Introduction and reasons for attempting this research topic

Vipers represent iconic elements of herpetofaunas across most continents, including Europe. Due to their venomous bite that, for many species, can be lethal to humans and their broad geographic distribution that includes also habitats shared with dense human populations, vipers have "gained" a rather notorious reputation since centuries. As such, a lot of research has been conducted about their venom, physiology, behavior, reproduction, external morphology, and internal organ anatomy.

However, our understanding of the evolution and the fossil record of vipers is much limited, owing to the fact that their fossil remains are mainly represented by isolated (and often fragmentary) vertebrae, with articulated skeletons and skull remains being rather rare. Moreover, identification of fossil remains can usually be rather challenging because, for the majority of extant species of vipers, the cranial and vertebral morphology is virtually unknown. This limited knowledge of their fossil record and skeletal anatomy of extant taxa, has a tremendous impact on our understanding of the emergence and evolution of modern vipers. Still though, this, currently patchy and inadequate, fossil record attests for a much greater and fascinating diversity of vipers, particularly in Europe, including extinct species and extreme size ranges, which are not observed any more among the extant forms.

Project goal and description of research

With this NCN SONATA project, I aim to provide novel insights on the palaeontology of European vipers, focusing on their fossil record, evolution, taxonomy, and skeletal anatomy. In particular, I plan to describe abundant new fossil material of vipers (including giant forms) from different European localities, revise important fossil specimens and species that were described in the 19th century, and document the cranial and vertebral morphology of several extant viper species. I aim to study complete, beautifully preserved, fossil skeletons embedded on sediment with the aid of micro-computed tomography (μCT) scanning, a powerful and non-destructive technology that allows full 3D reconstruction of whole specimens, including skeletal parts that are otherwise not visible. This μCT technology will also be used to study the skeletal anatomy of several extant viper species, based on alcohol-preserved specimens from herpetological collections; such better understanding of the skull and vertebrae of extant species will allow more confident taxonomic determinations of the fossil material and a more accurate evaluation about the phylogenetic affinities of the extinct viper taxa from Europe.

Substantial results expected

I anticipate that studying and documenting this fossil and extant material will have a great impact on our understanding of the evolution of European vipers but also generally of the European ecosystems during the Neogene and Quaternary (18 million years ago to today). The description of the large and giant-sized fossil vipers in particular can have direct implications about the palaeoclimatic reconstruction of our continent some millions of years ago. Moreover, μCT scanning will provide significant anatomical data about extinct vipers and allow novel taxonomic interpretations about their affinities and phylogenetic relationships. In addition, the comprehensive and thorough evaluation of the skeletal anatomy of several extant viper species (not only from Europe, but also from Africa and Asia), will enable me to identify new diagnostic features on their skull and vertebrae, which can be applied to the European fossil specimens. All these new data will eventually permit a comprehensive approach and critical review of the European fossil record, systematics, and palaeobiogeography of vipers and thus decipher valuable information about the evolution of the most dangerous, but also among the most fascinating, snakes from our continent.