



## SCIENTIFIC FINAL REPORT

Regnr Östersjöstiftelsen: 75/14

Project manager: Thomas Andrén

Project title: Late Pleistocene and Holocene climate forcing on the Baltic Sea

### 1. Purpose of the project

In 2013 the first ever scientific drilling expedition in the Baltic Sea within the Integrated Ocean Drilling Program (IODP) took place with Thomas Andrén of Södertörn University as co-chief scientists. IODP Expedition 347 Baltic Sea Paleoenvironment retrieved a total of 1.6 km cores from nine sites. The main objective of Expedition 347 (<https://www.ecord.org/expedition347/>) was to get a deeper understanding of the paleoenvironmental evolution of the Baltic Sea Basin during the last glacial cycle i.e. the last c. 130 000 years.

During the following onshore phase of the expedition when the cores were opened, documented, and subsampled at IODP Bremen Core Repository in early 2014, one more researcher from Södertörn University, Elinor Andrén, joined the science party. The subsamples were distributed to the 31 researchers in the science party representing research groups from 9 countries. After having studied the sediment core material we decided to primarily focus on Site M0063 located in the Landsort Deep, northeastern Baltic Proper, but of course in cooperation with the research groups working with other drilled sites. Thereafter we started to design an application to The Foundation for Baltic and East European Studies (ÖSS). In the application we formulated the following three overarching aims:

- To better constrain the model of the Scandinavian Ice Sheet with its global and regional isostatic and eustatic impacts.
- To investigate how Baltic in- and outflows have varied over time and how these variations are related to changes in large-scale atmospheric circulation and changing sea levels (threshold depths).
- To determine the main mechanisms behind hypoxia-driving processes in the Baltic and to what degree human activities have played a role.

We furthermore decided to apply for a PhD-student to work together with us and collaborate with our already employed PhD-student active within the ÖSS-financed project UPPBASER, and thus create a Södertörn University Baltic Sea palaeoecological research group.

The application was favorably evaluated, and the project started 1:st of January 2015.

### 2. The three most important results of the project and what conclusions can be drawn from them

**Resurrection of millenia old diatom resting spores (Sanyal et al. 2019).** Sediment from IODP core M0063 from the Landsort Deep was used to resurrect preserved ancient diatom resting spores of the genus *Chaetoceros*. We show for the first time revival, viability and germination rates of up to ca 6600 years old resting spores. Based on the morphology of the resting spores as well as the germinated vegetative cells we were able to identify the species as *Chaetoceros muelleri* var. *subsalsus*. Conclusions: It will be possible to examine



the genetic diversity and mechanisms of evolutionary changes in *Chaetoceros* populations across evolutionary timescales from the time the Baltic Basin became brackish about 8500 years ago. Revived *Chaetoceros* resting spores can be used to increase the understanding of the evolutionary fate of natural populations on a temporal scale by performing population genomic studies in changing environmental conditions like salinity and increased nutrient discharge caused as a response to climate change and human impact.

**Separating the effect of climate change and anthropogenic nutrient input on the Baltic Sea (van Wirdum et al., 2019; Warnock et al., 2019; Andrén et al., 2020; Norbäck Ivarsson et al., in manus).** Multiproxy studies with emphasis on changes in diatom species assemblages have been used to assess the importance of natural climate driven changes in the Baltic Sea ecosystem from the onset of brackish water conditions about 8500 years ago compared to ongoing climate warming and anthropogenic impact. We present the first decadal resolved record of a quantitative diatom-based salinity reconstruction from the Little Belt region and can further show that the surface water conditions during Medieval Climate Anomaly (MCA) in the open Baltic proper were more marine. Our data support that a warm and dry climate induced the extensive hypoxic areas in the open Baltic Sea during the MCA, which makes the hypothesis that it was caused by early human impact less likely. Further, there are no synchronicity between changes recorded the last hundreds of years in coastal and open Baltic settings, and local human impact in the coastal zone result in various onset of anthropogenic eutrophication. In the open Baltic Sea diatom species composition show clear signs of changes from 1975 due to climate warming. Conclusions: Our results emphasize the impact of natural climate forcing on the development of hypoxic conditions in the Baltic Sea. Although human-induced eutrophication is likely the most important forcing factor of the current spreading of hypoxia, future changes in salinity and productivity induced by both naturally and anthropogenically forced climate dynamics, can be of similar importance. Hence, a good understanding of such climatic processes is of importance when designing action plans to improve the status of the Baltic Sea ecosystem.

**An ice-free event during Marine Isotope Stage (MIS) 3 in the southern Baltic Sea (Andrén et al., 2015).** One of the intriguing findings within the project is the occurrence of an organic sediment sequence in the cores from southern Baltic Sea basin. In the core from Hanö Bay it represent a littoral facies and the core from Bornholm Basin a deep water facies and the stratigraphic position of the organic sequence in the Hanö Bay core may indicate that the sequence was deposited in a waterbody with its shores located c. 60 m below the present sea level. This sequence separates two lithological different varved glacial clays and is dated by radiocarbon to  $45\,700 \pm 1500$  years before present. This age indicates that the organic sequence was deposited during MIS 3 and that the front of the Scandinavian Ice Sheet prior to c. 45 700 years before present retreated to a position north of the southern Baltic Sea. The icesheet did not during the subsequent readvanced remove or disturb the soft organic sequence but only deposited the upper sequence of varved glacial clay during its final retreat. These information's taken together indicate a highly dynamic behavior of the front of the icesheet which may be the result of an icesheet advancing partly floating on water.



### 3. The project's contribution to the international research frontline

Our study on resurrected diatom resting spores has led to a huge interest from the research community and new collaborations have been initiated with scientist around the Baltic Sea (see below). Simultaneously there is also an expanded interest for ancient DNA preserved in the Baltic Sea sediment archive and need of the kind of paleoecological data we provide.

Collaboration has been initiated with Anke Kremp, Leibniz Institute for Baltic Sea Research Warnemünde, in the project “Predicting the future from signatures of the past: using living sediment archives and ancient DNA to understand responses of marine primary producers to environmental change” (PHYTOARK).

Another ongoing collaboration started 2020 with Eric Capo (Umeå University) and Anders Andersson (KTH Royal Institute of Technology) in the pilot project “Adapted or replaced? Understanding the freshwater-to-brackish transition of the Baltic Sea microbiome by ancient DNA analysis”. This project study how the transition of the Baltic Sea from freshwater to brackish conditions c. 8,000 years (the so called Ancylus Lake – Littorina Sea transition) shaped the genomes of the microbial lineages composing the modern Baltic Sea microbiome.

### 4. New research questions that the project has led to

- One of the most important results of the project was the germination of ancient resting spores of the diatom taxon *Chaetoceros muelleri*. This finding resulted in an application to The Foundation for Baltic and East European Studies which got funded 2020-2023 “REVIVE - Genomic signatures of diatom evolution on revived diatoms from natural archives (No. 42/19, PI Anushree Sanyal)”. In this project genetic changes in sediment revived diatom populations from the open Baltic Sea will be studied. The research will provide insights into diatom evolution over long time and help us predict the evolutionary response and adaptation of species to environmental changes. Genetic markers will be identified which can be used to detect the signals of environmental stress from climate (salinity) and excess nutrients (light conditions).
- There is a contradiction between our paleoenvironmental results from the western Gotland Basin and modelling data which show fresher conditions in the Baltic Basin during the MCA and too high oxygen levels in the bottom waters to develop the extended hypoxia recorded in deep bottoms during Medieval times. We suggest instead that massive flux of diatom shade flora (especially *Pseudosolenia calcar-avis* which seem to be a keystone taxon) promoted by warm and dry climate (higher salinity and thermal stratification) reinforced by cyanobacterial blooms and nitrogen fixation, increased carbon sequestration to the sediments by diatoms due to extended length of the growing season, which made it possible to get high primary productivity and hypoxia during MCA despite oligotrophic conditions. It would be interesting to go further and test this hypothesis in oceanographic models. Further, we need to expand the study and examine the relationship between climate warming and the diatom species composition (and if *Coscinodiscus granii* plays the same keystone role as carbon fixer today as *Pseudosolenia calcar-avis* did during MCA) in more than one site.
- On behalf of the Swedish Agency for Marine and Water Management (HaV) a pilot study was carried out to review how palaeodata and longer historical perspectives had potential to contribute to sustainable coastal marine management (Hornborg et al., 2021, <http://urn.kb.se/resolve?urn=urn:nbn:se:ri:diva-52981>). We see a tremendous potential in using the knowledge learned from the past when governing the Baltic Sea



environment. How can our palaeodata, which provide the range of natural variation and the speed and trajectories of change, be featured to be of use for marine management practitioners?

- The ice-free event in the southern Baltic Sea and the geographic extension of the waterbody the organic sequence was deposited in. Furthermore, the dating of the sequence needs to be refined to better constrain the age of the sequence and how long the waterbody existed in southern Balt Sea during MIS 3. Analyses of the fossil pollen content will provide information on climatic conditions at the time of the deposition of the sequence and geochemical analyses can provide even more information on the environmental conditions in the vicinity of the southern Balti Sea. This research will be carried out as a co-operation between researchers at Södertörn University, Lund University and Christian-Albrechts-Universität zu Kiel, Germany.

### **5. The contribution of the research to the knowledge of the Baltic Sea Region and Eastern Europe**

The research and the results produced within the project is primarily of interest for the countries facing the Baltic Sea. The gained information on e.g. the seas sensitivity to external forcing such as excessive input of nutrients and climate forcing is of outmost importance for the environmental authorities in all Baltic Sea countries. Knowledge of the environmental history of the Baltic Sea is essential for making wise decisions on actions for protecting, preserving, and hopefully keeping our unique semi-enclosed sea as healthy as possible.

The Black Sea and The Caspian Sea are unfortunately facing similar severe environmental problems as the Baltic Sea and we therefore envision that the results produced within the project are of interest also for decisionmakers in the countries facing those two seas.

### **6. Dissemination of the results of the project within and outside the research community**

#### **Scientific articles**

(CI=Citation index, 2021-04-29)

**Andrén, T.**, Jørgensen, B.B., Cotterill, C., Green, S., and the IODP Expedition 347 Scientific Party, 2015: IODP Expedition 347: Baltic Sea basin paleoenvironment and biosphere. *Scientific Drilling*, 20:1–12. **OA** <http://dx.doi.org/10.5194/sd-20-1-2015>. (CI=16)

Hardisty, D.S., Riedinger, N., Planavsky, N.J., Asael, D., **Andren, T.** & Jorgensen, B.B., and Lyons, T.W., 2016: A Holocene history of dynamic water column redox conditions in the Landsort Deep, Baltic Sea. *American Journal of Science*, 316(8):713–745. [doi.org/10.2475/08.2016.01](https://doi.org/10.2475/08.2016.01). (CI=32)

O. Hyttinen, A. T. Kotilainen, J. J. Virtasalo, P. Kekäläinen, I. Snowball, S. Obrochta & **T. Andrén**, 2016: Holocene stratigraphy of the Ångermanälven River estuary, Bothnian Sea. *Geo-Marine Letters* 1-16, Springer doi:10.1007/s00367-016-0490-2. (CI=11)

Obrochta, S. P., **Andrén, T.**, Fazekas, S. Z., Lougheed, B. C., Snowball, I., Yokoyama, Y., Miyairi, Y., Kondo, R, Kotilainen, A. T., Hyttinen, O. & Fehr, A., 2017: The undatables: Quantifying uncertainty in a highly expanded Late Glacial-Holocene sediment sequence recovered from the deepest Baltic Sea basin—IODP Site M0063.



- G<sup>3</sup>/Geochemistry, Geophysics, Geosystems*, 18, 1-14. **OA** <http://doi.org/10.1002/2016GC006697>. (CI=26)
- van Helmond, N.A.G.M., Quintana Krupinski, N.B., Lougheed, B.C., Obrochta, S.P., **Andrén, T.** & Slomp C.P., 2017: Seasonal hypoxia was a natural feature of the coastal zone in the Little Belt, Denmark, during the past 8 ka. *Marine Geology*. doi.org/10.1016/j.margeo.2017.03.008. (CI=15)
- Kotthoff, U., Groeneveld, J., Ash, J. L., Fanget, A.-S., Krupinski, N. Q., Peyron, O., Stepanova, A., Warnock, J., Van Helmond, N. A. G. M., Passey, B. H., Clausen, O. R., Bennike, O., **Andrén, E.**, Granoszewski, W., **Andrén, T.**, Filipsson, H. L., Seidenkrantz, M.-S., Slomp, C. P., and Bauersachs, T. 2017: Reconstructing Holocene temperature and salinity variations in the western Baltic Sea region: a multi-proxy comparison from the Little Belt (IODP Expedition 347, Site M0059), *Biogeosciences*, 14, 5607-5632. **OA** <https://doi.org/10.5194/bg-14-5607-2017>, 2017. (CI=17)
- Warnock, J. P., Bauersachs, T., Kotthoff, U., Brandt, H.-T., **Andrén, E.** 2018: Holocene environmental history of the Ångermanälven Estuary, northern Baltic Sea. *Boreas* 47, 593-608. doi.org/10.1111/bor.12281 (CI=12)
- Stepanova, A., Obrochta, S., Quintana Krupinski, N.B., Hyttinen, O., Kotilainen, A. & **Andrén, T.**, 2019: Late Weichselian to Holocene history of the Baltic Sea as reflected in ostracod assemblages. *Boreas*. doi.org/10.1111/bor.12375. ISSN 0300-9483 (CI=6)
- van Wirdum, F, Andrén, E,** Wienholz, D, Kotthoff, U, Moros, M, Fanget, A-S, Seidenkrantz, M-S and **Andrén, T.**, 2019: Middle to Late Holocene Variations in Salinity and Primary Productivity in the Central Baltic Sea: A Multiproxy Study from the Landsort Deep. *Frontiers in Marine Science* 6:51. **OA** [https://doi: 10.3389/fmars.2019.00051](https://doi.org/10.3389/fmars.2019.00051). (CI=7)
- Mhatre S. S, Kaufmann S., Marshall I. P. G., Obrochta S., **Andrén T.**, Jørgensen B. B., and Lomstein B. A., 2019: Microbial biomass turnover times and clues to cellular protein repair in energy-limited deep Baltic Sea sediments. *FEMS Microbiology Ecology*, 95, 2019, doi: 10.1093/femsec/fiz068. (CI=3)
- Norbäck Ivarsson L, **Andrén T**, Moros M, Andersen T J, Lönn M and **Andrén E**, 2019: Baltic Sea Coastal Eutrophication in a Thousand Year Perspective. *Frontiers in Marine Science* 7:88. **OA** [https://doi: 10.3389/fenvs.2019.00088](https://doi.org/10.3389/fenvs.2019.00088). (CI=6)
- Warnock, J., **Andrén, E.**, Juggins, S., Lewis, J., Ryves, D. B., **Andrén, T.** and Weckström, K. 2019: A high-resolution diatom-based Middle and Late Holocene environmental history of the Little Belt region, Baltic Sea. *Boreas*. doi.org/10.1111/bor.12419. (CI=3)
- Jørgensen B. B., **Andrén, T.** and Marshall, I.P.G., 2020: Sub-seafloor biogeochemical processes and microbial life in the Baltic Sea. *Environmental Microbiology* 22(5). **OA** [https://doi:10.1111/1462-2920.14920](https://doi.org/10.1111/1462-2920.14920). (CI=2)
- Andrén, E., van Wirdum, F.,** Norbäck Ivarsson, L., Lönn, M., Moros, M. and **Andrén, T.**, 2020: Medieval versus recent environmental conditions in the Baltic Proper, what was different a thousand years ago? *Palaeogeography, Palaeoclimatology, Palaeoecology*, 555. **OA** <https://doi.org/10.1016/j.palaeo.2020.109878>.
- Bathmann, U., Schuber,t H., **Andrén, E.**, Tuomi, L., Radziejewska, T., Kulinski, K. and Chubarenko, I. 2020. Editorial: Living Along Gradients: Past, Present, Future. *Frontiers in Marine Science*. 6:801. **OA** [https://doi: 10.3389/fmars.2019.00801](https://doi.org/10.3389/fmars.2019.00801)



Hyttinen, O., Quintana Krupinski, N., Bennike, O., Wacker, L., Filipsson, H. L., Obrochta, S., Jensen, J. B., Lougheed, B., Ryabchuk, D., Passchier, S., Ian Snowball, Herrero-Bervera, E., **Andrén, T.** & Kotilainen, A: Deglaciation dynamics of the Fennoscandian Ice Sheet in the Kattegat, the gateway between the North Sea and the Baltic Sea Basin. *Boreas*. [doi.org/10.1111/bor.12494](https://doi.org/10.1111/bor.12494). (CI=3)

### **Papers in progress**

**Andrén, T.**, Norbäck Ivarsson, L., **Andrén E.**: Radiocarbon dating of Late Holocene Baltic Sea coastal sediments – potential and pitfalls. To be submitted to *Boreas*.

Sanyal, A, Larsson, J, **van Wirdum, F**, **Andrén, T**, Moros, M, Lönn, M, **Andrén, E**: Not dead yet: Diatom resting spores can survive in nature for several millennia. bioRxiv. doi: <https://doi.org/10.1101/285122>

Norbäck Ivarsson L, Lönn M, **Andrén T**, and **Andrén E**: Exploring palaeoecological trends since 500 CE: a comparison between coastal and open Baltic Proper

### **Abbreviations used:**

IODP=2003-2013 Integrated Ocean Drilling Program. Since late 2013 Ocean Discovery Program.

ECORD=European Consortium for Ocean Research Drilling

EGU=European Geoscience Union

GEOTEC=Svenska Borrentreprenörers Branschorganisation

### **IODP publications**

#### ***Scientific Prospectus***

**Andrén, T.**, Jørgensen, B.B., and Cotterill, C., 2012. Baltic Sea Basin Paleoenvironment: paleoenvironmental evolution of the Baltic Sea Basin through the last glacial cycle. *IODP Scientific Prospectus*, 347. **OA** <http://doi:10.2204/iodp.sp.347.2012>. (CI=8)

#### ***Preliminary Report***

Expedition 347 Scientists, 2014. Baltic Sea Basin Paleoenvironment: paleoenvironmental evolution of the Baltic Sea Basin through the last glacial cycle. *IODP Preliminary Report*, 347. **OA** <http://doi:10.2204/iodp.pr.347.2014>. (CI=8)

#### ***Proceedings volume***

**Andrén, T.**, Jørgensen, B.B., and Cotterill, C., and the Expedition 347 Scientists, 2015. *Proceedings IODP, 347*: College Station, TX (Integrated Ocean Drilling Program). **OA** <http://doi:10.2204/iodp.proc.347.2015>. (CI=16)

#### ***Co-chief's report***

**Andrén, T.** & Jørgensen, B., B., 2014: IODP Expedition 347: Baltic Sea Paleoenvironment. Paleoenvironmental evolution of the Baltic Sea Basin through the last glacial cycle. Presented at ECORD Review Meeting on Exp. 347 at Aix-en-Provence, November 2014. 24 p.

**Books**

Snoeijs, P. & **Andrén, E.** 2017. Why is the Baltic Sea so special to live in? In: Biological Oceanography of the Baltic Sea. Eds P. Snoeijs-Leijonmalm, H. Schubert & T. Radziejewska. Springer Netherlands. Pp. 23-84. DOI: 10.1007/978-94-007-0668-2\_2 (CI=49)

Weckström, K., Lewis, J.P, **Andrén, E.**, Ellegaard, M., Rasmussen, P., Ryves, D.B. & Telford, R. 2017. Palaeoenvironmental History of the Baltic Sea: One of the Largest Brackish-Water Ecosystems in the World. In: Applications of Paleoenvironmental Techniques in Estuarine Studies. Eds K. Weckström, K.M. Saunders, P.A. Gell, C.G. Skilbeck. Springer Netherlands, pp 615-662. DOI: 10.1007/978-94-024-0990-1\_24. (CI=13)

**Popular science articles**

**Andrén, T.**, Jørgensen, B.B., Cotterill, C., and Morgan, S., 2012: IODP Expedition 347: paleoenvironmental evaluation of the Baltic Sea Basin through the last glacial cycle. *ECORD Newsletter*, 19, 14–16.

**Outreach (a brief summary)**

Thomas Andrén gave several presentations and interviews during the onshore science party when the cores were opened in Bremen 2014 to both press, radio, and television for example to the BBC. <https://www.bbc.com/news/science-environment-27110880>

Thomas Andrén participated in a preconference and gave presentations to journalists during the EGU meeting in Vienna 2014.

Based on an interview given by Thomas Andrén forskning.se published a short article on IODP Expedition 347 in 2014. <https://www.forskning.se/2014/02/14/borrkarnor-som-ska-kartlagga-ostersjons-miljoutveckling-oppnade/>

Thomas Andrén gave a presentation at Forskartorget during the Bookfair in Gothenburg 2014. [http://forskartorget.se/wp-content/uploads/2014/08/forskartorget\\_2014\\_low.pdf](http://forskartorget.se/wp-content/uploads/2014/08/forskartorget_2014_low.pdf)

Thomas Andrén was invited to give a presentation on the IODP project during GEOTEC's yearly meeting 2014. The presentation resulted in a subsequent interview published in the magazine "Borrsvängen". [http://geotec.se/wordpress/wp-content/uploads/2015/03/borrsvangen\\_nr4\\_2014\\_WEBB.pdf](http://geotec.se/wordpress/wp-content/uploads/2015/03/borrsvangen_nr4_2014_WEBB.pdf)

Thomas Andrén was interviewed by SVT Nyheter/Skåne in 2014. <https://www.svt.se/nyheter/lokalt/skane/ostersjons-klimathistoria-skrivs-om>

Thomas and Elinor Andrén was interviewed by Natursidan in 2016 on the IODP Expedition 347. The interview and the resulting article were published online in 2017. <https://www.natursidan.se/nyheter/nordeuropas-klimathistoria-kartlaggs-i-internationellt-borrprojekt/>

Elinor Andrén participated in Researchers Night (Forskarfredag), exhibition for the school children at Södertörn University, September 29, 2017

Elinor Andrén had the Researchers podcast of the month at Södertörn University, September 2017: <https://soundcloud.com/sodertornshogskola/elinor-andren>



Thomas Andréns four articles on the geological history of the Baltic Sea published in HavsUtsikt and the summary of them are still among the top 100 hits at Havet.nu.  
<https://www.havet.nu/?d=181>

Elinor Andrén invited to hold an open lecture and interview at Folkuniversitetet in Visby, February 19 2018: <https://www.youtube.com/watch?v=-u1WUMg5jyU>

<https://www.youtube.com/watch?v=0O2jtdzB8tE>

Elinor Andrén interview Radio P4 Gotland, broadcasted February 19 2018:  
<https://sverigesradio.se/sida/artikel.aspx?programid=105&artikel=6890322>

Elinor Andrén invited keynote speaker Briggen Tre Kronors autumn seminar, September 5, 2018:  
<http://www.briggentrekronor.se/uncategorized/program-2018-hallbarahavsem/>

[https://www.youtube.com/watch?time\\_continue=29&v=NJOAhK6gRUK](https://www.youtube.com/watch?time_continue=29&v=NJOAhK6gRUK)

Elinor Andrén nominated to one of Swedens coolest researchers by The International Science Festival in Gothenburg: <https://www.youtube.com/watch?v=SVEoO0grZpo>

Elinor Andrén have a conversation with the journalist Per Grankvist in the podcast Perspektiv:

[https://open.spotify.com/episode/2v9JIDj6ax9j9nEerKO6YJ?si=pWEICqGbRyqvZoDstvoL2A&utm\\_source=facebook&utm\\_medium=feed&fbclid=IwAR3yqbZDXU394szIQTItiGtxvY\\_GEntruRWS8FWMtcCJ20YuTxLY1\\_dSb8](https://open.spotify.com/episode/2v9JIDj6ax9j9nEerKO6YJ?si=pWEICqGbRyqvZoDstvoL2A&utm_source=facebook&utm_medium=feed&fbclid=IwAR3yqbZDXU394szIQTItiGtxvY_GEntruRWS8FWMtcCJ20YuTxLY1_dSb8)

Thomas Andrén acted as scientific advisory in 2019 for the paleoceanographic maps of the Baltic Sea at Baltic Sea Science Centre, Skansen, Stockholm. He also took part in the official opening of the Centre.

Thomas Andrén gave a presentation on the long geological history of the Baltic Sea in the Berwald Hall during the Baltic Sea festival in 2019.

<https://www.berwaldhallen.se/ostersjofestivalen-2019/sondag-25-augusti/>

Thomas Andrén was scientific expert in 2019 when Trelleborg's museum produced paleogeographic maps of the Baltic Sea for an archeological exhibition.

Finally, it should be noted that still in 2021 an Internet search on the two applicants, Thomas, and Elinor Andren, combined with IODP Exp 347 returns 32 pages of hits and in almost all of them are Södertörn university mentioned.

### **Papers presented and presentations given**

Thomas Andrén was invited to give a keynote presentation entitled "The Baltic Sea IODP Expedition 347 Baltic Sea Paleoenvironment" at the 31<sup>st</sup> Nordic Geological Winter Meeting in Lund, Sweden, January 2014.

Thomas Andrén was invited to give a presentation entitled "The Baltic Sea IODP Expedition 347 Baltic Sea Paleoenvironment - preliminary results from the cruise" in the session Euro Forum: Major achievements and perspectives in scientific ocean and continental drilling" (co-organized by IODP-ICDP ) at the EGU General Assembly, Vienna, Switzerland, May 2014.

### **Conferences organized**

Thomas Andrén (together with Martin Jakobsson, Stockholm University) arranged and chaired the Marine Geological session during the 32<sup>nd</sup> Nordic Geological Winter Meeting,





Helsinki, Finland, January 2016. Thomas Andrén also gave two oral presentations at the meeting.

Thomas Andrén arranged the 14<sup>th</sup> Colloquium on Baltic Sea Marine Geology, September 2018 at Södertörn University. The colloquium was opened by the Vice Chancellor of Södertörn University Gustav Amberg. Senior researcher Boris Winterhalter gave a keynote presentation entitled “How it all came about – the colloquia”. The meeting was attended by participants from Denmark, Estonia, Finland, Germany, Lithuania, Poland, Russia, and Sweden. Financial support was received from The Centre for Baltic and East European Studies (CBEES) at Södertörn University.

Elinor Andrén organized the 24<sup>th</sup> Nordic Diatomists Meeting at Södertörn University and Tovetorp research station in April 23-26, 2019. The meeting was partly funded by grants from The Wenner-Gren Foundations and Centre for Baltic and East European Studies (CBEES). Invited keynotes/workshops were presented by Professor Bart Van de Vijver, University of Antwerp, entitled “Exiting, raphelless and difficult: *Staurosira*, *Staurosirella* and *Pseudostaurosira*”, and Associate professor Richard J. Telford, University of Bergen entitled “Numerical methods for (palaeo) ecology”. The conference attracted participants from Sweden, Finland, Norway, Estonia, Lithuania, The Netherlands, and Belgium