies realms
- (2) Basin analysis of the Silurian "Baltic Gulf" (the Lithofacies subproject, final reports)
- (3) Downtonian - Podlasian - Pridolian Correlation
- (4) Ecostratigraphy in theory and practice

More than 40 papers will be presented within the first three main topics. The fourth main topic will be dealt with in a panel discussion with the audience. Papers will be presented by the members of the panel A.J. Boucot (USA), A. Hoffman (Poland), D. Kaljo (USSR), and A. Martinsson (Sweden).

The plenary meeting also includes presentations of activities of national Project Ecostratigraphy groups by J.D. Lawson (UK), B.S. Sokolov (USSR) and S. Laufeld (Sweden) and meetings with the progress reports of, e.g. Project Ecostratigraphy and the IUGS Subcommittee on the Silurian System.

The present publication contains the abstracts of almost all papers presented at the Project Ecostratigraphy Plenary Meeting on Gotland 22-28 August, 1981. These Proceedings reflect the tremendous amount of work that is put into Project Ecostratigraphy and towards its goal, "biochron correlation at the ecosystem level, using the Wenlockian-Gedinnian as a test sequence".

Finally, attention is drawn to the abstract at the end of the publication. This paper by G. Elaine Beane is but a part of the non-geological activities at the Project Ecostratigraphy Plenary Meeting but its outstanding quality merits its inclusion here since it reflects the motto of the Allekvia research station "a free-port of Science between East and West".

Agneta Ek, Steve Kershaw, P.H. Lundegårdh, Anders Martinsson, and Roland Skoglund have kindly lent their expertise towards the publication of these Proceedings.

The abstracts are arranged alphabetically after the authors' family name

## ABSTRACTS

1

TRILOBITE CORRELATION OF THE UPPER SILURIAN OF GOTLAND WITH ESTONIA,  
LATVIA, LITHUANIA, POLAND, GREAT BRITAIN AND GERMANY

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Relatively little attention has so far been paid to trilobites for correlation. This is partly due to insufficient study, but at present the situation in this respect is greatly improving. The authors' studies of trilobites from Gotland, Poland, East Baltic, Great Britain, and Germany yield important data for correlation:

Series	Eng-land	Graptolite Zones	Gotland	East Baltic Area (Latvia, Lithuania)	North and East Poland	Holy Cross Mountains	
LUDLOW	PRIDDLI	L5B	lochko- vensis	Kaugatuma Miriya Form.	Podlasie Lower	Rzepin Upper	
			formosus- ultimus	Proetus signatus subsp. 2 P. signatus Acastella prima P. signatus "templa knighti"	Acastella prima Proetus signatus P. cf. signatus Calymene latvica Häripidella sp. Ananaspis sp. Cheirurus sp.		Acaste dayiana Acastella cf. prima Acastella prima Calymene begeri (s.l.) Proetus signatus
	Ludfordian	Whiteliffian	Neo- cucullo- graptinae	Eke Härmä-Suutari	Paedra Stage	Siedlce Lower+Middle	Wydrysow
			leint- wardi- nensis	Proetus signatus subsp. 1 Encrinurus macrourus	Paedra Stage	Proetus signatus Scotiella sp. Calymene neointermedia Encrinurus macrourus	
	Gorstian Elk+Bring- milsoni	Leintw	tumes- cens	Hemse	Paedra Stage	Ludlow Mielnik	Pragowiec
			scanicus- milsoni	Calymene neointer- media	Dubysa Form.	"Spatha- calymene" sp. Calymene cf. neointermedia	

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## KEY POINTS FOR CORRELATION IN THE SILURIAN OF GOTLAND

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The accuracy of both local and inter-regional correlation in the Silurian succession of Gotland differs from level to level throughout the island. By integrating new and published data on the distributions of ostracodes, tentaculitids, shelly macrofaunas, and graptolites, plus some supplementary information on chitinozoans and conodonts, it is possible to recognise a number of key horizons of restricted vertical extent that appear to reflect time rather than environmental control. At present, dating of beds between the key levels must be made on the basis of extrapolation rather than on diagnostic faunal/floral elements.

The Llandovery/Wenlock boundary appears to lie at the base of the upper unit of the Visby Formation, and the Wenlock/Ludlow boundary is within the upper part of the Klinteberg Formation. The key biostratigraphical levels cut slightly obliquely across the thirteen major mapped divisions used in most accounts of Gotland stratigraphy, implying that in detail the latter are diachronous to varying degrees.

Relationships in the upper Slite, Halla, Mulde, Klinteberg, lower Hemse interval are particularly complex, with some levels indicating that parts of these units represent not a vertically successive stratigraphy but lateral facies associations within synchronous belts. The construction of new 'time-lines' for Gotland enables facies maps to be drawn to illustrate the pulsatory regression of the Silurian sea southwards and south-eastwards across this part of the Baltic platform.

3

## THE DOWNTON SERIES AS THE FOURTH SERIES OF THE SILURIAN SYSTEM

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A review of lithofacies and fossil distributions in the Downton strata of the Welsh Borderland and Wales indicates that these beds form a suitable basis for definition of a chronostratigraphical division of Series rank within the Silurian System. The basal boundary stratotype for the Downton Series is defined at the base of the Ludlow Bone Bed Member of the Downton Castle Sandstone Formation in a section at Whitcliffe Road, Ludlow. Shallow water marine sediments span the boundary, with no evidence of a measurable time break. Correlation of the base of the Downton Series from eastern North America through Balto-Scandia and Poland suggests that it lies at or very close to the base of the *Monograptus ultimus* Biozone and thus approximates to the base of the Prídolí beds of Bohemia. This paper formed a submission to the Subcommittee on Silurian Stratigraphy in May 1981.

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## DISPERSED POLYCHAETE JAWS AND CLUSTERS IN THE HÖGKLINT BEDS, GOTLAND

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In the lower Wenlockian Högklint Beds on Gotland the frequency of polychaete jaws varies from zero to over 2000 elements per kg of rock. Partial reconstructions of polychaete apparatuses are possible by means of numerical methods and the colour and morphology of the jaws. Rarely, fused elements and clusters of elements are found on bedding planes, but unfortunately provide little important information about jawed

polychaetes on Gotland due to the much greater abundance of dispersed jaws. The study of the variation within a population, the variation during ontogeny, the stratigraphical and geographical distribution, and ecological aspects must be based wholly on dispersed elements. It is only regarding the reconstruction of apparatuses that clusters will be of any significance.

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PALAEOCURRENTS, WAVE MARKS AND REEFS; A PALAEOGEOGRAPHICAL INSTRUMENT APPLIED TO THE SILURIAN OF GOTLAND.- THE WHOLE ENVIRONMENT - SILURIAN SLITE BEDS, GOTLAND

Claes F. Bergman

The Wenlockian Höglint and Slite reefs are roughly oriented NE-SW. This trend is regarded as related to water depth. Wave marks from the Höglint and Slite Beds show a uniform NE-SW orientation, probably caused by shallowing of the sea. In the Slite Marl on Fårö representatives of several groups of fossils show bimodal and unimodal orientation in a SE-NW and SE direction, respectively. At the locality Haganäs 1 the fossils were oriented by a current which carried a large proportion of mud and swept along the bottom towards the SE. Driven by its higher density, such a current moved perpendicular to depth contours towards deeper parts of the basin. Preferred orientation combined with the distribution of lithofacies, the extension of reefs and the orientation of wave marks strongly support a deepening of the basin in middle Wenlockian time towards the SE in the northern Gotland region.

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SHORELINE PROXIMITY DISTRIBUTION OF VERTEBRATES DURING  
THE PRE-DEVONIAN

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A survey of the known pre-Devonian vertebrate localities indicates that the Lower Silurian and older depositional occurrences are restricted to the marine environment, whereas the Upper Silurian include well documented marine and nonmarine environments. The pre-Devonian occurrences, both Upper Silurian and older, include both nearshore and shoreline remote environments. The oldest occurrences are in the Upper Cambrian, but varied occurrences are present as well in the Ordovician and Lower Silurian.

In the interval Wenlock-Gedinnian not much attention has yet been given to the recognition and definition of vertebrate communities in the strict sense. But, it is clear that such communities do exist. Biogeographic analysis of Wenlock-Gedinnian vertebrates has not yet been carried out to any usable extent. However, it is probable that the circum-North Atlantic vertebrate occurrences will be found to differ significantly from those present in both China and Asia.

In the marine environment during the Wenlock-Gedinnian interval it is probable that community analysis involving vertebrates will be of only ancillary importance as contrasted with the commonly far more abundant, associated invertebrates. But, in the non-marine environment the reverse will probably be the case.

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THE DOWNTONIAN/PRIDOLIAN/PODLASIE INTERVAL IN THE CANADIAN  
ARCTIC ISLANDS

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The Silurian-Devonian succession of the islands in Canadian Arctic Lowland belt are now relatively well known in their lithostratigraphy and include a wide range of marine and non-marine facies. Continuing work by the Geological Survey of Canada and the University of Ottawa Arctic Group is providing closer lithostratigraphic and biostratigraphic control, vertebrates, invertebrates and microfossil assemblages now being recovered and studied from an increasing number of localities and horizons. A contribution to this from the University of Bristol is a study of vertebrate faunas from Cornwallis, Somerset and Prince of Wales Islands. In particular, D.K. Elliott has traced cyathaspid-pteraspid lineages through the succession in eastern Prince of Wales Island and has also examined primitive pteraspid faunas from Somerset Island. D.L. Dineley and E.J. Loeffler continue with surveying and revision of traquairaspid and cyathaspid forms, principally from Somerset Island.

There appears to be evidence for establishing a continuous (?phylogenetic) sequence of these forms from the Ludlovian into the Downtonian. The traquairaspids previously described are early Downtonian in age; the earlier (Silurian) species of the group are not so immediately recognisable. The presence of marine macrofauna and conodonts in beds between those yielding the vertebrates is of value in correlation; spores have so far been conspicuous by their absence.

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## A CRINOID THANATOTOPE FROM THE EKE BEDS

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The När slab (approximately 1 x 1 m) from the Ludlovian Eke Beds displays a magnificent crinoid thanatotope of 260 specimens belonging to four species of three genera. Two species and one genus are new. They occur in marked preferred orientation on the upper surface of a lens composed of *Coenites* fragments and bioclastic debris, and were buried in place by a sudden influx of the same type of sediment. The fossilizable community comprised crinoids only: those other organisms occurring on the surface, including the ubiquitous *Coenites*, were obviously washed in with the sediment burying the crinoids and were no part of the community itself. Crinoid stem lengths indicate a multi-level growth pattern where the different species occupied different niches depending on height above the sea floor. The populations of two of the genera include juvenile specimens while the third genus comprises adults only. Regeneration of parts of crown and arms occurred in several occasions; no signs of parasitism has been found.

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## STATUS OF PRE-DEVONIAN SPORE WORK

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A continuous record of land-plant spores — very possibly of vascular plant origin — and of the same basic morphologies as spores found *in situ* in sporangia of early vascular plants (Allen 1980; Gensel 1980), exists from the Caradoc into the Devonian around the North Atlantic Basin and in North Africa in strata suggesting nonmarine or shallow-water,

nearshore marine deposition. Unpublished data from China indicates the presence of Wenlockian and Ludlovian land plant spore assemblages in Eastern Asia. Pre-Devonian spore assemblages are also known from Peru and Bolivia (Laubacher, Boucot, Gray in press).

A fundamental change in spore morphology occurs during the Ordovician-Devonian interval. Caradocian to pre-mid-late Llandoveryan (ca. C2/C3 boundary) strata are dominated, usually exclusively, by the occurrence of small, smooth-walled, compact tetrahedral tetrads of spores. The tendency for these tetrads to increase in size during the late Llandovery is interpreted as an indication of evolutionary diversification. Although these tight tetrahedral spore tetrads persist into the post-mid-late Llandovery, latest Llandovery and Late Silurian spore assemblages are marked by an increase in the number and diversity of single trilete spores and in some cases (as in Gotland) by an increase in the diversity of tetrad types. This fundamental change from spore tetrad to single trilete spore assemblages occurred throughout the North Atlantic Basin and in North Africa and can be exploited to provide a first order biostratigraphy for nearshore, shallow-water Ordovician-Llandoveryan strata. Although post-Llandoveryan spore assemblages have an increased number of spore taxa, diverse spore assemblages are now known prior to the Devonian, only in the Wenlockian-Ludlovian of North Africa (Richardson and Ioannides 1973) and in the Ludlovian of Gotland (Gray and Boucot, Ms.). These assemblages have many striking differences, possibly of ecological or biogeographic significance and the Gotland Ludlovian assemblages is also distinct from coeval spore assemblages known from Great Britain and eastern North America.

The evolutionary implications of (1) Caradocian land plant spores in North Africa, (2) spore evidence which suggests the possibility of incipient heterospory in that area in the early Silurian, and (3) the presence of an advanced "Devonian" megafossil flora in the Silurian of Libya, will be discussed.

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## THE STATE OF SILURIAN STRATIGRAPHY

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Progress in Silurian studies — palaeontological, palaeoecological, palaeobiogeographical, sedimentological, tectonic, palaeogeographical, etc. — require an understood and agreed standard global stratigraphical scale. The Subcommittee on Silurian Stratigraphy, in many ways closely associated with Project Ecostratigraphy, is in the fifth year of an eight year programme designed to achieve an agreed and complete Silurian chronostratigraphy. Achievements so far are briefly reviewed. Remaining problems are outlined as are developments towards their possible solution.

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## PRIDOLIAN GRAPTOLITES — WORLD DISTRIBUTION, ZONES

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Benthic dendroid graptolites occur frequently through the sequence of interbedded platy limestones and calcareous shales of the type Pridolian in the Barrandian area and in coeval rocks of similar lithology in Nevada, but have no biostratigraphical significance. The planktic graptoloid graptolites of Pridoli age are of outstanding value for world-wide correlations, individual faunas containing a fair number of cosmopolitan species or consisting exclusively of cosmopolitan species. All continents, except South America and Antarctica, have yielded Pridolian graptolites.

In the Barrandian type area the following seven zones and inter-zones are recognized at present (in ascending order): Zones of *Monograptus parultimus*, *M. ultimus*, *M. similis*, *M. lochkovenssis*,

*M. bouceki*, *M. perneri* and Interzone of *M. transgrediens*. Most of these are also known from areas outside the Barrandian, some even from several continents.

Recent discoveries of Pridolian graptoloids, particularly in Kasachstan, but also in the Barrandian type area, reveal a greater diversity of forms than hitherto known.

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#### COMMENTS ON THE GRAPTOLITE CHRONOLOGY OF GOTLAND

Hermann Jaeger

I have no new graptolite data on the Visby Marls and Höglint Limestone. The occurrence of *Monograptus priodon* s.l. in various levels of the Slite Beds, inclusive of its uppermost portion, indicates that these do not range higher than the top of the Upper Wenlock Zone of *Cyrtograptus lundgreni*. The association of *Gothograptus nassa* and *Monograptus dubius*, and total lack of *M. priodon* s.l., in the Mulde Marl, suggests correlation of much of this unit with the Interzone (Interregnum) of *M. dubius*/*G. nassa*, but the occurrence of an early form of *Monograptus deubeli* in the uppermost Mulde indicates that the Mulde Beds extend into the succeeding Zone of *M. deubeli*.

The uppermost graptoloids from Gotland that allowed safe identification to be made are from the Hemse Beds, i.e. the fauna of Lilla Hallvards 1 in Hablingbo; this is dominated by *M. chimaera*, index of the Zone of *M. chimaera* (= Zones of *M. scanicus* and *M. tumescens*).

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## THE CONODONT FAUNAS IN THE BEYRICHIEKALK

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The conodont faunas in the *Beyrichienkalk sensu stricto* are dominated by *Ligonodina elegans* and *Hindeodella steinhornensis*. In a few samples *H. confluens* occur. Different subspecies occur and thus the unit can be subdivided. This study is a part of A. Martinsson's project on the *Beyrichienkalk*, and it is based on his samples from the unit, to a large part on those which he discussed in 1965 (Geol. Fören. Stockholm Förh. 87:109-138). Thus the conodont-based subdivisions can be tied in with the ostracode faunas (Martinsson's faunas 3-6).

In boulders with *Frostiella cornuta* and *Nodibeyrichia tuberculata* (fauna 3) there is a population of *L. e. elegans* — without any sign of alternating denticulation — and *H. steinhornensis* ssp.a.

In boulders with *F. pliculata* and *N. tuberculata* (fauna 4) the above conodonts are joined by *H. s. interposita*.

In boulders with *Kloedenia leptosoma* and *N. tuberculata* (fauna 5) there is *L. e. elegans* — often in typical form with strains of white matter in the processes between the denticles — and *H. s. buchaniensis* s.str.

In pebbles with *K. wilckensiana* and *N. tuberculata* (fauna 6) there is a population of *L. e. detorta* — with one or two small denticles in each space between the normal-sized denticles on the posterior process of some of the hi elements and occasionally on other elements too — and *H. s. buchaniensis*.

*L. e. detorta* occurs also in three other faunas important for the correlation of fauna 6. In other aspects, the four conodont faunas differ.

(A) The taxon occurs in the conodont fauna described by Wolska (Acta Pal. Polonica 1969:577-590) from 103.6-105.6 metres above strata with *Pristograptus transgrediens* — the youngest graptolite zone in the Silurian — and 22.6-24.6 metres below strata with *Monograptus uniformis angustidens*.

(B) It occurs also in a condont fauna from my sample Tj80-7 from about 1.1 metres below the top of the Silurian at Klouk — the type locality for the Siluro-Devonian boundary. This is about 0.65 metre above the highest find of *P. transgrediens*, and 1.1 metres below strata with *M. u. uniformis* and *M. u. angustidens*.

(C) In Cellon, in beds 45 and 46, about 1.0 and 0.6 metre below the top of the Silurian as presently identified. Here *L. e. elegans* is known from older beds. In bed 46A — about 0.5 metre below the boundary — a population of *L. e. detorta* occurs that is slightly more advanced than those now known from the *Beyrichienkalk* (8 small samples with about 170 elements). *M. uniformis* occurs in bed 50, approx. 3 metres above bed 46.

This very precise correlation of the uppermost fauna in the *Beyrichienkalk* confirms that based on ostracodes.

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#### CORRELATION OF LOWER SILURIAN CARBONATES ON THE NORTH AMERICAN PLATFORM BY MEANS OF SEA-LEVEL CURVES

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Exposures of Lower Silurian carbonates extend for over 2000 km across the middle of North America from eastern Iowa through eastern Wisconsin, northern Michigan, and central Ontario, to Anticosti Island, Quebec. A new approach to the time-rock correlation of these platform carbonates involves the use of regional sea-level curves. An amalgamation of the traditional methods of biostratigraphy and paleoecology with the concept of "event stratigraphy" is the key to this approach. Interpretation of a regional sea-level curve requires: (1) thorough coverage of thick, geographically redundant stratigraphic sections, (2) preservation of depth-associated communities which can be readily differentiated, and (3) some degree of 1st order time control checked by evolutionary lineages.

At least four very distinctive communities thrived in different carbonate environments of the Early Silurian platform seas. A low diversity, ostracode-vermiform animal community is commonly associated with laminites, evaporite mineral casts, and mudcracks. A coral-algal community comprised of large disc-shaped tabulate corals, stromatoporoids, and stromatolites is representative of shallow, high energy water. Pentamerid brachiopod communities dominated by *Virgiana*, *Pentamerus* or *Pentameroides* are suggestive of an intermediate water depth. The high diversity, stricklandiid brachiopod communities with their associated crinoids and bryozoans are indicative of a deeper water setting. Community changeovers recorded in the strata of a given region, tell the number and extent of local sea-level changes. Members of evolutionary brachiopod lineages which overlap the various communities help to date these events.

Three peaks in sea-level fluctuations are widely recognized in equivalent  $C_{1-2}$ ,  $C_{4-5}$ , and  $C_6$  - Lower Wenlock rocks. A fourth, older peak of early or mid-Llandovery age sometimes appears. Deep-water peaks are not necessarily identified from one region to another by the same depth-associated community. Stricklandiid communities in Iowa and on Anticosti Island, for example, were apparently contemporaneous with shallower water pentamerid communities in Michigan and on Manitoulin Island. At times of somewhat lower sea level, pentamerid communities in some regions were apparently contemporaneous with coral-algal communities elsewhere. Although more prone to reflect purely local influences, sea-level curves can also be reconstructed for regions of exclusively clastic sedimentation (Lower Silurian of Pennsylvania and Alabama) or for regions of mixed carbonate and clastic sedimentation (Lower Silurian of New York). Use of these sea-level curves allows not only for refinements in time-rock correlation on a continent-wide basis, but also permit a clearer picture of Silurian biogeography on a marine platform of vast size.

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## ATRYPOIDEA: ITS POTENTIAL USE FOR WORLDWIDE CORRELATION OF UPPER SILURIAN STRATA

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The brachiopod genus *Atrypoides* Mitchell & Dun (= *Atrypella* Kozłowski) has long been of interest since it is commonly the dominant brachiopod in Upper Silurian carbonate strata. Detailed work in Arctic Canada has demonstrated that species such as *A. phoca*, *A. foxi* and *A. erebus*, as well as some undescribed species, have the potential for biostratigraphic zonation. This potential, however, is complicated by the fact that the various species of *Atrypoides* had environmentally controlled as well as time controlled ranges.

Two types of *Atrypoides* communities can be recognized, (1) a low-diversity *Atrypoides* community comprising 3 or 4 brachiopod species and little other fauna that apparently lived in a quiet, near-shore environment and (2) a high-diversity *Atrypoides* community comprising 8 to 10 brachiopod species as well as numerous corals, sponges and trilobites that apparently lived in a quiet, off-shore environment. This community pattern can be recognized both in Arctic Canada and southern China. In the off-shore environment where the *Atrypoides* were associated with reefs, different species inhabited different habitats and this serves to complicate the picture.

The pattern of ecological control of the various species of *Atrypoides* is more apparent in the Pridolian strata than in the Ludlovian strata. Despite these problems, detailed work is demonstrating that *Atrypoides* may have some use for the biostratigraphic correlation of Upper Silurian strata.

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THEORY AND PRACTICE OF ECOSTRATIGRAPHY AS UNDERSTOOD IN THE  
EAST BALTIC AREA

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The majority of papers published on ecostratigraphy (with or without the logotype) are rather variable in contents but usually without any attempt to work out its theory. It is normal not putting conceptual aspects first and foremost. Ecostratigraphy has rather been a "wide movement among scientists" (Martinsson).

As Project Ecostratigraphy has passed its first stage of development it seems necessary to us to pay more attention to the theoretical aspects, i.e. we consider the latter possible and ecostratigraphy must have it. Different approaches can be taken in order to achieve a theoretical basis.

The Institute of Geology of the Academy of Sciences of the ESSR sees the main task of ecostratigraphy as the working out of methods for the so-called basin analysis, for the correlation of formations of different facies in particular (or for overcoming facial boundaries by tracing synchronous levels) and for the improvement of stratigraphical schemes.

Local and regional stratigraphical subdivisions (members, formations, regional stages) are considered as corresponding to palaeoecosystems. Distribution and change of the palaeoecosystems in space and time form the main framework for the stratigraphy of the basin.

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## SILURIAN LITHOFACIES AND PALAEOGEOGRAPHY OF BALTO-SCANDIA

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A series of sixteen lithofacies maps provides a picture of the dynamic evolution and palaeogeography of Balto-Scandia through successive intervals of Silurian time. Most of the map levels are tied to specific graptolite zones to ensure accuracy of correlation across the area. The maps cover the region from west of the Oslo graben eastwards to the Silurian shoreline of the East Baltic states, and from Dalarna in the north to the Tornquist line in the south, with some added indication of the extension of the basin southwards into central Europe. Data for the maps have been compiled by working groups from Estonia, Latvia, Lithuania, Sweden, Norway, Denmark, Poland, and the GDR.

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## CORAL REEFS IN THE BALTIC SILURIAN (TYPES, FACIES RELATIONS)

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Organic buildups (bioherms, biostromes — informally called reefs) of the Baltic Silurian belong to two facies belts: (1) high-energy shoal belt (the overwhelming majority) and (2) open shelf.

The shoal belt is represented by detritic crinoidal and shelly detritic limestones, associated by coral-stromatoporoid bioherms: aulocystid-algal-favositid bioherms of Early Llandoveryan Juuru time; halysitid-teciid-stromatoporoid bioherms of Wenlockian Jaagarahu and Slite time; favositid-teciid-stromatoporoid bioherms of Ludlovian Paadla and Hemse time.

The onshore side of the shoal belt, mainly with algal bioherms, is represented by biomicrites, bituminous clayey limestones

and marls, coastwards replaced by homogeneous dolomitic marls. The organic buildups of the shoal belt are the largest in the Baltic Silurian and of conspicuously linear distribution (especially the Höglint and Early Jaagarahu bioherms).

The reefs of the open shelf are small, patch-reef-like, enclosed in the nodular clayey limestone or marl and built by flat coralla of favositids, thickwalled halysitids and fasciculate syringoporids (buildups of Upper Visby Marl, Hemse Marl, and Ludlovian Ventspils Formation).

The bioherms and biostromes of the Baltic Silurian were formed in the regressive phases of basin development. The time of reef-building maxima were Middle Wenlockian and Middle Ludlovian. During that interval of time, the most suitable for reef-builders, the shoal belt migrated for 300 km in the East Baltic but only for 15-40 km in Gotland and Podolia. It means that the slope was noticeably steeper and more stable in the last two regions.

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#### PROGRESS REPORT ON THE PRIDOLIAN IN THE PRAGUE BASIN, BOHEMIA

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The Prague Basin (Barrandian, Bohemia) provides an excellent basis for the definition of the fourth chronostratigraphical unit of the Silurian System — the Pridolian. In agreement with the statements of the International Stratigraphic Guide the Ludlovian-Pridolian boundary occurs in a purely marine succession in which fossil-rich carbonate and shale facies predominate. Unaffected by Late Caledonian movements, marine sedimentation persisted without a substantial break from the beginning of the Silurian to the upper part of the Middle Devonian. These conditions, in combination with many excellent exposures and a long history of investigation, provide unique possibilities for the detailed study of the Pridolian and particularly

for the establishment of its international boundary stratotype.

The base of the Pridolian can be correlated accurately across wide areas of the world on the basis of graptolites, condonts, chitinozoans, bivalves, ostracodes, trilobites and associated faunas. The top of the Pridolian is defined automatically by the base of the Devonian System at its international stratotype section at Klouk in the Prague Basin.

Since 1973 all available sections of the Pridolian in the Prague Basin were revised and the 10 best sections have been studied in great detail by a team of fourteen people. The aim is to prepare a submission on the boundary stratotype as a contribution to Project Ecostratigraphy in 1982 and a final report on the Pridolian at the IGC in Moscow 1984.

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THE WHOLE ENVIRONMENT — SILURIAN SLITE BEDS, GOTLAND. — INTRODUCTION OF A NEW SUBPROJECT

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Correlation is the most important task in geology since correct interpretations of the geological history of an area — large or small — can be made only when time lines have been reconstructed. It is impossible to make, e.g. palaeoecological and palaeogeographical reconstructions of any validity without a firm basis of time lines. At the present time evolving lineages of certain taxa seem to be the best means of reconstructing time lines by palaeontological methods.

However, the organisms used for this type of work are environmentally controlled and thus occur only in some lithofacies. Gotland abounds in examples. All fossils are facies-controlled and to find out which are more and which are less affected by environmental changes one has to trace the fossils laterally. Time lines are

necessary for such palaeoecological studies. But palaeontologists and biostratigraphers often use time lines reconstructed from ranges of fossils whose ecology, furthermore, is virtually unknown.

Hence, it seems evident that biotic information has to be combined with other parameters, e.g. physical and chemical, but these in turn are affected by the organisms that once lived where the sample was collected. However, if petrographical, chemical and palaeontological information is combined and quantified it should be possible, at least theoretically, to single out certain ecological factors and their importance.

A new subproject has been started by the Swedish group of Project Ecostratigraphy using three sections in the Wenlockian Slite Beds on Gotland as a test area for integrating information from biotic and abiotic data. By centralized and quantified bed by bed sampling in the three sections and by using pyroclastic beds and discontinuity surfaces as time lines it should be possible to work out the auto- and synecology of the fossils. Such an understanding will enhance the use of some of those fossils for correlation. The new subproject demands a large number of specialists and we invite cooperation.

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#### THE LOWER DEVONIAN SPORES OF THE ARMORICAN MASSIF: BIOSTRATIGRAPHY AND EVOLUTIONARY TRENDS

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A spore analysis of Upper Silurian - Early Devonian strata of the Armorican Massif is presented. Five sections from two regions, the "Synclitorium median armoricain" (Central Brittany) and the Cotentin peninsula (Normandy), have been selected considering their good marine faunal control. On the basis of a preliminary range chart of 52 spore species, regarded as the most significant, a tentative sequence of

spore assemblages is drawn up. Five assemblage-zones are recognized:

- (1) *Ambitisporites avitus*, Pre Gedinnian - Lowermost Gedinnian;
- (2) *Streelispota newportensis* - *Emphanisporites microornatus* - *Apiculiretusispora spicula*, Lower Gedinnian - Lowermost Siegenian;
- (3) *Dictyotriletes emsiensis* - *Brochotriletes Mcgregori* - *Brochotriletes* cf. *foveolatus*, Lower Siegenian - Middle Siegenian;
- (4) *Dibolisporites echinaceus* - *Dictyotriletes subgranifer* - *Craspedispora craspeda*, Upper Siegenian;
- (5) *Emphanisporites annulatus* - *Acinosporites* cf. *lanceolatus*, Lower Emsian.

These Upper Silurian - Early Devonian assemblages are compared with previous spore biozonations from other areas such as Europe, North America and North Africa. In spite of some minor differences concerning the precise stratigraphical range of some taxa, the main evolutionary trends are comparable. The assemblages described here include some forms which have a restricted geographical distribution. The occurrence of these spore species suggests that, during Early Devonian times, the Iberian and Armorican regions were part of a Perigondwanian unit.

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#### SILICIFIED BIVALVES FROM THE SILURIAN OF GOTLAND

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Extremely well preserved shells of bivalves have been recovered in large amounts through etching in acetic acid. Bivalves are very abundant at Möllbos in the Wenlockian Halla Beds. The state of preservation allows tiny rarely fossilized details to be examined, sometimes making reconstruction of the soft parts possible. More than 3000 valves have been subjected to biometrical analysis of ontogenetic growth series and morphological variation within species.

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MICROPALAEONTOLOGICAL CORRELATION OF THE LLANDOVERY/WENLOCK  
BOUNDARY BEDS OF THE WELSH BASIN

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The stratotype section for the base of the Wenlock Series near Leasows Farm, Hughley, Shropshire, has been closely sampled for microfossils. All samples yielded rich microfaunas and microfloras and a detailed biostratigraphy for the section is based on the examination of more than 20 000 specimens of acritarchs, chitinozoans, conodonts, ostracodes and foraminifera. The Llandovery/Wenlock boundary lies within the *amorphognathoides* conodont interval between the base of acritarch zone 5 and the *amorphognathoides* extinction datum; this interval is represented by 40 cm of strata in the type section. At Domas, in the type area, 30 000 specimens were studied; here the boundary interval is represented by approximately 90 cm of strata.

Correlation based on similarly detailed collections at other localities in the Welsh Borderland and Wales indicate that the Llandovery/Wenlock boundary lies within the Trewern Brook Mudstone Formation of the Long Mountain, close to the base of the Woolhope Limestone Formation in the Malvern Hills, in the upper part of the Upper Haugh Wood Beds at Woolhope and within the Coralliferous Group of south-west Dyfed, Wales.

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STATE OF THE ART IN DOWNTONIAN OSTRACODE CORRELATION

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The number of graptolite zones (or subzones) ascribed to the Downtonian, generally in Pridolian facies, varies between five and nine in those areas from which a complete succession has been described. This indicates that the Downtonian has about the same

biostratigraphic scope as the three older Silurian series. Analysis of the ostracode faunas shows that the number of biozones based on them would attain that of the graptolite zones. In some areas (Poland, Baltic USSR) ostracode zones have been formalized, whilst in other areas this remains to be done. However, on essential points there seem to be incompatible records of the succession of ostracode species in different sections, and in the Polish-Lithuanian area questions arise regarding the relations of the uppermost ostracode zone to the top of the Downtonian Series. The Downtonian ostracode zones are recognized over a wide area between Maine and the sub-surface of western USSR, but good and detailed correlations with the graptolite succession are lacking.

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#### APPLICATION OF SHELF AND SLOPE CONCEPT TO THE SILURIAN BALTIC BASIN

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The Silurian Baltic Basin was situated on a passive margin of a continent and it opened directly into the Middle-European geosynclinal basin of oceanic origin. Such a position allows us to interpret the Baltic Basin in the Silurian as a pericontinental sea with differentiated shelf and continental slope. We consider that most likely the shelf could coincide with the belt of mainly carbonate sedimentation that bordered on the flattened Fenno-Sarmatian continent.

The axial part of the Baltic Basin with graptolite-bearing shales and mudstones can be thought of as a deep-subsided block of a continental margin which tectonically belonged to the continental slope but sedimentologically represented a tongue of the large North-European undercompensated depression, intruded north-eastward up to 1000 km into the East-European craton.

The basin slope in its more strict, geomorphological sense probably embraced the belt of sedimentation of calcareous-argillaceous muds between shelf carbonates and graptolitififerous pelitic deposits of

the central depression of the basin. Erosional channels, turbidites and other phenomena characteristic of the steep basin slopes were lacking in the Baltic Basin due to relatively low gradients of the sea bottom.

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#### SILURIAN RUGOSE CORALS FROM GOTLAND

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A research group at the Geological Institute, University of Bergen is making a detailed examination of Silurian rugose corals from Gotland and the Oslo Region. Modern taxonomy of rugose corals is based on careful studies of the morphological structures and their ontogenetic development. Several ecologic factors influence the growth of sessile marine benthos like rugose corals and cause considerable variation of the morphological structures. Mode of growth and variation of external and internal structures is exemplified by different species of the genus *Phaulactis* and other genera. Faunal provinces of rugose corals and their usefulness for biostratigraphical purposes will be discussed.

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#### CHITINOZOAN BIOSTRATIGRAPHY OF THE LUDLOVIAN-PRIDOLIAN BOUNDARY IN THE BARRANDIAN AREA

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The Chitinozoa of the Ludlovian-Pridolian boundary have been studied in the Branik and the Kolednik sections (Bohemia). Both sections are

composed of biosparite, biomicrite or micrite beds alternating with calcareous shales. The latter are poorly developed in the Kolednik section but better represented in the Branik succession. Seventy-six samples collected bed by bed, or even more closely spaced, have been processed. In addition to numerous Chitinozoa most of the samples have yielded abundant graptolite fragments, scolecodonts, sporomorphs but few acritarchs and spores. The thick-walled Chitinozoa are usually preserved in full relief while the thin-walled forms are often wrinkled or broken.

In the Kolednik section the abundance of the Chitinozoa varies but rarely exceeds fifteen specimens per gram of rock (bed no.16d). Up to bed no.22 the Chitinozoa assemblages show a progressive vertical evolution. In the lower part of the sequence, the genus *Eisenackitina* dominates and characterizes a first assemblage. Different species of this genus are accompanied by several forms of *Ancyrochitina*, *Angochitina*, *Sphaerochitina*, and *Cingulochitina*. A major break appears in the Chitinozoan distribution at the base of bed no.23 where a second assemblage begins with the first occurrence of *Linochitina klonkensis* and *Urnochitina urna*. Both species are well known up to the Uppermost Pridolian in the neighbouring sections of Klonek and Karlštejn. *Angochitina*, *Gotlandochitina* and some specimens of *Calpichitina* and *Cingulochitina* are also present in this upper part of the Kolednik section.

The abundance of the Chitinozoa in the Branik section shows great variations (exceeding 100 specimens per gram of rock in bed no.31) but graptolite fragments and scolecodonts are less abundant. In this section two main assemblages have been recognized. The first one is characterized by a large amount of *Eisenackitina*. The second one which contains numerous Angochitinae (*Angochitina*, *Sphaerochitina*, *Gotlandochitina*) in its lower part (beds no.14 to 19) is dominated higher in the succession (beds no.20 to 35) by *Urnochitina urna*. This latter species shows important morphological variations in the Lower Pridolian.

In summing up, the main biostratigraphical limit based on the Chitinozoa distribution in the Kolednik and the Branik sections seems to be independent of the lithology. This limit is located less than 20 cm above the Ludlovian-Pridolian boundary as defined by the graptolites.

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"NONPALEOCOPE" OSTRACODE SUCCESSION IN THE WENLOCK SERIES OF  
THE WELSH BORDERLAND

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Metacope, prodocope and platycope ostracodes (referred to collectively as "nonpaleocopes") are common elements of the shelly faunas of the Wenlock Series of the Welsh Borderland. Thirty-two species representing 18 genera are known from more than 11 000 specimens in our collections. Of these, 24 species are sufficiently abundant and adequately defined to demonstrate the value of these nonpaleocopes for a generalized biostratigraphic subdivision of the Wenlock Series in the area studied. Six species are restricted to the lower part of the Wenlock Series (Buildwas Fm. and lower part of the Coalbrookdale Fm. — *centrifugus* through *ellesae* Graptolite Biozones); fourteen species are known from only the upper part of the Wenlock Series (upper part of the Coalbrookdale Fm. and Much Wenlock Limestone Fm. — *lundgreni* through *ludensis* Graptolite Biozones); and four species range throughout or nearly throughout the Wenlock Series.

The early Wenlockian ostracode assemblage is characterized by *Thlipsura martinsoni* and "*Thlipsurella*" n. sp. which are ancestral to *Thlipsura corpulenta* and "*Thlipsurella*" *v-scripta*, two species common in the late Wenlockian assemblage. Although more detailed sampling of the sequence will refine the stratigraphic ranges of the "nonpaleocopes" in the type Wenlock Series, the preliminary evidence presented here clearly indicates that a significant faunal change takes place in an interval around the Sheinwoodian-Homeric boundary.

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ACRITARCHS, MIOSPORES AND CORRELATION OF THE LUDLOVIAN-DOWNTONIAN  
AND SILURIAN-DEVONIAN BOUNDARIES

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An attempt is made to use palynomorphs to correlate the Ludlovian-Downtonian and the Silurian-Devonian boundaries in successions from the British Isles, Estonia, Podolia, and north Africa. Miospores are found to be of most use for this purpose:

(a) the *micromatus-newportensis* zone can be recognised in the Anglo-Welsh area, in Podolia and in north Africa, and the base of this zone indicates a level above, but close to, the Silurian-Devonian boundary;

(b) the Ludlovian-Downtonian boundary is well-defined in the Anglo-Welsh area on the basis of miospores and can be determined approximately in north Africa and Estonia since several miospore species appear at or close to this boundary.

The lack of stratigraphically important acritarch and miospore species in the Silurian-Devonian stratotype at Klonk (Czechoslovakia) underlines the importance of the Podolian sequence for the recognition of the Silurian-Devonian boundary in continental sequences. Recognition of the Ludlovian-Downtonian boundary in Podolia is difficult since the miospores below the Borschov Horizon have not been systematically described and are probably rare. Further, there are difficulties in using acritarchs for inter-regional correlation since they appear to be considerably influenced by provinciality and local environmental factors.

From the palynological point of view therefore the Ludlovian-Downtonian boundary should be chosen from a sequence in which miospores are common, since one based on acritarchs would involve two stratotypes, one from the *Deunffia-Domasia*, and one from the *carminae*, realms.

Finally, some features of current palinspastic continental plate reconstructions are discussed in the light of acritarch provinciality.

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THE SUCCESSION OF BRACHIOPODS AS A TOOL FOR CORRELATION IN THE  
SILURIAN OF THE EAST BALTIC

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The distributions of 77 species or groups of late Silurian brachiopods in 14 East Baltic boreholes have been studied in order to estimate their value for correlation of widely separated sections in different facies. The correlative value of taxa is here determined by their total ranges in the given area and occurrence in the sections studied. The former may be considered as a temporal aspect of the study and the latter as an environmental one.

The total ranges of taxa have been derived from the observed mutual vertical positions of widespread taxa before any correlations of the sections. Only 19 of all taxa studied can be arranged into unambiguous succession which has been used for correlation of the sections. It is shown that there are only one to two datum planes traceable by brachiopods in most of the studied sections.

Many even widespread brachiopods have facially restricted and/or temporally shifted distribution and, therefore, they can be used only in local correlations, within the limits of a few facies belts. In the same time these taxa are definitive to the brachiopod communities.

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THE APPLICATION OF QUANTITATIVE ANALYSIS TO THE SOLUTION OF  
STRATIGRAPHIC PROBLEMS. — THE WHOLE ENVIRONMENT — SILURIAN SLITE  
BEDS, GOTLAND

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The usual types of information utilized by stratigraphers working with sedimentary rocks — fossils, gross lithology, geographic position, etc. — have limitations. An attempt has been made to

increase the number of measured parameters to assist in the solution of problems where traditional methods are of little value. Separation of the sedimentary rock into two primary phases followed by individual analyses of each phase is proposed.

Components determined quantitatively include %CaO, %MgO, %FeO, %P, % Coarse insoluble residue, % Fine insoluble residue, % clastics, % nonclastics, identification of minerals, microscopic description of the original rock, coarse residue and fine residue and where applicable, the determination of grain-size parameters on coarse insoluble materials. Other analyses can be made depending on instrumentation available.

Much of the work is with samples ranging from 200 to 500 milligrams in weight, which permits detailed studies of layers of rocks. Illustrations and applications are presented from the geology of North America and Gotland.

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THE TRANSITION FROM OZARKODINA SNAJDRI TO O. CRISPA (CONODONTS)  
IN THE UPPER SILURIAN

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Subject of this conodont study is to prove, whether or not both conodont species represent an evolutionary lineage and hence can be used as a "datum plane" in the Upper Silurian. The transition from *Oz. snajdri* to *Oz. crispa* has been studied in four sections, i.e., Santa Creu near Barcelona (Spain), Cellon (Austria), Na Pozarech and Kolednik (Barrandian, Czechoslovakia). Results from the latter two sections are derived from bed-by-bed sampling and fairly rich collections. The material of the other two sections was kindly made available by O.H. Walliser, Göttingen. Additional samples yet collected through the critical interval at Cellon was carried out recently.

Preliminary results from Cellon show a joint occurrence of *Oz. snajdri* and *Oz. crispa* in bed no. 30a, which is 1.40 m below the base of the Pridoli defined by the first appearance of *M. parultimus* Jaeger.

At Santa Creu joint occurrences of both species have not been found yet. Morphologically, both species are distinctly separated. More samples at closer intervals are needed.

At the quarry Na Pozarech in the Barrandian the transition has been traced in the middle part of the marker bed no. 87 (1.03 m thick). In the upper part of that bed *Oz. crispa* is associated with *Oz. r. eosteinhornensis*. According to H. Jaeger this is about 2.50 m below the first occurrence of *M. parultimus*, i.e. the base of the Pridolian Stage. At Kolednik Quarry joint occurrences of both species were found in bed no. 17, i.e., approximately 1.80 m below the Kopanina/Pridoli boundary. These results are in excellent agreement with the section at Cellon as well as Na Pozarech.

Within the range of *Oz. crispa* two morphotypes have been recognized in the Barrandian sections.

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#### LATE WENLOCK - EARLY LUDLOW TRILOBITES FROM THE DINGLE PENINSULA, IRELAND

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The Dunquin group of the Annascaul area, Dingle Peninsula, has yielded some 15 trilobite genera, the richest trilobite fauna presently known from the Silurian of Ireland. Most of the material, numbering over 1000 exoskeletal parts, comes from the (oldest) Annascaul Formation and the best preserved material in particular from two small isolated limestone lenses of the Ballynane Member. The precise age of these limestones is in debate, though an horizon in the late Wenlock or early Ludlow is probable for both of them. At the generic level, the Dunquin Group fauna is fairly cosmopolitan;

at the specific level there is evidence of links, at various times, with the Anglo-Welsh, central European and Scandinavian areas.

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#### GEDINNIAN SPORES FROM THE TYPE-REGION

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Basal Gedinnian "Poudingue de Fêpin" and "Arkose d'Haybes" as well as Upper Gedinnian "Grès de Oignies" and "Schistes de St Hubert" contain rich miospore assemblages which allow not only correlations between the Southern, Northern and Eastern flanks of the Dinant synclinorium but also correlations with Wales and Welsh Borderland.

Data are provided for a time correlation between the basal Gedinnian in the type area and the basal level of the "*Psammosteus* Limestone" in Wales and Welsh Borderland.

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#### SILURIAN ONCOCERID NAUTILOIDS FROM GOTLAND

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The oncocerids from Gotland are undescribed but are partly similar to those in Bohemia. Silicified material from one locality allows detailed studies of the shell growth and thus ontogenetic studies can be carried out. The shell aperture changes a lot in shape during growth and these stages have sometimes been described as different genera. Furthermore, it is evident from my material that the variation within species is greater than the presently accepted

variation within some of the established genera. Thus, there is reason to believe that the number of genera and species among the oncocerids have been overestimated.

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#### LITHOFACIES DEVELOPMENT OF THE HEMSE BEDS, GOTLAND

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The Ludlovian Hemse Beds (lower Gorstian to upper lower Ludfordian) are composed of very heterogeneous rocks, ranging from argillaceous shales with calcareous nodules to stromatoporoid coral buildups. The unit is interpreted as a transgressive-regressive sequence, but including several sedimentation breaks and penecontemporaneous erosional levels. Microtextures indicate occasions of subaerial exposure. A general outline of sedimentary rock-types will be presented, and their environmental significance discussed.

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#### THE WHOLE ENVIRONMENT - SILURIAN SLITE BEDS, GOTLAND. - PETROGRAPHY

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The locality Haganäs 1, which represents the transition from Slite Marl to Slite Beds, unit g, is one of 3 localities included in this subproject. From a section of 273 cm 55 samples were collected for petrographic analysis. 110 thin-sections (with about 600 points in each) provide the data for graphical plots. A comparison with Recent analogues shows that the locality represents a transgression and not a regression which is currently thought.

CORRELATION OF THE GRAPTOLITE AND TRILOBITE SUBDIVISIONS OF THE  
SIEDLCE AND PODLASIE IN THE UPPER SILURIAN OF POLAND

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In specifically developed Silurian rocks in Poland, guide graptolite fauna is fairly often accompanied by trilobites. The latter are highly important as they give the basis for correlating graptolite-bearing claystones and shallow-neritic carbonate rocks in which graptolites are sporadically found, if ever. Silurian trilobites also appear useful for the purposes of biostratigraphy despite of the fact that their stratigraphic ranges are longer than those of graptolites. Moreover, trilobites may be used, as benthic fossils, in delineating individual neritic zones of the Prototethys shelf, for which graptolites appear unuseful.

The Lower and Middle Siedlce are represented by deposits of clay-siltstone facies with graptolites in the platform areas and greywacke-siltstone facies with markedly impoverished fauna in the Holy Cross Mts. Trilobites are here represented by fragmentary findings, mainly of the genera *Calymene* and *Acaste*.

Graptolites become accompanied by numerous trilobites not before the onset of sedimentation of marly-carbonate deposits of the Upper Siedlce and their lithofacies equivalents — Lower Rzepin Beds. In these rocks, the trilobite fauna comprises representatives of the genera *Acaste*, *Scotiella*, *Acastella*, *Calymene*, *Proetus*, *Trimerus*, *Dipleura*, *Homalonotus* and more rare ones — *Ananaspis*, *Otarion*, *Hemiarges*.

In the Lower Podlasie Stage, both the trilobite and graptolite assemblages become impoverished. *Acastella prima* is here accompanied by *Proetus signatus*, *Leonaspis bidentata* and *Calymene cf. beyeri*, higher up there occur *Acaste dayiana*, *A. podolica* and *Calymene sp.*

In the Upper Podlasie Stage of the area adjacent to the Baltic Sea, *Acaste praeacastopyge* appears, followed by *Acastopyge shergoldi* as well as *Calymene tentaculata* and, occasionally, representatives of the genus *Proetus*. In eastern Poland, *Acastella spinosa podolica* and *Calymene tuberculata* are sometimes found.

In the top part of the Podlasie (upper part of the *M. angustidens* Zone), the first representatives of *Acastella elsana* were found in the Radom-Lublin area and northern part of the Holy Cross Mts. The peak in occurrence of that species is marked in the Lower Gedinnian, delineating the lowermost zone of the Bostovian Stage. In the Gedinnian of Poland, trilobites are gaining the role of main guide fossils as graptolites are only sporadically recorded and lose their stratigraphic sensitivity.

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## UPPER SILURIAN SHALLOW AND DEEP WATER CONODONTS OF THE EAST BALTIC

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Conodont faunas from the Upper Silurian of the North East Baltic are analyzed on the basis of a rich collection from 7 borings and more than 30 localities. The conodont distribution is related to the facies belts of the Paleobaltic Basin.

The *Ctenognathodus murchisoni* association is restricted to lagoonal and near-shore shoal belts; the *Ozarkodina* and *Oulodus* associations occur in shoal and open shelf belts; *Ozarkodina confluens* shows a preference for the shoal belt; *Ozarkodina e. excavata* and *O. s. eosteinhornensis* are characterized by a wider environmental differentiation as compared to *O. confluens*. Conodonts of the slope belt are represented by the *Kockelella variabilis* and *Polygnathoides siluricus* association.

Based on the environmentally controlled conodont distribution two local zonal schemes are given. Zonation for the shelf region includes *O. sagitta bohémica* Zone (Wenlockian, with *C. murchisoni* Subzone), "*S. aff. snajdri*" Zone (with *Ozarkodina* sp. S and *Distomodius dubius* Subzones), and *O. s. eosteinhornensis* Zone (with four subzones). Walliser's zones of *sagitta silurica* and *eosteinhornensis* are established in the basin region

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## AMERICAN INDIAN ART FROM MEDICINE MAN TO MOTION PICTURES

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Traditionally, the American aborigines used their artistic abilities for three purposes: to decorate objects, to aid in contacting the supernatural, and to manipulate the supernatural for curing or other ceremonial purposes. The designs and forms were often static in appearance, a reflection of the fact that the aborigines' world was relatively unchanging. Since the first contacts with the 'white man' — European Americans — there has been a fourth reason why the American aborigines produce art. A market for the arts and crafts of the American Indians has existed since the 1600's, and of the Eskimos, since the 1800's. At first, the European Americans were interested primarily in articles of clothing and utility, such as baskets. In the 1800's, museum collectors and private collectors purchased large amounts of the old ceremonial art, as well as the decorative art of the American Indians. In the 1900's, there have been attempts to revitalize the old traditional art forms, such as pottery in the southwest, and the emergence of new forms, such as the graphic art of the Eskimos and the paintings of the Great Lakes tribes. This lecture focuses upon the process of change in both the art and the people who produce it. Change has occurred because of contact with 'white' American culture and because of the existence of a lucrative market for the art produced.

The Indian or Eskimo artist has several problems. First, he or she must deal with the fact that his culture originally did not have an occupational category labelled 'artist'. Thus, if you are labelled as 'artist' by the white man, your own people may ignore you or be hostile. Both the money that you earn through your art, and the fact that you are using (and probably changing) traditional forms and motifs may lead to hostility from your own people. This is particularly true if the medicine man or shaman was traditionally the only person to utilize

the designs and images that you are now producing for sale to 'white man' buyers. The hostility of your group can be handled by sharing the money that you earn and by teaching others how to produce the items for sale. This leads to another problem. Now that many people are making the same kind of art objects, the buyers demand that you mark the pieces that *you* make, because yours are more 'valuable'. This creates competition and individualism in cultures that traditionally avoided these disruptive social forces. There are still, even in highly acculturated tribes, artists who band together and sign their work *as a group*, refusing to identify the individual. The last major problem is that of adjusting your art to a different culture. The traditional forms and motifs may be changed intentionally so that they will be more easily understood and liked by buyers from 'white man' culture. Or your art may differ from the traditional because you have come in contact with new materials, new technologies, and new art forms from the European American culture. This last influence is very strong. The mass media, especially cartoons from motion pictures, television, and comic books, have had a considerable influence on the artistic style of several American Indian groups.

The culture and lifestyle of American aborigines are changing rapidly, and their art reflects this. Animals are now depicted in motion, and designs are now often dynamic rather than static. As the Indian or Eskimo artist takes aspects of his own tradition and of 'white man' culture and merges them into his own unique creation, his individualism is increased. This, in turn, has social consequences, as does the question of who will market the art produced. The artist may market his own work, or a man or woman of the tribe may become a trader and do the marketing. A 'cooperative' may emerge — a group which subsidizes the creation and marketing of the art of its members. Or 'white man' traders may maintain a monopoly on the marketing. Each of these possibilities has social, economic, and political consequences for the artist and the tribe.

The lecture will be illustrated with approximately 150 slides, demonstrating the points made above. The slides will show a wide range of traditional and modern art from all areas of North America — the Pacific Northwest, the Southwest, the Southeast, the Great Plains, the Arctic, and the Great Lakes. Modern Indian art of the Great Lakes region will be given special attention.

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