On *Arenomeandrospira* gen.nov. (Foraminiferida, Ammodiscidae), and its association with Natural Gas Seepage

R.W. JONES\(^1\) and A.A.H. WONDERS\(^2\)

1. BP Exploration Operating Company Ltd., Chertsey Road, Sunbury-on-Thames, Middlesex, TW16 7LN, UK
2. The Bridge, 14 Lakeland Drive, Frimley, Surrey, GU16 5LD, UK.

**ABSTRACT**

The new ammodiscid genus *Arenomeandrospira* is erected. The genus is diagnosed by its modified streptospiral or “meandrospiral” coiling. The only recorded occurrences to date are from the Holocene of Scandinavia, Trinidad and Croatia, and the Miocene of Vietnam and Borneo. In certain cases, the occurrences may be associated with natural gas seepage.

**INTRODUCTION**

In 1947, in his now classic monograph of the Holocene foraminifera of the Gullmar Fjord and Skagerak, Hans Höglund described a new ammodiscid species which he called *Glomospira glomerata* n.sp.. Höglund distinguished it on the basis of the arrangement of the post-prolocular chamber, which he described as “wound up in sharp, meandering turns around the initial part”.

We believe that this species is so distinct in terms of this modified streptospiral or “meandrospiral” coiling (reminiscent of the “thalamannamminiform” coiling of Platon (1997)) that it merits a genus to itself. We formally describe *Arenomeandrospira* gen.nov. below, with *A. glomerata* (Höglund, 1947) [*Glomospira glomerata* Höglund, 1947] as type species by monotypy. We supplement the description with illustrations of the holotype and paratypes from the Holocene of the Gullmar Fjord and Skagerak (deposited by Höglund in the Department of Invertebrate Zoology of the Swedish Museum of Natural History (Naturhistoriska Riksmuseet), Stockholm, Sweden) and of hypotypes from the Miocene of Vietnam (deposited by us in the Department of Palaeontology of the Natural History Museum, London).

We also include data on its ecological and stratigraphic distribution.

**SYSTEMATIC MICROPALAEONTOLOGY**

Order ASTORRHIZIDA Brady, 1881
Superfamily AMMODISCACEA Reuss, 1862
Family AMMODISCIDAE Reuss, 1862
Genus *Arenomeandrospira* gen. nov.

**Type species.** *Arenomeandrospira glomerata* (Höglund, 1947) [*Glomospira glomerata* Höglund, 1947]; OD(OM). Scandinavia, Trinidad, Venezuela, Croatia, Vietnam, Borneo; Miocene-Holocene.

**Derivation of Name.** Aren(o)sus- (L.), sandy, with reference to the wall structure + Meandrospira, a porcelaneous foraminiferan genus.

**Diagnosis.** An ammodiscid genus diagnosed by modified streptospiral or “meandrospiral” coiling (see below).

**Description.** As type species (see below).

**Ecological Distribution.** As type species (see below).

**Stratigraphic Distribution.** As type species (see below).

*Glomospira glomerata* n.sp. Höglund, 1947, pp. 130-131, pl. 3, figs 8-10 (reproduced herein as text-figs. 1-3), text-fig. 104 (reproduced herein as text-fig. 4).


*Glomospira glomerata* Höglund.- Daniels, 1970, p. 67, pl. 1, fig. 6, text-fig. 42.


*Glomospira glomerata* (Höglund) (sic).- van Borren, Koopman & Schreurs, in Sandal, 1996, p. 90, fig. 4.4m.

See also Simmons *et al.* (1999) and Bidgood *et al.* (this volume).

**Material.** Several hundred specimens.

**Repository.** The syntypes (holotype and paratypes) of Höglund’s (1947) *Glomospira glomerata* n.sp. (Figure 1, nos. 1-4; Plate 1, Figs 1a-d) from the Holocene of Scandinavia are housed in the Swedish

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Museum of Natural History (Naturhistoriska Riksmusset) in Stockholm, Sweden. The holotype (Plate 1, Fig. 1a-d) is housed in inside a cottonwool-stoppered alcohol-filled glass phial labelled "Glomospira glomerata n.sp." which in turn is inside a larger glass phial labelled "Glomospira glomerata n.sp.: Stat. Bjorkholmen, 16/8/1927: c. 30 m: Holotype" and signed Hans Höglund. The holotype no. is 2054.

Figured and other representative hypotypes from the Miocene of Vietnam (Plate I, Fig. 2a-b) are housed in the Department of Palaeontology of the Natural History Museum, London.

Description (syntypes). Test free, spherical, consisting of a spherical proloculus and an elongate tubular post-prolocular second chamber; chamber arrangement modified streptospiral or "meandrospiral" (second chamber formed into a line of tight folds with subparallel axes, each fold approximately four times as high as wide, line of folds wound streptospirally around proloculus, typically four to six folds per whorl, only those of final whorl visible externally); wall finely arenaceous, cemented, inner and outer surfaces smooth; aperture terminal, at open end of tube.

Dimension. Test diameter 0.2–0.3 mm; proloculus diameter 23–30 μm; coil diameter (proximal) 8–10 μm to 0.08–0.10 mm (distal); wall thickness 10 μm (Höglund, 1947).

Variability. Höglund (1947) noted some variability in the coiling of this species, stating that not all specimens is his collections were as regular as those he illustrated. A similar range of variability is evident among studied hypotypes from the Miocene of Vietnam, which also exhibit varying degrees of compression due to burial.

Type Locality. Bjorkholmen, Gullmar Fjord, Scandinavia.

Type Level. Holocene.

Comment. Glomospira glomerata Höglund, 1947 is a junior homonym of G. glomerata (Grzybowski, 1898) auctt. [Ammodiscus glomeratus Grzybowski, 1898]. However, it does not require a replacement name, nor has one been proposed, as it is clearly not congeneric with Grzybowski's species, and in any case the homonymy is only secondary (subjective).

Ecological and Palaeoecological Distribution. Höglund (1947) recorded Arenomeandrospira glomerata [as Glomospira glomerata n.sp.] as rare (up to 12 specimens per sample) in Cores G14a, G26, G27, G54, G57, G58, G65, G71, G74 and G75 from the Gullmar Fjord (water depths 24–67 m) and Core K30 from the Kattegat (48 m), and abundant (>200 specimens) in a dredge from Bjorkholmen (the holotype locality) in the Gullmar Fjord (30 m). Station locations are shown on Figures 2-3. Location, depth and substrate data from the stations where A. glomerata was recorded are shown on Table 1. The depth distribution of the species in the Gullmar Fjord is
Figure 2. The Gullmar Fjord (from Höglund, 1947). *Arenomeandrospira glomerata* (Höglund, 1947) was recorded by Höglund (as *Glomospira glomerata* n. sp.) in cores from Stations G14a, G26, G27, G54, G57, G58, G65, G71, G74 and G75 (water depths 24-67 m) and in a dredge sample adjacent to station G26 (30 m).

Figure 3. The Skagerak and Kattegat (from Höglund, 1947 (shallow gas and pockmark occurrences from Hovland, 1992c)). *Arenomeandrospira glomerata* (Höglund, 1947) was recorded by Höglund (as *Glomospira glomerata* n.sp.) in a core from station K30 in the Kattegat (48 m).
Figure 4. Depth Distribution of Arenomeandrospira glomera (Höglund, 1947) in the Gullmar Fjord (modified after Höglund, 1947). Höglund referred to this type of distribution as “stenobathic middle water”.

shown on Figure 4. Alve & Nagy (1986) later recorded A. glomerata [as Glomospira glomerata Höglund, 1947] at 11 stations in the Sandebukta (a branch of the Oslo Fjord) at depths ranging from 16 to 66 m.

Todd & Bronnimann (1957), Bermudez (1966) and Daniels (1970) recorded A. glomerata [as Glomospira glomerata Höglund, 1947] between 2-18 fathoms (4-36 m) in the Eastern Gulf of Paria, offshore Trinidad, off the central and eastern coasts of Venezuela, and in a depth of 32 m in the Limski Channel in the Northern Adriatic, offshore Croatia respectively. Incidentally, one of us (RWJ) has also come across uncorroborated records (in proprietary reports) of “Glomospira glomerata” in the Miocene of the Gulf of Paria.

We have recently recorded locally abundant (up to 50 specimens per sample) occurrences in the Miocene of a recent BP Exploration well drilled in the Nam Con Son Basin, offshore Vietnam, the precise details of which cannot be disclosed for reasons of commercial sensitivity.

Van Borren et al., in Sandal (1996), Simmons et al. (1999), and Bidgood et al. (this volume) have recently recorded occurrences in interpreted shallow and deep marine environments in the Miocene of Northwest Borneo.

In the case of the Miocene of the well in Vietnam, A. glomerata occurs in the drowning (seal) sequence immediately overlying the shallow marine carbon-ate reservoir target, and forms part of an assemblage interpreted as associated with natural gas seepage (on the basis of analogy with work by Jones (1992, 1993, 1996) and Coles et al. (1996)). The gas seepage was evidently taking place as the seal sequence was being deposited and the trap formed.

It is conceivable that the occurrences in the Kattegat and Skagerak are also associated with gas seepage. These are areas of known shallow gas occurrence characterised by periodic explosive release and the development of “pockmarks” (e.g., Howland, 1991, 1992a-c, 1993; Laier, 1993; Figure 3). Methane-derived carbonate forms “pseudoreefs” that favour the epifauna at the expense of the infauna (Dando, Jensen et al., 1994). Some macrofaunal species host symbiotic methanotrophic bacteria (Dando, Bussmann et al., 1994).

Stratigraphic Distribution: Miocene-Holocene.

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Karine Sindemark of the Department of Invertebrate Zoology of the Swedish Museum of Natural History (Naturhistoriska Riksmusset), Stockholm, Sweden, is thanked for arranging the loan of the holotype of Glomospira glomerata Höglund, 1947, John Whittaker of the Department of Palaeontology of the Natural History Museum, London, for assistance with photography and plate production. BP Exploration provided word-processing and drafting facilities, and are also thanked for permission to publish.

REFERENCES
Bidgood, M.D., Simmons, M.D. & Thomas, C.G.C., this volume. Agglutinated foraminifera from Miocene sediments of northwest Borneo.
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**Table 1.** Location, depth and substrate data on stations where *Arenomeandrospira glomerata* (Höglund, 1947) was found (compiled from Höglund, 1947).

<table>
<thead>
<tr>
<th>Station</th>
<th>General Location</th>
<th>Specific Location</th>
<th>Depth</th>
<th>Substrate</th>
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</thead>
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<tr>
<td></td>
<td></td>
<td>Latitude</td>
<td>Longitude</td>
<td></td>
</tr>
<tr>
<td>G14a</td>
<td>Gullmar Fjord</td>
<td>58° 16.80' N</td>
<td>11° 28.50' E</td>
<td>32m</td>
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<td>G26</td>
<td>Gullmar Fjord</td>
<td>58° 23.85' N</td>
<td>11° 38.90' E</td>
<td>24m</td>
</tr>
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<td>G27</td>
<td>Gullmar Fjord</td>
<td>58° 24.20' N</td>
<td>11° 36.10' E</td>
<td>33m</td>
</tr>
<tr>
<td>G54</td>
<td>Gullmar Fjord</td>
<td>58° 19.45' N</td>
<td>11° 32.40' E</td>
<td>67m</td>
</tr>
<tr>
<td>G57</td>
<td>Gullmar Fjord</td>
<td>58° 20.40' N</td>
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<td>34m</td>
</tr>
<tr>
<td>G58</td>
<td>Gullmar Fjord</td>
<td>58° 20.85' N</td>
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</tr>
<tr>
<td>G65</td>
<td>Gullmar Fjord</td>
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<td>G71</td>
<td>Gullmar Fjord</td>
<td>58° 24.15' N</td>
<td>11° 57.60' E</td>
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<td>K30</td>
<td>Kattegat</td>
<td>57° 25.00' N</td>
<td>11° 32.00' E</td>
<td>48m</td>
</tr>
<tr>
<td>Björkholmen(dredge)</td>
<td>Gullmar Fjord (close to G26)</td>
<td>-</td>
<td>-</td>
<td>30m</td>
</tr>
</tbody>
</table>


Plate 1. 1a-d. Environmental chamber SEM microphotographs of various aspects of the holotype, Holocene, Bjorkholmen. 2a-b. SEM microphotographs of various aspects of a hypotype, Miocene, Vietnam.