Traces of Common Xylophagous Insects in Wood

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Atlas of Identification - Western Europe

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Foreword

A Professional Passion Turned into a Much-Needed Book

I was a student in wood science when I stumbled on wood-boring insects. I loved thinking, talking and studying about wood-boring insects. I even thought of a possible career in entomology. But the prospect of drilling deeper into a single academic field felt confining. So, I ended up building my academic career around the anatomy and ecology of plant stems. I do teach about these topics too. It was while teaching at an International Course on Wood Anatomy and Tree-Ring Ecology held in Switzerland that I met Magali Toriti. At that time she was a PhD student in archaeology supervised by Aline Durand. Both Magali and Aline were curious about some small circular holes in charcoal samples. But both didn't know if it was worth exploring further into them. Thus we compared the holes in the charcoal with the material available in the teaching slide collection. And we found similarities to traces from wood-boring insects. To further meet Magali scientific curiosity the expertise in entomology of Fabien Fohrer came into play. Some years later Fabien also attended the same course on Wood Anatomy. Once I got acquainted with both Magali and Fabien, I felt so fortunate to share their motivation in understanding wood-boring insects with my old passion for the topic. Together we spent much time collecting insects, looking at wood samples, cutting thin anatomical sections and learning from the microscope.

The result of these efforts is summarised in the *Traces of Common Xylophagous Insects in Wood. Atlas of Identification—Western Europe* which gathers the knowledge they collected over the past eight years of collaboration. The book, after presenting some distinctive biological features of various types of wood pests and introducing wood structure, details the life cycle of a wood-boring beetle and provides a guide to using the identification keys. Two identification keys are introduced. The first focuses on the galleries and faecal pellets of wood-boring insects and is useful for applications when the damaged piece of wood is still visible, such as a museum object. The second key describes the sole faecal pellets of wood-boring insects. It helps when the wood is completely decayed or not readily available, such as in archaeological wood. Later (chapter 3), the bulk of the book describes the most common xylophagous insects. They are described by family within the Coleoptera, Curculionidae, Lyctidae, Ptinidae, and Hymenoptera and Isoptera.

This book represents what I was desperately looking for at the beginning of my career: a guide for the beginner into the world of wood-boring insects. But the book is also a valid tool for the expert of the field looking for a comprehensive description of the problem of wood pests.

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Contents

Introduction

Wood-boring insects are natural pests of trees, stored wood or timber. In forests, they participate in the partial or total degradation of dead wood. Depending on the species, they can be major pests of forests, of a given woody species population, or even destroy museums and wooden heritage collections. As for wood, it is a key element of the economy and the environment, both past and present.

In Western Europe, fundamental works on wood anatomy and keys for determining the comparative anatomy of insects only emerged in the last 80 years. They described the great variability of the discriminating characteristics of wood (Huber and Rouschal 1954; Greguss 1955; Brazier and Franklin 1961; Jacquiot et al. 1973; Couvert 1977; Schweingruber 1990; Vernet et al. 2001; Ruffinatto and Crivellaro 2019) and in insects and other arthropods (Lepesme 1944; Bremond and Lessertisseur 1973; Hoffmann 1986; the XIXth c. Die Kafer Europas collection, or the fauna collections "Faune de France", "Fauna Iberica", "Fauna Italiana", *per* country (e.g. Berger 2012)).

The starting point of this book was the analysis of charred wood from an alpine archaeological Gallo-Roman site. The rural settlement, well preserved according to archaeological criteria, was burnt down in the third century AD. As a result, various wooden construction elements were preserved and with them numerous traces of wood-boring insects (galleries and frass). In the absence of elements from the adult insect(s), it was not possible to identify the agent(s) of such an infestation, which could affect *pro parte* more than a third of the structure. Within the community of bioarchaeologists, many have noticed these traces, noted as "holes" on both charred and waterlogged wood, but few have attempted to identify the insect(s) that bored them. Most of the time, the more or less hazardous conservation of archaeological woody heritage makes the task even more difficult. For example, the ship The Mary Rose, discovered in the 1960s, was infested by *Nacerdes melanura* from the 1990s, when she was stored in a wet warehouse (Pitman et al. 1993). It was only by comparing these archaeological traces with those of current insects, whose exact species are known, that identification was made possible.

For a decade now, various tests have been carried out to identify the traces left by larvae on/in the wood. These tests concern only a few large families of woodborers. Sometimes it is necessary to evaluate and quantify the damage caused by an insect to a structure before insecticide treatment, in particular by observing the number of flight holes and trying to identify them due to the absence of an adult individual. Within the museum environment, one of the rare cures used until the 1950s consisted of regular checks of the collections in order to limit damage. Subsequently, notably with the commercialisation of organo-chlorinated insecticides among others, and especially the awareness of their toxicity for humans, interest in and knowledge of wood-boring insects and lignivorous fungi increased, with the aim of better preserving the woody heritage while eliminating pest threat. Thus, beyond museums, these methods are opening up and adapting to different media (ancient carpentry *in situ*, organ pieces in a church, current furniture and architecture, underwater wrecks …). A few rare works (Gambetta 2010; Blanchette 1991; CTBA 1996; Bobadilla et al. 2015) or mentions (Lepesme 1944; Español 1992) underline the importance or specificity of the traces left by the larvae of wood-boring insects in the wood, i.e., galleries and larval dejections.

This book is based on the knowledge acquired by crossing over two disciplines, i.e., archaeology and heritage conservation-restoration. This crossover led to the creation of an original identification key, applicable to these two scientific fields. In addition to these two sectors, the key is also applicable to other fields: forest protection, wood industry and engineering, building and public works, or in the judicial field, for example in a dispute due to an infestation after or before property purchase. In the field of heritage conservation, insects damage works and buildings, making them a source of concern. In view of the diversity of species of wood-boring insects, their identification makes it possible to choose the best way to protect the object, structure, building, etc. Similarly, in forests, it is essential to know the causal agent of the decline of a woody population in order to better control it and face up with the situation.

There are currently more than 600 species of xylophagous insects in Western Europe. Each of these species preferentially colonises one or more woody species, whatever the context. Each of them usually has specific requirements, as insects do not attack any wood under any conditions: softwood or hardwood, coniferous or deciduous wood or both, standing wood,

dead wood, decaying wood or storage wood, in the presence of fungi or not, etc. Each one should therefore be studied on a case-by-case basis. To sum up, infestation can occur at the following times, ranked from the most ancient to the most recent one: when the wood is standing in full vigour, when it is diseased or freshly felled/dead, during a possible storage phase, when it is used as timber or as an object, when it is in advanced decomposition. In archaeology, infestation can be recorded after burying the remains and before archaeological investigations between two excavation campaigns or during excavation (if it rains a lot, for example, or if conditioning is bad), or even after the wooden remains have been conditioned. Then comes the heritage area with infestations during exhibitions or during the storage of works in collections.

This book is thus devoted to insects with a xylophagous diet, particularly in their larval state, more rarely in the adult state, as well as to some insects that perforate wood in order to nest (carpenter bees, ants, termites). Woodborers are insects whose larvae develop in woody plants and mainly belong to four main orders: beetles (capricorns, Ptinidae, bark beetles, weevils …), isopterans (termites), hymenopterans (*sirex*) and certain diptera such as the wood-cake beetle for example. In fact, all the insects that degrade wood and thus affect its mechanical properties are concerned. However, this excludes live-wood pests such as biting-sucking insects, phytophagous insects and most saproxylophagous insects such as chafers, which are more often found in litter or compost. A few other xylophagous insects belonging to beetles (such as certain buprestes, platypus) but also belonging to Lepidoptera (*Cossus cossus*, *Zeuzerina pyrina*, some Sessidae …) could not be studied. Consequently, they are not mentioned in this work and will be the subject of a later addition. Finally, marine woodborers, which are not insects but molluscs such as *Teredo navalis*, whose biology and ravages could be the subject of specialised and independent work, were also excluded.

The present work is primarily a practical tool to assist in the work of determining the indirect traces left by insect pests, i.e., galleries and frass. For this reason, it is largely based on the presentation of various anatomical sections of infested wood combined with the description of the indirect traces left by wood-boring insect larvae on their feeding material. Since its aim is to help preserve forests, buildings or objects, whether heritage ones or not, it is a means of gaining a better understanding and assessing the condition of a wood, structure, tree, forest, etc., and even of being able to reconstruct the environment and/or the context that led to this condition. This way, it helps in writing the history of the construction and deconstruction of buildings.

Because they are perfectly integrated into the forest ecosystem or the timber, it is essential to know the main biological characteristics of these insects (their diet, reproduction cycle, mode of action) in order to better prevent their multiplication and control them.

In addition, it is necessary to be aware of the anatomical diversity of wood species and insects and, above all, of the adaptability of living organisms to different habitats and environmental or climatic conditions, which offers thousands of possible combinations that cannot all be described here.

The identification key is accompanied by an atlas illustrating some of the various families, genera and species of wood-boring insects. This book does not claim to be exhaustive, but is intended to be a workbook for the reader, who should take the potential of such a subject, its variability and therefore its complexity into consideration.

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