I. Preliminary Report on the Physical Geography of the Litorina-Sea.

by

Henr. Munthe.

(With two maps.)

By *Litorina-time* we mean, according to modern terminology, that relatively (in comparison with the present) salt phase of the *Baltic Sea's* post-glacial history, which was subsequent to the Ancylus-time, during which the Baltic was shut off from the ocean and had the character of a fresh-water inland lake[1].

Before entering upon my real subject it may be convenient to give some of the most important of the historical data touching the question above-mentioned.

One of the earliest notifications published, concerning the raised strata of the Litorina-time is probably that by BROMELL[2], who reports the occurrence of marine shell-remains in the district near Stockholm; these are undoubtedly to be regarded partly as accumulations of *Mytilus*-shells (»Bolus purpurei coloris» etc. loc. cit. p. 59) and partly as specimens of *Cardium edule L.* (cf. description and figure loc. cit. p. 59).

Further, the occurrence of *Mytilus*-accumulations in Helsingland is mentioned under the name of »Helsingmylla» (»humus conchacea Helsingica») by LINNÉ in the very first edition of his »Systema Naturæ» (1735), and later both by him and other writers in several other districts too, especially in central Sweden.

It is however CHARLES LYELL, who really laid the foundation of our knowledge of the *Litorina*-strata and their fossil remains. LYELL travelled in South Sweden in 1834, and published next year the results of his researches in a very valuable work[3].

[1] MUNTHE: Öfversigt af K. Vetenskaps-Akademiens i Stockholm Förhandlingar (= Ö. K. V. A. F.) 1887, No. 10.

[2] MAGNUS BROMELL: Lithographiæ svecanæ specimen secundum — —, Upsaliæ 1727. Cap. sec., Art. primus: De testaceis marinis wariis, quæ integra immutata e tellure effodiuntur, p. 58 et seq.

[3] On the proofs of a gradual rising of the land in certain parts of Sweden. Philos. Trans. Roy. Soc. London, 1835. I.

Thus in the Stockholm district he obtained »many striking geological proofs of a change of level of land and sea, since the Baltic was inhabited by the same species of *Testacea* which it now supports» (p. 4)[1].

As a matter of fact the list he gives of the Mollusca found by him is so complete that up to the present time it has not been possible to make any additions to it, as far as the Stockholm district is concerned, which he made a special study of. The list is as follows:

Pelecypoda:	Gastropoda:
Tellina Baltica var. *a*) and *b*)[2]	*Littorina littorea (Turbo littoreus* LINN.)[3]
Cardium edule var.	*Littorina rudis (Turbo rudis)*
Mytilus edulis	*Paludina ulvæ?*
	Rissoa parva (Turbo parvus MONT).

On *Mytilus* he had moreover found »the small white flustra now so commonly attached to them in the Baltic» (p. 14); and lastly we have to mention the Gasteropod *Neritina fluviatilis* which lives in fresh and brackish waters.

LYELL also directs our attention to the interesting fact, »that the *Mya arenaria* is the only one found — — in great abundance in any part of the Baltic, which I (LYELL) did not see among the fossils».

He goes on rightly enough, to point out that some of the above-mentioned fossil Mollusca are smaller than the corresponding ones in the ocean, in some cases actual dwarf-forms and that this concurs with those living in the Baltic.

When he says however that »the whole assemblage of shells is such as characterizes the Baltic», his statement is not correct, as A. ERDMANN and S. LOVÉN have since shown[4] for the *Litorina*-species »are not now to be found alive in the Baltic; this circumstance seems to denote that the Baltic's water have become unserviceable for these animals, by reason of the saltness of the same having diminished somewhat during the prehistoric period»[5].

This view of the greater saltness of the Baltic in former times soon received confirmation from later investigations, especially those of G. LINDSTRÖM[6] who found in the Litorina-strata in Gotland besides *Rissoa labiosa,*

[1] It should however be mentioned that LYELL had received information from SVEN NILSSON: "that marine shells of species similar to those in the Baltic had been found near Stockholm" (LYELL, loc. cit. p. 5.).

[2] LYELL (p. 34.) points out that "there is a passage between these two varieties and they undoubtedly are of the same species".

[3] *Littorina crassior (Turbo crassior)* is given as well; probably coincides with L. littorea?

[4] Ö. K. Vet.-Akad. Förh. 1852.

[5] Last-named and some other writers seem however, unaware that the Litorina-species in question are actually now found living in the southern Baltic (see below).

[6] cf. his papers: Ö. K. Vet-Akad. Förh., 1852, pp. 194 et seq.
Geologiens Grunder, 1857, p. 125.
Om Gotlands nutida mollusker, 1868, pp. 44—46.

Litorina rudis var. *tenebrosa* and others, *Spirorbis borealis* DAUD., and the shells of *Cardium edule,* larger in size than those now living near Gotland; further, by the researches of O. GUMÆLIUS[1] who gives for Ångermanland, *Litorina rudis* among others (proved by later research to be, more accurately, var. *tenebrosa*). On the extent of Litorina-strata in central Sweden there are a number of notes in the publications of the Swedish Geological Survey (S. G. U.) and for the North-Baltic district valuable information is given by HISINGER (musselbed near Djekneboda in Westerbotten[2]), by F. SVENONIUS[3] (a musselbank found by K. A. FREDHOLM in Neder-Kalix parish at a height of at least 110 feet) and later by A. G. HÖGBOM[4] (marine shellgravel from Löfängers and Rickleå parishes in Westerbotten).

For occurrence of Litorina-strata, etc. in Finland and the Russian Baltic provinces see particularly the works of A. M. JERNSTRÖM[5] and F. SCHMIDT[6].

In the fifties H. VON POST and A. ERDMANN also issued descriptions of strata belonging to the Litorina-sea, and the nomenclature they then proposed has been for the most part usual since; (there is no occasion for me to enlarge upon this question in this place).

It is on the other hand worth mentioning that LOVÉN quite early separated *older* strata, or such as contain *Litorinas* from *younger* or such as are without Litorinas but contain *Limnæas;* this gave rise to the distinguishing of two »periods» (Litorina- and Limnæa-periods)[7].

DE GEER, in 1882, showed that Baltic postglacial marine clay is formed in south Sweden, during a separate sinking of the region; thereby E. ERDMANN'S[8] and A. G. NATHORST'S[9] discoveries in south Skåne of marine deposits above supermarine ditto got a better explanation, and the same may be said of G. LINNARSSON'S[10] and LINDSTRÖM'S[11] (later) similar finds in Gotland.

My investigations in the quaternary strata in the Baltic district began in Gotland (1886—87). I endeavoured, in a preliminary communication in 1889[12] to show that during the phase between the close of the younger glacial epoch and the Litorina-time, the Baltic had the character of a fresh-water inland lake.

[1] Geolog. Fören:s i Stockholm Förhandl. (= G. F. F.), Bd. 1, 1873, p. 234.
[2] Anteckn. i Physik o. Geognosie, 7 H., 1840.
[3] Bidrag till Norrbottens Geologi, Stockholm 1880, p. 71.
[4] G. F. F., 1887, p. 23.
[5] G. F. F., Stockholm 1876, pp. 133 et seq.
[6] cf. particularly Zeits. d. deutsch. Geol. Gesells. 1884.
[7] cf. particularly LINDSTRÖM, Gotlands nutida mollusker 1868, pp. 44—46 and G. F. F. 1886, pp. 251 et seq.
[8] G. F. F. 1872, pp. 93 et seq.
[9] — — 1873, pp. 281 et seq.
[10] — — 1876, pp. 120 et seq.
[11] — — 1886, pp. 251 et seq.
[12] Ö. K. V. A. F. 1887, No. 10.

It thus become evident that the opinion previously expressed by LOVÉN and not afterwards contradicted that the Baltic from being an ice-sea containing *Yoldia arctica* GRAY had been gradually or without intermission transformed to one containing Litorinas etc. could not be maintained; that on the contrary the Litorina-fauna was a completely distinct fauna that immigrated to the Baltic comparatively late and could scarcely be supposed to have entered by any other route than that of the Sound and the Belts.

In 1888, amid other investigations I pursued my study of Litorina-strata in certain parts of South Sweden, extending the same in 1889 to the coast-districts of North Sweden up to the region of Neder-Kalix. I endeavoured, especially on the latter journey, to determine the northern boundaries of the different molluscan species in the Litorina-sea, and to obtain more certain information about the extent of land-subsidence during the period[1].

Furthermore I collected material for subsequent investigation of the *diatomaceous flora* and of the *rhizopod-* und *ostracodfaunas* of the Litorina-sea; for concerning these subjects researches in the Litorina-clay of Upsala-district had afforded some new results. The detailed working-up of this material was begun in the autumn of 1889 and continued in the main during the succeeding winter.

Since however the information up to that time acquired, about the present physical geography of the Baltic was too incomplete to permit of any definite conclusions being drawn as to the condition of the Litorina-sea in the particular named, it was needful to try and supply the more essential details wanting[2]. I therefore made some dredging and fishing operations in certain parts of the Baltic (1888 near Bornholm and Malmö

[1] Some of these observations which I communicated to DE GEER, are to be found in one of his papers (G. F. F., 1890 p. 104).

[2] The most important works up to the present published, dealing with the present molluscan fauna in different parts of the Baltic, are: —

1868. G. LINDSTÖM: Om Gotlands nutida mollusker.

1872. H. MEYER o. K. MÖBIUS: Fauna d. Kielerbucht, Bd. 2, Prosobranchiata u. Lamellibranchiata.

1873. MÖBIUS: Die wirbellosen Thiere d. Ostsee, Commiss. z. wissenschaftl. Unters. d. deutschen Meere.

1875. H. LENZ: Die wirbellosen Thiere d. Travemünder Bucht. Theil I. Deutsche Kommiss. (Anhang I).

1884. M. BRAUN: Physikal. u. biolog. Unters. in westl. Theile d. finnischen Meeresbusens, Archiv f. Naturkunde Liv-, Ehst- u. Kurlands, Ser. 2, Bd 10, Liefr. 1. (Dorpat).

1887. R. LUNDBERG: Unders. om naturförhåll. — — i Stockholms skärgård — 1885—86. Meddel. rör. Sveriges Fiskerier, H. 2.

1888. M. BRAUN: Faunist. Unters. in d. Bucht v. Wismar. Archiv — — in Mecklenburg, Jahrg. 42. (Güstrow).

1888. C. G. JOH. PETERSEN: Om de skalbærende Molluskers Udbredningsforhold i de danske Have indenfor Skagen. (Kopenhagen). Cf. also "Hauchs" Togter etc. II (1889) and V (1893).

1890. O. NORDQVIST: Bidrag t. känned. om Bottniska vikens o. norra Östersjöns evertebratfauna. Soc. pro Fauna et Flora fennica, 17.

etc.; 1889 in the Gulf of Bothnia; 1890 near Rügen, Warnemünde and Wismar; 1891 in East and North Upland). The collections of material made in 1890 are of special importance; they were in the district or districts, which, according to the results of my researches into the Litorina-fauna, may be calculated as containing at present organisms which find their closest parallel in the Litorina-strata.

Before I reached the point of communicating my results of research into the physical geography of the Litorina-sea in comparison with the Baltic of the present time, some works appeared, which deserve mention here.

By far the most important one was the continuation by DE GEER of his work: »Om Skandinaviens nivåförändringar under qvartärperioden» (G. F. F. 1890, pp. 61 et seq.). He treats there among other things the question of the limit of extent of the Litorina-sea and the proportion of salt it contained. Though his isobases for the Baltic district (for the third of it to the south) show too low results — from that for 30 metres onward — one can obtain from his exposition an approximate idea of the extent of the Litorina-sea at the time of the maximum subsidence of land.

In noting that *Litorina litorea* L. and *Rissoa membranacea* ADAMS, that nowadays are not found beyond the S. W. portion of the Baltic where the proportion of salt at the surface is 0.8 %, could exist formerly as far up as the head of the Bothnian Gulf, where the water does not contain now more than 0.4 % of salt (loc. cit. pp. 107—8), DE GEER is somewhat in error, as I shall later proceed to show, because the species mentioned, especially *Rissoa* had an extreme northern boundary in the Litorina-time not as far north as »Norra Qvarken» a district where the water now has a proportion of 0.4 % of salt at the surface.

Of importance, in considering the Baltic is furthermore C. G. JOH. PETERSEN'S work »Om de skalbærende Molluskers Udbredningsforhold . . . indenfor Skagen»[1] — as DE GEER (in the last-mentioned work) pointed out — and in connection therewith also K. RÖRDAM'S »Saltvandsalluviet i det nordostlige Själland»[2]. In these works among other things the fact is revealed that the south part of the Cattegat contained during a period, coinciding with the Litorina-sea in the Baltic a fauna of a warmer and salter character than is now the case.

At a meeting of Naturalists in Copenhagen in 1892 I gave an account of the most important of my results in investigating, among other things the physical geography of the Litorina-sea; in the very brief report published, of that paper[3] this point among others was brought out, »that the fauna that inhabited the Baltic in the Litorina-time from the most northerly point of the Bothnian Gulf down to Gotland correspond most nearly

[1] Dissertation, Copenhagen 1888.

[2] Danmarks Geolog. Unders., No. 2, 1892.

[3] Forhandl. v. de skandinaviske naturforskeres 14:de möde. Copenhagen 1892, pp. 440—3.

to the present fauna of the comparatively limited area of the same sea that lies between Bornholm and Warnemünde». — — »Hence one might conclude that the hydrographic (especially as to the amount of salt) characteristics of the Baltic Litorina-sea correspond closest to those now existing in the district named (Bornhom—Warnemünde) having a proportion of about 0.78—1.2 % of salt at the surface.»

A little later, in the Dec. No. of G. F. F. 1892 (Stockholm) the Danish geologist V. MADSEN gave in the course of an essay on kindred matters some account of an examination of Litorina-gravel from Åland, whereby he arrives at this result, that the proportion of salt at Åland in the Litorina-time probably reached a height of 1.5 % — this figure, as I shortly afterwards sought to prove[1], must be regarded as quite too high. In that essay of mine I gave the chief reasons I had for differing from MADSEN on this and other points, and the review I am about to give here of the physical geography of the Litorina-sea may be in the main regarded as a more elaborate, and I hope, clearer exposition of the subject than that given in the paper spoken of.

Since it is the *Mollusca* that afford the best and most reliable results at any rate for the hydrographical characteristics of the Litorina-sea, after giving a summary of the present saltness of the Baltic, and in immediate conjunction therewith a report of the present distribution of the Mollusca that concern the Litorina-sea especially, I shall proceed to discuss the question of the distribution of Mollusca during the saltest part of the Litorina-time and therefrom draw conclusions as to the hydrographical characteristics of the time last mentioned[2].

Then comes a report on the extent of Litorina-sea to illustrate the »salifying process» etc. of the former Ancylus-lake and last some remarks on the latest immigrated Baltic fauna. [Since all the different particulars just-mentioned are illustrated on the maps (Pl. I and II) I can for the most part express myself with brevity.]

Then I go on to report on my investigations of the *diatomaceous flora* of the *Litorina-sea* and its *rhizopod-* and *ostracod*-faunas, (on which subject but little has been hitherto published), and in conjunction with that I discuss shortly the special subject of the testimony of diatoms in the hydrography of the Litorina-sea.

Saltness of the surface-water and distribution of Mollusca at the present time and at the Litorina-time.

The limits of saltness or *isohalinic lines* on the sketchmap (I) that are underlined *black* are intended to give a general view of the distribution of *surface* percentage of salt within the *present* Baltic and adjacent districts.

[1] G. F. F., Bd 15, 1893, pp. 67—68.

[2] Along with the Mollusca, a Bryozo *Membranipora pilosa* forma ***membranacea*** SMITT and an Annelide, *Spirorbis borealis* DAUDIN are mentioned.

The isohalinic lines for the south Baltic district and for the Cattegat are taken from the daily observations kept for many years past at the Danish and German stations. Total amounts are to be found for the German stations in »Sechster Jahresbericht der Kommission zur wissenschaftl. Untersuch. d. deutschen Meere», Berlin 1893, p. 221. On the other hand those for Danish stations are calculated from the figures in »Meteorologisk Aarbog udgivet af det danske Meteorolog. Institut», 1874—91 or during part of this period.

The isohalinic lines for the whole of the rest of the Baltic are derived, from F. L. EKMAN and O. PETTERSSON: »Den svenska hydrografiska expeditionen år 1877»[1] fig. XIII, which gives a review of percentage of salt at surface in the month of July 1877. Though this latter part of the map thus represents the distribution of salt during only one limited space of time, it may nevertheless probably be regarded as a tolerably satisfactory exposition of the average salt percentage in later times. That this is the case, is confirmed partly by the fact that the salt constituent in large sections of the Baltic is subject to comparatively inconsiderable variations, partly also by the circumstance, that if all the observations made up to the time of the publication of EKMAN'S observations upon the distribution of salt in the Baltic (beyond the Danish and German stations), that are for the most part scattered, were collected together, they would give as a result isohalinic lines which coincide fairly closely with those communicated by EKMAN and PETTERSSON. In the following table we have the average salt percentage at the surface for some of the Danish and German stations spoken of above, the time the observations embrace being given; and it is from these numbers that the isohalinic lines here given have been made up. (Cf. further sketch-map (I) on which the stations are easily found with the aid of the numbers giving the percentage of saltness.)

Stations of observations	"Skagens Rev"	"Læsö Trindel"	"Kobbergrunden"	"Anholts Knob"	"Schultz's Grund"	"Samsö Belt"	Kiel	Poel, off Wismar	Warnemünde	Darsser Ort	"Gjedsör Rev"	"Lappegrunden"	"Sundets nordre Del" (The Northern part of Öresund)	Kjöbenhavn	"Drogden"	Lohme (Rügen)	Christiansö (North of Bornholm)	Hela (W.-Prussia)
Duration of observations Years	14	15	15	15	15	12	22	17	17	18	14	9	12	18	16	19	16	18
& months	—	—	—	—	—	—	& 7	& 8	& 7	& 2	—	—	—	—	—	& 2	—	& 9
Saltness in percent	2.96	2.49	2.32	2.10	1.93	1.55	1.60	1.24	1.18	1.06	1.01	1.41	1.25	1.21	1.08	0.81	0.78	0.72

[1] K. Vet. Akad. Handl., Bd. 25, No. 1. Stockholm 1893.

The *black roman figures* on the map are intended to represent the innermost known localities where the different marine *Mollusca* are *nowadays* found (+ *Membranipora* and *Spirorbis*), hitherto known from the Litorina-strata[1]. The corresponding *red figures* denote the innermost occurrences up to the present known of the same species *in the Litorina-time*.

These prove therefore that all the species lived in the Litorina-sea further in than now, or else have been as it were displaced considerably further into the Baltic and what is more, in this displacement kept among themselves the same order as now.

The comparison therefore of the distribution of Mollusca in Litorina-time and at present goes to show that the hydrographical conditions were different then and more favourable to marine fauna and flora then than now. That is also evident from the circumstance that the marine shells were of larger growth (and thickness) in the Litorina-sea than those in the same latitude at the present day; this is most clearly exemplified by the *Mytilus edulis* L., the size of which varies in direct ratio with the quantity of salt, as is evident from the following table giving the *maximum-size* of this species in different sections of the Baltic (cf. the map I).

Kiel (MEYER & MÖBIUS)	110.0	mm.	
Bay of Travemünde (LENZ)	84.0	»	
Betw. Möen a. Falsterbo (MUNTHE)	64.0	»	
Rügen, Hiddensö »	52.4	»	
Gotland (LINDSTRÖM) . . . . . ca.	40.0	»	(probably too little)
Stockholm Archipelago, Ornö (MUNTHE) . . .	43.0	»	
Åland (MADSEN) . . . . . ca.	35.0	»	
Ulfön, the innermost known Swedish loc. (MUNTHE)	22.5	»	
Stånggrund, the innermost known Finnish loc. (NORDQVIST)	21.0	»	

In illustration of that just remarked, I will just add that, as I have already pointed out[2] specimens of *Mytilus* with a maximum length of about 52 millimetres — thus corresponding to those found now near Rügen — are met with in Litorina-strata as northly as in Skellefteå district.

The hydrographical factor of greatest weight for the distribution and size of Mollusca and other organisms in the Litorina-sea is probably the percentage of salt, and since the time in question (Litorina-time) lies so near that of our own, it is justifiable to draw tolerably definite conclusions from the distribution and characteristics of the organisms in

[1] *Mya arenaria* and *Balanus improvisus* are exceptions; see further on.

[2] G. F. F., Bd. 15, 1893, p. 69.

the last-named time as to its hydrographical conditions, and in this case particularly, as to the distribution of the salt percentage.

In agreement therefore with what has been said above, particularly about the distribution of Mollusca at the Litorina-time as compared with the present, one may conclude that the distribution of the salt percentage in the Litorina-sea — from its inmost regions down to Gotland — has its closest parallel in the comparatively confined district between Bornholm and Wismar-Bay where the surface water contains from 0.79 (Bornholm) to 1.24 % of salt (Wismar, Poël). (Cf. what has been said above pp. 5—6).

The *isohalinic lines for the Litorina-sea* at the point of its highest percentage of salt, which seem to coincide with the maximum of land-subsidence in the Litorina-time, are marked in *red* in accordance with the following principles, laid down already for the most part (G. F. F. Bd. 15, p. 68).

The isohalinic line for *0.8* % is drawn through the northern part of the Bothnian Gulf proper, since *Litorina rudis.* var. *tenebrosa* MONT., which nowadays does not extend beyond the limit of Bornholm in water with a salt percentage of 0.79 %, is met with in Litorina- strata a little N.W. of Neder Kalix (= »Ka» on the map).

The isohalinic line for *1.0* % is placed intersecting the southern part of the Bothnian Gulf (in wider sense) since *Rissoa membranacea* ADAMS var. which now reaches as far as the south part of the Sound and the Bay of Kjöge (I obtained some specimens at Kjöge 1892) in water with about 1.0 % of salt, was found in Litorina-deposits as far north as on Åland (by DE GEER) and near Upsala (by myself)[1].

The isohalinic line for *1.3* % I have drawn south of Gotland, for I found on that island, but not further north, in Litorina-strata *Scrobicularia piperata* GMEL., which does not seem living to have been with certainty met with in modern times further in than in Wismar-bay[2] where the salt percentage, on the island of Poël, reaches 1.24.

In the present state of information about the distribution of Mollusca in the Litorina-sea it is impossible to define still more accurately and in fuller detail isohalinic lines in the Baltic region as a whole, least of all in the south part of it where we possess but comparatively little knowledge of the fauna, which results partly from the fact that the Litorina-strata are here to be sought only to a small extent above the sea level. That a closer examination in favourable localities will throw some light on the subject is proved for example by the fact that I obtained several specimens of *Scrobicularia piperata* in 1890 from a quantity of clay mixed with sand, dredgings from the harbour-bottom at Warnemünde. Of these

[1] What other *Rissoa*-species lived in the Litorina-sea may for the present be left an open question (cf. specially PETERSEN and MUNTHE in G. F. F., Bd. 15, pp. 121—23 and p. 70.)

[2] *Braun:* Archiv . . . in Mecklenburg 1888, p. 76. In 1890 I had opportunity of seeing Mr. BRAUN's specimens from Wismar, the largest of which I found to be 33.4 millim. in greatest section.

specimens the largest measured 47 mm. in length, little less therefore than those now living in Kiel-bay which may be, according to MEYER and MÖBIUS, 50 mm. long. Surface percentage of salt in the Warnemünde district at the time of the formation of the clay containing *Scrobicularia* may therefore be probably estimated at about 1.5, that is to say a percentage not met with nowadays except much closer to Kiel and in the Great Belt.

Of other organisms proving, like the marine Mollusca, a displacement of salt percentage within the Baltic sea during the Litorina-time, these deserve mention:

Membranipora pilosa var. *membranacea* SMITT whose most northerly habitats (in living form) at the present time are the neighbourhood of Kristinestad, in Finland (NORDQVIST) and Ulfön (betw. Hernösand and Örnsköldsvik) in Sweden (MUNTHE). In fossil form I have found it as far north as Skellefteå in company with *Mytilus* and *Tellina*. Moreover in the same deposit a spruce-fir (*Pinus Abies* L.) leaf was to be seen — proving that the spruce-fir existed here during (probably) the latter part of Litorina-time.

Another form belonging to this part of the subject is the *Spirorbis borealis* DAUDIN (1800) [= *S. nautiloides* LAM. (1801)] not penetrating now, as it appears, further than to about Ystad, where I found it on *Mytilus* 1888[1], but in Litorina-strata found in Gotland (by Prof. G. LINDSTRÖM, Gotlands nutida moll. p. 45) and in Upsala (by myself).

On the other hand the *fresh-water Mollusca* found in Litorina-deposits are of little importance in determining the variations of the salt percentage during the Litorina-time, because they [*Neritina fluviatilis* L. and (rarer and on lower level) *Limnæa ovata* DRAP. var.] can exist also in water with a fairly large percentage of salt — the former in water with about 1.2 % (Landscrona[2]), the latter in water with about 1.15 % (Malmö).

Finally in Litorina-deposits in Gotland there are found remains of *Halichærus grypus* O. F. MÜLLER. (Cf. This Bull., Vol. I, N:o 2, p. 282).

To illustrate the course of the »salifying process» of the Baltic during the Litorina-time, I have thought it advisable to give a sketch-map (Plate II) of the extent of land-subsidence within the Baltic district and the Danish archipelago at that time.

In accordance with DE GEER'S proposition and partly with the help of his communications[3], I have therefore drawn the *isobases* or lines, through such points as — after the maximum of land-subsidence in Litorina-time — have been uplifted to the same height above the sea-level, (which is supposed to be constant). The isobases are drawn for a rise of every 10 metres, except in the south Baltic district, where also the isobase for 5 metres is inserted [following researches in Själland made by K. RÖRDAM and V. USSING, and in Skåne (Malmö district and Hven) by

[1] MÖBIUS gives it in extreme east of Warnemünde district.

[2] MUNTHE: G. F. F., Bd. 15, p. 69.

[3] G. F. F., Bd. 10 (1888) and Bd. 12 (1890).

myself] for the purpose of showing more clearly the extent of depression in the district adjacent to the Cattegat. The isobases are drawn in *unbroken* lines, where the extent of subsidence is known more accurately. On the other hand the *dotted lines* especially in the northern parts of the district are to be regarded merely as a first attempt to indicate on the map the extent of the subsidence.

If a comparison is made between DE GEER'S isobases and mine for the Litorine-subsidence it will be found that the latter have a not inconsiderably greater value right from the Stockholm district inwards to the central districts. This is because my researches in the Upsala district afforded results coinciding with the curves I have here drawn.

Thus, as DE GEER (loc. cit) points out, it follows from the values of the isobases, that the land-upheaval, even after the maximum subsidence of the Litorina-time, became greater by degrees the further one went towards the central parts of the district.

With the help of the isobases and topographic maps the coast-line of the Litorina-sea has been in part constructed, but since access to trustworthy topographic maps was very limited, this coast-line as regards Finland and North Sweden must be regarded as very hypothetical.

From having lain at the Ancylus-time considerably higher than now[1], the south Baltic district and adjacent parts towards the north, have, as is known, gradually sunk, until they finally reduced the »thresholds» of the south part of the Sound and western Baltic to the level of the ocean.

The outflow of fresh water from Ancylus-lake took place probably in ever increasing rapidity the longer the land-subsidence in the southern and the upheaval in the central portions of the Baltic district went on (the latter had possibly been in operation ever since the late glacial time). This outflow got another character from the time when the surface of the Ancylus-lake was of about like level with the ocean, and water from Cattegat could begin to flow into the Baltic depression. For while the Ancylus-lake formerly got rid of water by means of floods which conveyed it into the Cattegat, specially favourable circumstances, such as storms coming from the interior of the Ancylus-lake in that direction or a rise in the barometer in that part, were now requisite to bring about a more rapid outflow, while on the other hand the opposite conditions would bring about the opposite result, that is to say, would decrease or entirely bar the outflow of water from the Ancylus-lake, and at the same time facilitate the transportation of salt water into the Baltic-depression — in the same way as happens in our time. In addition, what F. L. EKMAN has called »reaction streams»[2] probably make their great importance especially noticeable here[3].

[1] Cf. MUNTHE, in Bull. Geol. Inst. Upsala, No. 2, Vol. I (1893), p. 118 and seq.

[2] Cf. for example PETTERSSON and EKMAN: Kattegats och Skageracks Hydrografi, K. V. A. H., 24, No. 11, p. 156 et seq.

[3] Since the fauna and flora of the transition stage between the Ancylus-lake and the Litorina-sea are hitherto but very little known they are now passed over.

The condition of things was of course most favourable for the transport of salt water from the Cattegat to the Baltic at the stage when the land-subsidence in Litorina-time had reached its maximum, and that seems to have been the case, to judge from the characteristics of the molluscan fauna in the highest Litorina-strata of the various parts of the district, about simultaneously in the Danish archipelago and the Baltic. We saw from the previously given description of the physical geography of the Litorina-sea, the degree the saltness in reality reached.

It is worth noticing that, as DE GEER has shown previously[1], the Litorina-sea got all its salt by way of the Belts and the Sound, and that too, irrespective of the fact that the level at that time for the former districts was about the same as now, and that the »threshold» in the south part of the Sound only lay some 5 metres lower than at present. The circumstance calls for remark however here, that among other places the southern part of the Cattegat, during the *Tapes*-time (or the post-glacial time, corresponding pretty nearly to the Litorina-time in the Baltic) can be proved to have had a greater degree of saltness and a higher temperature than nowadays[2], due to the fact that salter and warmer ocean-currents had freer access to it, owing to subsidence of the land in the Cattegat district etc. This circumstance may as DE GEER points out (loc. cit.) »contribute some explanation of the greater saltness in the Baltic» too. Bearing in mind moreover that the land-subsidence in the Baltic district became greater, the nearer one advanced to the central portions, so that it reached, as the isobases show, a depth, for instance in the Upsala district, of about 64 metres and in the central parts, that had sunk most, probably of about 110 metres — or in other words, remembering that the Baltic basin's bottom at the Litorina-time lay comparatively deep below the surface of the ocean, we can see that especially at the stage of greatest subsidence, the salt currents from Cattegat must have been able to force their way much more easily than at present even across the bars hidden under water, that are to be found in the district both at the boundary between the Bothnian Gulf and the Baltic proper and in North »Quarken».

As the results of the EKMAN expedition in 1877[3] show, these hidden bars, lying now at a depth of less than 40 metres, hinder to an appreciable extent the influx of salter under-currents. This cannot have been to the same extent the case in the Litorina-time, for the bars then lay at a considerably greater depth, viz. at a depth of about 90, and 130 metres respectively.

Since, as stated above, the south Cattegat can be proved to have had during the *Tapes*-time (Litorina-time) not only a greater saltness, but also a higher temperature than now, and since a comparatively extensive

[1] G. F. F., Bd. 12, 1890, p. 107—8.

[2] Cf. in addition to other works PETERSEN: skalber. Molluskers Utbredningsforhold etc., pp. 50—62 and DE GEER (last-mentioned work p. 100).

[3] K. V. A. H., 25, No. 1. 1893.

influx of Cattegat water into the Litorina-sea must have taken place, it follows that the temperature of the sea then must also have been higher than its present one, which as regards a great part of the district, may be said to be of subarctic character[1].

That this was really the case, that a milder climate reigned during the time in question than is now the case in the land-districts in and around the Litorina-sea is proved moreover by the interesting investigations of the flora found in peat-deposits of the Litorina-time. These investigations have been carried on principally during recent years.

Finally as to the fact of the molluscan fauna of the Litorina-sea being so scanty of species, even in the southern districts (e. g. Gotland) that possessed in the Litorina-time similar hydographical characteristics to those of the present Wismar-district and the south half of the Sound with their comparatively plentiful fauna, we may ascribe it to the bars in the districts bounding the Baltic proper, across which hardly any other forms could force their way save those of the *litoralfauna* proper. The litoral-fauna of the present day in the districts spoken of also contains nearly exactly the same sorts as that of the Litorina-time.

It has been remarked (p. 3) that Professor LOVÉN a long time ago divided the fauna of the marine deposits in the Baltic into two parts: — the older, lying higher containing *Litorinas*, the younger, lying lower, with the *Litorinas replaced by Limnæas*. This division has been adopted by later writers, among whom Prof. LINDSTRÖM deserves special mention. My researches in Gotland go to show also that *Limnæa ovata* var. did not immigrate into the Baltic till the end of the Litorina-time, inasmuch as I came upon the last-named variety in company with Litorinas in some places, (e. g. in S. E. portion of the island) only some few metres above the surface of the sea[2].

The entrance of *Limnæa ovata* into the Baltic thus proves that the Baltic water gradually became less and less salt. This was caused naturally by the ever increasing limitation of the communication between the Cattegat and the Baltic due to upheaval of the land, while at the same time the bars mentioned above hindered to a constantly increasing extent the salter undercurrents penetrating to the inner parts of the district. A

[1] Cf. especially F. L. EKMAN and O. PETTERSSON in the work mentioned. — Seeing that the reaction of marine species found in Litorina-strata for varying conditions of temperature in water such as that of the Litorina-sea, with but little salt in it, has not yet been fully enquired into, I shall not proceed now to discuss what results might possibly be deduced from the Litorina-fauna, with respect to the conditions of ***temperature*** in the Litorina-sea.

[2] When Prof. LINDSTRÖM however ascribes (G. F. F., Bd. 8, 1886) the marine strata E. of Qvinnegårda in the parish of Hafdhem in Gotland, to the "Limnæa-period", he would seem to be wrong, for they are the highest Litorina-strata in the district and evidently are without Litorinas because the latter are deposited in water less salt than this and in an ***estuary*** of the former Litorina-sea. — It ought to be further remarked that ***Limnæa peregra***, "large form, **22** mm. long" (LINDSTRÖM, l. c. p. **251**) is most probably in this locality not original, inasmuch as its occurrence arises either from the supramarine strata below, or else it has been carried out into the sea from the fresh water.

further result of this land-upheaval was, as in well-known, that the marine species gradually retired towards the Cattegat until finally the distribution of species became that shown on the sketch-map I[1]. A circumstance, found out long ago, may also be referred to here, that namely certain other fresh-water species, besides the one mentioned, *Limnæa ovata*, immigrated to the Baltic, but it lies outside the scope of this essay to go into this question more fully.

It only remains, in conclusion, to say a few words concerning two marine species that must be looked upon as not having immigrated to the Baltic until comparatively modern times, inasmuch as they are never found either in Litorina-strata nor in the younger *raised* baltic deposits with *Limnæa* etc.

The one is *Mya arenaria* L., whose late date of immigration LYELL was aware of as above mentioned[2]; the other is *Balanus improvisus* DARWIN, found now living as far up as the Gulf of Finland — by BRAUN near Reval and at Helsingfors by GRIMM. (Cf. BRAUN l. c. p. 96.)

Moreover NORDQVIST (loc. cit) found in plankton a *cirriped*-larva in the southern part of the archipelago of Åland, which probably belongs to this species.

Among marine species that have possibly immigrated at a late

---

[1] Since the marine Mollusca of the Baltic nowadays are chiefly found attached to the coast-belt in salter districts such as Cattegat etc. it is interesting to find that many in the first mentioned district also live at a considerable depth. It would be premature to express any definite opinion concerning the probable time of the distribution downwards and concerning the cause thereof, especially as it is not yet known, whether the species increase in size downwards or decrease.

[2] Concerning *Mya arenaria* and its late immigration to our districts it is worth while remarking that E. ERDMANN's statement is probably incorrect, where he gives occurrence of *Mya truncata* in recent shoresand at Barsebäck about 15 kilometres S. E. of Landscrona (G. F. F., Bd. 1, 1872, p. 98); the form met with belongs probably to *M. arenaria*. Upon my inquiry relative to this matter, ERDMANN informed me recently that the specimens found in the material tested (they were by the way very fragmentary), had been since examined also by DE GEER, and moreover with the result just given. — Following ERDMANN, K. RÖRDAM gives *M. truncata* from the locality in question (Danmark's Geolog. Undersög. No. 2, p. 2), mentions however among "Corrections" (loc. cit p. 137) that ERDMANN only gives, in his description to the geological sheet-map "Landscrona" (S. G. U. Series A. No. 75, 1881.), *Cardium* and *Mytilus*. RÖRDAM is guilty of an unfortunate misprint (loc. cit. p. 2) where he gives *Ostræa edulis* instead of ERDMANN's *Cardium edule* (G. F. F. Bd. 1, p. 98.)! *Ostræa edulis* has never been found in Litorina-strata of the Sound district, but on the other hand in corresponding deposits e. g. in the Great Belt, probably as far south as the Svendborg district (Aarb. for Nord. Oldk. o. Hist., Copenhagen 1888, p. 321). — Since *Mya arenaria* came into the Baltic from Cattegat just as the other marine species, it is naturally interesting to find out when the species was to be found first on its coasts or rather at what level it is to be met with in the very young post-glacial deposits in West Sweden and Norway. (Cf. G. O. SARS: Moll. reg. arcticæ Norvegiæ, Christiania 1878, p. 92). It may be à priori taken for granted that the level is higher the more northerly one goes along the West coast of Sweden.

Since *Mya arenaria* is an easily identified and characteristic species in the present Baltic it seems suitable to call the present time the "*Mya-time*" or "*Mya arenaria-time*" in opposition to "Litorina-time" etc.

time, the following also deserve mention: *Astarte borealis* CHEMN. and *A. elliptica* BROWN. They are, as is known, found in the Rügen-sea and a little east of Bornholm[1]. They are however in these localities of diminutive growth and live therefore doubtless, under unfavourable conditions. There can be no question that these species immigrated to the Baltic after the Ancylus-time. Whether they came in the Litorina-time, or not till later cannot probably be ascertained before a comparison of the size of the dead shells and of the living ones has been made. For if the former are bigger, it is probable that the species came in at the Litorina-time, and existed then under more favourable conditions than at present.

The diatomaceous flora of the Litorina-Sea.

Statements of the occurrence of diatoms in Litorina-strata are not numerous in the literature of the subject, but some of them are of interest.

Thus A. ERDMANN[2] reports presence of salt-water diatoms in mud from some localities in East Sweden; two of these are of interest from their occurrence at a comparatively great height above the sea-level; they are *Sundsmossen* (Geological sheet-map »Skattmansö») about 62, and *Ingbo* (sheet-map »Lindsbro») 59 metres above the sea. The mud at these places was deposited in the Litorina-sea. Hence land-subsidence amounted to at least the extent given by these figures.

JUHLIN-DANNFELT reports in his »On the diatoms of the Baltic sea»[3] occurrence of species, in part of strongly marine character, in raised clay- and mud-strata of the Baltic district, and draws therefrom the conclusion that the Baltic was formerly, owing to a freer communication with the ocean, salter than now.

Minor notices occur also in a few of the geological sheet-maps embracing eastern Upland (»Furusund» 1885, »Rådmansö» 1885, »Norrtelje» 1887 — all executed by E. SVEDMARK); further in CLEVE's »The diatoms of Finland»[4] where the species I myself obtained in the elutriations of Litorina-deposits from Finland (Finl:s Geol. Unders.) are mentioned.

The locality Råkneby in Ryssby parish, Kalmar province[5] described by HOLST affords incomparably the strongest interest. Here CLEVE found a numerous diatomaceous flora in a deposit of marine sand lying over peat (in which remnants of *Bos primigenius* BOJ. among others were met with) and fresh-water ooze. This showed that at the time the sand came there »the saltness of the water seemed to have been greater than it is nowadays at the same latitude and corresponds more closely to the salt-

[1] Cf., besides other works, PETERSEN: "Hauchs Togter" II, pp. 75—76.

[2] Sveriges qvartära bildningar, Stockholm 1868, p. 261. (Statements are taken from descriptions to certain of the geological sheet-maps.)

[3] Bih. K. Vet. Akad. Handl., Bd. 6, 1882.

[4] Acta soc. pro Fauna et Flora Fennica, 8, 2 (1891).

[5] G. F. F. Bd. 10 (1888).

ness in the south Baltic, on the Kiel side» (CLEVE in HOLST, loc. cit., p. 5, reprint)[1].

Of interest is also CLEVE's find of marine diatoms in some samples of »river-deposits» collected by FEGRÆUS[2] at Medelpad, at a considerable height, in places, above sea-level. The flora found here, (also comprehended in the diagram) gives evidence of a saltness proportionate to that of the Baltic nowadays at the same latitude (CLEVE).

I pass on now to give a report on the result of my own researches in the diatomaceous flora of Litorina-strata, together with that of those communications of HOLST, FEGRÆUS, and CLEVE (Finland) just mentioned. To that end I give in advance a diagram of the species found in the various localities. FEGRÆUS' localities however are all collected under the one head »Medelpad». There is no impropriety in that seeing that the flora of the various localities displays very simular characteristics. Besides the column of localities I have noted in each case the height of the locality above the sea-level.

In the main the species are arranged on the same plan as in my »Studier ö. Balt. hafvets quartära historia I» (B. K. V. A. H., 18892) i. e. according to its present-day distribution in water of different degrees of saltness[3].

I-diatoms: such species as exist in salter surface-water than that of the Baltic now within a line from, say, Wismar to the north part of the Sound, having a surface-saltness of over ca 1.25 %.

II-ditto from the line mentioned to about Bornholm having a surface-saltness of from ca 1.25 %—0.79 %.

III-ditto in Baltic sea proper and Åland sea having a surface-saltness of from 0.79 %—0.55 %.

IV-ditto in whole of Gulf of Bothnia having surface-saltness of from 0.55 %—0.2 %.

V-ditto in fresh water.

Combinations of these (Roman) figures mark the distribution of the species within two or more of these districts.

It deserves mention that according to CLEVE no very definite boundaries can yet be made in regard to the recent distribution of the different species. This is still more the case in reference to the letters *S. N.* or *w* attached to the species. These letters have regard to the present distribution of the species, in as far as that depends in any great degree on conditions of *climate.* Thus *S.* denotes species extending *southwards* i. e. having their northern boundary in West Finmark; *N.* those extending *northwards* into the arctic districts and southwards about as far as Scotland and *w* = *widely-extended* species exsiting both in S. and in N. districts.

[1] Species found here are given further on, in diagram.

[2] FEGRÆUS in G. F. F., Bd. 12, 1890.

[3] It is worth mentioning that the boundary between I and II may fitly be placed (approximately) within Danish archipelago district, where surface-saltness amounts to about 1.25 % not 1.6 % as I assumed (loc. cit.).

B. denotes that the species are exclusively *Baltic; c* and *r* adjoined to some species in certain districts denote that the species in question occur *commonly* or *rarely* while an * implies that the species are *plankton*-forms.

The *samples* on which the researches in diatoms are based, have as a rule been *clay* or *shell-gravel* with more or less clay mixed with it or *sand;* only in a few cases, at Nosaby N. of Kristianstad in Skåne, Norrtorp S. of Örebro and E. of Qvinnegårda, Hafdem parish in Gotland, have the specimens consisted of *ooze*.

The samples from SW.-Finland are kindly sent to me from the Geological Survey of Finland, and the sample from Bettorp, N. of Örebro I have received from R. SERNANDER.

All localities where diatoms are found in Litorina-strata are displayed on sketch-map (I) and will probably be easily found with the aid of the further particulars given on the large diagram. They will at another opportunity be more fully described.

Prof. P. T. CLEVE has been kind enough to classify the diatoms, and the statements on the distribution of the species are also due to him. For his assistance I should like express here my sincere gratitude.

Provinces		Norrbotten	Westerbotten			Ångermanland				
Localities		Luleå ("Lu" on the map!)	N. of Skellefteå ("Sk"), Allhem	S. of Skellefteå, E. of Falkträsket	Löfånger parish, between "Sk" and "U" (= Umeå), Gärde	The same locality – upper part	The same locality – middle part	Grundsunda parish, betw. "N" and "Ö" (= Örnsköldsvik) – lower part	Ulfön, betw. "Ö" and "H" (= Hernösand)	Hernön, Gånsvik
Height of localities above sealevel in *metres*		2-3	ca 65	74	ca 23	15?	14?	13?	ca 3	ca 35
Diatoms:	General geographic. distribution.									
I:										
**Coscinodiscus Asteromphalus* EHB.	w.	—	—	—	—	+(r)	+(r)	—	+(r)	—
**Dicladia Mitra* BAIL.	N.	—	—	—	—	+(r)	+(r)	—	—	+(c)
Melosira sulcata EHB.	w.	—	—	—	—	—	—	—	—	—
(= *Paralia marina* EHB.)										
» *(Paralia) Westii* W. SM.	S?	+	—	—	—	—	—	—	—	—
Navicula brevis GREG.	w.	—	—	—	+	—	—	—	—	—
**Rhizosolenia Calcar avis* SCHULZE	S?	—	—	—	—	—	—	—	—	+(r)
I—II:										
*? *Actinocyclus Ralfsii* W. SM. .	S.	—	—	—	—	—	—	—	—	—
Amphora commutata GRUN. . . .	S.	+(r)	—	—	—	—	—	—	—	—
Campylodiscus bicostatus W. SM.	S.	—	—	—	+	+	—	—	—	—
Epithemia Musculus KÜTZ. . . .	S.	—	—	—	—	—	—	—	—	—
Mastogloia lanceolata THWAITES	S.	—	—	—	—	—	—	—	—	—
Navicula latissima GREG.	S.	—	—	—	—	—	—	—	—	—
» *digitoradiata* GREG. . .	w.	—	—	—	—	—	—	—	—	—
(= *Cyprinus* EHB.)										
Nitzschia navicularis (BRÉB.) . .	S.	—	—	—	—	—	—	—	—	—
Pinnularia quadratarea A. SM.	w.	—	—	—	+(r)	—	—	—	—	—
Pleurosigma balticum (EHB.). . .	w.	—	—	—	+	—	—	—	—	—
Rhabdonema arcuatum KÜTZ. . .	w.	+(r)	+	+(r)	+(r)	+(c)	+(c)	—	+(c)	+
» *minutum* KÜTZ. . .	w.	+(r)	—	—	+(r)	+(c)	+(c)	—	+(c)	+(c)
I—III:										
Achnanthes brevipes AG.	w.	—	—	—	+	+	—	—	+	+
» *longipes* AG.	S.	—	—	—	+	+	+	—	+	—
*? *Actinocyclus crassus* W. SM. .	S.	+(r)	—	—	+	+	+	—	—	—

Skåne	Gotland	Småland		Östergötland	Södermanland		Nerike	SW.-Finland		Upland		Helsingland		Medelpad
NE. of Kristianstad ("Kr"), Nosaby	Hafdhem parish, E. of Qvinnegårda	13 kilom. N. of Kalmar ("K"), Ryssby (described by Holst)	Westervik ("W"), Lucerna	30 kilom. E of Norrköping ("No"), Lönö	4 kilom. S. of Stockholm, Örby (The loc. described by Lyell)	Stockholm ("St"), kame-pit S. of Brunnsviken	17 kilom. S of Örebro, Skyllerstad parish, E. of Norrtorp	4 kilom. N. of Örebro ("Ö"), Bettorp, kame-pit	45 kilom. WNW. of Åbo ("Å"), Kumnarais	4 kilom. SW of Ekenäs, Lexvall	4 kilom. E. of Helsingfors ("Hs"), Stansvik	S. of Upsala, kame-pit	26 kilom. NNE of Upsala ("Up"), Slesbyn	5 kilom. W of Söderhamn ("Sö"), Bagberget	25 kilometre NNE of Hudiksvall ("Hu"), Bringsta	Some localities in Medelpad, described by T. Fegræus
ca 1.2	14-15	3.7	ca 5	ca 5	ca 21	30?	49	ca 37	3.0	0.0	?	33.5	ca 62	ca 22	40-50?	25-65
—	—	+ (r)	—	+	—	+ (r)	—	—	—	—	+ (c)	+ (c)	—	—	+	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	+ (r)	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	+ (r)	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+	—
+	+	+ (c)	—	—	—	—	+	—	—	—	—	—	—	—	—	—
—	—	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	+	—	—	—	—	—	—	+	—	—	—	—	—	—	—	+
—	—	+ (c)	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	+ (c)	+ (r)	+ (c)	—	+ (c)	—	+ (r)	+ (c)	—	+ (c)	+ (c)	—	+ (c)	+	—
—	—	+ (c)	—	—	—	—	—	—	—	—	+	—	—	—	+	—
—	—	+	—	—	+	—	+	—	+	—	—	—	—	—	+	—
—	—	+ (c)	—	—	—	—	—	—	—	—	+	—	—	—	—	—
—	—	+	—	—	+	—	—	—	+	—	—	—	—	—	—	—

Provinces		Norrbotten	Westerbotten			Ångermanland				
Localities	General geographic. distribution.	Luleå ("Lu" on the map!)	N. of Skellefteå ("Sk"), Alhem	S. of Skellefteå, E. of Falkträsket	Löfånger parish, between "Sk" and "U" (= Umeå), Gärde	The same locality – upper part	The same locality – middle part	Grundsunda parish, betw. "N" and "Ö" (= Örnsköldsvik) – lower part	Ulfön, betw. "Ö" and "H" (= Hernösand)	Hernön, Gånsvik
Height of localities above sealevel in *metres*		2-3	ca 65	74	ca 23	15?	14?	13?	ca 3	ca 35
I–III:										
Diploneis didyma EHB.	w.	+(r)	—	—	+	—	+	—	—	+
Grammatophora oceanica EHB. (= *macilenta* W. SM.)	w.	+	+	+	+	+	+	+	—	—
Hyalodiscus scoticus KÜTZ. . . .	w.	+(r)	—	—	+	+	+	—	—	+
Mastogloia Braunii GRUN. . . .	S.	—	—	—	—	—	—	—	—	—
Melosira Borreri GREV.	w.	—	—	—	+	+	+	—	+	+
Navicula elegans W. SM.	S.	—	—	—	—	—	—	—	—	—
» *formosa* GREG.	S?	—	—	—	—	—	—	—	—	—
» *humerosa* BRÉB.	w.	+(c)	—	—	+	+	+	—	—	+
» *marina* RALFS . . . . (incl. *N. Cluthensis* GREG.)	w.	—	—	—	—	—	—	—	—	—
Navicula pusilla W. SM.	w?	—	—	—	—	—	—	—	—	—
Nitzschia punctata (W. SM.). . .	S.	—	—	—	+	+	—	—	—	—
» *sigma* KÜTZ.	w.	—	—	—	+	+	—	—	—	—
Synedra affinis KÜTZ.	w.	+	—	—	+	—	—	+	+	—
» *crystallina* KÜTZ. . . .	S.	—	—	—	—	—	—	—	—	—
I–IV:										
**Chætoceras Wighami* BTW. . .	w. or S.	—	—	—	—	—	—	—	—	—
Cocconeis Scutellum EHB.	w.	+(r)	—	—	+	+	—	—	—	—
Diploneis interrupta KÜTZ. . . .	w.	—	—	—	+	+	—	—	—	+
» *Smithii* BRÉB.	w.	—	—	—	+	+	+	—	—	+
Navicula Crucicula W. SM. . . .	w?	—	—	—	—	—	—	—	—	—
II–IV:										
Biddulphia subæqua var. *baltica* GRUN.	B.	—	—	—	—	—	—	—	—	—
Campylodiscus Clypeus EHB. . .	w.	+(r)	—	—	—	—	—	—	—	—

Skåne	Gotland	Småland	Östergötland	Södermanland		Nerike		SW.-Finland		Upland		Helsingland		Medelpad
NE. of Kristianstad ("Kr"), Nosaby	Hafdhem parish, E. of Qvinnegårda	13 kilom. N. of Kalmar ("K"), Ryssby (described by Hoisr)	30 kilom. E. of Norrköping ("No"), Lönö	4 kilom. S. of Stockholm, Örby (The loc. described by Lyell)	Stockholm ("St"), kame-pit S. of Brunnsviken	17 kilom. S. of Örebro, Skyllerstad parish, E. of Norrtorp	4 kilom. N. of Örebro ("Ö"), Bettorp, kame-pit	45 kilom. WNW. of Åbo ("Å"), Kunnarais	4 kilom. SW. of Ekenäs, Lexvall	4 kilom. E. of Helsingfors ("Hs"), Stansvik	S. of Upsala, kame-pit	26 kilom. NNE of Upsala ("Up"), Slesbyn	5 kilom. W of Söderhamn ("So"), Bagberget	25 kilometre NNE of Hudiksvall ("Hu"), Bringsta	Some localities in Medelpad, described by T. Fegræus
ca 1.2	14-15	3.7	ca 5	ca 21	30?	49	ca 37	3.0	0.0	?	33.5	ca 62	ca 22	40-50?	25-65
—	—	+ (c)	—	+	—	+	+	+	+	—	+	+	+	+	+
—	+	+ (c)	—	—	+	—	+	+	+	+	—	+	—	+	+
—	—	+ (c)	—	—	—	—	—	+	—	+	—	—	—	+	—
—	+	+ (r)	—	—	—	+	—	—	—	+	+	+	+	+	+
—	+	+ (c)	—	+	—	—	—	+	—	+	+	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	+ (r)	—	—	—	—	—	—	+	—	—	—	—	—	—
—	—	+	—	—	—	+	—	—	—	+	—	—	—	—	—
—	—	+ (r)	—	+	—	—	—	—	—	—	—	—	—	—	—
—	+	+ (c)	—	—	+	+	+	—	—	+	+	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	+ (c)	—	+	—	+	—	—	—	+	+	—	—	—	—
—	+	+ (c)	—	+	+	+	+	+	+	+	+	—	+	+	+
—	—	+ (r)	—	—	—	—	+	+	—	—	—	—	—	—	—
—	—	+ (r)	—	+	—	—	—	—	—	—	—	—	—	—	—
—	+	+ (c)	+	—	—	—	—	—	+	—	—	—	—	—	—

Some localities in Medelpad, described by T. Fegræus

Provinces		Norrbotten	Westerbotten			Ångermanland				
Localities		Luleå ("Lu" on the map!)	N. of Skellefteå ("Sk"), Alhem	S. of Skellefteå, E. of Falkträsket	Löfånger parish, between "Sk" and "U" (= Umeå), Gärde	The same locality – upper part	The same locality – middle part	Grundsunda parish, betw. "N" and "Ö" (= Örnsköldsvik) – lower part	Ulfön, betw. "Ö" and "H" (= Hernösand)	Hernön, Gånsvik
Height of localities above sealevel in *metres*		2-3	ca 65	74	ca 23	15?	14?	13?	ca 3	ca 35
II—IV:	General geographic distribution.									
Campylodiscus Echineis EHB. . .	w.	—	—	—	+	+	+	—	—	—
**Coscinodiscus balticus* GRUN. . .	B.	+	—	—	+	+	—	—	+	—
**Cyclotella Meneghiana* K.	S.	—	—	—	—	—	—	—	—	—
Mastogloia elliptica (AG.) . . . . (= *Dansei* THWAITES).	S.	—	—	—	—	—	—	—	—	—
Melosira Jürgensii AG.	S.	—	—	—	+	+	+	—	—	—
Navicula peregrina KÜTZ. . . .	w.	—	—	—	—	—	—	—	—	—
» *sculpta* EHB.	S.	—	—	—	—	—	—	—	—	—
» *subsalina* DONK.	w.	—	—	—	+	—	—	—	—	—
Nitzschia circumsuta BAIL. . . .	S.	—	—	—	—	—	—	—	—	—
» *hungarica* GRUN. . . .	S.	—	—	—	—	—	—	—	—	—
» *scalaris* DONK.	S.	—	—	—	—	—	—	—	—	—
Surirella ovata KÜTZ.	w.	—	—	—	+	+	—	—	—	—
» *striatula* TURP.	S.	—	—	—	+	—	+	—	—	—
Synedra pulchella KÜTZ. . . .	S.	—	—	—	—	—	—	—	—	—
I—V:										
Amphora ovalis var. *affinis* KÜTZ.	w.	—	—	—	+	+	+	—	—	—
Epithemia turgida EHB.	S.	+ (c)	+	+	+	+	+	+	+	+
Rhoicosphenia curvata KÜTZ. . .	w.	+	—	—	+	+	—	—	—	—
II—V:										
Cocconeis Pediculus EHB. . . .	S.	+ (c)	—	—	+	+	+	—	—	—
» *Placentula* EHB.	S.	—	—	—	—	—	—	—	—	—
Epithemia Argus KÜTZ.	S.	—	—	—	—	—	—	—	—	—
» *cistula* var. *proboscidea* GRUN.	S.	—	—	—	—	—	—	—	—	—

Medelpad	Helsingland		Upland		SW.-Finland			Nerike		Södermanland		Östergötland	Småland		Gotland	Skåne
Some localities in Medelpad, described by T. FEGRÆUS	25 kilometre NNE. of Hudiksvall ("Hu"), Bringsta	5 kilom. W. of Söderhamn ("Sö"), Bagberget	26 kilom. NNE. of Upsala ("Up"), Slesbyn	S. of Upsala, kame-pit	4 kilom. E. of Helsingfors ("Hs"), Stansvik	4 kilom. SW. of Ekenäs, Lexvall	45 kilom. WNW. of Åbo ("Å"), Kunnarais	4 kilom. N. of Örebro ("Ö"), Bettorp, kame-pit	17 kilom. S. of Örebro, Skyllerstad parish, E. of Norrtorp	Stockholm ("St"), kame-pit S. of Brunnsviken	4 kilom. S. of Stockholm, Örby (The loc. described by LYELL)	30 kilom. E. of Norrköping ("No"), Lönö	Westervik ("W"), Lucerna	13 kilom. N. of Kalmar ("K"), Ryssby (described by HOLST)	Hafdhem parish, E. of Qvinnegårda	NE. of Kristianstad ("Kr"), Nosaby
25-65	40-50?	ca 22	ca 62	33.5	?	0.0	3.0	ca 37	49	30?	ca 21	ca 5	ca 5	3.7	14-15	ca 1.2
+	+	—	+	+	+	—	—	+	+	+	+	+	+	+(c)	+	+
—	—	—	—	—	—	+	—	—	+	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+
—	—	—	—	—	—	—	—	—	—	—	—	—	—	+	+	+
+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
+	—	—	—	—	—	—	—	+	—	—	—	—	—	+(c)	—	+
—	—	—	—	—	—	—	—	—	+	—	+	—	—	+(r)	—	+
—	—	—	—	—	—	—	—	—	+	—	—	—	—	+(r)	—	—
+	+	—	—	—	+	—	—	—	—	—	—	—	+	+	—	+
+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	+	—	+	+	—	+
+	—	—	—	—	—	—	—	—	+	—	—	—	—	+	—	—
+	—	—	+	—	+	+	—	—	+	—	+	—	—	+	+	+
+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+	—
+	—	—	—	—	—	—	—	—	+	—	—	—	—	—	—	+
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+(c)	+	—
+	—	—	—	—	—	—	—	—	+	—	—	—	—	—	—	+
+	—	—	—	+	—	—	+	—	+	—	—	—	—	+	+	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	+	—	+
—	—	—	—	—	—	—	—	—	+	—	—	—	—	+	+	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+

Provinces		Norrbotten	Westerbotten			Ångermanland				
Localities		Luleå ("Lu" on the map!)	N. of Skellefteå ("Sk"), Alhem	S. of Skellefteå, E. of Falkträsket	Löfånger parish, between "Sk" and "U" (= Umeå), Gärde	The same locality – upper part	The same locality – middle part	Grundsunda parish, betw. "N" and "Ö" (= Örnsköldsvik) – lower part	Ulfön, betw. "Ö" and "H" (= Hernösand)	Hernön, Gånsvik
Height of localities above sealevel in *metres*		2-3	ca 65	74	ca 23	15?	14?	13?	ca 3	ca 35
II–V:	General geographic distribution.									
Epithemia gibba EHB.	S.	+(r)	—	—	+	+	+	—	—	—
» *Sorex* KÜTZ.	S.	—	—	—	+	—	—	—	—	—
Mastogloia Smithii THWAITES .	w.	—	—	—	—	—	—	—	—	—
Navicula amphisbæna BORY . .	w.	—	—	—	—	—	—	—	—	—
» *limosa* KÜTZ.	w.	—	—	—	—	—	—	—	—	—
III–V:										
Amphora ovalis KÜTZ.	w.	—	—	—	—	+	—	—	+	+
**Coscinodiscus lacustris* (W. SM.) GRUN.	w.	+ (c)	—	—	+	+	+	—	+	+
Cymatopleura elliptica BRÉB. . .	S.	—	—	—	+	+	+	—	—	—
» *Solea* BRÉB.	S.	—	—	—	—	—	—	—	—	—
Cymbella Cistula HEMPR.	w.	—	—	—	—	+	—	—	—	—
» *cymbiformis* EHB. . . .	S?	—	—	—	—	—	—	—	—	—
» *lanceolata* EHB.	S.	—	—	—	—	—	—	—	—	—
Encyonema prostratum RALFS .	S.	—	—	+	—	—	—	—	—	—
Epithemia Zebra EHB.	S.	—	—	—	—	—	—	—	—	—
Gomphonema acuminatum EHB.	w.	—	—	—	+	—	—	—	+	—
» *olivaceum* EHB. . .	S.	—	—	—	—	—	—	—	—	—
Navicula oblonga KÜTZ.	S.	—	—	—	—	—	—	—	—	—
Nitzschia Tryblionella HANTZSCH	w.	—	—	—	—	—	—	—	—	—
IV–V:										
Cymbella gastroides KÜTZ. . . .	w.	—	—	—	—	—	+	—	—	—
» *helvetica* KÜTZ. . . .	w.	—	—	—	—	+	—	—	—	—
Gomphonema geminatum AG. . .	N.	—	—	—	+	+	+	—	—	—

Medelpad	Helsingland		Upland		SW.-Finland			Nerike		Södermanland		Östergötland	Småland		Gotland	Skåne
Some localities in Medelpad, described by T. Fegræus	25 kilometre NNE. of Hudiksvall ("Hu"), Bringsta	5 kilom. W. of Söderhamn ("Sö"), Bagberget	26 kilom. NNE. of Upsala ("Up"), Slesbyn	S. of Upsala, kame-pit	4 kilom. E. of Helsingfors ("Hs"), Stansvik	4 kilom. SW. of Ekenäs, Lexvall	45 kilom. WNW. of Åbo ("Å"), Kunnarais	4 kilom. N. of Örebro ("Ö"), Bettorp, kame-pit	17 kilom. S. of Örebro, Skyllerstad parish, E. of Norrtorp	Stockholm ("St"), kame-pit S. of Brunnsviken	4 kilom. S. of Stockholm, Örby (The loc. described by Lyell)	30 kilom. E. of Norrköping ("No"), Lönö	Westervik ("W"), Lucerna	13 kilom. N. of Kalmar ("K"), Ryssby (described by Holst)	Hafdhem parish, E. of Qvinnegårda	NE. of Kristianstad ("Kr"), Nosaby
25-65	40-50?	ca 22	ca 62	33.5	?	0.0	3.0	ca 37	49	30?	ca 21	ca 5	ca 5	3.7	14-15	ca 1.2
+	—	—	—	—	+	+	—	—	+	—	—	—	—	+	+	+
+	—	—	—	—	—	—	—	—	+	—	—	—	—	+	+	+
+	—	—	—	—	—	—	—	—	+	—	—	—	—	+	+	+
—	—	—	—	—	—	—	—	—	—	—	—	—	—	+	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	+(r)	—	+
+	—	—	—	—	—	—	—	—	+	—	—	—	—	—	+	+
+	+	—	—	—	—	+	—	+	—	—	—	—	—	—	—	—
+	—	—	—	—	—	—	—	—	—	—	—	—	—	+(r)	—	+
+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+
—	—	—	—	—	—	—	—	—	—	—	—	—	—	+(r)	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	+(r)	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+
+	—	—	—	—	—	—	—	—	—	—	—	—	—	+	+	+
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+
—	—	—	—	—	—	—	—	—	+	—	—	—	—	+(r)	—	+
+	—	—	—	—	—	—	+	—	+	—	—	—	—	+	—	+
+	—	—	—	—	+	—	—	—	—	—	—	—	—	+	—	+
+	—	—	—	—	—	—	—	—	—	—	—	—	—	+(r)	—	—
+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Provinces	Norrbotten	Westerbotten			Ångermanland				
Localities	Luleå ("Lu" on the map!)	N. of Skellefteå ("Sk"), Alhem	S. of Skellefteå, E. of Falkträsket	Löfånger parish, between "Sk" and "U" (= Umeå), Gärde	The same locality – upper part	The same locality – middle part	Grundsunda parish, betw. "N" and "Ö" (= Örnsköldsvik) – lower part	Ullön, betw. "Ö" and "H" (= Hernösand)	Hernön, Gånsvik
Height of localities above sealevel in *metres*	2-3	ca 65	74	ca 23	15?	14?	13?	ca 3	ca 35
V:									
Amphora Pediculus KÜTZ.	—	—	—	—	—	—	—	—	—
Campylodiscus hibernicus EHB.	—	—	—	—	+	—	—	—	—
**Cyclotella comta* EHB.	+(r)	—	—	—	—	—	—	—	—
Cymbella Ehrenbergii KÜTZ.	—	—	—	—	—	—	—	—	—
» *maculata* KÜTZ.	—	—	—	—	+	—	—	—	—
Diploneis ovalis HILSE	—	—	—	—	—	—	—	—	—
Eunotia Clevei GRUN.	—	—	—	—	—	+	—	—	—
» *Formica* EHB.	—	—	—	—	—	+	—	—	—
» *prærupta* EHB.	—	—	—	+	+	—	—	—	—
Fragilaria construens EHB.	—	—	—	—	—	—	—	—	—
Gomphonema intricatum KÜTZ.	—	—	—	—	—	—	—	—	—
» *Vibrio* EHB.	—	—	—	—	—	—	—	—	—
Melosira granulatum EHB.	+	—	+	+	—	—	—	—	—
Meridion circulare AG.	—	—	+	—	—	—	—	—	—
Navicula amphibola CL.	—	—	—	—	—	—	—	—	—
» *platystoma* EHB.	—	—	—	—	—	—	—	—	—
» *Semen* EHB.	—	—	—	—	—	—	—	—	—
» *tuscula* EHB.	—	—	—	—	—	—	—	—	—
» *vulpina* KÜTZ.	—	—	—	—	—	—	—	—	—
Nitzschia acuminata GRUN.	—	—	—	—	—	—	—	—	—
Pinnularia borealis EHB.	—	—	—	—	—	—	—	—	—
» *cardinalis* EHB.	—	—	—	—	—	—	—	—	—
» *divergens* W. SM.	—	—	—	—	+	—	—	—	—
» *distinguenda* CL.	—	—	—	—	—	—	—	—	—
» *lata* BRÉB.	—	—	—	—	+	+	—	—	—
» *Legumen* EHB.	—	—	—	—	—	—	—	—	—
» *major* KÜTZ.	—	—	—	—	+	—	—	—	—
» *mesolepta* EHB.	—	—	—	+	—	—	—	—	—
» *streptoraphe* CL.	—	—	—	+	—	—	—	—	—

Medelpad	Helsingland		Upland		SW.-Finland			Nerike		Södermanland		Östergötland	Småland		Gotland	Skåne
Some localities in Medelpad, described by T. FEGRÆUS	25 kilometre NNE. of Hudiksvall ("Hu"), Bringsta	5 kilom. W. of Söderhamn ("Sö"), Bagberget	26 kilom. NNE. of Upsala ("Up"), Slesbyn	S. of Upsala, kame-pit	4 kilom. E. of Helsingfors ("Hs"), Starsvik	4 kilom. SW. of Ekenäs, Lexvall	45 kilom. WNW. of Åbo ("Å"), Kunnarais	4 kilom. N. of Örebro ("Ö"), Bettorp, kame-pit	17 kilom. S. of Örebro, Skyllerstad parish, E. of Norrtorp	Stockholm ("St"), kame-pit S. of Brunnsviken	4 kilom. S. of Stockholm, Örby (The loc. described by LYELL)	30 kilom. E. of Norrköping ("No"), Lönö	Westervik ("W"), Lucerna	13 kilom. N. of Kalmar ("K"), Ryssby (described by HOLST)	Hafdhem parish, E. of Qvinnegårda	NE. of Kristianstad ("Kr"), Nosaby
26-56	40-50?	ca 22	ca 62	33.5	?	0.0	3.0	ca 37	49	30?	ca 21	ca 5	ca 5	3.7	14-15	ca 1.2
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	+(r)	—	+
+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+
—	—	—	—	+	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	+	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+
—	—	—	—	—	—	—	—	—	—	—	+	—	—	+(r)	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+
—	—	—	—	—	—	—	—	—	+	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	+	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	+(r)	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+
—	—	—	—	—	—	—	—	—	—	—	—	—	+	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	+	—	—	—	—	—	—	—	—	—	—	—

Provinces	Norrbotten	Westerbotten			Ångermanland				
Localities	Luleå ("Lu" on the map!)	N. of Skellefteå ("Sk"), Alhem	S. of Skellefteå, E. of Falkträsket	Löfånger parish, between "Sk" and "U" (= Umeå), Gärde	The same locality – upper part	The same locality – middle part	Grundsunda parish, betw. "N" and "Ö" (= Örnsköldsvik) – lower part	Ullön, betw. "Ö" and "H" (= Hernösand)	Hernön, Gånsvik
Height of localities above sealevel in *metres*	2-3	ca 65	74	ca 23	15?	14?	13?	ca 3	ca 35
V:									
Pinnularia viridis KÜTZ.	—	—	—	+	+	+	—	—	—
Stauroneis Phœnicentron EHB.	—	—	—	—	—	+	—	—	—
**Stephanodiscus astræa* (EHB.)	—	—	+	—	—	—	—	—	—
Surirella biseriata BRÉB.	—	—	—	—	+	—	—	—	—
» *Capronii* BRÉB.	—	—	—	—	—	—	—	—	—
» *robusta* EHB.	—	—	—	—	—	—	—	+	—
?:									
Amphora arenicola var. *major* CL. (= *robusta* A. SM., nec GREG.)[1]	—	—	—	—	—	—	—	—	—
Terpsinoe americana BAIL[2]	—	—	—	—	—	—	—	—	—

It is evident from the diagram above that the majority of samples contain a *mixed diatomaceous flora,* or in other words a number of species that cannot be supposed to have existed in the Litorina-sea along with the other forms characteristic of that sea, since the saltness was too *great* for some, and too *small* in respect to others.

To the former belong first and foremost the fresh-water forms, (*V-diatoms*) that are generally of rare occurrence among the specimens; further *IV—V-* and *III—V-diatoms,* of which not even the last-named can have lived in the salter phase of the Litorina-sea *in more open localities,* where a degree of saltness prevailed that was normal for a certain district. Most of the localities mentioned are just such as lay open towards the former Litorina-sea. The more obvious exceptions are the following, divisible into:

a) Such as formed shallow *estuaries* of the Litorina-sea as Nosaby

[1] Known living only in the Black Sea (CLEVE).

[2] Known living in brackish water from Hudson river to Florida (CLEVE).

Medelpad	Helsingland		Upland	SW.-Finland			Nerike		Södermanland		Östergötland	Småland		Gotland	Skåne
Some localities in Medelpad, described by T. Fegræus	25 kilometre NNE. of Hudiksvall ("Hu"), Bringsta	5 kilom. W. of Söderhamn ("Sö"), Bagberget	26 kilom. NNE. of Upsala ("Up"), Slesbyn	S. of Upsala, kame-pit	4 kilom. E. of Helsingfors ("His"), Stansvik	4 kilom. SW. of Ekenäs, Lexvall	45 kilom. WNW. of Åbo ("Å"), Kunnarais	4 kilom. N. of Örebro ("Ö"), Bettorp, kame-pit	17 kilom. S. of Örebro, Skyllerstad parish, E. of Norrtorp	Stockholm ("St"), kame-pit S. of Brunnsviken	4 kilom. S. of Stockholm, Örby (The loc. described by Lyell)	30 kilom. E. of Norrköping ("No"), Lönö	Westervik ("W"), Lucerna	13 kilom. N. of Kalmar ("K"), Ryssby (described by Holst)	Hafdhem parish, E. of Qivnnegårda	NE. of Kristianstad ("Kr"), Nosaby
26-65	40-50?	ca 22	ca 62	33.5	?	0.0	3.0	ca 37	49	30?	ca 21	ca 5	ca 5	3.7	14-15	ca 1.2
—	—	—	—	—	—	—	—	—	—	—	—	—	—	+	—	+
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	+	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	+	—	—
—	+	—	—	+	—	—	—	—	—	—	—	—	—	+(r)	—	—

(Skåne), Hafdhem (Gotland) and Norrtorp (Nerike). — The samples obtained from them are more or less mixed with ooze.

b) Such as are situated in far-reaching *bays* of the Litorina-sea; among these the localities of the Medelpad are the most obviously representative.

In localities of this last-named nature (a and b) the water has undoubtedly been from time to time to a greater or less extent adulterated with fresh water from the adjacent land, for which reason III—V-diatoms particularly can be supposed to have lived and become imbedded here together with salter forms, while *V*- and *IV—V*-diatoms must be imagined as having been transported from fresh or almost fresh water or else from Ancylus-deposits[1] and then fallen to the bottom after a longer or shorter time of

[1] Thus for instance *Eunotia Clevei* Grun, seemingly a fresh-water form, and regarded by Cleve as probably a characteristic fossil of the Ancylus-clay (cf. Munthe, This Bulletin, Vol. I, No. 2, pp. 123—24, and Nathorst, G. F. F., Bd. 15, 1893, p. 559) has been found

transportation. The presence of representatives of all the above-named groups (*V-, IV—V-* and *III—V*-diatoms) in material from the above localities more obviously lying on the open Litorina-sea, may be undoubtedly explained best by assuming transportation by means of the sea-currents.

The other sort of diatoms, that cannot be imagined as having existed in the interior part of Litorina-sea, because the *saltness was too small* are *I-diatoms,* met with in many localities, even in the most northerly ones.

Their occurrence may be best interpreted, by assuming transportation from the Cattegat and South Baltic district (within which latter they probably existed too) just as *plankton* — either direct, e. g. *Coscinodiscus Asteronphalus, Dicladia Mitra* and *Rhizosolenia Calcar avis,* which are really according to CLEVE, plankton-forms, or attached to higher algæ. In some cases such transportation seems to have gone on to a considerably large extent, evidenced by the fact that *Dicladia Mitra* for example occurs *commonly* in clay at Gånsvik in Hernön, and *Coscinodiscus Asteromphalus* is common at Upsala (kame-pit) and also at Stansvik E. of Helsingfors.

In connection with what has just been said it deserves mention however that:

firstly, the material from some of the less remote localities in the open Litorina-sea, that contain *III—V-* and *IV—V*-diatoms can be supposed to have been formed in part either during the earlier or the later

	Luleå		Löfånger par., Gärde		Grundsunda par. Middle part		Grundsunda par. Upper part		Ullön		Hernön, Gånsvik		Medelpad (FEGRÆUS)		NNE. of Hudiksvall, Bringsta	
Number of species (= N.) and percent (= %).	N.	%	N.	%	N.	%	N.	%	N.	%	N.	%	N.	%	N.	%
I—II-diatoms:	3	18.7	5	16.1	2	11.7	3	12.5	2	25.0	2	20.0	3	10.4	4	25.0
I—III- »	6	37.5	11	35.5	7	41.2	9	37.5	4	50.0	5	50.0	8	27.5	7	43.7
Sum:	—	**56.2**	—	**51.6**	—	**52.9**	—	**50.0**	—	**75.0**	—	**70.0**	—	**37.9**	—	**68.7**
I—IV- »	1	6.3	3	9.7	1	5.9	3	12.5	—	—	2	20.0	3	10.4	2	12.5
II—IV- »	2	12.5	6	19.3	3	17.6	4	16.7	1	12.5	—	—	8	27.5	2	12.5
I—V- »	2	12.5	3	9.7	2	11.8	3	12.5	1	12.5	1	10.0	3	10.4	1	6.3
II—V- »	2	12.5	3	9.7	2	11.8	2	8.3	—	—	—	—	4	13.8	—	—
Sum:	16	—	31	—	17	—	24	—	8	—	10	—	29	—	16	—

at Grundsunda in Litorina-clay — "in the middle part of the stratum" — and at Upsala in Litorina-clay of kame-pit. In all probability therefore the specimens derive from displaced Ancylus-strata. The occurrence of the species at the first-named locality is of peculiar interest

part of the Litorina-time, when the saltness was less than in its really salt phase, in which case the diatoms spoken of could exist in the place where they were embedded;

secondly, that the material from the localities containing *I*-diatoms can be supposed to have been to some extent formed at a considerable depth in the Litorina-sea, where the saltness was naturally appreciably greater than at the surface.

A possible mistake may have arisen in the former case from the fact that the samples were not collected and examined layer by layer, — without doubt the best method, and one to be recommended for future investigations. In consideration however of the fact that the diatoms in the groups mentioned, as far as most of the samples are concerned, are relatively scarce, their occurrence may with equally good reason be regarded as dependent on transportation as assumed above.

The same may possibly be assumed too of the samples for the occurrence of *I*-diatoms; it is however a matter that is at present difficult of solution, since the bathymetrical distribution of the living diatoms seems at present to be very little known. — By reason of the uncertainty still prevailing in the respects mentioned I have thought well to leave out of account all the groups named (*V*-, *IV—V*-, *III—V*- and *I*-diatoms) in discussing the characteristics of the diatomaceous flora of the Litorina-sea, to which I now proceed.

Upsala, kame-pit		E. of Helsingfors, Stansvik		SW. of Ekenäs, Lexvall		W. of Åbo, Kunnarais		N. of Örebro, Bettorp		S. of Örebro, Norrtorp		S. of Stockholm, Örby		N. of Kalmar, Ryssby		Gotland, Hafdhem par.		Skåne, Nosaby	
N.	%	N.	%	N.	%	N.	%	N.	%	N.	%	N.	%	N.	%	N.	%	N.	%
2	18.2	3	17.6	—	—	2	16.7	4	28.6	3	10.7	—	—	6	13.6	4	16.7	2	9.1
5	45.4	7	41.2	3	30.0	5	41.7	3	21.4	8	28.6	6	42.9	14	31.8	7	29.2	1	4.5
—	**63.6**	—	**58.8**	—	**30.0**	—	**58.4**	—	**50.0**	—	**39.3**	—	**42.9**	—	**45.4**	—	**45.9**	—	**13.6**
1	9.1	1	5.9	2	20.0	2	16.7	4	28.6	3	10.7	2	14.3	4	9.1	2	8.3	2	9.1
1	9.1	4	23.5	3	30.0	1	8.3	2	14.3	6	21.4	5	35.7	11	25.0	5	20.8	9	40.9
1	9.1	1	5.9	1	10.0	1	8.3	1	7.1	3	10.7	1	7.1	1	2.3	1	4.2	2	9.2
1	9.1	1	5.9	1	10.0	1	8.3	—	—	5	17.9	—	—	8	18.2	5	20.8	6	27.2
11	—	17	—	10	—	12	—	14	—	28	—	14	—	44	—	24	—	22	—

as a possible proof that Ancylus-clay is to be met with in such northerly parts, which by the way might be expected from a consideration of the temperate nature of the Ancylus-fauna and -flora in southern Sweden.

In the diagram above (pp. 30—31) I have therefore simply given the *number* and *percentage* of the species in the rest of the groups, which are all such as can be imagined as having lived in Litorina-sea during its salter phase. The localities that afford an inconsiderable number of species have however here been omitted.

Thus from this diagram we see, among other things, that:

1) *I—III-diatoms* give at every locality, almost without exception, the highest percentage;

2) the sum of *I—II- and I—III-diatoms* generally gives at least 50 % of the whole number;

3) especially the localities spoken of above, that formed *estuaries* or *bays* in the former Litorina-sea (the most manifest are Nosaby, Norrtorp, and Medelpad[1]) form exceptions to either one or both of these statements;

4) the diatomaceous flora of the Litorina-deposits show throughout the region investigated a considerably greater similarity than could be expected from the testimony afforded by the Mollusca etc. relative to the distribution of saltness in the Litorina-sea.

The last-mentioned circumstance seems distinctly to make clear that the sea-currents played an important part in the distribution of the diatoms in the Litorina-sea inasmuch as the northern localities can show a flora of a salter nature, speaking generally, than the southern ones. The reason of that probably lies principally in the fact that the material at many of the northern localities was deposited at a comparatively great depth — in consequence of the greater land-subsidence in these parts, and that thus the salter under-currents were the most important carriers of the salter diatoms. It is therefore possible that some of (especially) the *I—II*-diatoms too, besides the I-diatoms, did not exist in the regions, where they are now found, lying in the Litorina-deposits.

From the foregoing it seems then clear, that in such cases the diatoms do not give such certain information concerning the hydrographical conditions of former times as the Mollusca. It would not however be possible to deny, that in the case before us they point to a greater saltness in the Litorina-sea than in the Baltic nowadays.

The following results of investigations upon certain recent samples taken from the south Baltic and adjacent regions (diagram p. 33) prove that the diatomaceous flora of the Litorina-sea has roughly its closest parallel nowadays in about the same region as its molluscan fauna, which has been spoken of above. The samples I have collected, were formed of higher algæ with adjacent diatoms. The classification was made by Prof. CLEVE.

---

[1] Material from Ryssby and Ekenäs, Lexvall has possibly been formed of a mixture of deposits of deep and of shallow-water, i. e. more typical and younger (or older) Litorina-strata?

Number of Species and percent	Depth in *metres*	Apenrade harbour (Schleswig)		Langeland, Ristinge (Denmark)		Betw. Wismar and Poël, (near Wismar harbour)		Warnemünde		Öresund, Hven, S.-side		Öresund, Hven, S.-side		Öresund, W. of Landscrona		Öresund, W. of Limhamn		E. of the preceding loc. (Arkona)		Rügen, Northern part (Arkona)		S.-Gotland, Hoburg	
	Saltness in percent	0—1		0—1		1—2		0—1		7—10		0—1		4—5		4—5		16		0—1		0—1	
		ca 1.7		ca 1.5		ca 1.1		1.18		ca 1.25		ca 1.23		ca 1.2		ca 1.15		ca 0.90		ca 0.85		0.7	
		N.	%	N.	%	N.	%	N.	%	N.	%	N.	%	N.	%	N.	%	N.	%	N.	%	N.	%
I-diatoms		3	27.3	3	20.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
I—II- »		1	9.1	4	26.7	4	22.2	3	23.1	1	9.1	2	14.3	2	11.8	3	23.1	2	15.4	—	—	—	—
I—III- »		4	36.3	4	26.7	7	38.8	6	46.1	7	63.6	8	57.1	9	52.9	6	46.1	6	46.1	6	42.8	7	35.0
Sum:		—	—	—	—	—	**61.0**	—	**69.2**	—	**72.7**	—	**71.4**	—	**64.7**	—	**69.2**	—	**61.5**	—	**42.8**	—	**35.0**
I—IV-diatoms		1	9.1	2	13.3	2	11.1	2	15.4	2	18.2	1	7.1	1	5.9	1	7.7	1	7.7	1	7.2	2	10.0
II—IV- »		—	—	—	—	1	5.6	1	7.7	—	—	—	—	1	5.9	—	—	1	7.7	1	7.1	4	20.0
I—V- »		2	18.2	2	13.3	2	11.2	1	7.7	1	9.1	2	14.3	2	11.7	1	7.7	2	15.4	2	14.3	1	5.0
II—V- »		—	—	—	—	2	11.1	—	—	—	—	1	7.2	2	11.8	2	15.4	1	7.7	4	28.6	4	20.0
III—V- »		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	10.0
Sum:		11	—	15	—	18	—	13	—	11	—	14	—	17	—	13	—	13	—	14	—	20	—

As appears from the diagram, the sum of the percentages for I—II- and I—III-diatoms gives, in general for the coast-region Wismar (Hven)—Rügen more even and somewhat higher figures than in respect to the Litorina-deposits, except for the coastbelt to the North Rügen, where the sum is lower. In Gotland it has sunk further, and here moreover the specimens of the III—V-diatoms come in too.

On the other hand (in salter water) the percentage of salter forms has increased and I-diatoms are found here.

Diatoms:	A.	B.	Common in *A* are further:	A.	B.
I—II:			**I:**		
Rhabdonema arcuatum . .	18	6	*Coscinodiscus asterompha-*		
» *minutum* . .	(9)	6	*lus*	9	—
I—III:			**I—II:**		
Achnanthes longipes	(6)	6	*Campylodiscus bicostatus* .	8	—
Diploneis didyma	16	5			
Grammatophora oceanica .	17	7	**I—III:**		
Hyalodiscus scoticus	(9)	8	*Navicula humerosa*	11	2
Melosira Borreri	16	7	*Nitzschia punctata*	12	2
Synedra affinis	(7)	7			
			II—IV:		
I—IV:			*Campylodiscus Clypeus* . .	9	1
Cocconeis scutellum	(9)	8	*Surirella striatula*	11	—
Diploneis interrupta	15	(1)			
» *Smithii*	14	(1)	**II—V:**		
			Cocconeis Pediculus	10	2
II—IV:					
Campylodiscus Echineis . .	18	—	**III—V:**		
			Coscinodiscus lacustris . .	10	—
I—V:					
Epithemia turgida	25	7			
Rhoicosphenia curvata . .	(6)	6			
II—V:					
Epithemia gibba	(11)	4			
» *Sorex*	(6)	4			

In the next diagram (p. 34) a review is given of the most generally occurring species in the 26 *Litorina-localities* (= *A*) mentioned in the large diagram, and in the 8 South Baltic [Wismar (Hven)—Rügen (= *B*)] samples of recent times. The number of localities for the different species is also given, but only such species are noticed, as have been obtained in at least half of the localities in one or other of the two groups *(A* and *B)*. In conjunction herewith a notification has been appended of the other species that occur fairly commonly especially in the Litorina-deposits.

Here we see that a large proportion of the species that are found pretty generally distributed over the South Baltic district now are numerous or fairly so in the Litorina-deposits too. On the other hand there is a proportion of species with tolerably general distribution in the Litorina-strata, that are only rarely to be met with in samples from the South Baltic district. That depends possibly to some extent on the fact that most of the latter samples were collected solely in the coast-belt.

Just as the Litorina-sea contained Mollusca of not only *widely-extended (Mytilus, Cardium edule*, *Tellina baltica* and *Hydrobia (?))* but also *Southerly (Scrobicularia* and *Rissoa)* and *Northerly (Litorina litorea)* distribution, so it did the diatoms too.

As regards diatoms the percentage of northerly species is still less than is the case with the Mollusca and if we exclude, as above, the groups I-, III—V , and IV—V-diatoms, the northerly species are unrepresented. The percentage of species with southerly and widely extended distribution remains about the same. (There are besides two forms specifically Baltic).

It would scarcely be possible to come to any very definite conclusions from the distribution of diatoms in Litorina-deposits, as to the *temperature* at the time in question. So much however may apparently be affirmed that to assume a higher temperature than the present Baltic one, for the Litorina-sea is not at variance with the view expressed above.

Rhizopoda in Litorina-deposits.

There are in the literature very few statements about the occurrences of *Rhizopoda* in Litorina-strata.

Prof. G. LINDSTRÖM speaks of the discovery of a shell of a form which probably belongs to the genus *Polystomella*. He procured it from clayey sand lying over peat-»dy» at the above-mentioned locality, E. of Qvinnegårda, Hafdhem parish, South Gotland[1].

I pointed out in discussing the distribution of *Nonionina depressula* WALKER & JAC. that the species is exceedingly common in post-glacial marine clay in the Baltic district[2].

A little later (Dec. No. of G. F. F., 1892, p. 588) V. MADSEN

[1] G. F. F., Bd. 8, 1886, p. 252.

[2] Bih. K. Vet. Akad. Handl., Afd. 2. No. 1, 1892, p. 103.

reported the 3 following species found in shell-gravel containing *Rissoa* etc. near Knutsboda in Åland: *Rotalina Beccarii* L., *Polystomella striatopunctata* FICHTEL & MOLL var. and the above-mentioned *Nonionina depressula*.

These three species are, by the way, the only ones I succeeded in finding in Litorina-strata and *Nonionina* is the commonest of them, and goes moreover furthest north. *Polystomella* comes next, while *Rotalina* is the rarest and is found furthest south. That is plain, by the way, from the following diagram, which displays the innermost known occurrences in the Baltic district, both for the present time and in Litorina-strata.

Rhizopoda	Innermost known localities			
	present-day	in Litorina-strata	*metres* above sea	
Nonionina depressula	Warnemünde [1] . . .	NW. of Neder-Kalix	ca 55	MUNTHE (1889)
Polystomella striatopunctata	d:o [1] . . .	Hernön, Gånsvik . .	ca 35	„ „
Rotalina Beccarii .	Great Belt [1]	Åland, Knutsboda .	27.8	MADSEN (l. c.)
	Sound, S. of Hven [2]	Obbnäs, 35 km. SW. of Helsingfors . .	ca 18	MUNTHE (Finl. Geol. Und:s collections).

Specimens found in Litorina-deposits seem in general to be dwarf-forms, and their distribution, just as that of the before-mentioned marine organisms, points to different hydrographic conditions from the present.

Ostracoda in Litorina-deposits.

As far as I can see there are no statements, in the literature, about the occurrence of *Ostracoda* in Litorina-deposits, with the exception of MADSEN'S find of 9 (not classified) such shells in shell-gravel at Knutsboda in Åland (l. c. p. 588). In the course however of my washings of Litorina-deposits Ostracoda proved themselves to be no rarity at all in clays and clayey shell-gravel, and the forms found belong to the following species, as shown on the diagram below. They are arranged according to its present-day distribution in water of different degrees of saltness, in such a way that only those localities are mentioned, which lie furthest in in the Baltic district. It may however be remarked that the distribution of Ostracoda nowadays within the Baltic sea is not yet fully known. The statements are taken partly from verbal communications of Prof. W. LILLJEBORG who has kindly classified the fossil forms, partly from F. DAHL'S »Die Cytheriden der Westlichen Ostsee» (Zoolog. Jahrbuch, Bd. III, Abth. f. System., Jena 1888).

[1] F. E. SCHULTZE, in Jahresbericht d. Kommission etc. II—III, Berlin 1875, p. 99.

[2] During dredging operations I conducted at this place June 1892 I obtained besides this species, from a clay-sample at about 50 metres' depth: *Haplophragmium canariense* d'ORB., *Reophax scorpiurus* MONTF., *Verneuiliana polystropha* Rss et varietas, *Nonionina scapha* FICHT. & MOLL, *Miliolina seminulum* L. var. *arenacea* (= ? *M. fusca* BRADY) and *M. ringens* LAM. — Dr. A. GOËS kindly classified these as well as the fossil ones.

Ostracoda:	Present distribution:		Fossil occurrences:		
	In Baltic and Cattegat	Elsewhere	*In Litorina-deposits* (the most northerly occurrence)	*Metres* above sea	*Elsewhere*
Cytheridea punctillata BRADY	Skeldervik, NW. Scania (LILLJ.)	Spitzbergen—Mediterranian sea	Grundsunda, in the lower part of the clay-deposit	13?	Britain, Sicily.
Cythere lutea O. F. MÜLLER	Kiel, Dahme — S. of Fehmarn — at greater depths	Greenland—Mediterranean	Luleå	2—3	Scotland, Iceland, Norway, Canada.
Cytheridea papillosa BOSQUET	In the Stockholm archipelago	Spitzbergen—Britain	Luleå	2—3	*Quaternary:* Britain, Norway, Canada, Rügen. *Tertiary:* France, Belgium.
Cytherura nigrescens (BAIRD)	Kiel, Neustadt; Stockholm archipelago (LILLJ.)	Norway—Bay of Biscay	Skellefteå, Falkträsket	74	Britain, Norway, Canada.
Cytheridea sorbyana JONES	Bornholm (L. KOLMODIN a. MUNTHE 1882), Stockholm archipelago (LILLJ.) and Åland (NORDQVIST)	Spitzbergen—Britain	Luleå	2—3	*Quaternary:* Britain, Norway, Canada. *Crag:* England.
Cytheridea torosa (JONES)	Neustadt—Greifswald; Stockholm archipelago (LILLJ.)	Britain—Norway—sea of Azov etc.	Gotland, in the parish of Hall	ca 12	*Quaternary:* Britain, *Crag:* »
Cytherura gibba (O. F. MÜLLER), [»A typical brackish-water species» (BRADY and NORMAN)]	South-Baltic; Stockholm archipelago (LILLJ.)	Britain—Norway—Holland	Northern part of Alnön, off Sundsvall (Medelpad)	ca 50	Scotland, Norway.

Since our knowledge of the present distribution of Ostracoda within the Baltic and adjacent districts is yet defective (as is above mentioned) we cannot discuss more in detail the account of the fossil finds given in the diagram as regards the hydrographical conditions of the Litorina-sea. It may however be seen, that in general the fossil ostracodean fauna also points to different hydrographical conditions from the present.

As appears from the preceding communication, the later quaternary history of the Baltic can be shortly summed up in the following manner (from older to younger times):

A. *Younger glacial epoch*

1) *Time of the younger Baltic glacier.*

2) *Late glacial time* (Late *Yoldia*-time). — The younger Baltic glacier is melting away. The land-subsidence in Scandinavia now reaches its maximum during the quaternary period. The Baltic has the character of an ice-sea with *Yoldia arctica* GRAY etc. and is in open connection with the Cattegat across the northern part of South Sweden (the lakes Wettern, Wenern etc.) and possibly also with the White Sea across the Ladoga etc.

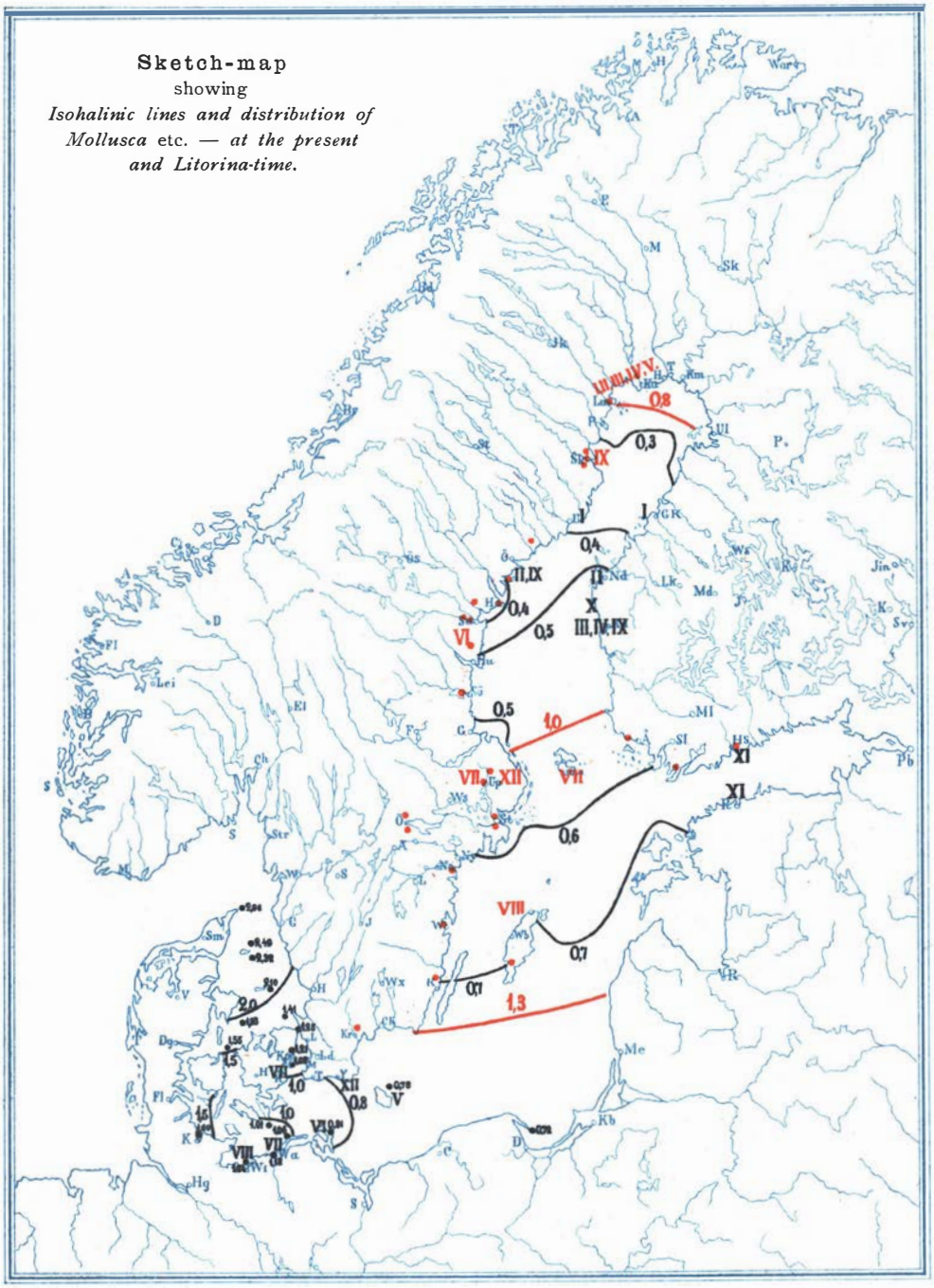
B. *Postglacial epoch*

1) *Ancylus-time.* Owing to upheaval of land in the South Baltic district and gradually also in adjacent parts towards the north, the Baltic ice-sea got the character of a fresh-water inland lake with *Ancylus fluviatilis, Limnæa ovata, Pisidia* and other Mollusca, fresh-water Ostracoda, diatoms etc. Climate temperate. A transgression of the Ancylus-lake takes place at a later phase — due to upheaval of land in the central and subsidence in the southern portions of the Baltic district. At that phase the lake had its outlets within the Danish archipelago.

2) *Litorina-time.* In consequence the Baltic by degrees came in to open connection with the Cattegat through the Belts and the Sound and finally reached the extent and salter and warmer character, which I have tried to show in the preceding paper. Owing to a later upheaval of land — that has been greater the further one goes towards the central parts of Scandinavia — the saltness decreased more and more and in consequence the more stenohalinic forms (such as *Scrobicularia, Rissoa*, the two *Litorina*-species) retired towards the South Baltic district. Instead of those mentioned *Limnæas* etc. immigrated; the Baltic thus entering into the

3) *Limnæa-time.* This time seems to come however so near the present or the *Mya-time,* that I hesitate, whether it is suitable to maintain the »*Limnæa-time*» as a particular one. With regard to the physical geography of the Baltic nowadays I refer to the preceding paper.

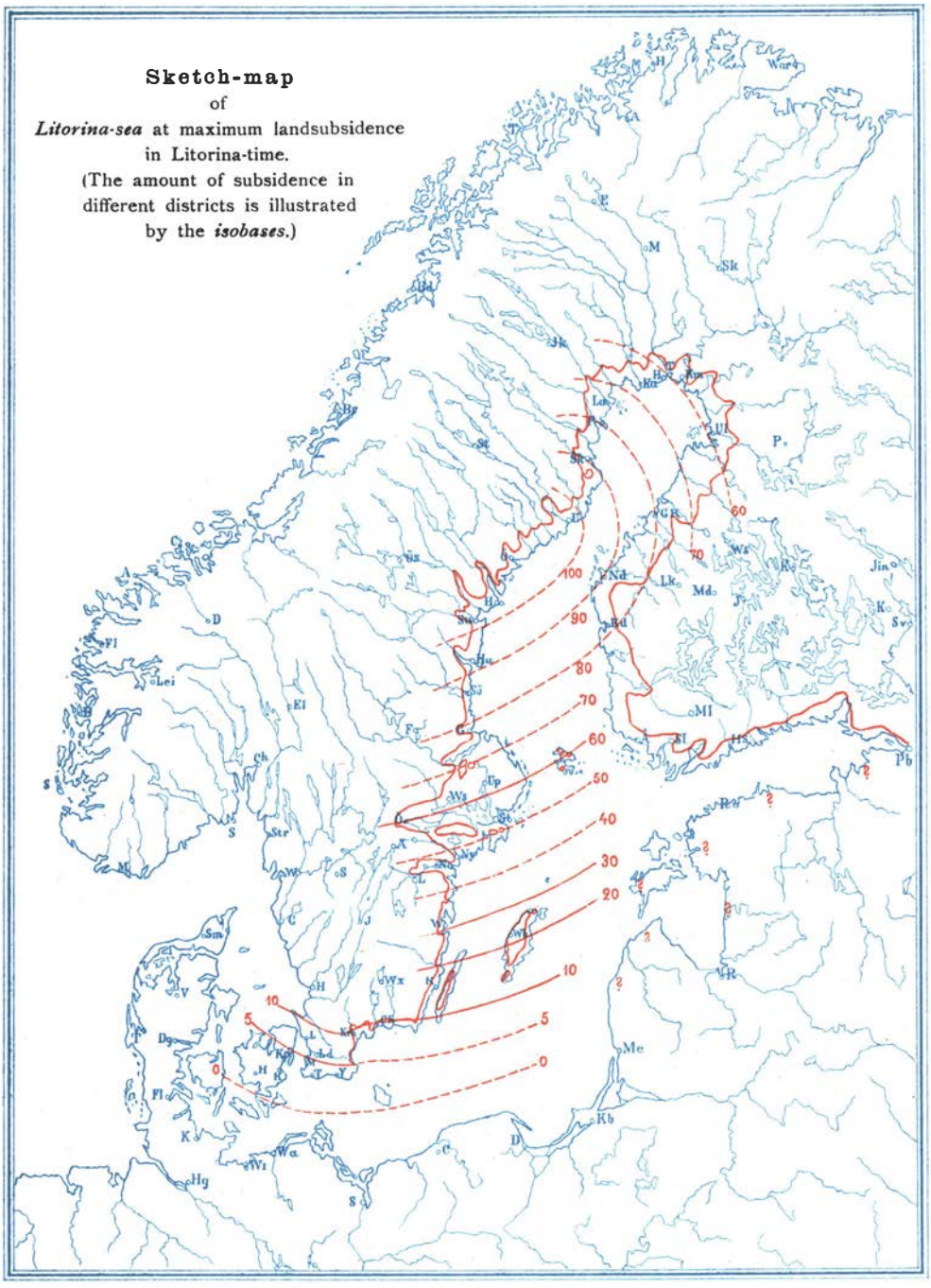
Upsala, May 1894.



Bull. of the Geol. Instit. of Upsala. *Lith. L. Ljunggren.*

I = *Tellina baltica* L.
II = *Mytilus edulis* L.
III = *Cardium edule* L.
IV = *Hydrobia ulvæ* Penn.
V = *Litorina rudis* var. *tenebrosa* Mont.
VI = „ *litorea* L.
VII = *Rissoa membranacea* Adams var.
VIII = *Scrobicularia piperata* Gmel.

IX = *Membranipora pilosa* var. *membranacea* Smitt
X = *Mya arenaria* L.
XI = *Balanus improvisus* Darw.
XII = *Spirorbis borealis* Daud.



Bull. of the Geol. Instit. of Upsala.

Lith. L. Ljunggren.