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Modern palynological record in the Bay of Brest (NW France): Signal calibration for palaeo-reconstructions

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ABSTRACT

Modern palynological investigations (pollen and non-pollen palynomorphs) have been carried out for the first time in the entire Bay of Brest (BB; NW France), a semi-enclosed oceanic basin flooded during the Holocene that today is exposed to both marine (North Atlantic surface waters) and fluvial (Aulne and Elorn rivers) influences. Palynological analyses were conducted on 41 surface sediments collected in several mudded bays where low-energy conditions prevail, allowing for fine particle decantation, and also on 12 moss samples considered to be pollen rain collectors taken on the periphery of the BB. Furthermore, the BB allows a direct comparison between landscapes and fossilized pollen assemblages in sediments thanks to relatively small watersheds and well-studied vegetation cover on land. Our data display a well-known distortion between pollen taxa percentages calculated from palynological slides and current vegetation cover on land, with a particular overestimation of arboreal taxa as well as an underestimation of herbaceous ones, especially of cereal crops that represent a major component of the regional continental vegetation. Various factors may be involved, including pollen transport issues, taphonomic processes, and different pollination rates according to trees/herbaceous taxa. Under close examination, we find that while all surface sediments show the same major species, palynological maps established in the BB regarding some specific pollen taxa exhibit differences and upstream-downstream gradients. Also, the comparison between the pollen content in BB surface sediments and in mosses supports the hydrodynamic influence acting on the pollen distribution in sediments. More specifically, we suggest that some arboreal taxa reflect a watershed effect, especially *Alnus*, which seems to be highly correlated to river influences and could therefore be considered as a potential proxy for fluvial Holocene palaeo-discharges within the BB.

1. Introduction

Coastal areas are highly sensitive to climatic variations and human pressures and may therefore be ideal sites to discuss palaeoenvironmental changes through time. In Brittany (NW France, NW Europe), a recent sedimentological study carried out in the Bay of Brest (BB) highlights high, modern (up to 0.2 cm/year) and Holocene, sedimentation rates (Gregoire et al., 2016); the BB thus offers a unique opportunity to explore palaeoenvironmental changes at a high temporal resolution over the last century (Klouch et al., 2016), as well as over the last 9 ky BP (Gregoire et al., 2016). Within this context, palynology has commonly been used during the last few decades to discuss past Holocene environmental reconstructions (e.g. Ritchie et al., 1985; Lézine and Casanova, 1989; Davis et al., 2003; Mauri et al., 2015). However, understanding present-day palynomorph deposits (organic microfossils mainly including pollen, spores, and cysts of dinoflagellates or dinocysts) in modern sediments is first required before any palynological-based palaeoecological reconstructions. Past studies based on modern pollen records underline a distortion between current vegetation cover in surrounding watersheds (studied by botanists, biogeographers) and preserved pollen grains in modern sediments (studied by palynologists, palaeoenvironmentalists), this distortion being explained by different factors such as pollen preservation (taphonomic processes) or pollen production rates (e.g. Smirnov et al., 1996; Brown et al., 2007; Zhao et al., 2009; Ganne et al., 2016). This pollinic bias has mainly been discussed in continental environments under different latitudes and climatic contexts (e.g. Ruffaldi, 1994, East of France; Gaillard et al., 1998, Sweden; Zhao et al., 2009, China) as well as in coastal-to-estuarine environments (e.g. Brush and DeFries, 1981 and Smirnov et al., 1996: both studies in North America, the Potomac and Mississippi rivers,

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respectively). More specifically, a recent study carried out in the Loire River evidenced a large homogeneity of the pollen content throughout the entire upstream-downstream transect (from the upper inner estuary to the river mouth) but a distortion between the arboreal pollen content in sediments (i.e. high percentages of *Quercus* and *Pinus*) and the scarcity of trees within the surrounding landscapes (Ganne et al., 2016). Also, in stratified estuarine environments, dinocysts have often been explored in parallel with pollen grains (e.g. Matsuoka et al., 1999, Chengjang river, China; Sildever et al., 2015, Baltic Sea; Ganne et al., 2016, Loire River, France), highlighting the mixed influence of marine and estuarine waters.

The aim of this study is to describe and understand for the first time the modern palynological signature (pollen and dinocysts) recorded within the BB through 41 surface sediments collected throughout the bay, in order to support future Holocene pollen investigations (Lambert, C., PhD ongoing). Also, in order to discuss aerial vs. river inputs and to identify different vegetation-types around the BB, 12 moss pollsters were collected from the periphery of the BB, and their palynological contents were compared to those of the surface sediments. We then discuss some key issues regarding present-day palynomorph deposits, constituting relevant information for palynological calibration studies:

i) BB watersheds are relatively small and well circumscribed, avoiding long-distance pollen transport and related taphonomic processes, their vegetation cover being regularly studied by the National Botanical Conservatory of Brest. This favourable context allows for a direct comparison between pollen assemblages preserved in sediments and landscape maps built from the Corine Land Cover database. What are the main similarities and differences according to both palynological and botanical approaches?
ii) Complex hydrodynamic features in an estuarine environment involve meteorological and current forcings (wind, wave, fluvial, and tidal forcings) that are able to disperse pollen grains and micro-algae over the BB. Distribution maps of major taxa will enable us to discuss if specific pollen distribution patterns are noticeable within the BB.

2. Environmental settings

2.1. Geographical context

The Bay of Brest is located in north-western Brittany (Fig. 1a) and represents a shallow semi-enclosed basin of 180 km^2 surrounded by a 200 km long coastline. Its basement corresponds to Proterozoic igneous rocks in the north and Brioverian (Neoproterozoic, possibly Early Cambrian) to Palaeozoic (Ordovician, Devonian and locally Carboniferous) sediments in the south and east (Chauris and Plusquellec, 1980). Present-day low reliefs (few hills reach 330 m high) are inherited from the peneplanation of the Hercynian chain (Ballèvre et al., 2009). The department of Finistère has been subsident since the Eocene (Ziegler, 1992) and continued to sag slightly during the Holocene (Goslin, 2014;

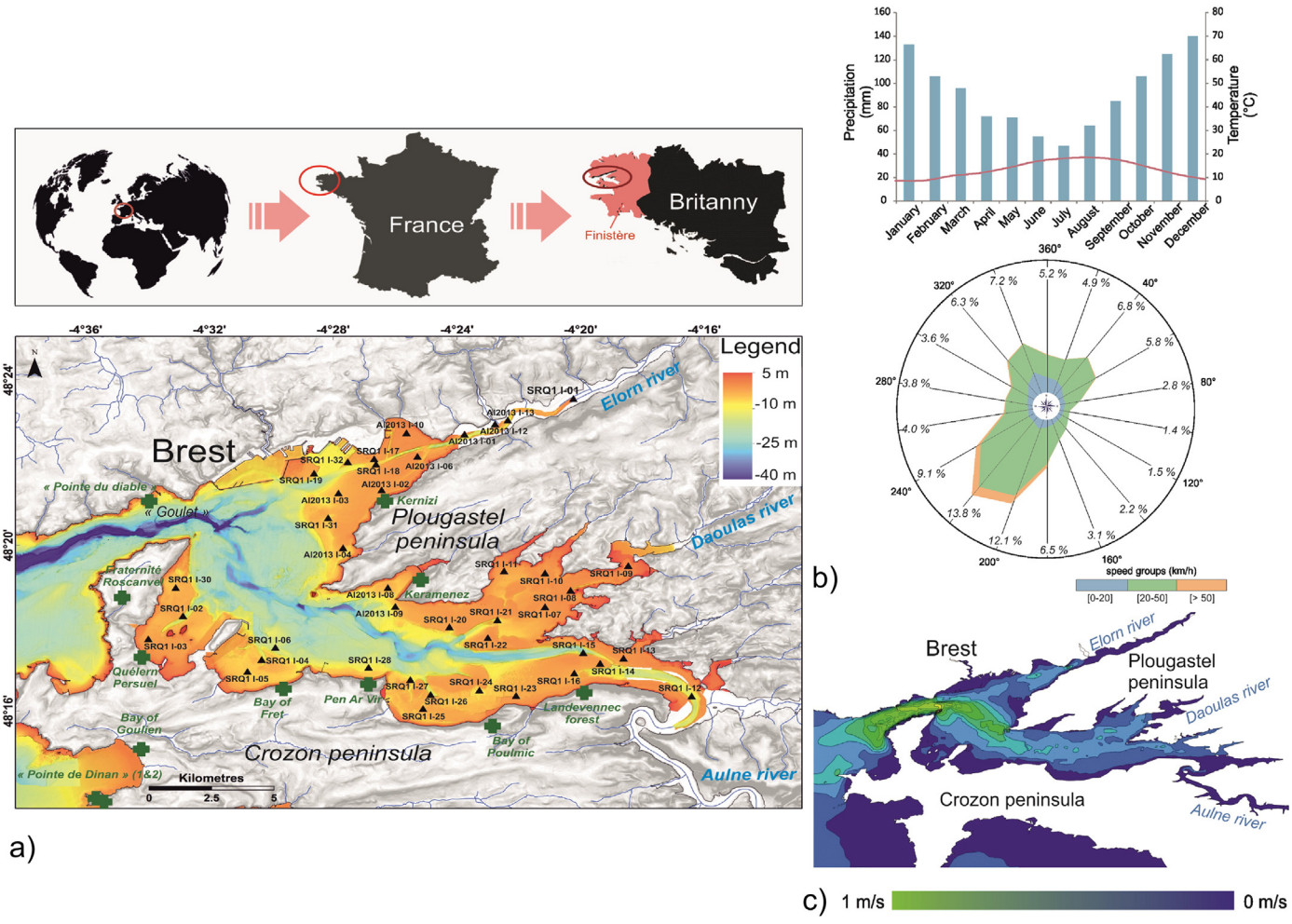

Fig. 1. Location of the Bay of Brest (BB) in northwestern France. a) Location of sampling sites on a topographical map of the BB (after Gregoire et al., 2016). Black triangles: surface sediment samples; green crosses: moss samples. b) Present-day climate data with an ombrothermic diagram (temperatures and precipitations) and wind rose showing prevailing wind directions, strength (km/h) in course of one year averaged over 10 years. (Sources: station of Brest-Guipavas "climate-data.org", and Météo France, respectively.) c) Map of surface currents speed (m/s) across the BB (source: SHOM).