THE FOSSILS OF THE PESCIARA LAGERSTÄTTE (BOLCA, NORTHEASTERN ITALY): A STATISTICAL ANALYSIS

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Introduction

Bolca is a small town in northeastern Italy located in the Alpone Valley, at 852 m a.s.l., in the **Lessinia Regional Nature Park**. Bolca is well-known for its fossil deposits including fishes, plants, crustaceans, insects and jellyfish of Ypresian age, early Eocene (approximately 50 million years ago). *Fig. 1* shows the location of the main geosites, **Pesciara** and **Monte Postale***.

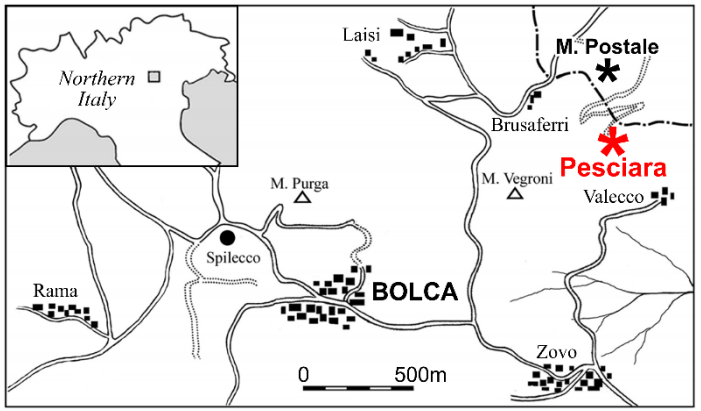


Fig. 1

The first reliable information on the Bolca fossils appears in a document from **1550** by Andrea Mattioli. In 1571, Francesco Calceolari exhibits some of the Bolca fishes in his private museum (*Fig. 2*). It is only two centuries later, in the late 1700s, that Count Giovanbattista Gazola gathers an important collection of Bolca fossils, which was subsequently described by Serafino Volta in his illustrated monograph *Ittiolitologia Veronese*.

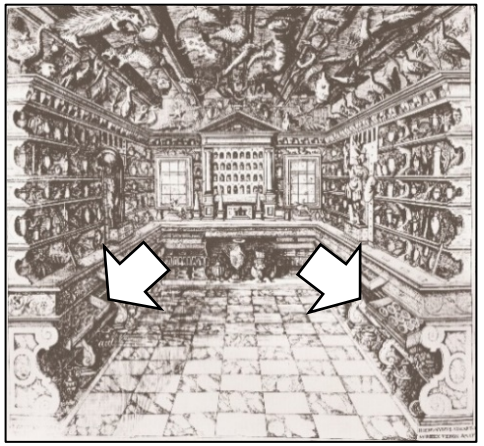


Fig. 2 – The Calceolari museum (print of 1622)

Soon, Bolca's fame spreads abroad: in 1797 Napoleon Bonaparte transfers about 600 fossils from Verona to Paris. In this period the **Cerato** family rented the "Maffei quarry", the future ***Pesciara*** (*Fig.3*). Since 1843, the Cerato family has passed down their fossil extraction methods through five generations.

Fig. 3 – The Pesciara geosite

Since the 2000s, funding from the Veneto Region and the Municipality of Verona allowed the Natural History Museum of Verona to conduct **new excavations** at the Pesciara site, in collaboration with some Italian universities and with the Lessinia Regional Nature Park.

* Pesciara and Monte Postale are the most important Ypresian *Fossil-Lagerstätten* in Italy, and arguably in the world. For this reason, they have been nominated for the **UNESCO** Tentative List of World Heritage Sites.

MATERIALS AND METHODS

The 2010 paleontological campaign at the **Pesciara** site involved approximately 2 m^3 of rock layers.
A series of surveys was conducted in order to secure the excavation site, both on the rock walls leading to the tunnel and in the tunnel itself. Excavation tools inlcuded sledgehammers, hammers and chisels of various sizes and shapes, metal wedges, percussion drill, levers, shovels, picks and a motorized wheelbarrow (*Fig. 4*).

As the investigations proceeded, useful information was retrieved for a subsequent paleoenvironmental investigation. For this purpose, **rock samples** were extracted from both sterile and fossiliferous layers.

Fig.4 – Workers at the Pesciara site

Fig.5 – Operations at Bolca's museum laboratory

Some of the fossils were damaged, and were therefore assembled in the nearby **laboratory** at the Museo dei Fossili di Bolca (*Fig. 5*). Subsequently, the restored specimens were transferred to the Natural History Museum of Verona for inventory and cataloging, and finally stored at the Geology and Paleontology Section where they remain available for researchers.

At the end of the paleontological campaign, the excavation area was protected and secured. The **topographic survey** was also updated in order to document the progress of the works, and at the same time to correlate the new stratigraphic data with the previous ones (*Fig. 6*).

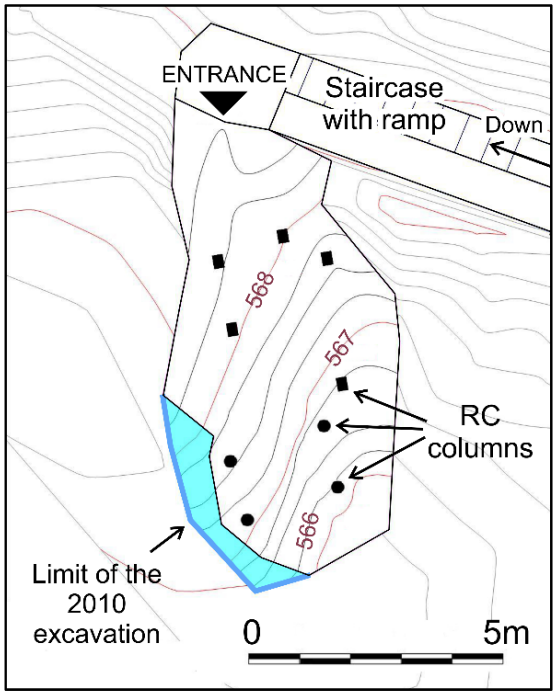


Fig.6 – Planimetry of the 2010 excavation

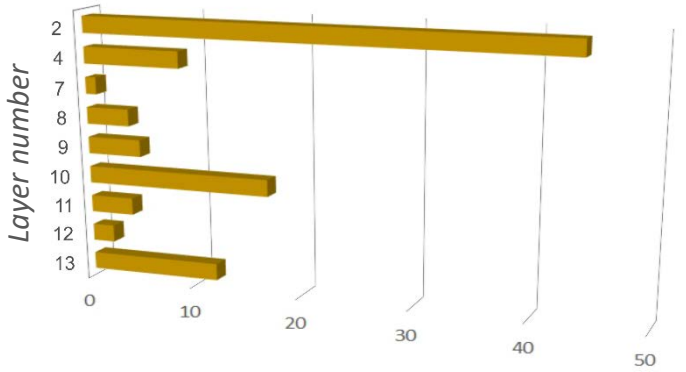
RESULTS (1)

The 2010 paleontological campaign at the Pesciara geosite involved a total of **thirteen strata**, nine of which contained macro-fossils and are described in this study *(Fig. 7)*.

The total thickness of the excavated succession is **140 cm**.

- ✓ The most fossiliferous layers are: Layer **2, 10** and **13** (*Fig. 7*)
- ✓ Highest fish abundance is found in Layer **2** (23 findings, *Fig. 8*)
- ✓ Greatest fish diversity is found in Layer **10** (6 families, *Fig. 8*)
- ✓ Layers **4** and **7** contain no fish (*Fig. 9*)
- ✓ All layers contain vegetal remains (terrestrial plants and/or algae, *Fig. 9*)

Fig. 7 – Total findings by layer



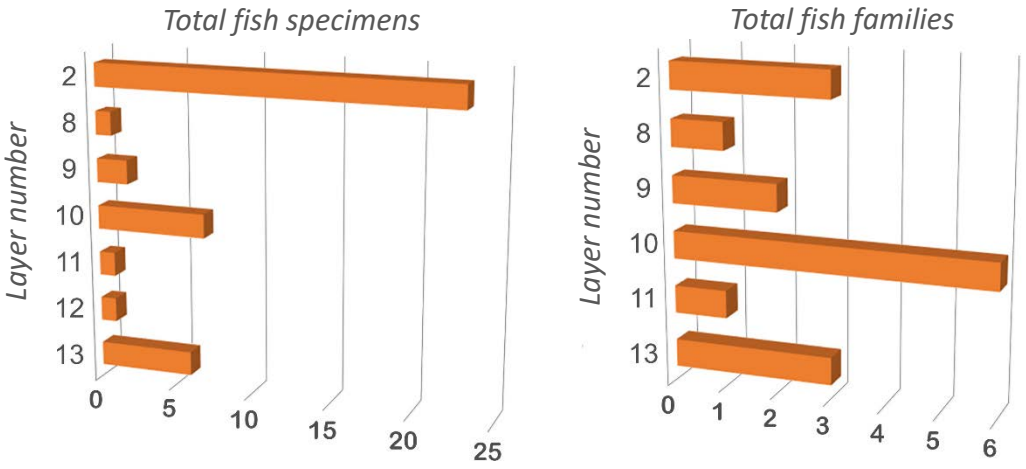


Fig.8 – Total fish specimens and total fish families by layer

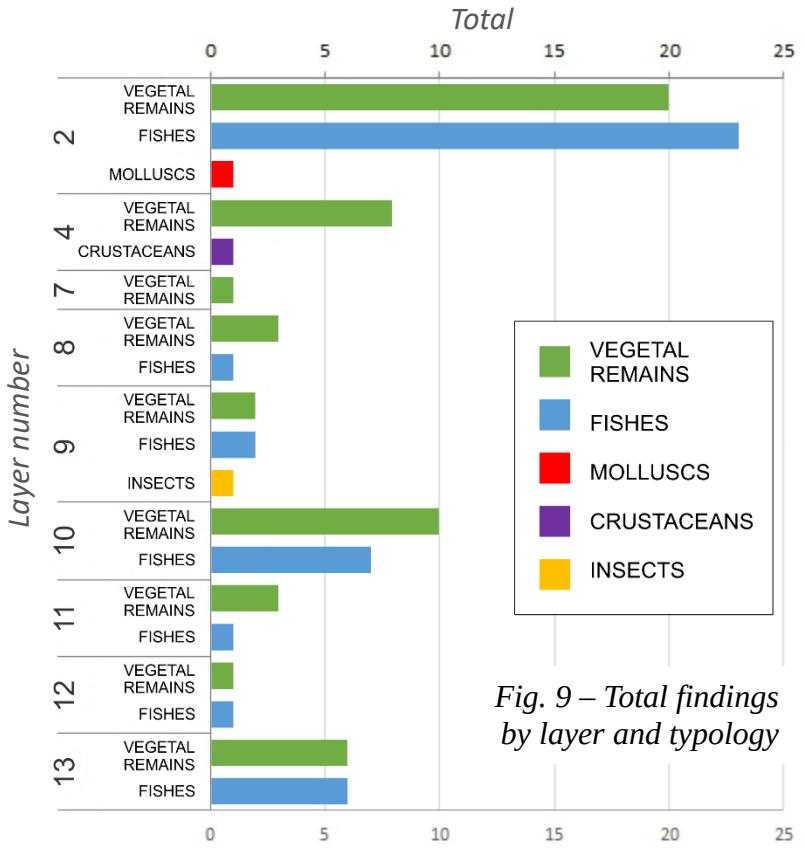


Fig. 9 – Total findings by layer and typology

RESULTS (2)

The 2010 excavations at the Pesciara site allowed to retrieve **98 fossil specimens** (145 including the counterparts). 42% of the findings are fish (*Fig. 10*).

- ✓ Fishes are represented by **10 different families** (*Fig. 11*)
- ✓ The most represented family is **Clupeids** (24 specimens, 59% of total fish) followed by Holocentrids, Sparids and Atherinids (*Fig. 11*)
- ✓ 12% of findings are **undetermined** (*Fig. 11*)

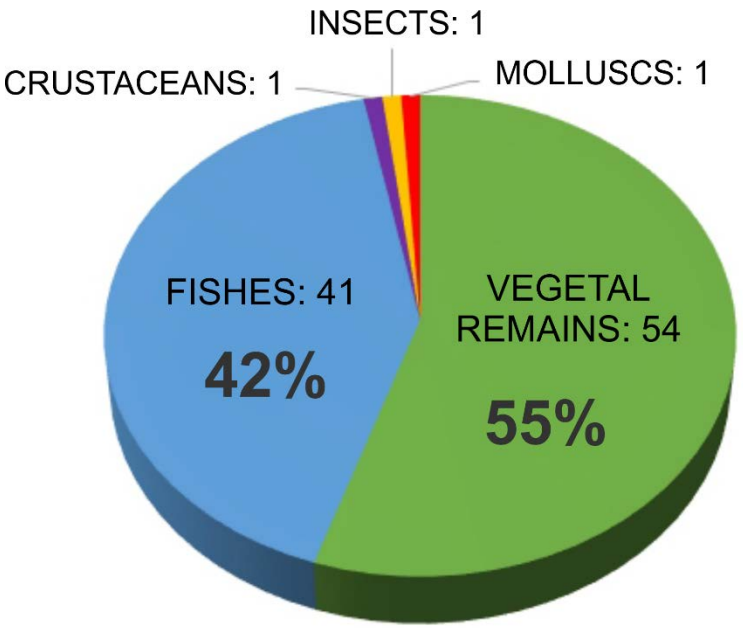


Fig. 10 – Type of findings

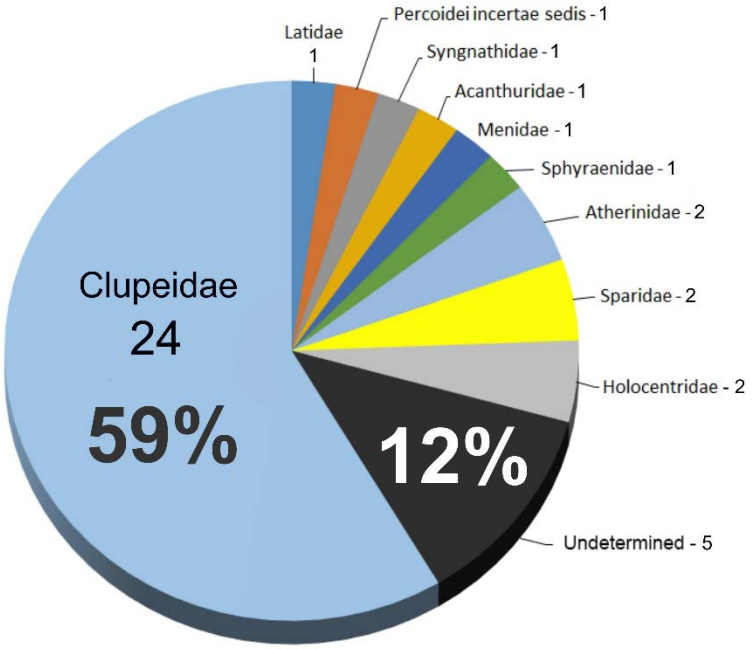


Fig. 11 – Total fish specimens by family

DISCUSSION AND CONCLUSIONS

The 2010 excavations conducted at Pesciara, supplemented with two coring and two geoelectric prospecting, allowed to significantly expand knowledge on the subsoil of the Pesciara and Monte Postale geosites. Knowledge on the paleoclimatic, paleoecological, paleobiogeographical and phylogenetic aspects of the Eocene faunas is of great importance for the reconstruction of the paleogeographic characteristics of the Tethys Ocean. It is no coincidence that the Bolca area, and more generally the Val d'Alpone, can be referred worldwide as "a type-territory for Eocene marine fauna".

Here we present the results of a statistical survey on the findings, especially fishes, of the 2010 paleontological campaign. The excavation, which affected the entire southern front of the Pesciara excavation site, revealed a total of 145 specimens, including the counterparts. These are mainly fishes, algae and land plants (*Fig. 12*), but also crustaceans, molluscs and insects. Our quantitative study allowed to identify the most fossiliferous layers, along with those with highest fish abundance and diversity.

This type of investigation will be applied to other excavation campaigns, in order to verify this early study. New excavations at Bolca are scheduled for the period 2020-2021.

Fig. 12 - Some of the fossils found at Bolca during the 2010 excavations at the Pesciara site: a. Mene rhombea, *b. terrestrial plant, c.* Pygaeus

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