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LOWER ORDOVICIAN (ONTIKAN) CONODONT BIOSTRATIGRAPHY IN SCANDINAVIA

The aim of this note is to briefly outline the appearance of important conodont species within the Scandinavian region. The data are compiled from publications (Bagnoli et al., 1988; Kohut, 1972; Lindström, 1954; Löfgren, 1978; Rasmussen, Stouge, 1988; Stouge, 1975; van Wamel, 1974) and from work still in progress (Stouge, in prep.). Full species ranges are



Approximate location of the sections. The confacies (after Jaanusson, 1976) are comparable with the confacies in the Lower Ordovician.

1 — Hølanda Limestone, Trondheim (Bergström, 1979), 2 — Tøyen Shale and Kalkberget Limestone, Jämtland (Löfgren, 1978), 3 — Heramb Shale and Stein Limestone, Norway (Rasmussen, Stouge, 1988; Rasmussen, in prep.), 4 — 3C Limestone, Oslo, Norway (Kohut, 1972; Rasmussen, Stouge, 1988; Rasmussen, in prep.), 5 — Stora Backor, Sweden (Lindström, 1955; Stouge, in prep.), 6 — Komstad Limestone, Scania (Stouge, 1974; Stouge, in prep.), 7 — Komstad Limestone, Bornholm (Stouge, 1974; Stouge, in prep.), 8 — "Orthoceras" Limestone, S. Öland (Stouge, in prep.), 9 — "Orthoceras" Limestone, N. Öland (van Wamel, 1974; Bagnoli et al., 1988; own observation), 10 — Finngrundet, Sweden (Löfgren, 1985).

rarely documented in individual Scandinavian sections, and the full range of a species is generally determined by correlation of partial ranges between sections. The graphic correlation method (Shaw, 1964; Miller, 1977) has been applied on sections within the eight areas shown on the Figure, 2—10. The Jämtland region (the Figure, 2; Löfgren, 1978) was chosen as a standard reference. More than eight sections have been compared graphically and the preliminary results are summarized here. The chronostratigraphic scheme of Jaanusson (1960a, b) is adopted, as modified by Tjernvik and Johansson (1980).

In this paper the broad zonal classification of Lindström (1971) and Löfgren (1978) is adopted but the determination of zone boundaries with respect to the range of certain species differs and is discussed below.

Paroistodus proteus Zone

The *Paroistodus proteus* Zone is the lowermost zone of the Latorpian Stage. *Paroistodus proteus* ranges throughout the Hunnebergian Substage. The base of the zone is characterized by the first appearance of *Paroistodus proteus*, *P. parallelus*, *Scandodus furnishi* and *Paracordylodus gracilis*.

The Tremadocian species *Paltodus deltifer* is present in the lower part of the zone and the top of the range of this species coincides with the upper boundary of the *Megistaspis armata* trilobite Zone. The younger part of the *P. proteus* Zone is characterized by the first appearance of *Paltodus subaequalis* and "*Acodus*" *deltatus*. The fauna is characteristic of the *P. proteus* Zone *sensu* Lindström (1971) and the *P. inconstans* Zone of Bergström (1968). This upper *P. proteus* subzone is restricted to the *Megistaspis planilimbata* trilobite Zone.

Prioniodus elegans Zone

The *Prioniodus elegans* Zone succeeds the *P. proteus* Zone and extends from the first appearance of *Prioniodus elegans* to the base of the *Oepikodus evae* Zone. The *Prioniodus elegans* Zone is rarely found in Scandinavia (Lindström, 1971) due to the presence of a hiatus at this level (Bagnoli et al., 1988). *Prioniodus elegans* appears first in beds with *M. planilimbata* (Tjernvik, Johansson, 1980) and therefore the zone is considered to be part of the Hunnebergian Substage (Bagnoli et al., 1988). *P. elegans*; however, ranges into the Billingenian Substage (Stouge, Bagnoli, 1988).

Oepikodus evae Zone

The Billingenian Substage includes the *Oepikodus evae* Zone (Lindström, 1971). This zone was subdivided into two subzones by Lindström (1971) but the upper "subzone" is nonrecognizable because *O. evae* is rarely found. *O. evae* Zone is also characterized by the first appearance of *Oistodus lanceolatus*, *Drepanoistodus forceps*, *Peridon flabellum* and *Stolodus stola*.

The *O. evae* Zone corresponds to the *M. aff. estonica* "zone" (Transition Beds), the *Megalaspides dalecarlicus* Zone and the *Megistaspis estonica* Zone (Tjernvik, 1956; Tjernvik, Johansson, 1980; Löfgren, 1985).

The Lanna-Volkhovian Stage comprises the *Megistaspis lata*, *M. simon* and *M. limbata* trilobite Zones. Important hiatus may be found at the

base and the top of the *M. lata* Zone and at the top of the *M. limbata* Zone. The hiatus may be related to eustatic sea level changes, but localities within the Scania Confacies have "Transitional beds" from which the missing faunas have been recorded.

Oepikodus evae ranges from the base of Billingenian Substage into the Lanna-Volkhovian Stage (van Wamel, 1974; Rasmussen, Stouge, 1988). Together with associated forms (see above), it occurs with *Baltoniodus triangularis* and *B. navis* (Rasmussen, Stouge, 1988). This transitional conodont assemblage occurs in the *Megistaspis lata* trilobite Zone (Nielsen, pers. comm. 1988).

Baltoniodus triangularis Zone

The lower Lanna-Volkhovian *Baltoniodus triangularis* Zone is defined by the appearance of *B. triangularis*. The zone may be difficult to recognize because fossils are rare in the interval (van Wamel, 1974; Löfgren, 1978). *Microzarkodina flabellum* appears together with *B. triangularis*, but in very low numbers.

Baltoniodus navis Zone

The *Baltoniodus navis* Zone is characterized by the first appearance of *B. navis* and *Eoneoprioniodus brevibasis* (s.l.). *M. flabellum* becomes abundant and the zone is equivalent to *M. flabellum* Zone *sensu* van Wamel (1974).

Transitional beds separate the *B. navis* Zone from the following *P. originalis* Zone *sensu* Lindström (1971). The fauna is characterized by the common occurrence of *B. triangularis*, *B. navis*, *Drepanoistodus forceps*, *D. basiovalis*, *Oistodus lanceolatus*, *Paroistodus originalis* and *E. brevibasis*. It is unknown whether these "Transition Beds" belong to the basal *M. simon* or to the very top of *M. lata* trilobite Zones.

Paroistodus originalis Zone

The succeeding *P. originalis* Zone *sensu* Lindström (1971) and the higher *M. parva* Zone are ecologically dependent and are diachronous from one confacies to another.

The base of *P. originalis* Zone in the Central Baltoscandian Confacies is marked by the first appearance of *Scalpellodus latus* and *Microzarkodina parva*. The common occurrence of *M. flabellum*, *M. parva* and *B. navis* is characteristic of the zone and it correlates with the *M. simon* trilobite Zone *sensu* Tjernvik, Johansson (1980).

Microzarkodina parva Zone

The *Microzarkodina parva* Zone has been defined by the first appearance of "*Semiacontiodus*" *cornuformis*. This shallow water species, however, apparently migrated to Scandinavia from the east Baltic, although the genus has North American affinities. The species appeared first in the Baltic Region and reached the Scania Confacies either late in Lanna-

Volkhovian time or in early Kundan beds (Kohut, 1972; Stouge, 1974). The migration of this species into the Scania Confacies is associated with a major regression and hence it is not useful as an index fossil in the Scandinavian region. Instead the interval is identified by the first appearance of *Baltoniodus norrlandicus*. The *Microzarkodina parva* Zone correlates with *M. limbata* Zone.

Eoplacognathus? variabilis Zone

The regression resulted in a prominent hiatus (cf. Tjernvik, Johansson, 1980), but "Transitional Beds" between the Lanna-Volkhovian and Kundan Stages occur in the Scanian and along the western margins of the Central Baltoscandian Confacies. The fauna includes *Amorphognathus* sp. cf. *falodiformis*, a primitive *Eoplacognathus? variabilis* and *Baltoniodus norrlandicus*. The interval is contained within the *A. variabilis* Zone sensu Lindström (1971), and the *E.? variabilis*—*M. flabellum parva* Subzone of Löfgren (1978) and it correlates with the lower *Asaphus expansus* trilobite Zone. *E.? variabilis* s. str. appears first in the upper *A. expansus* trilobite Zone and *Baltoniodus medius* and *Amorphognathus clarus* are the important markers for this level. *A. clarus* is restricted to this part of the *A. expansus* Zone. Taxa known from outside Europe including *Drepanoistodus venustus*, *Polonodus* spp. and *Ansella jemtlandica* appear first in Scandinavia at this level. This interval merits its own name and *B. medius* "zone" is informally introduced here awaiting its formal definition (Stouge, in prep.).

The *A. "raniceps"* Zone follows above the *A. expansus* Zone within the *E.? variabilis*—*M. flabellum parva* Subzone of Löfgren (1978) and the *A. variabilis* Zone sensu Lindström (1971). However, *M. ozarkodella* elements have their first appearance at this boundary (cf. Löfgren, 1985, p. 123, own observation and Rasmussen, pers. comm. 1988). This species has its acme high in the *A. "raniceps"* Zone. *Histiodela holodenta* appears at the base of *A. "raniceps"* Zone, which suggests that the Hølanda Limestone (the Figure, 1; Bergström, 1979) cannot be much older than the top of the *A. expansus* Zone. *H. holodenta* is restricted to the *A. "raniceps"* Zone in Scandinavia.

The *E.? variabilis*—*M. ozarkodella* Subzone was defined by the appearance of *M. ozarkodella* (Löfgren, 1978). The maximum abundance of *M. ozarkodella* may have local importance but the chronostratigraphical value of the zone is uncertain.

Eoplacognathus suecicus Zone

The *E. suecicus* Zone sensu Löfgren (1978) is the highest zone in the Kundan Stage of the Ontikan Subseries. It is characterized by the first appearance of the nominal species, i. e. *E. suecicus* sensu Löfgren (1978). Associated species that appear within the zone include *Protopanderodus graeai*, *Panderodus sulcatus*, and *Scalpellodus viruensis*. Löfgren (1978) subdivided the *E. suecicus* Zone into subzones on the basis of the latter two species. The appearance of the index species *Histiodela kristina* in the *E. suecicus* Zone is important for international correlation (Stouge, 1984; Dzik, 1978).

The *E. suecicus* Zone corresponds with the *M. obtusicauda* and *M. gigas* trilobite Zones.

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SKANDINAAVIA ALAMORDOVIITSIUMI (ONTIKA LADEJÄRGU) BIOSTRATIGRAAFIA KONODONTIDE PÕHJAL

Artikkel võtab kokku nimetatud teemal juba publitseeritud ja mõned uued andmed. On esitatud üheksa konodontitsooni assotsiatsioonide liigiline koostis ning korrelatsioon lademetega ja trilobiititsoonidega.

C. СТОУГЕ

БИОСТРАТИГРАФИЯ НИЖНЕГО ОРДОВИКА (ОНТИКАСКОГО ЯРУСА) СКАНДИНАВИИ ПО КОНОДОНТАМ

Обобщены опубликованные и некоторые новые данные по данной теме. Приведены видовой состав ассоциаций девяти конодонтовых зон, а также их корреляция с трилобитовыми зонами и горизонтами нижнего ордовика.