SVERIGES GEOLOGISKA UNDERSÖKNING

SER. C. Avhandlingar och uppsatser. N:o 533

ÅRSBOK 47 (1953) N:o 4

DE GEOLOGISKA RESULTATEN FRÅN BORRNINGARNA VID HÖLLVIKEN

DEL VI:

CHAROPHYTA FROM THE MIDDLE TRIAS OF THE BORING HÖLLVIKEN II

PRELIMINARY ACCOUNT

BY

HENNING HORN AF RANTZIEN

WITH 1 PLATE

Pris 1,50 kronor

STOCKHOLM 1953
KUNGL. BOKTRYCKERIET. P. A. NORSTEDT & SÖNER
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Preface.

The Charophyta constitute a small group of green algae, remotely allied to the Chlorophyta. They comprise about 300 species of 7 genera and are found in fresh water in most parts of the world. A few of them also occur in slightly brackish water, but none can stand a normal marine habitat. The recent charophytes are the last offshoots of a large and morphologically diverse group of plants found in Devonian and later fresh-water deposits. The recent representatives of this group belong to the family Characeae of the order Charales, but the fossil forms are divided into 3 orders and 6 families as recognized in a recent survey (Mädler 1952). Though vegetative remains of a complicated structure and reproductive organs have occasionally been found in the fossil state, most of the material consists of "fruits" — gyrogonites — preserved by the ability of the living enveloping cells to secrete calcium carbonate (Horn af Rantzien 1951, Croft 1952, Mädler 1952). Such gyrogonites are composed of a large central cell — oosphere or oospore — surrounded by varying numbers of spirally twisted enveloping cells meeting at the upper ends, where they form apical structures of varying shapes. The classification of the fossil forms has made great advances in recent years by a closer study of their morphology and variation, and by the method of embedding gyrogonites in plastics and grinding them into sections for investigating their internal structure (Croft 1952, Horn af Rantzien 1953). The gyrogonites are of considerable importance as stratigraphic markers for the correlation of fresh-water deposits, and have accordingly also attached the attention of geologists.

During the Swedish Government's borings for salt and oil at Höllviken (Höllviksnäs), SW Scania, South Sweden, charophytes were found at depths of 1 762—1 845 m in the Middle Trias[1] of the boring Höllviken II. Their presence in these strata was reported by Brotzen (1950, p. 11, 16—19, fig. 3—4), in fact the first record of Pre-Quaternary charophytes from Sweden. For particulars of the profiles obtained from these borings, see Brotzen (1945, 1950).

The Swedish Geological Survey submitted the material for identification by the writer. The investigation has been carried out in the Paleobotanical Department of the Riksmuseum, Stockholm, Sweden, under the supervision of Professor Olof H. Selling, Sc. D. and with the technical assistance of Mr. K. E. Samuelsson.

The Middle Trias gyrogonites from Höllviken will be described and discussed in detail later on. Some preliminary notes on their taxonomy and

[1] The stratigraphical range of this series is uncertain. According to Brotzen 1950, this part of the profile may belong to the Lower Keuper or Muschelkalk.

vertical distribution are given in this paper as well as a discussion of their matrix and probable habitat, matters which — being mainly of geological interest — will not be dealt with in the publication of the final paleobotanical results.

Previous records of Triassic Charophyta.

Whilst a good many papers have been published on the charophytes of the Devonian, and on Upper Jurassic, Cretaceous, and Lower Tertiary forms, information on their occurrences in the Upper Paleozoic and Lower and Middle Mesozoic is comparatively scanty. No comprehensive material has been investigated from strata of this age, and the references given are merely to more or less accidentally discovered specimens.

Early records of Triassic Charophyta (Schimper 1869, p. 217, Schimper & Schenk 1879, p. 44, 393, Solms-Laubach 1887, p. 377, Hauptfleisch 1897, p. 566—567; see also Pia 1924, p. 181) are either very uncertain or refer to the presence of *Spirangium* in the Bunter and Lower Keuper. *Spirangium* was interpreted as a charophyte by Nathorst (1879, p. 88); it is certainly no alga, however, but its systematical position is still unclear (cf. Schmidt 1928, p. 47, and Mägdefrau 1953, p. 283—284 for references). Incorrect — as to age determination — is moreover a report by Leriche (1928, p. 49) of a species of "*Chara*" in "Triassic" strata of the Lubilash of Central Africa. The Lubilash is nowadays considered to belong to the Kalahari System (Upper Cretaceous—Lower Miocene).

In 1934, a few gyrogonites from the upper part of the Chugwater formation of Wyoming, U. S. A., were described as "*Gyrogonites*" *glyptus* (Peck 1934 a, p. 52). The age of the Upper Chugwater is disputed, but is mostly considered Upper Triassic (for particulars and references see Wilmarth 1938 under the headings of "Chugwater", "Jelm", and "Popo Agie").

The first gyrogonites from the Bunter of East Germany were reported as "*Gyrogonites*" sp. by Krause (1939, p. 406). In that year also Wicher (1939, p. 8) gave a somewhat more detailed account of the same material; he also noted the presence of charophytes in the Rhaetic of Berlin. Brotzen (1950, p. 11, 16—19, fig. 3—4) reported Trias gyrogonites from South Sweden and Denmark, figuring two of the more striking types. In a report on embedding of gyrogonites in plastics, Horn af Rantzien (1953, p. 516, fig. 2) mentioned the occurrence of Triassic charophytes in South Sweden with two gyrogonites illustrated. In a survey of the stratigraphic distribution of charophytes, Mädler (1953, p. 63—64, Taf. 1) finally indicated the probable occurrence of the genera *Clavator* and *Tolypella* in the Triassic.

To sum up the above data, there is accordingly evidence of the presence of charophytes in the Bunter of East Germany, in the Middle Trias of South Sweden and Denmark, in the Rhaetic of Berlin, and in the Chugwater (Upper Triassic) of Wyoming, U. S. A. The references are to forms of "*Gyrogonites*" or to entirely unidentified specimens; a specific identification has been attempted in one case only (Peck 1934 a).

Composition of the charophyte flora of Höllviken.

From a stratigraphical point of view, the Höllviken Charophyta are rather isolated. There are a few scattered notes, partly uncertain, on occasional specimens from the Carboniferous—Permian and the Liassic—Middle Jurassic. The youngest Paleozoic charophyte flora investigated is that of the Sylamore limestone of Missouri (Basal Mississippian, Peck 1934 b), and the oldest Mesozoic floras as far described are Upper Jurassic (Kimmeridge, Mädler 1952; Morrison, Peck 1937; Purbeck, Harris 1939, Carozzi 1947).

The entire material of gyrogonites from the Höllviken II comprises about 90 determinable specimens and about 20 gyrogonites that are too fragmentary or otherwise too badly preserved for a specific identification. In comparison with fossil gyrogonites from other strata, the Höllviken material is not very well preserved; it is often corroded, crushed, or deformed in other ways. In this respect there is a vertical difference (see p. 8—10). The Middle Trias profile of Höllviken II has been divided into zones (Zones a—f) by Brotzen (1950) according to the character of the rock. The following numbers of identifiable isolated gyrogonites from the zones were submitted for examination: Zone a 0, b 22, c 0, d 54, e 0, f 10. Ground sections of the matrix in Zone b yielded about another 100 sections of gyrogonites.

Two families, Clavatoraceae and Characeae, are represented.

Of the Clavatoraceae, of which only extinct forms are known, there are two genera in the present material, neither of them previously described. The geological range of this family extends from the Middle Trias (present material), the Kimmeridge (Mädler 1952) and Purbeck Formations (Harris 1939, Brückner & Pia 1935, Carozzi 1947) of the Upper Jurassic, several formations of the Lower Cretaceous of North America (Peck 1938, 1941), and the Middle Cretaceous and Paleocene of Hungary (Rásky 1945, 1952). The Middle Trias species are accordingly the oldest known representatives of this family, which appears to have been especially well developed in the Purbeck of England and Switzerland. The Clavatoraceae are characterized by a complex vegetative structure, well preserved in the British Purbeck material (Harris op. c.), and by the presence of utricles — structures of somewhat doubtful phyletic origin investing the gyrogonites. The latter are foremost distinguished in having their apical poles prolonged and formed by the upwards-directed ends of the enveloping cells. No utricles have been found adherent to the gyrogonites of the Höllviken Clavatoraceae, which makes a direct comparison with later forms difficult.

Some peculiarities in the structure of the apical pole of one of the two Höllviken genera distinguished, *Stellatochara* n. g., prevent an identification with any previously known form. Three species are represented. The genotype, *S. sellingii* n. sp. (Brotzen 1950, fig. 3; this paper pl. 1, fig. 1—3), is in several respects the most interesting of the Höllviken charophytes. It is comparatively large (length of gyrogonite about 500—700 μ), not very variable, fairly characteristic, and is by far the most common species in this material (about 50 specimens). It is restricted to the 1 805 m level (Zone d). Characteristic appearance and relative abundance may make it of some importance as a stratigraphic marker for fresh-water deposits of the Middle Trias. In comparison with the other Höllviken charophytes it is fairly well preserved internally, and ground sections have yielded useful information on the anatomical structure of Clavatoraceae gyrogonites in general. There are two other species of this genus in the material, the small *S. mädleri* n. sp. (pl. 1, fig. 4), of which about 10 gyrogonites were found in Zone f at 1 762 m, and a larger form, *S. höllvicensis* n. sp. (pl. 1, fig. 5) whose convolutions are strongly concave in contrast to those of *S. sellingii;* it is represented by a few specimens at 1 825 m.

The other genus of Clavatoraceae found at Höllviken, *Clavatorites* n. g. (genotype: *C. höllvicensis* n. sp., pl. 1, fig. 6), shows some resemblance to the genus *Clavator* of which five species are known from the Kimmeridge of NW Germany (Mädler 1952, p. 15, 1953, p. 64), the Purbeck of England (Reid & Groves 1916, p. 253, Groves 1924, p. 79, Harris 1939, p. 16—54) and Switzerland (Brückner & Pia 1935, p. 117—121, Carozzi 1947, p. 13), a number of North American Lower Cretaceous formations (Peck 1941, p. 292), and the Middle Cretaceous (Rásky 1945, p. 54) and Paleocene (Rásky 1952, p. 42) of Hungary. *C. höllvicensis* looks very distinct; as, however, only one gyrogonite was found (at 1 762 m) its range of variation is unknown.

The Characeae, to which all recent charophytes are referred, are mainly characterized by the structure of their vegetative system and reproductive organs. The gyrogonites are morphologically rather diverse, but common to all forms is that the apical ends of the enveloping cells are never — or rarely — prolonged. The lime-shells are, at least in most cases, structurally uniform. Utricles are never developed. This family includes several, both extinct and living genera of which three — all extinct — are represented in the Höllviken flora. The forms discovered in the Trias are the oldest known of this family; the oldest records were previously Kimmeridgian (Mädler 1952) and from there the family occurs throughout the Cretaceous and the Tertiary.

Of all fossil charophytes, the genus *Aclistochara* Peck is perhaps the commonest. It forms a very distinct group, primarily characterized by its peculiar apical centre, indicating a kind of protrusion of the proembryo and primary root somewhat different from that of other Characeae (Mädler 1952, p. 6—7, 15). *Aclistochara* was originally described from the Morrison Formation (Upper Jurassic) of Wyoming (Peck 1937, p. 86). Several species have since been described from strata ranging in time from the Kimmeridge to the Lower Miocene (Mädler op. c., p. 18—30, Peck 1941, p. 290—292, Peck & Reker 1947, p. 5, 1948, p. 87—89, Rásky 1941, p. 300—301, 1945, p. 40—46, 1952, p. 43). The characteristic *A. brotzenii* n. sp. (Brotzen 1950, fig. 4, Horn af Rantzien 1953, fig. 2 right, present paper pl. 1, fig. 7) is represented by some 10 gyrogonites from Zone b at 1 844—1 845 m. The gyrogonite of a second form of this genus (pl. 1, fig. 8), perhaps a distinct species, differs from *A.*

brotzenii in its smaller size, narrower spiral cells, and smaller apical pore. It was obtained at 1 762 m.

The genus *Sphaerochara* recently established by Mädler (1952, p. 6) comprises gyrogonites of spherical shape and provided with a minute apical pore or with no pore at all. This genus seems very distinct. Species of this group have been found in the Middle and Upper Cretaceous of North America and Peru, and in the Oligocene (Mädler l. c., 1953, Taf. 1). The genotype, *S. hirmeri* (Rásky) Mädler, is described from the Upper Oligocene of Hungary (Rásky 1945, p. 36). The single specimen found among the Höllviken Charophyta (pl. 1, fig. 13) is the oldest species of *Sphaerochara* known, and its presence in the Middle Trias implies a considerable extension of the geological range of this genus. Our well preserved specimen was obtained from Zone d at 1 805 m together with the dominant *Stellatochara sellingii*.

Whilst the gyrogonites of *Aclistochara* are conspicuosly flattened in the top region and provided with comparatively large apical orifices surrounded by expanded spiral cells, those of *Sphaerochara* are characterized by evenly rounded apical poles, generally with minute openings surrounded by cells of normal shape. The third genus in the Höllviken material, *Praechara* n. g., comprises forms with conical, usually somewhat protruding apical regions with small pores encircled by unexpanded enveloping cells. Specimens of this genus are often superficially like the gyrogonites of *Chara* and *Tolypella* (recent and fossil), but comparative studies of the external and internal morphology of these two genera undertaken in connection with this investigation show that *Praechara* differs from them in several respects. The geological range of *Praechara* may be rather wide; at present it is known only from the Middle Trias. Four taxonomic entities of the Höllviken Charophyta are referable to this genus. The genotype, *P. mädleri* n. sp. (Horn af Rantzien 1953, fig. 2 left, present paper pl. 1, fig. 9) is a small and distinct species of which about 10 gyrogonites were found in Zone b at 1 844—1 845 m. Two other forms of *Praechara* were also obtained at this depth, viz. 4 gyrogonites of the still smaller, more oval *P. pseudoglypta* n. sp. (pl. 1, fig. 10) primarily characterized by its closely spaced, narrow convolutions, and a specimen of a further, unusually distinct form (pl. 1, fig. 12) with a low number of wide convolutions and intercellular sutures deeply sunk into the surface of the gyrogonite. One specimen of yet another unnamed species of this genus (pl. 1, fig. 11) was found together with the dominant *Stellatochara sellingii* at 1 805 m. It is larger — about double the size of the three other species.

In view of the smallness of the sample, which contains some 90 gyrogonites of 11 species, it is difficult to decide whether its composition is representative of the Middle Trias Charophyta or not. The general character of this small flora makes it quite clear, however, that it is related to the younger charophyte floras of Upper Jurassic, Cretaceous and Early Tertiary age. A comparison with the Upper Jurassic Kimmeridge and Morrison floras described by Mädler (1952) and Peck (1937) is especially informative in this respect. Although the relations of the Höllviken material to the said younger floras are apparently not very close, certain morphological types, and also genera are common to them all. *Clavatorites* is rather reminiscent of the genus *Clavator*, found in the Upper Jurassic, the Cretaceous, and the Paleocene. It may in fact belong to the latter genus though this cannot be settled until the utricles of *Clavatorites* have been encountered. Of the Characeae, *Aclistochara* is represented abundantly in most of the younger floras up to the Lower Miocene, and *Sphaerochara* occurs in the Cretaceous and in the Upper Tertiary. Although *Praechara* is at present not known from the younger strata, at least one of its species, *P. pseudoglypta*, is somewhat similar to certain species of *Tolypella* described from the Kimmeridge by Mädler (1952).

No connections of the above nature exist between the Middle Trias flora and the charophyte floras of the Paleozoic, which in the Devonian and Basal Mississippian are characterized by dominant trochilisks and sycidiads and in the Pennsylvanian by *Palaeochara* and some morphologically inadequately studied forms. Quite the contrary — there are no common morphological types or genera.

The main interest of the Höllviken gyrogonites is that they are an indication that a charophyte flora of prevalently Upper Mesozoic—Cenozoic character existed already in the Middle Trias. Most of its morphological types were still flourishing in the Early Tertiary.

Environment of the Höllviken Charophyta.

Although some recent charophytes prefer or extend into slightly brackish habitats, most of them are confined to fresh water. The fossil charophytes are usually found associated with shells of fresh-water ostracodes and gastropodes, and were accordingly presumably also inhabitants of fresh water. The Trochiliscales and Sycidiales have been considered exceptional in this respect, being sometimes found in marine deposits (Karpinsky 1906, p. 153, Peck 1934 b, p. 93). Croft has recently (1952, p. 209—212) pointed out that the comparatively few finds of trochilisks in marine strata may be explained by these plants having drifted out to sea (cf. Groves 1933, p. 6) or by considerable contributions of residual soils containing gyrogonites from landmasses invaded by the sea. Croft (op. c., p. 215) is thus of the opinion that the trochilisks also "probably lived in fresh or brackish water". The presence of fossil charophytes will accordingly generally support the assumption of a fresh-water origin of the deposit in which they are found.

The following is a short summary of the number and state of preservation of the gyrogonites at the various depths, the geological characterization of the zones according to Brotzen (1950), and the occurrence of plant fossils (Lundblad 1949) other than gyrogonites.

Zone a. 1 862—1 854 m. No charophytes.

Zone b. 1 854—1 843 m. Greyish, hard calcareous marls ($CaCO_3$ at 1 844.5 m 62.6 %). — Charophyte gyrogonites common. "Such fossils exist in all parts of this zone, they occur especially abundantly in the harder and more calcareous layers" (Brotzen op. c., p. 17, in Swed.). The gyrogonites submitted for examination were obtained from depths of 1 844.0 (ground sections through matrix), 1 844.5 (individual gyrogonites and ground sections), 1 845.0 (ground sections), and 1 845.7 m (individual gyrogonites and ground sections). The 22 specimens sent for identification are relatively well preserved, and not — or only slightly — corroded. This also applies to the numerous sections of the matrix. Remains of fishes are not rare in this zone, but any plant fossils other than gyrogonites have not been identified. From the presence of the numerous well preserved gyrogonites alone, we may infer the existence of a shallow lake with lime-sediments, which was situated comparatively close to the then shore line of the sea. The habitat might also have been a shallow lagoon with brackish water in occasional communication with the sea, though this seems less likely. Considering the apparently common occurrence of well preserved gyrogonites, it is unlikely that the deposit is of marine origin and accordingly that tangles of charophytes should have drifted out to sea, or that residual earlier fresh-water deposits should have contributed to the formation of the actual marl. The profile of the part of the zone containing gyrogonites has been described by Brotzen (op. c., p. 17) as

1 843.60—1 844.20 m. Greyish argillaceous shale
1 844.20—1 844.70 m. Greyish hard calcareous marl
1 844.70—1 845.60 m. Greyish soft argillaceous shale
1 845.60—1 850.90 m. Greyish hard calcareous marl with occasional sandy intercalations.

Zone c. 1 843—1 827 m. No charophytes.

Zone d. 1 827—1 800 m. Greyish sandstones, argillaceous shales and marls with calcareous concretionary beds. — Gyrogonites common. "In layers between 1 800 and 1 830 m, oogonia of charophytes are the most common fossils" (Brotzen op. c., p. 11, in Swed.). Eight fragments of gymnospermous cuticles and two pollen-grains were obtained from this zone (Lundblad 1949, p. 4—5) as well as fish remains. The gyrogonites from 1 805 m differ in their state of preservation from those of 1 825 m. The reconstructed profile of this zone is described by Brotzen (op. c., p. 19) as follows:

1 800—1 804 m. Sandstone.

1 804—1 807 m. Calcareous concretions with numerous plant fossils and a thin layer of charcoal. About 60 whole or fragmentary gyrogonites were obtained from 1 805 m. They are better preserved than those of Zone b, and hardly or not at all corroded, but compressed specimens are more commonly met with than in that zone. Lundblad (l. c.) has identified one of the cuticles found here as "Mesozoic pteridosperm (or pre-bennettitalean)" and another as "possibly cycadalean". Fish bones and scales occur. The inference from the occurrence of the numerous gyrogonites is the same as in Zone b (cf. above). The presence of other plant fossils than charophytes probably indicate allochthonous material fallen into the water and drifted together into a small bank, or transported into the lake by river action.

1 807—1 820 m. Sandstone with plant remains. No charophytes.

1 820—1 821 m. Sandstone.

1 821—1 827 m. Greyish fine-grained sandstones and clays with plant remains and calcareous concretionary beds (about 5 cm thick) between 1 822—1 824 m and 1 824—1 826 m. — Five badly preserved and rather corroded gyrogonites were obtained from 1 825 m. Pollen grains and fragments of cuticles from 1 824.69 m have been examined by Lundblad (l. c.) who identified three of the latter as "Mesozoic pteridosperm (or pre-bennettitalean)". Any conclusions are very difficult to draw from the small

number of charophytes obtained, but habitat conditions similar to those in Zone f (see below) are possible.

1 827—1 828 m. Sandstone.

Zone e. 1 800—1 784 m. No charophytes.

Zone f. 1 784—1 755 m. Greyish sandstones, clay shales and marls with calcareous concretionary beds, fish and plant fossils. — Ten more or less corroded, often compressed or otherwise deformed gyrogonites were obtained from 1 762 m of this zone. Structures interpreted by Brotzen (op. c., p. 20) as calcareous algae were found, and at the 1 769.29 m level fragment of a cuticle which Lundblad (l. c.) has referred to as "conifer, cf. *Voltzia*". Ostracodes and fish remains are scarce. The matrix at 1 762 m has been described by Brotzen (op. c., p. 21) as a layer about 40 cm thick, consisting of calcareous concretions with plant fossils. Conclusions are difficult to draw from the few gyrogonites present, but their bad preservation, and the possible occurrence of calcareous algae seem to indicate that the possibility of a marine habitat at this level is by no means excluded.

The above shows that the vertical distribution and the preservation of charophyte gyrogonites in the Höllviken II profile present some noteworthy features. The comparatively numerous and well preserved gyrogonites at depths of 1 844.0—1 845.7 and of 1 805 m, are likely to indicate the existence of a shallow calcareous lake or — less probably — a shallow lagoon of brackish water. The remains of fishes found together with the charophytes are accordingly of fresh or brackish water origin. The vertically orderly sequence of the gyrogonites cannot be reconciled with the hypothesis that residual fresh-water deposits containing gyrogonites have been invaded by the sea and redeposited in a marine sediment. Nor does the relative abundance of gyrogonites favour the assumption that tangles of charophytes have at times drifted out to sea and contributed to the present sediment.

Inferences from the few and badly preserved gyrogonites at the 1 825 and 1 762 m levels are more difficult to draw. Corrosion is common there, which indicates less favourable conditions for the preservation of the gyrogonites; in other deposits this corrosion is often due to the dissolution of the superficial layers of the lime-shell in acid or neutral matrices. The presence of calcareous algae at 1 762 m would — if verified on reexamination — greatly strengthen the assumption that the sediments in Zone f are of marine origin. That would probably also explain the corroded surface of the present specimens as a result of chemical action by sea-water. The gyrogonites of Zone f might have come from plants that have drifted out to sea or from residual fresh-water soils containing gyrogonites. The aggregate occurrence of corroded gyrogonites, fish remains, and possible calcareous algae in the same stratum of Zone f might thus be explained by assuming a shallow marine environment comparatively close to the shore indicating marine transgressions on fresh-water deposits in the upper part of the Middle Trias.

Stratigraphic distribution of the species.

The importance of the Charophyta as index fossils has of late been repeatedly discussed in a number of papers. Although the usefulness of charophyte gyrogonites for stratigraphic purposes has been questioned (e. g. by Harris 1939, p. 78—79), it has been convincingly demonstrated several times — e. g. by the excellent results attained in correlating the Swiss Purbeck beds with those of England (Brückner & Pia 1935, Carozzi 1947), the Hungarian Paleocene with that of Dalmatia (Rásky 1945, 1952; cf. Stache 1889) and various Lower Cretaceous formations of North America (Peck 1941).

As far as the fresh-water deposits of the Middle Trias are concerned, this point cannot be definitely settled as long as only one profile containing gyrogonites has been examined. As, however, Brotzen (1950, p. 17) reports occurrence of charophytes in Jutland, Denmark, in the strata approximately corresponding to the Middle Trias of Höllviken, this question could probably be decided by an investigation of material from there.

Table 1. Vertical distribution of charophytes at the boring Höllviken II

depth in m	zone acc. to Brotzen 1950	species
1 762	Zone f	*Clavatorites höllvicensis* *Stellatochara mädleri* *Aclistochara* sp.
1 805	Zone d	*Stellatochara sellingii* *Praechara* sp. *Sphaerochara* sp.
1 825	Zone d	*Stellatochara höllvicensis*
1 844	Zone b	*Aclistochara brotzenii* *Praechara mädleri* *Praechara pseudoglypta*
1 845	Zone b	*Aclistochara brotzenii* *Praechara mädleri* *Praechara pseudoglypta* *Praechara* sp.

Judging by the Höllviken deposits alone, however, the vertical distribution of the species of Charophyta distinguished appears to be rather characteristic (Tab. 1). Should their distribution in samples of charophytes from other localities of the Middle Trias prove similar, the gyrogonites might be used as submarkers for the zones described by Brotzen (1950).

Tab. 1 also shows that the Clavatoraceae (*Stellatochara, Clavatorites*) are confined to the upper zones (Zones d—f), whilst the Characeae are mostly found in Zone b, only three species being found higher up. But Tab. 1 does not reveal that these three species are only represented by one gyrogonite each, and that accordingly only three specimens of Characeae have been found in the upper zones, as against the large number found in sections through the matrix and as isolated specimens from Zone b. The significance of this difference in vertical distribution between the two families — which may be accidental — is not clear.

Summary.

1. This paper is a preliminary account of a small and stratigraphically rather isolated charophyte flora represented solely by gyrogonites found in the Middle Trias of a boring (Höllviken II) at Höllviksnäs, SW Scania, South Sweden.

2. Very little information has been published on Triassic Charophyta and this group is on the whole but little known from the Upper Paleozoic—Lower Mesozoic. A few unidentified Triassic gyrogonites have occasionally been reported from the Bunter of East Germany, the Middle Trias of South Sweden and Denmark, and the Rhaetic of Berlin, and a species of "*Gyrogonites*" has also been described from the Chugwater of Wyoming, U. S. A. (Upper Triassic).

3. Eleven species are represented in the Höllviken charophyte flora. Four of these represent two genera (*Stellatochara* n. g., *Clavatorites* n. g.) of the family Clavatoraceae, and the remaining seven the genera *Aclistochara* Peck, *Sphaerochara* Mädler, and *Praechara* n. g. (Characeae). None of the forms of the Höllviken flora can be identified with any previously described species of fossil charophytes. In its general composition, the material is rather reminiscent of the Upper Jurassic charophyte floras (esp. Kimmeridge and Morrison); on the other hand there is almost no resemblance to the Paleozoic floras.

4. His studies of the occurrence and preservation of the gyrogonites in the zones of the Middle Trias profile at Höllviken, in conjunction with the general geological conditions in the respective zones and the presence of remains of other plants than charophytes, have led the writer to the conclusion that the charophytes — at least from the 1 844—1 845 and 1 805 m levels — have been deposited in a fresh-water basin or brackish water lagoon. They are much less likely to have been primarily deposited, or redeposited, in a marine habitat. Conditions are somewhat different at 1 825 m and 1 762 m, where certain circumstances point to the possibility that the few and rather badly preserved gyrogonites were deposited in a marine habitat. In that case, marine transgressions over fresh-water deposits in the upper part of the Middle Trias would be indicated.

5. The species distinguished in the Höllviken charophyte flora are characteristically distributed vertically (Tab. 1). Species of Characeae, though found throughout the profile, dominate the lower zone, whilst the Clavatoraceae are confined to the upper zones.

Paleobotanical Department, Riksmuseum, Stockholm 50, Sweden, July 1953.

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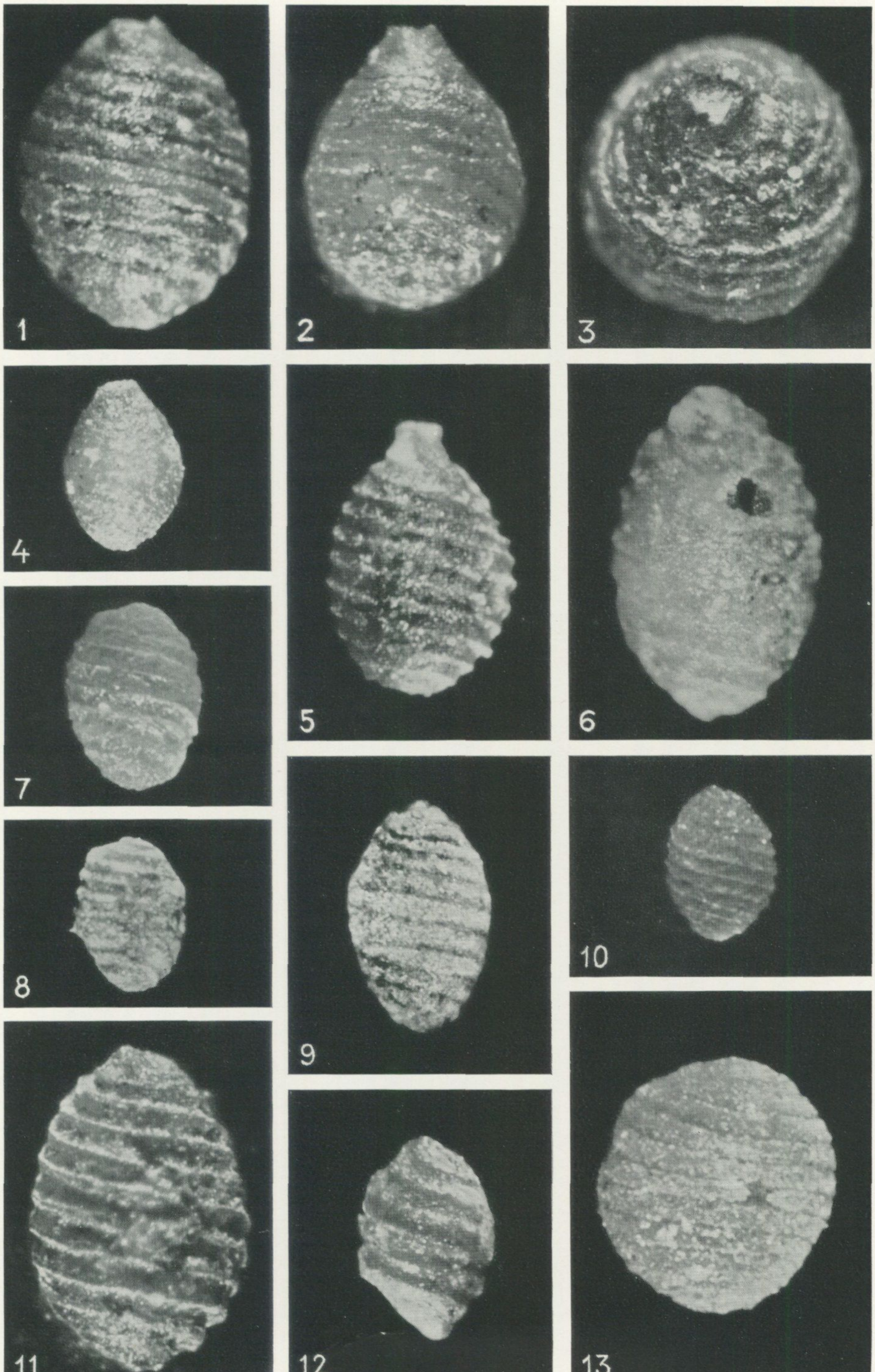
Explanation of Plate.

The figures in the plate are untouched photographs, made by Mr. K. E. Samuelsson, Paleobotanical Department, Riksmuseum, Stockholm 50, Sweden. The specimens figured are from the Middle Trias of the Höllviken II boring.

Plate 1.

Figs. 1—3. *Stellatochara sellingii* n. g., n. sp. 1 805 m.
Fig. 1. Lateral view. — 70/1.
Fig. 2. Lateral view. — 70/1.
Fig. 3. Apical view. — 70/1.
Fig. 4. *Stellatochara mädleri* n. g., n. sp. 1 762 m.
Fig. 4. Lateral view. — 70/1.
Fig. 5. *Stellatochara höllvicensis* n. g., n. sp. 1 825 m.
Fig. 5. Lateral view. — 70/1.
Fig. 6. *Clavatorites höllvicensis* n. g., n. sp. 1 762 m.
Fig. 6. Lateral view. — 70/1.
Fig. 7. *Aclistochara brotzenii* n. sp. 1 844 m.
Fig. 7. Lateral view. — 70/1.
Fig. 8. *Aclistochara* sp. 1 762 m.
Fig. 8. Lateral view. — 70/1.
Fig. 9. *Praechara mädleri* n. g., n. sp. 1 845 m.
Fig. 9. Lateral view. — 70/1.
Fig. 10. *Praechara pseudoglypta* n. g., n. sp. 1 844 m.
Fig. 10. Lateral view. — 70/1.
Fig. 11. *Praechara* sp. 1 805 m.
Fig. 11. Lateral view. — 70/1.
Fig. 12. *Praechara* sp. 1 845 m.
Fig. 12. Lateral view. — 70/1.
Fig. 13. *Sphaerochara* sp. 1 805 m.
Fig. 13. Lateral view. — 70/1.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