

# Rudists from the Moulin de la Roque section and other Santonian outcrops of La Cadière-d'Azur Formation (Le Beausset basin, SE France) housed in the MCNB palaeontological collections

## Introduction

Palaeontological collections of the Natural Sciences Museum of Barcelona (MCNB) preserve rudist bivalve fossils from several classical fossil localities from the Cretaceous of France. Among all the French localities represented in the collections, the specimens from Le Beausset basin deserve special consideration for their well preservation, quantity, and diversity. In the present work we have studied the rudist faunas occurring at La Cadière-d'Azur Formation cropping out in the municipalities of La Cadière-d'Azur, Le Castellet and Le Beausset (Var department, Provence-Alpes-Côte d'Azur region).

## Geological setting

The well-known La Cadière-d'Azur Formation forms a carbonated sedimentary lenticular body rich in rudist banks that was developed in a perideltaic environment of early Santonian age (Late Cretaceous). This formation extends from NE to SW forming an elongated strip of about 6 km in the central part of Le Beausset synclinal basin, and is interbedded between the Saint-Cyr marls (early Santonian) and Le Moutin sandstones (late Santonian).

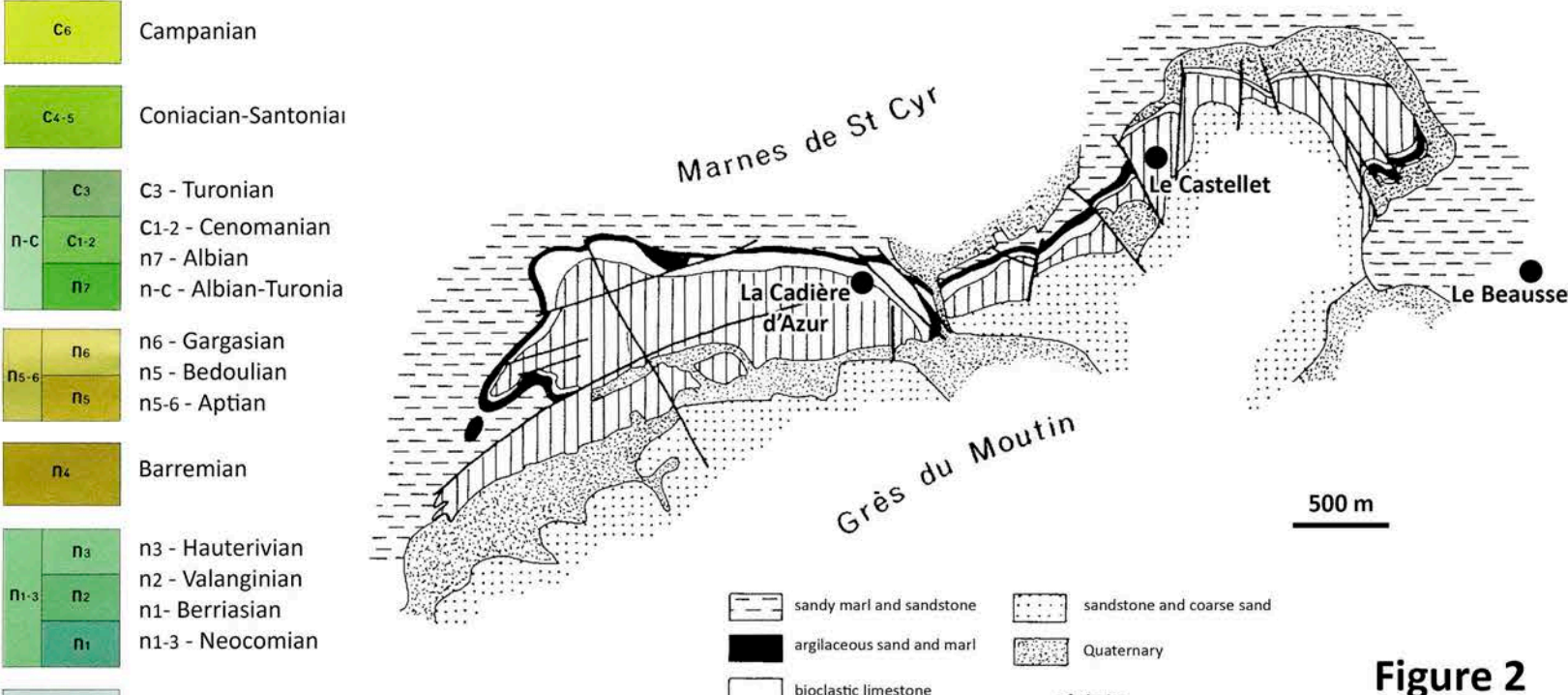
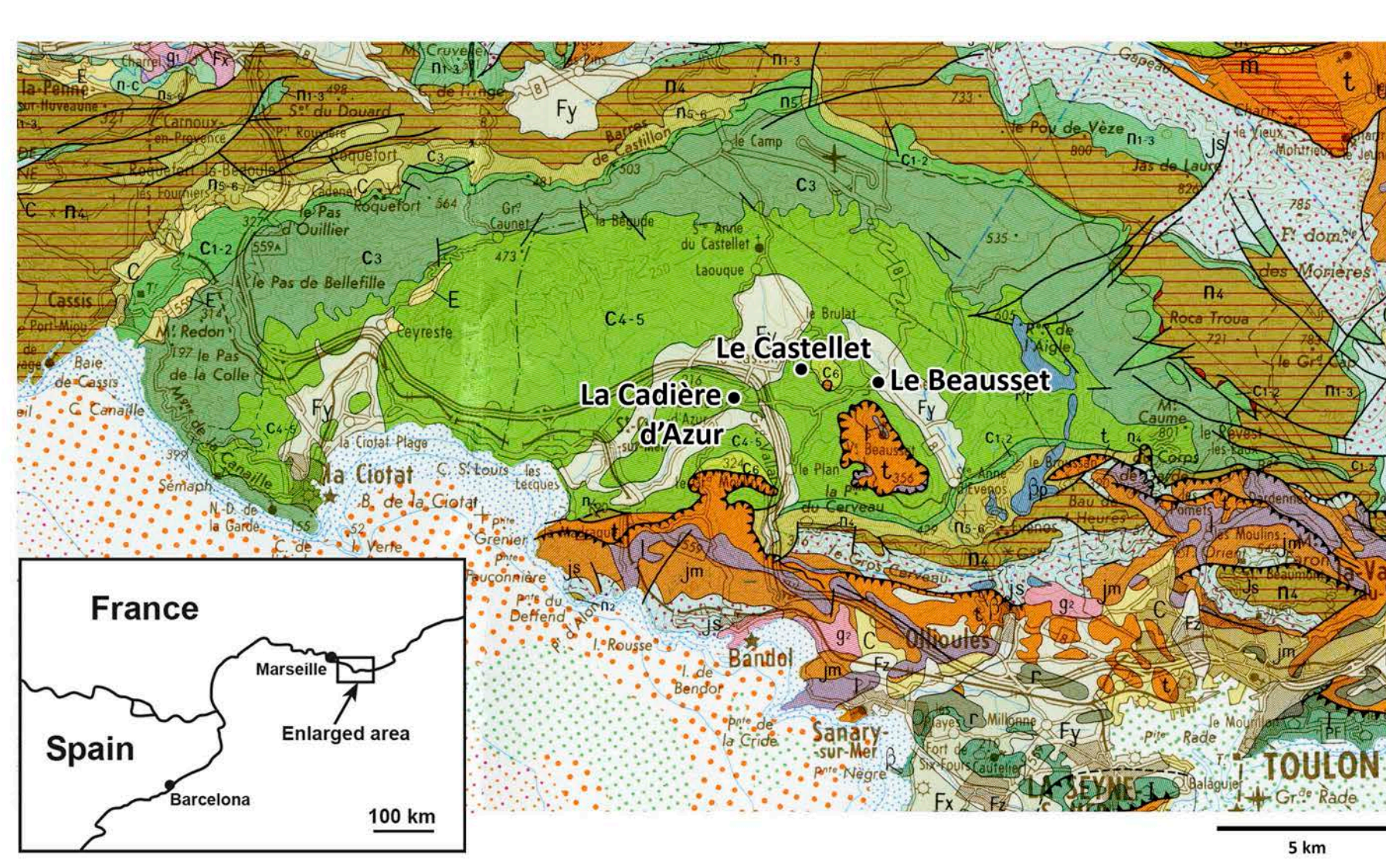


Figure 1. Geological map of Le Beausset syncline. Modified from *Carte géologique de la France 1/250.000, 39, Marseille*. Figure 2. Location and facies map of La Cadière-d'Azur Formation. Modified from Grosheny & Philip (1989, *Bull. Soc. géol. Fr.*, nº 6).

## The rudists of Le Beausset basin in the MCNB palaeontological collections

MCNB Palaeontological collections house a series of collections of diverse origins, from historical collections to more recent ones, called modern collections, accessioned in latest years, resulting from research projects participated by museum technicians and from private individuals donations. Santonian rudist fossils from the basin of Le Beausset preserved in the Museum, come from two important historical collections (Pisani and Vidal), as well as from recent collecting in field campaigns. The Pisani collection was the first large collection purchased in 1891 by the Museum after its opening in 1878. With about 12,000 specimens, the collection contained a broad representation of all groups, most of them invertebrates, from well-known fossil sites of the time, ranging from Cambrian to Pliocene. Felix Pisani was a palaeontological dealer established in Paris. The Vidal collection, a legacy of the mining engineer and geologist Lluís Marià Vidal i Carreras (1842-1922), is undoubtedly the most significant Catalan palaeontological collection from both the 19th and early 20th centuries. The collection displays a great diversity of taxa from Spanish and European basins, highlighting the main fossil sites of Catalonia. Most of the types and figured fossils of the Catalan palaeontology of that time belong to it.



Figure 3. Photographs of the original labels corresponding to Pisani and Vidal specimens: 1) Original label of a rudist specimen from Le Beausset, Pisani collection. 2-3) Smaller labels on specimens surface, Pisani collection; 4) label corresponding to *Hippuritella toucasi* (originally named *Radiolites acuticostatus*); 5) label corresponding to *Hippuritella toucasi*. 6-5) Two original and different labels of the Vidal collection corresponding to specimens of *Bournonia excavata* (originally named *Radiolites excavata*) from La Cadière-d'Azur.

## MOULIN DE LA ROQUE SECTION

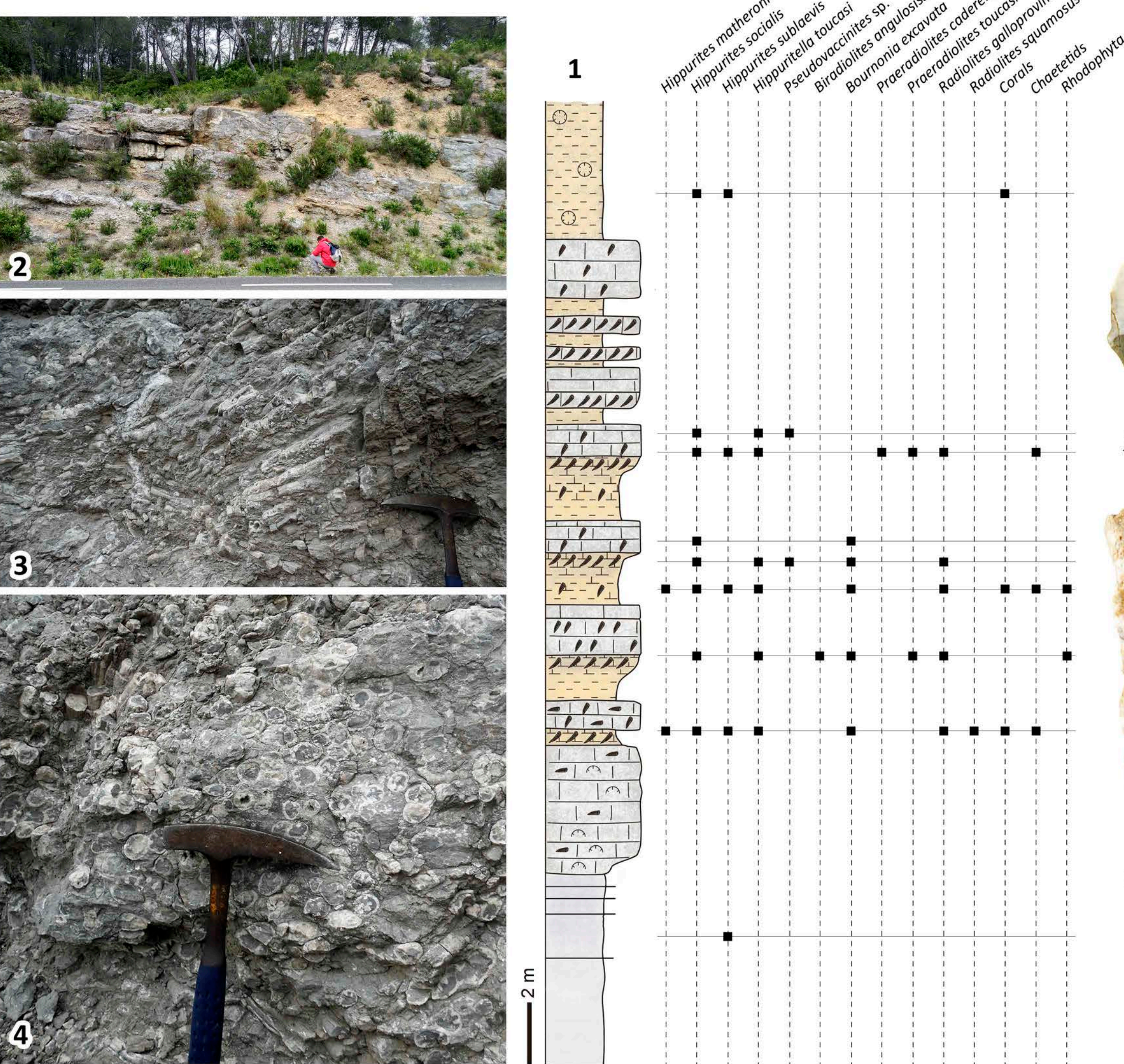


Figure 4. 1) Stratigraphic section of Moulin de la Roque and distribution of recognized faunas. Occurrences of rudist species, and also corals, chaetetid sponges and rhodophycean algae, identified in the sampled beds are marked with dots in its corresponding position (horizontal lines). 2-4) Field photographs of the outcrop; 2) general view of a part of the section, 3 and 4) detail of the rudists bioconstructions in some beds, showing densely packed thickets of hippuritids and radiolitids. Person and hammer for scale in the photographs.

The Moulin de la Roque section crops out along D82 road, in the municipality of Le Castellet. This section shows part of La Cadière-d'Azur Formation (part of units B3 and C described by Grosheny & Philip, 1989) and consists in an alternance of marly limestones and marls with intercalated limestones. The section is rich in rudists, and some bioconstructed beds with life-position specimens are well developed. The following rudist species has been recognized from our material: *Hippurites matheroni*, *Hippurites socialis*, *Hippurites sublaevis*, *Hippuritella toucasi*, *Biradiolites angulosissimus*, *Bournonia excavata*, *Praeradiolites cadomensis*, *Praeradiolites toucasi*, *Radiolites galloprovincialis*, and *Radiolites squamosus*. Specimens of *Pseudovacinites* sp. are present in the outcrop as natural sections. Among all them, *H. socialis*, *H. toucasi* and *R. galloprovincialis* are the most abundant and the main bioconstructing organisms. *B. excavata*, *H. matheroni* and *H. sublaevis* are also abundant, whereas the other species are poorly represented.

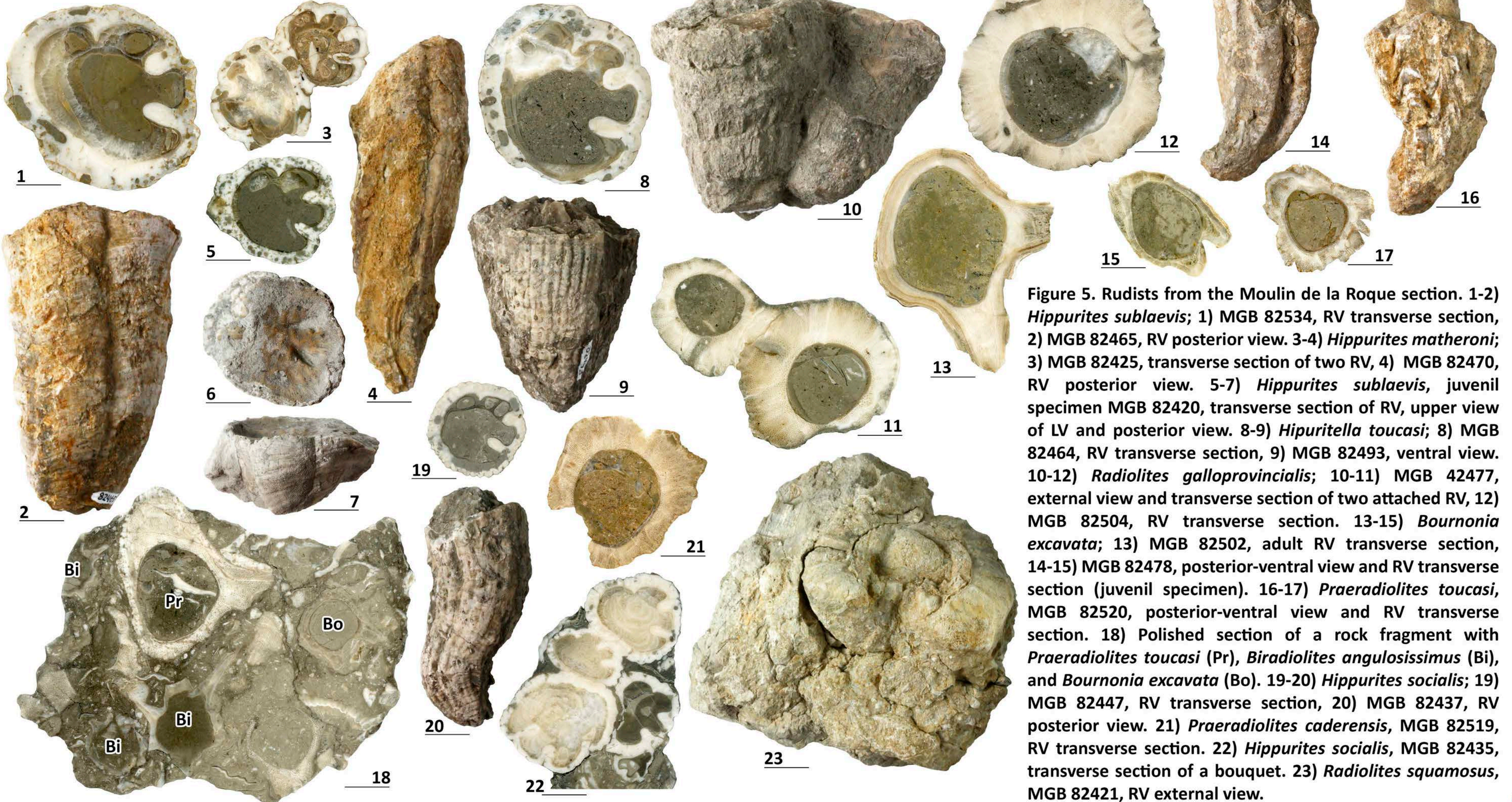


Figure 5. Rudists from the Moulin de la Roque section. 1-2) *Hippurites sublaevis*; 1) MGB 82534, RV transverse section, 2) MGB 82465, RV posterior view. 3-4) *Hippurites matheroni*; 3) MGB 82425, transverse section of two RV, 4) MGB 82470, RV posterior view. 5-7) *Hippurites sublaevis*, juvenile specimen MGB 82420, transverse section of RV, upper view of LV and posterior view. 8-9) *Hippuritella toucasi*; 8) MGB 82464, RV transverse section, 9) MGB 82493, ventral view. 10-12) *Radiolites galloprovincialis*; 10-11) MGB 82477, external view and transverse section of two attached RV, 12) MGB 82504, RV transverse section. 13-15) *Bournonia excavata*; 13) MGB 82502, adult RV transverse section, 14-15) MGB 82478, posterior-ventral view and RV transverse section (juvenile specimen). 16-17) *Praeradiolites toucasi*, MGB 82520, posterior-ventral view and RV transverse section. 18) Polished section of a rock fragment with *Praeradiolites toucasi* (Pr), *Biradiolites angulosissimus* (Bi), and *Bournonia excavata* (Bo). 19-20) *Hippurites socialis*; 19) MGB 82447, RV transverse section, 20) MGB 82437, RV posterior view. 21) *Praeradiolites cadomensis*, MGB 82519, RV transverse section. 22) *Hippurites socialis*, MGB 82435, transverse section of a bouquet. 23) *Radiolites squamosus*, MGB 82421, RV external view.

## LE CASTELLET (VILLAGE)

Some rudists of the modern collections come from outcrops around the medieval village of Le Castellet; *Hippuritella toucasi*, *Hippurites socialis*, *Biradiolites fissicostatus*, *Radiolites galloprovincialis*, and *Radiolites squamosus* have been identified.

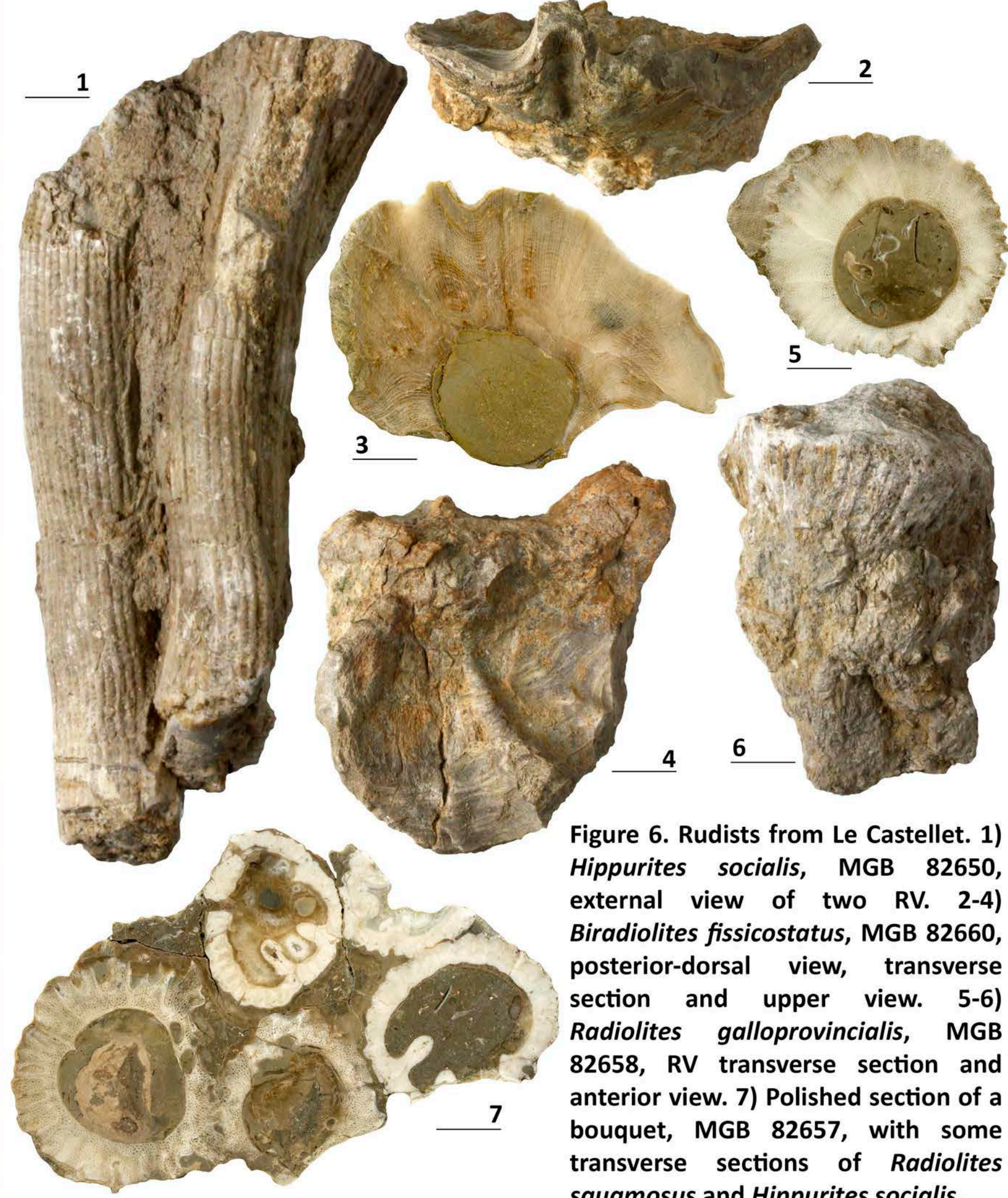


Figure 6. Rudists from Le Castellet. 1) *Hippurites socialis*, MGB 82650, external view of two RV. 2-4) *Biradiolites fissicostatus*, MGB 82660, posterior-dorsal view, transverse section and upper view. 5-6) *Radiolites galloprovincialis*, MGB 82658, RV transverse section and anterior view. 7) Polished section of a bouquet, MGB 82657, with some transverse sections of *Radiolites squamosus* and *Hippurites socialis*.

## LA CADIÈRE-D'AZUR

Rudists from La Cadière-d'Azur are both represented in Vidal and modern collections by *Hippuritella toucasi*, *H. maestrei*, *Hippurites matheroni*, *H. socialis*, *Pseudovacinites galloprovincialis*, *Bournonia excavata*, *Praeradiolites toucasi*, *Radiolites galloprovincialis*, and *R. squamosus*.

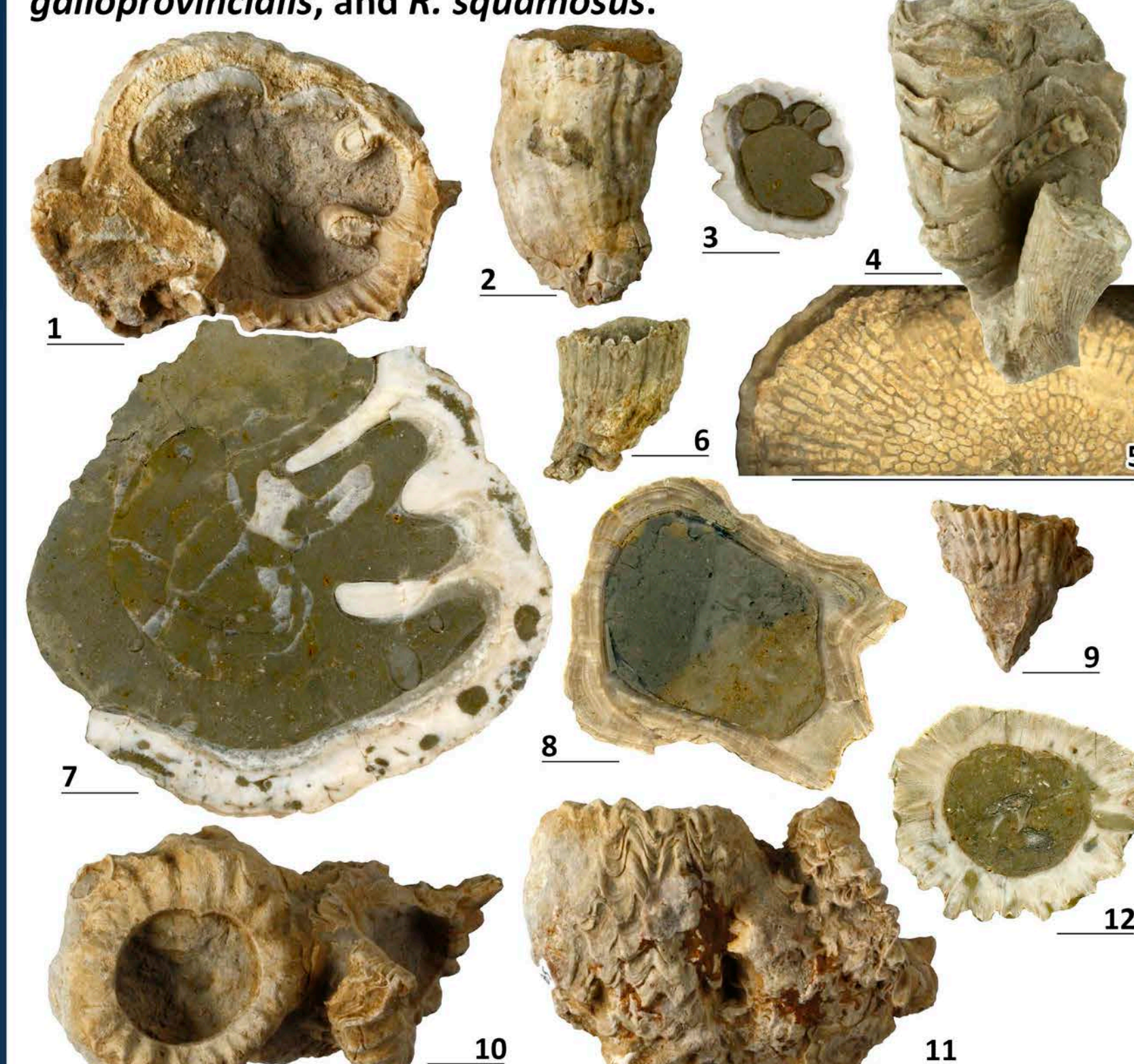


Figure 7. Rudists from La Cadière-d'Azur. 1) *Hippuritella toucasi*, MGB 82675, RV upper view. 2-3) *Hippurites matheroni*, MGB 82673, RV posterior view and transverse section. 4-5) *Praeradiolites toucasi* and *Hippuritella maestrei*, MGB 3232; 4) dorsal view, 5) detail of the LV pores of *H. maestrei*. 6) *Hippurites socialis*, juvenile specimen MGB 3227-3, posterior view. 7) *Pseudovacinites galloprovincialis*, MGB 82665, RV transverse section. 8) *Bournonia excavata*, MGB 82680, RV transverse section. 9) *Radiolites galloprovincialis*, MGB 82690, RV dorsal view. 10-12) *Radiolites squamosus*; 10-11) MGB 82685, upper and posterior-ventral views, 12) MGB 82686, RV transverse section.

## LE BEAUSSET

Specimens from Le Beausset, in Vidal and Pisani collections, are represented by *Hippuritella toucasi*, *Hippurites matheroni*, *H. socialis*, *H. sublaevis*, *Pseudovacinites beaussetensis*, *Biradiolites acuticostatus*, *Bournonia excavata*, *Praeradiolites cadomensis*, *P. toucasi*, and *Radiolites galloprovincialis*.



Figure 8. Rudists from Le Beausset. 1-2) *Pseudovacinites beaussetensis*, MGB 3224, 1) ventral view, 2) RV transverse section. 3-6) *Hippurites sublaevis*, MGB 86430; 3) RV posterior view, 4) LV upper view, 5) detail of the LV pores, 6) RV transverse section. 7-8) *Praeradiolites cadomensis*; 7) MGB 86437, RV transverse section, 8) MGB 86436, posterior-ventral view. 9-10) *Praeradiolites toucasi*, MGB 3283, posterior-ventral and upper views. 11-12) *Biradiolites acuticostatus*, MGB 86435, RV transverse section and posterior-ventral view.