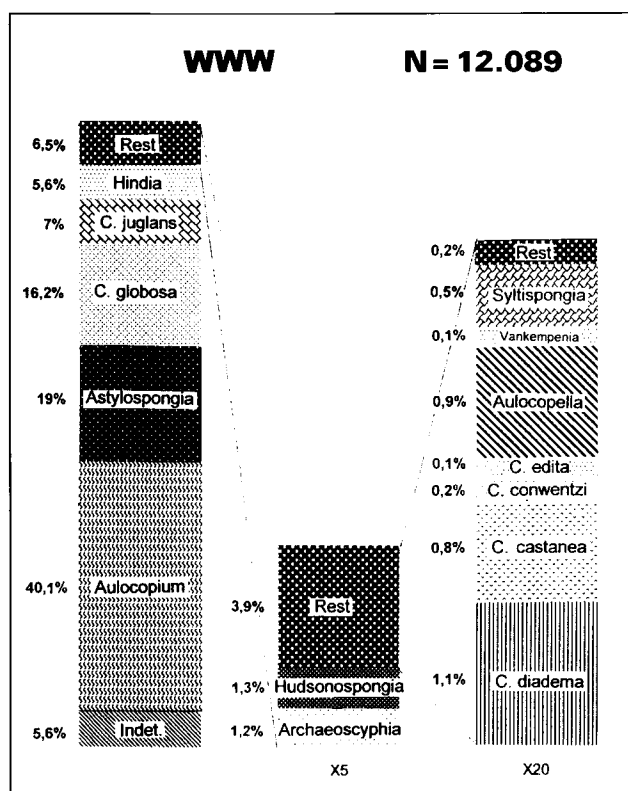


Summary

Introduction

Over many years more than 60,000 silicified Ordovician erratic sponges from the palaeocontinent Baltica have been collected in some areas in Northern Europe. Especially in the Netherlands some hundred enthusiastic amateur geologists have stored about 20,000 specimens in their private collections or housed them in museums. However, appropriate literature to identify them properly is not readily available. Either the literature is too old to be loaned out by museums or institutes, or it is inaccessible to the average amateur, due to both the scientific level and the need to read foreign languages. The purpose of this volume is first of all to provide a guide, a manual for Dutch (and German) amateurs. This atlas also serves other purposes: It is also meant to give an overview of the current knowledge of this subject at a time that sponges are the subject of extensive research. Besides, there is presently a concentration of knowledge, experience and availability of the material.

The third purpose is to draw the attention of sponge specialists throughout the world to the extensive and varied sponge assemblages from Baltica. It is remarkable that in the 19th century German sponge specialists, such as Roemer, Rauff and Von Zittel, were leading the research and even examined American sponges. After that generation only a few European palaeontologists continued these investigations. Over the years American specialists dominated sponge research. Perhaps as a result of this development Baltic sponges were gradually left out of the palaeontological focus. Perhaps this atlas will stimulate renewed interest in these varied, sometimes wonderfully preserved, erratic sponge assemblages. Nearly all sponges in this atlas have been collected in sandpits around the villages Wilsum, Wielen and Westerhaar, here shortened to the 'WWW-area', in the Twente region in the NE of the Netherlands and in the adjacent county of Bentheim in the westernmost part of Germany (fig. 20). As in most Ordovician sponge faunas in other parts of the world, the over-



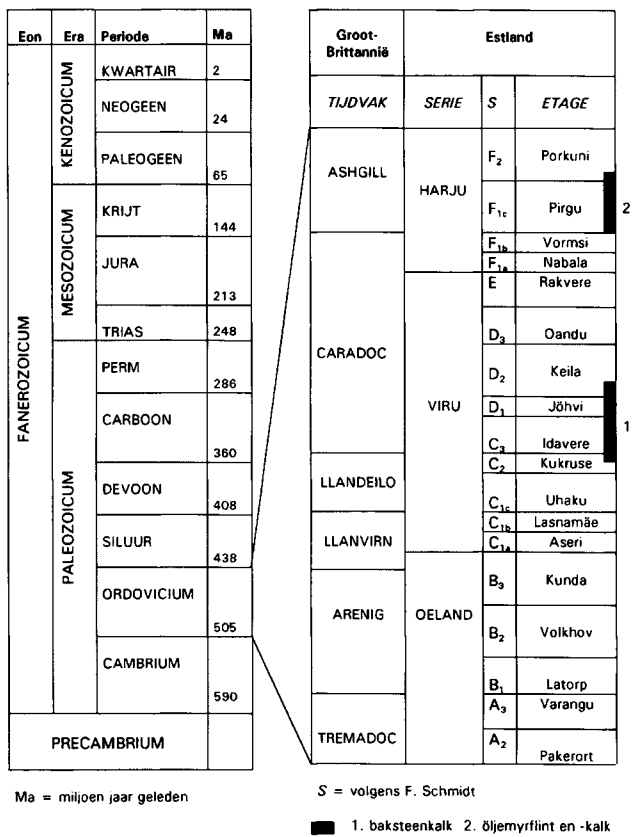
[fig. 26].

whelming majority of the sponges is represented by only two families: the Anthaspidellidae and the Astylospongiidae. The chiastoclonellid genera *Chiastoclonella* and *Syltispungia* are rare. From the Hindiidae only *Hindia sphaeroidales* and perhaps *Cotylahindia panaca* occur. (See the taxonomic scheme in fig. 6.) The form of anthaspidellids generally is (sub)cylindrical and ranges from obconical to disc shaped. They appeared in the Cambrian and radiated in the Middle Ordovician. These sponges were important reef builders and lived predominantly on outer shelf areas and upper parts of continental slopes. The astylospongiids generally are spherical to subspherical. They are younger, appearing in the Middle Ordovician and radiating in the Upper Ordovician, and, in some parts of the world, in the Silurian. They were reef dwellers but lived also on carbonate mounds in rather shallow continental basins. It is interesting to compare the Baltic assemblage with those from the

palaeocontinent Laurentia, which is now North-America. On one hand there is a striking similarity of genera that occurred along the margins of both palaeocontinents, which is reflected in many 'American' genera in the Baltic region. On the other hand there are two major differences. First the genera *Archaeoscyphia*, *Calycocoelia* and *Patellispongia*, which are dominant in the North-American sponge fauna, are rare in the Baltic region. Conversely, *Aulocopium aurantium* comprises about 45 - 50 % of the total Baltic assemblage but is relatively rare in North-America.

Secondly we presume that from Baltica the astylospongiids are represented by far more species and in far larger numbers of specimens than those occurring in Laurentia. There might have been a limited 'exchange' between both assemblages, but for short-lived sponge larvae, which usually need to settle down on hard rock within three days, the lapetus Ocean was perhaps still too wide to cross.

Since the Miocene an extended river system, that originated in the Baltic area or possibly further to the North-East, transported huge masses of sand and pebbles which are called the Baltic Gravel Association (abbreviated to BGA). It filled continental basins, fanning from East to West from Poland and East Germany to North-West Germany (fig. 35) and finally to the region that is the subject of this study (fig. 38). About a million years ago, during the Menapian (Early Pleistocene) period, these sediments were deposited in the Dutch-German area. Part of these deposits originated from the Baltic region. Another part



[fig. 21]

originated from areas in South-East Germany, such as Riesengebirge and Erzgebirge, and from bedrock formations in West Germany, such as Teutoburgerwald and Wiehengebirge, that were eroded by the river system (fig. 36). These latter sediments are not relevant and therefore not considered here.

The erratic Ordovician sponges are part of the Baltic component. However, the source areas of these sponges are unknown. Part of the sponge research by Von Hacht and Rhebergen was to try to localize the source rock of the sponges and the other Ordovician silicified erratics. (See below.)

The sandpits in the Dutch-German border region are concentrated in some ice-pushed ridges, due to the Saalian glaciers. During and after the process of overriding on the pushed-up ridges hardly any till or other erratics were deposited. However, in other areas in the Netherlands and

Comparison of areas with a concentration of ordovician erratic sponges

The sponges from the WWW-area are part of a wider assemblage of Ordovician erratic sponges. Other areas with a concentration of sponges are

- the Lausitz area, SE of Berlin;
- the island of Sylt in northernmost Germany;
- the island of Gotland, Sweden;
- Sadewitz (Sawidowice) E of Wroclaw, Poland. (map, fig. 23).

In the Middle-Miocene fluvial sediments from northern areas were deposited in the Lausitz area. Some 1,000 sponges have been collected. They are part of a varied assemblage of silicified stromatopores, tabulates and silicified Ordovician limestone, the 'lavenderblue silicifications' with their characteristic agate formations (fig. 24).

Fluvial and fluvio-glacial deposits from Pliocene time on the island of Sylt yielded a profusion of the same kind

Germany the Saalian glaciers did deposit till, mixed with Baltic Cambrian, Ordovician and Silurian erratics. Locally with masses of East Baltic Silurian limestone and corals. Ordovician sponges are extremely rare in Saalian till. The few specimens that nevertheless do occur are probably reworked specimens from older overridden Pliocene or Menapian fluvial sediments.

The importance of the sponges increases if the assemblages of Baltic sponges are considered as a whole.

of erratics, among them numerous sponges, of which more than 24,000 specimens have been investigated (fig. 25). The sponge assemblages of these two areas are nearly identical. The anthaspidellids predominate. *Syltrochos* and *Diotricheum* are characteristic genera in these assemblages. The astylospongiids are an important minority. Some species, such as *Carpospongia conwentzi* and *Carpospongia langei*, occur relatively frequently. In assemblages from the Lausitz area and on the island of Sylt *Astylospongia praemorsa* is represented with 1,2 % and 5 %, respectively.

During the latest glaciation, the Weichselian, Ordovician erratic sponges were deposited on the island of Gotland (Sweden) (fig. 27). In this sponge assemblage, comprising until now some 5,000 specimens, the astylospongiids dominate. *Astylospongia praemorsa* is with 17 % the second most frequent sponge species, whereas genera and species as *Syltrochos*, *Diotricheum* and *Carpospongia conwentzi* have not been found up to now. Lavenderblue silicifications seem to be absent. Part of the (originally calcified) sponges are not silicified completely.

The erratic sponges from Sadewitz (Poland) were collected in the middle of the 19th century. They were part of a huge erratic Upper Ordovician carbonate plate that was transported and fragmented by the Saalian glaciers. This sponge assemblage, that we know only from literature, seems to be identical with that of Gotland, including the partial silicification of some of the specimens.

The sponges in the WWW-area (fig. 26) have an intermediate position. They were transported in the Menapian (Early Pleistocene), which means an intermediate position in time, between the 'old', Miocene-Pliocene sedimentations from the Lausitz and Sylt respectively and the 'young', Late Quaternary periods of sedimentation from Sadewitz and Gotland. Also with respect to the accompanying Ordovician erratics and the composition of the assem-

blage the WWW-area has an intermediate position.

A minority of the sponges, especially specimens of the rare genera and species such as *Diotricheum*, *Syltrochos*, *Carpospongia conwentzi* and *Carpospongia langei*, have the same features as the sponges from the Sylt-Lausitz assemblage, including agate formations. Generally they have a bluish-grey colour. That is in accordance with the component of the 'lavenderblue silicifications', which is relatively rare in this region as well: about 2 % of the Ordovician erratics. By contrast, the majority of the sponges from the WWW-area is brownish-grey and lacks agate formations. This component is more or less similar to the Gotland-Sadewitz assemblage. Here again *Astylospongia praemorsa* is the second most frequent sponge. However, there are differences. All WWW-sponges are silicified completely and the number of species is larger than in the Gotland assemblage. The accompanying yellow-greyish, silicified and deeply weathered Ordovician limestone, the so called 'Backsteinkalk', is in the WWW-area a rather common type of erratic with a fossil assemblage, that has an East Baltic or possibly Russian character. The flora and fauna in it are different from those in the lavenderblue erratics. This 'Backsteinkalk' is rare both on Gotland and on Sylt, and seems to be absent both in the Lausitz area and in Sadewitz.

Unknown source areas

The complexity of all these phenomena may seem to be discouraging in tracing the source areas of the erratic sponges, but there may be some clues. Rhebergen and Von Hacht distinguish a bipartition in the erratic sponges:

- a. the Sylt-Lausitz assemblage in which the anthaspidellids dominate and that is connected with the Middle- to Upper-Ordovician lavenderblue silicifications.
- b. the Gotland-Sadewitz assemblage in which the Upper Ordovician astylospongiids dominate and that is connected with erratic, Upper-Ordovician, partly silicified, partly

'real' limestone.

The WWW-assemblage is a mixture of the first two. The lavenderblue component and the 'blue' sponges in the WWW-area might be remnants of Miocene or Pliocene deposits that have been reworked by the Baltic river system during the Menapian. The majority of the 'brown' WWW-sponges demonstrates a close relation with the Gotland-sponges. However, the frequently combined occurrence of both the WWW-sponges and the 'Backsteinkalk' prevents the assumption that the WWW-sponges originate from exactly the same source area as the Gotland-sponges. Von Hacht and Rhebergen assume that the Sylt-Lausitz sponges originate from an unknown source area that was in the Middle- and Upper-Ordovician part of the shelf areas of the palaeocontinent Baltica. In palaeogeographic reconstructions by McKerrow and Scotese this continent is situated south of the equator. However, its northern part was situated in the tropical zone and thus providing an environment required for all sponges in the Ordovician. That is also in accordance with the ecological niche of the anthaspidellids: they lived preferably as reef building organisms on the outer shelf and upper slope areas. Considering their geographical position in the Ordovician, it could be possible that these sponges originate from areas that are now situated in Northern Russia or the Barents Sea area. Both the sponges and other silicifications may have been transported since the Miocene in two or more reaches with long intervals. Somewhere they were exposed to the surface where they acquired their 'blue' colouring due to oxidation in an arid environment. Little can be ascertained about the time, location and conditions of the genesis of the frequently occurring agate formations. Anyhow, a transportation from the source area in a southwestern direction and an intermediate deposition in the Baltic region cannot be excluded.

The sponges from Gotland, Sadewitz and the 'brownish-grey' component of the WWW-sponges seem to be

younger. They are of Upper-Ordovician age. In that period Baltica moved rather rapidly to the north. Due to this movement the southern part of Baltica reached the tropical zone in Late-Ordovician times. The sponges that lived in that period may partly originate from a relatively shallow continental basin, which could be the Southern Baltic Basin in the present Baltic Sea. Another part may originate from unknown areas farther to the north or to the north-east. They may have been transported in one or several stages. Often they show evidence of fluvial transport, but some of the sponges show so many fragile details that during transportation those specimens must have been embedded in clay balls or in original (carbonate?) rock, that must have been washed away or dissolved during or after the last sedimentation.

The Hirnantian extinction

For hitherto unknown reasons the sponge fauna became extinct at the end of the Ordovician, as part of the worldwide Hirnantian extinction. This event marks the dividing line between the Ordovician and Silurian periods. During this event the effects of extensive glaciations in the southern hemisphere destroyed a majority of Ordovician life. The Hirnantian glaciations may have caused a fall in the sea level as a result of which the sponge niches might have been disturbed by these periods of regression. Possibly the required water temperature fell too far for sponges to survive. Perhaps the forthcoming closing of the Iapetus Ocean was already playing a role. Anyhow, the sponge fauna from Baltica became extinct. However, perhaps there were some survivors. Up to now four Silurian globular specimens (two of them being *Hindia sphaeroidalis*) have been collected in bedrock of Upper Llandovery and Lower Wenlock age on Gotland. Besides, some new species tried to resettle in the Wenlockian in the Gotland area, but as a whole the sponges, having lost their niches, were probably replaced by more modern or faster growing organisms such as corals.