

**Review on Ph.D. thesis by Tomáš Bešta, “*Diatom analysis of the late Quaternary sediments from the area of the Czech Republic*”, defended in the University of South Bohemia in České Budějovice, Faculty of Science.**

**(Ph.D. specialization: Botany)**

The assessed Ph.D. thesis consists of four original papers, two already published in high-quality journal (*Hydrobiologia*, IF=1.99), while others two are submitted in the manuscript form. The candidate contributed to these interdisciplinary papers by diatom analyses, diatom data processing and interpretations and, in most cases, by writing the manuscript. He apparently conceived many ideas contained in the papers. I am entirely convinced that *Tomáš Bešta* is an excellent, critically thinking taxonomist and hydrobiologist – the prerequisite that is crucial for further application of diatom method in palaeoecology.

Despite the fact that diatoms are much utilized proxy in palaeoecological studies of past aquatic environments (Quaternary, as well as pre-Quaternary ones), the development of this discipline in the Czech Republic is so far insufficient due to historical reasons. The current efforts of *Tomáš Bešta* give hope that this unsatisfying local situation may improve in the foreseeable future.

#### General criticism:

Despite the obvious fact that the underdeveloped state of the discipline in the Czech Republic requires descriptive pilot studies, I would expect from Ph.D. thesis more targeted, question-oriented approach. Moreover, the submitted set of (rather descriptive) papers gives somewhat heterogeneous impression. The main subject that holds the writing together are diatoms themselves, while hypotheses and questions to be answered are generally underrated to my view.

On the other hand, I very much appreciate introductory discussion on the advantages and limitations of *transfer functions* (that are based on modern “training sets”) and of the use of empirically determined *environmental indices* in palaeoecological reconstructions (pages 4 – 10). I agree that such a “tool sharpening” is crucial, as the time-transgressive behaviour of the studied systems - from relatively simple diatom communities to complex ecosystems - is presumably non-linear and thus sensitive to input parameter adjustments.

What I miss in the Introduction chapter, as well as in the individual papers, is another important discussion: One that would concern the taphonomy of the studied diatom thanatocenoses. (See the essential difference between *biocenoses* that we deal with in actuoecology and *thanatocenoses* of palaeoecology). To give an example: Isn't it possible, that somewhere in a shallow, littoral micro-habitat some thermophilous diatom community develops during the maximum vegetation (summer) season, and, subsequently, the dead

frustules are washed into the main basin via erosion processes (accelerated by e.g. winter ice)? How seriously this would affect our ability to reconstruct past macro-climates from diatom thanatocenoses, which were obtained from a sediment core in a lake profundal *versus* sublittoral *versus* littoral zones? Analogically, we may speculate about these effects for the case of nutrients, pH, salinity, etc. Diatoms are short-living organisms and thus the role of micro-habitat dynamics must not be negligible to my view.

Specific criticism:

(1) page 8: "... 'Something happened, but we do not know why and what does it mean'. Maybe this is the most straightforward approach to palaeolimnological research and a very good starting point to better understand our interpretations of past (recent) reality."

Isn't such a statement little bit too nihilistic? Or, is this an irony?

(2) pages 10 and 11, parts concerning the existence of a time lag in the response of diatom communities to climatic changes.

I miss more detailed and sophisticated discussion on this controversial subject. I do not entirely agree with the notion (although only rather vaguely expressed) that the reaction of diatom communities to climatic changes is straightforward compared to pollen data that "are more linked with succession and migration patterns". Isn't the aquatic environment partly driven by the development of vegetation and soils in the catchment? Isn't this development successive, long-term and often complicated?

(3) page 13: "...The current division of the LGIT based on sediments from the CR is less clear. Differentiation of the Bølling interstadial is almost impossible. ..."

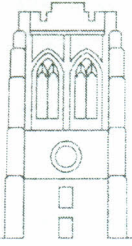
May be, but see Hošek *et al.* (2014), *Palaeogeography, Palaeoclimatology, Palaeoecology* 396:155-172.

Reviewer's recommendation to the Examination Committee:

The candidate, *Tomáš Bešta*, has demonstrated by his thesis abilities for serious scientific career. Therefore I do recommend his work to the defence in order to obtain Ph.D. title.



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J O H N C A R R O L L U N I V E R S I T Y  
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To Whom It May Concern:

**Review of the Ph.D. thesis of Tomáš Bešta, entitled: *Diatom analysis of the Late Quaternary sediments from the area of the Czech Republic.***

The Ph.D. thesis of Tomáš Bešta demonstrates strong competencies in diatom identification and analysis, collecting of samples from fish guts, and the multivariate analyses associated with interpretation of paleolimnological diatom data from cores. The four papers are fairly independent efforts, having very different times frames, from the present (demonstration of fish gut diatom analysis), to the fishpond of a medieval Prague suburb, to the Holocene Climactic Optimum, and finally to the Last Glacial-Interglacial Transition 10,000-14,500 years before present. The work is sophisticated and modern, and this work together with the work that may follow from this candidate in years to come will be critical for understanding the recent (Late Quaternary) history of Central Europe. Three of the papers demonstrate excellent collaborative efforts, with diatoms, plant macrofossils, pollen, algae, and core chemistry being combined from several authors to produce a cohesive and congruent history. Mr. Bešta was responsible as lead author on three of the four papers, and played a significant role in the other. Two of these papers have been published (or are accepted) and two have been submitted. *Hydrobiologia* is an excellent, well-known journal with a good impact factor (IF=1.99). I consider this work to be of excellent quality, demonstrating clear competency and interpretive skills, and I especially like how the changes in pH and trophic status are linked to past climatic conditions. The work represents a significant contribution to paleolimnology. I enthusiastically support the acceptance of this thesis as meeting the requirements for the awarding of the doctoral degree.

**Introduction**

The general introduction was excellent. It gives a very good background on the use of diatoms in paleolimnology, so much so that I am considering using it as reading material for my Algae as Bioindicators class at John Carroll University. It covers the difference between using transfer functions to infer specific past conditions (pH, temperature, trophic status, total phosphorus, salinity, etc.) and indices that reflect natural and cultural eutrophication. There recently has been some controversy in this field caused by the publication of the paper by Steve Juggins (2013 - cited in the thesis). I felt the review of these methods was clear and reflected an understanding of very current trends in this field.

The second part of the introduction discussed what has been postulated by others about the Last Glacial-Interglacial Transition period, and was critical for my understanding of the chapters that followed. This part of the introduction demonstrated an understanding of the

complexity of trying to use records from around Europe to reconstruct climatic history that certainly differed by region. The prose is very clear, and I enjoyed Bešta's dry humor that occasionally comes through (the reference to Einstein's General Theory of Relativity was especially nice).

From the introduction, I have several related questions that I would like to ask the candidate:

Juggins (2013) has questioned the use of weighted averaging and transfer functions in using diatoms to reconstruct past conditions, and this study has likely had a chilling effect on the use of diatoms in paleolimnology. 1) What do you really think of this paper? 2) Do you agree with Juggins that diatoms cannot be used to reconstruct variables that do not directly drive the diatom community (e.g. temperature, water depth)? 3) How will you move forward in paleolimnological reconstructions given this critical paper?

**Paper I: Late Pleistocene-early Holocene transition recorded in the sediments of a former shallow lake in the Czech Republic.**

This paper gives an account of the paleolimnological history of a shallow lake existing during the LGIT period of fairly chaotic climatic transition from ice age to interglacial period. While this period has been examined from more western and northern European localities, this work represents the first paleoclimatic study using diatoms in the Czech Republic for this interesting time in recent earth history. The diatoms reveal changes that are consistent with what has been observed in other European localities, but the intensity of some climatic shifts were perhaps more pronounced in this region of central Europe than seen elsewhere (e.g. the Older Dryas). I like the integration of the plant macrofossil data in reconstruction of climatic shifts.

From this chapter I have a few questions for the candidate. 1) John Smol has demonstrated climatic warming in polar desert lakes in Canada using diatom communities with shifts in taxa. Does your lake show any similarities with what he has documented is occurring in recent times in these polar lakes? 2) Do you think your lake had near continuous ice cover during any of the history you have recovered with your cores?

**Paper II. The oldest Czech fishpond discovered? An interdisciplinary approach to reconstruction of local vegetation in mediaeval Prague suburbs.**

This paper is interesting because it looks at the sediment of a fishpond that filled in almost 1000 years ago in a region experiencing anthropogenic impacts. It documents changes in the plants communities surrounding the pond as the suburbs became settled, and the eventual loss of diatoms and fish as water quality became degraded by human waste. The work was very collaborative, and this is the one paper in which Mr. Bešta did not take a leading role, although his role was significant. I have no questions from this chapter.

**Paper III. Comparison of diatom community structure from epilithon and fish guts for future paleolimnological application.**

Reconstructing the paleohistory of streams and rivers is nearly impossible given the erosional nature of these aquatic systems. In North America, a few studies have come out which explore the use of diatoms in the guts of herbivorous or omnivorous fish to examine recent water quality. Many museums have very old collections of preserved fish, and the guts of these fish can be removed fairly nondestructively to the specimen and the diatoms extracted. Such samples are valuable because they often provide very exact dates of collection and places of collection.

They also are free of the problems of taphonomic processes that can be experienced in sediments. In this study, Mr. Bešta and his colleagues have examined the gut contents of three European species of fish (*Barbus barbus*, *Chondrostoma nasus* and *Squalius cephalus*) from three rivers in South Bohemia and compared the indices calculated from these samples with samples collected from epilithic diatom communities in the same sites. The researchers found that all three fish floras were similar in community structure, but that the species community recovered from fish guts was not very similar to the community composition in the epilithon. This implies that the fish are not feeding exclusively or majorly on the epilithon. However, the water quality indices calculated from the fish were similar to the indices calculated from the epilithon, a finding consistent with previous studies. The fish are excellent as samplers, but there is some decrease in their usefulness in rivers of elevated trophic status.

I have some questions from this chapter. 1) Is the candidate aware of significant fish collections in Czech museums and academies that could be used to examine past conditions in Czech rivers? 2) How old are some of the fish in these collections? Would it be possible to recover 200 years of history in some rivers? 3) What sorts of questions are interesting to the candidate that could be answered with this short-term reconstruction method?

**Paper IV. Middle Holocene development in the infralittoral zone of a shallow lake, Lake Komořany, Czech Republic.**


In this paper, Tomáš Bešta and his collaborators examine a core of a shallow lake that was drained in the 19<sup>th</sup> century. The study focuses on an undisturbed portion of lake sediment dating from 7,200 years BC to 2,100 years BC. This is another period that is climactically interesting in the Holocene, spanning the period of warm climate known as the Holocene climactic optimum. The influence of human events can be detected in the pollen record, particularly with the spread of *Corylus* (hazel) stimulated probably by intentional fires set by neolithic peoples. However, the authors did not detect an anthropogenic change in trophic status or pH in the lacustrine environment until near the end of the Eneolithic.

I have only one question from this study. 1) In the period specified as DAZ-3, littoral-living benthic species become quite common, whereas in DAZ-2 and DAZ-1 they are practically absent. What is the significance of this major shift in in the diatom communities of Lake Komořany?

In summary, I consider this an excellent body of work that fulfils all criteria for obtaining the Ph.D. degree. It demonstrates high competency, dedication to exhausting data collection, and uses accepted modern approaches in analysis of paleolimnological data.

**Final evaluation: I enthusiastically recommend the thesis by Tomáš Bešta for the award of Doctor of Philosophy (Ph.D.).**

Signed in České Budějovice on 9 June 2014



Prof. Jeffrey R. Johansen, Ph.D.