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# Human occupation because of a regression, or the cause of a transgression?

## A critical review of the interaction between geological events and human occupation in the Belgian coastal plain during the first millenium AD

**Sonderdruck aus:**

**Probleme der Küstenforschung im südlichen Nordseegebiet**
**Band 26**

1999
ISENSEE VERLAG · OLDENBURG

Probleme der Küstenforschung im südlichen Nordseegebiet | 26 | 97-121 | Oldenburg 1999



# Human occupation because of a regression, or the cause of a transgression?

## A critical review of the interaction between geological events and human occupation in the Belgian coastal plain during the first millennium AD

By Anton Ervynck, Cecile Baeteman, Hendrik Demiddele, Yann Hollevoet, Marnix Pieters, Jaap Schelvis, Dries Tys, Mark Van Strydonck & Frans Verhaeghe

With 10 figures and 2 plates

**Abstract:** Through an interdisciplinary approach, this paper re-evaluates the common use of the Dunkerque transgression model as an explanation for the occurrence of gaps in the occupational history of the Belgian coastal plain, during the first millennium AD. The validity of the marine transgression model derived from a previous interpretation of the geological evidence is assessed; and new ideas about the geological history of the area are discussed. Alongside a re-assessment of the available archaeological data, new archaeological, historical and ecological evidence is reviewed and interpreted. The combined knowledge gained from this range of disciplines leads to a working hypothesis summarising the new ideas about the history of occupation in the coastal plain during the Roman and early medieval periods, explaining how the trends observed can be integrated with the geological and anthropogenic changes in the landscape.

**Key words:** Belgium, First millennium AD, Coastal Holocene geology, Sea-level changes, Dunkerque transgressions, Palaeoecology, Environmental reconstructions, Archaeology, Occupation history.

**Inhalt:** Mit einem interdisziplinären Ansatz wird das allgemein gebräuchliche Modell der Dünkirchen-Transgressionen, mit dem die Lücken in der Besiedlung der belgischen Küste während des 1. Jahrtausends n. Chr. erklärt werden, neu bewertet. Die Gültigkeit des Modells der marinen Transgressionen, das von einer früheren Interpretation des geologischen Befundes ausging, wird überprüft, und neue Vorstellungen zum geologischen Ablauf werden diskutiert. Das bereits vorliegende archäologische Material wird neu beurteilt, und darüber hinaus werden neue archäologische, historische und ökologische Ergebnisse erörtert und interpretiert. Die aus der interdisziplinären Arbeit gewonnenen Kenntnisse führen zu einer Arbeitshypothese, die die neuen Vorstellungen zur Besiedlungsgeschichte der Küste während der Römischen Kaiserzeit und des Frühen Mittelalters zusammenfaßt. Sie erklärt, wie sich die beobachteten Tendenzen mit den geologischen and anthropogenen Veränderungen der Landschaft vereinbaren lassen.

**Schlüsselwörter:** Belgien, Holozän, 1. Jahrtausend n. Chr., Küstengeologie, Meeresspiegelbewegungen, Dünkirchen-Transgressionen, Paläoökologie, Umweltrekonstruktionen, Archäologie, Besiedlungsgeschichte.

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## 1 Introduction

The Belgian coastal plain is a polder area approximately 10 to 15 km wide, the elevation of which varies from +2 to +5 m TAW (the Belgian ordnance datum TAW refers to mean low water spring, about 2 m below mean sea level). The 65 km of shoreline is bordered by an almost continuous dune belt. The Belgian coastal plain is part of the lowlands of the southern littoral of the North Sea, where the Holocene sequence is characterised by an alternation of clastic tidal deposits and peat beds, filling a Pleistocene palaeo-valley in the western part. Plate 1 shows the geomorphological features of the area and provides a useful reference framework within which to interpret the geological features present (see below). Fig. 1 shows the location of the present-day villages and towns discussed in the text.

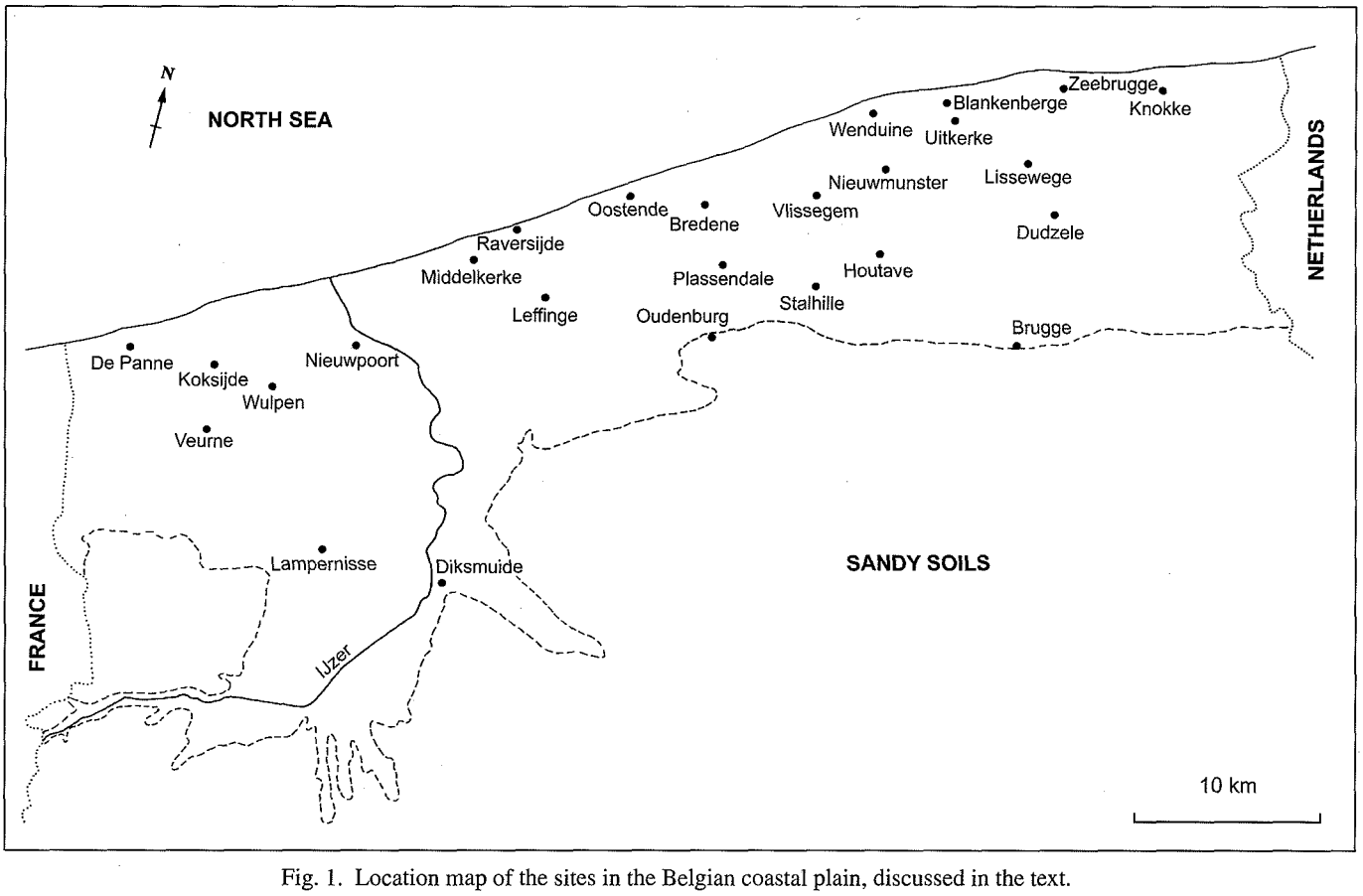


Fig. 1. Location map of the sites in the Belgian coastal plain, discussed in the text.


Plate 1. Geomorphological map of the central part of the Belgian coastal plain. Scale ca. 1:130,000.
Clearly visible are (moving landwards from the sea) the dune belt (yellow), the zone of tidal sediments (shades of blue), and the inland sandy soils (yellow and purple) with the sand ridge of Oudenburg protruding into the coastal plain (after De Moor 1990).

It is commonly accepted that the occupational history of the area, as reflected in the archaeological record, is characterised by discontinuities. For the first millennium AD, an important gap in habitation has been suggested from the 5th to the 8th century. A lack of archaeological finds fueled the impression that during the early Middle Ages no human activity or occupation took place in the Belgian coastal plain. Traditionally, such gaps have been related to the inaccessibility of the area caused by marine transgressions inundating the plain, rendering all human activities impossible.

It is the aim of the present paper to re-evaluate this common explanation; and in so doing, some of the inconsistencies in the model identified here, result from earlier criticisms. In 1980, the historian Verhulst wrote that *"the question must be asked whether it is still acceptable to explain the absence or the presence of human habitation in the coastal areas merely as a function of physical and geographical conditions."* He asked himself *"whether it is not true that there has been a permanent drive within human populations to occupy these marginal areas because of their outstanding economic value?"*, and stressed the possibility that *"the diverse and interrupted habitation phases could be the result of demographic and economic expansion movements"* (Verhulst 1980). This paper seeks to extend such questioning, by assessing the validity of the geological marine transgression model itself; by reviewing the published archaeological data, and by presenting new archaeological, historical and ecological data. The new interpretations derived from these different forms of data are then integrated within a new working hypothesis of occupation within the Belgian coastal plain, during the first millennium AD.

It must be stressed that, in the present paper, no extrapolations are made towards the occupation history of other regions around the North Sea, *i. e.* Northern France, the Netherlands, Germany or England. Since these regions border the same marine basin, it is certainly so that comparisons must be made between them, but it was considered best to leave this to each region's experts. Global geological asymmetries, local geographical conditions, and differences in cultural development could have produced a different story per region. However, it is hoped that the Belgian case-study is at least thought-provoking when the interaction between geological events and human occupation history is reassessed for other coastal areas along the North Sea.

## 2 The Dunkerque transgression model

An extensive review of the literature on the Holocene geology of the Belgian coastal plain has already been published (Baeteman 1981; 1983). Therefore, it may suffice here to discuss only briefly the development of the marine transgression model that has long dominated the Holocene geology of the coastal plain.

The model of several Dunkerque transgressions was introduced into the geological literature of Belgium by Tavernier (1948) at the occasion of the systematic Soil Survey which started in the coastal plain. It is most likely that difficulties in explaining the different facies changes in the tidal deposits were the reasons for attributing them to different transgressions; whereby it was thought that each time a sea-level rise caused the rupture of the dune belt, the complete inundation of the plain followed. It should be mentioned that the sedimentology of tidal flat deposits was not yet well elaborated at that time. In this context, and by analogy with archaeological investigations in Zeeland, in the Netherlands (see Vos & van Heeringen 1997 for a synthesis and extensive bibliography) three transgressions were defined: Dunkerque I, II and III.

The term *"Dunkerque"*, as well as the ideas about the geological history of the coastal plain, was adopted from the studies by Dubois (1924), in northern France, and by Cornet (1927) and Briquet (1930), in Belgium. According to these authors, the coastal plain was formed by a transgression which occurred during the Atlantic period. The deposits consist of sand, and were labeled *"Calais"*. A peat layer overlying these deposits was called the *"surface peat"*. Its origin was explained by a lowering or *"stand still"* of the sea level. Another transgression (the Dunkerque) resulted in deposits covering the surface peat. This idea, which formed the basis for a stratigraphical subdivision, was criticised by Halet (1931) but in the literature the implications of his remarks were not pursued.

Further field observations and research in the 1950s, mainly by Moormann and Ameryckx, within the context of soil mapping in the area around Veurne and Oostende, led to the conclusion that the threefold subdivision of the Dunkerque transgression was insufficient to describe the various sediments overlying the peat layer. For example, Moormann (1951) introduced a *"Dunkerque 0"* because he found deposits covering the peat which must have been older than the Dunkerque I; and Ameryckx (1954) subdivided the Dunkerque III transgression into a *"Dunkerque IIIA"* and a *"Dunkerque IIIB"*. A few years later, Ameryckx (1959) introduced the term *"regression"* to indicate a retreat of the marine influence, causing a pause in the deposition of sediments. In general, the Dunkerque II transgression is considered to be the most important. It also had the greatest geographical extent (see Fig. 5).

Except for a thin peat bed, occurring locally in the upper metre of the deposits and labeled as a marker bed separating the Dunkerque I from the Dunkerque II deposits by Moormann (1951), the subdivision into different transgressions and regressions was never supported by field observations or lithological descriptions. Nevertheless, the transgressions and regressions became an established, rigid framework into which any facies change had to fit.

Geological research in the coastal plain ceased almost completely in the 1960s. On the other hand, renewed historical geographical research was carried out (*e. g.*, VERHULST 1959; 1964). The established transgression and regression framework, however, was adopted without any criticism for the interpretation of the observations.

## 3 Archaeology, history and the transgression model

The relationship between archaeology and the geological model of marine transgressions has always been complex. Because of the lack of other dating possibilities, archaeological and historical information was very often used to date the transgression that caused the end of the surface peat. Already in 1906, Blanchard pointed to archaeological material from the second half of the 4th century, found in the upper part of the peat layer, to state that the drowning of the peat must have started from that time onward (BLANCHARD 1906). Dubois stated that the *"Assise de Dunkerque"*, in Northern France, originated from the period between the 3rd and the 8th centuries (DUBOIS 1924). In Belgium, it was thought that an inundation of the coastal plain took place around the 4th century AD, at the end of the Roman occupation, because of the apparent lack of archaeological finds from periods later than that time (CORNET 1927; TAVERNIER 1938). Tavernier also pointed to the absence of historical data on coastal Flanders, from the period between the 4th and the 7th century, and viewed this as an indication of the duration of the transgression until the 7th century (TAVERNIER 1938).

When the idea of a threefold subdivision of the Dunkerque deposits was launched, a refined chronology was put forward (TAVERNIER 1948). Dunkerque I sediments in Belgium would have been deposited during the 1st century AD, following an archaeologically-derived date presented for the oldest Dunkerque transgression in Zeeland, in the Netherlands (BENNEMA 1948). Dunkerque II was chronologically situated in the early 4th century, again on the basis of archaeological finds from Zeeland; and the Dunkerque III deposits were thought to have originated in the 11th century, or even in a somewhat later period, according to the historical record. In subsequent Belgian publications, these dates were often repeated and sometimes slightly altered (see BAETEMAN 1981; 1983); one of the most important changes being that the date range of Dunkerque I was extended from the 2nd century BC to the 1st century AD (MOORMANN 1951). On an international level, the dates for the transgressions differed more widely (see for an overview: ROELEVELD 1980, 296, table 1).

The mentioned attempts to date the transgressions were all based upon the absence of archaeological material from a certain time period. In some cases, however, the actual presence of finds was used for interpretation. A notable example is provided by the discovery at Brugge of the remains of a boat that was believed to date from the 5th to the 6th century (JONCKHEERE 1903; PLEYTE 1936). After the geological model of the Dunkerque transgressions was developed, it was decided that the boat must have been found in Dunkerque II deposits, and that consequently, the dating of the boat gave a date to the transgression (see, for example, TAVERNIER & AMERYCKX 1970). Recent research, however, has revealed that the boat dates from the Roman period (MARSDEN 1976). A similar boat find was made in Oostende in 1952, and this was also believed to date from the same (early medieval) period as the find from Brugge. Since the context of the recovery of the Oostende boat was interpreted as a Dunkerque II creek (AMERYCKX & NAGELMACKERS 1956), the archaeological date attributed to the boat again gave a date to the transgression (see again TAVERNIER & AMERYCKX 1970). However, an early medieval date for this find is very unlikely (ELLMERS 1972, 291).

It must not be forgotten that during the period when the Dunkerque transgression model was developed, radiocarbon dating was not yet available. Only in 1978 was a first attempt made to date the Dunkerque II transgression. A cockle shell (*Cardium* sp.) from the filling of a gully at Uitkerke was dated to 1630 ± 90 BP, a date that was converted into calendar years as 320 AD (IRPA-87: THOEN 1978, 42, note 62). However, this date is no longer reliable for a number of reasons: first, because of the large standard deviation; secondly, because it is uncertain whether the marine reservoir age has been taken into account; and finally, because the fractionation of stable carbon isotopes has not been measured, which renders an adjustment for the $\delta^{13}C$ value impossible.

The dating of the Dunkerque regressions alternated quite logically with that of the transgressions. The regression between Dunkerque I and II became known as the *"Roman regression"* and would have covered the period from the 1st to the 4th century AD. The regression between Dunkerque II and III was chronologically situated from the 8th to the 11th century AD and was labelled *"the Carolingian regression"* (AMERYCKX 1959). In the literature, the existence of a Roman regression was corroborated by the presence of Roman artefacts and sites in the coastal plain, and by the presence, at least in the western part of the coastal area, of a thin peaty layer and sometimes even a terrestrial horizon between the so-called Dunkerque I and II deposits. The occurrence of a Carolingian regression was supported by the historical data suggesting a gradual reclaiming of the coastal area from the 8th century onwards.

A summary of the Dunkerque chronology, as it was originally proposed, is given in Fig. 2. Until renewed geological research provided critical insights (see below), the model survived, although some attempts were made to refine its chronology. Thorough historical research concentrated mainly on the Dunkerque III transgression (AMERYCKX & VERHULST 1958; VERHULST 1959), in which attempts were also made to link certain catastrophic storms, mentioned in historical texts, with phases in the transgression model (VERHULST & GOTTSCHALK 1980).

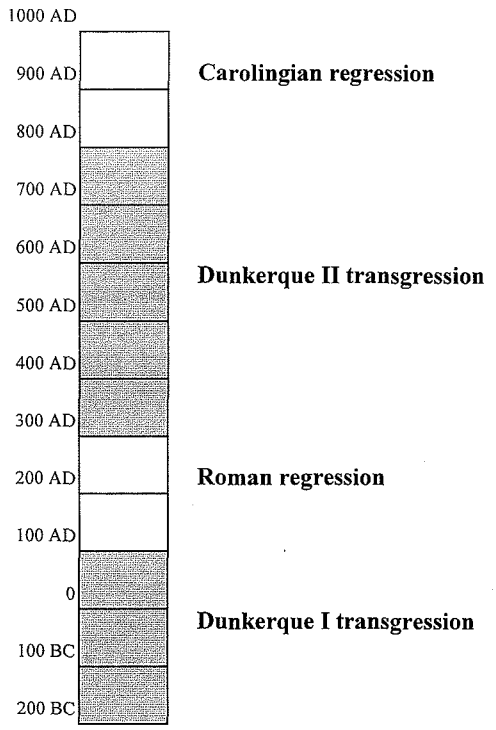


Fig. 2. Schematic view of the classical Dunkerque chronology (following TAVERNIER & AMERYCKX 1970).

The chronological questions and connotations linked to the Dunkerque IIIA transgression even led to a problem-oriented excavation focusing on the date of the *Oude Zeedijk* (the "Old Sea-Dike"), in the area of Veurne, in the western part of the coastal area. The *Oude Zeedijk* was seen as a defensive dike, deemed to have protected part of the area against the onslaught of the Dunkerque IIIA transgression after the Carolingian regression. At the same time, it was interpreted as the boundary separating the territory not subjected to flooding after the Dunkerque II transgression (the *Oudland* or "Old Land") from the area flooded during Dunkerque IIIA (the *Middelland* or "Middle Land".

Behind this *Oude Zeedijk*, a number of settlements, some of them deserted, had been located during the fieldwork of the Belgian Soil Survey. These sites were believed to have been "defended" by the *Oude Zeedijk* and therefore, they were assumed to pre-date this *Oude Zeedijk*. This in turn meant that the date of the emergence of those sites would provide a *terminus post quem* for both the Oude Zeedijk and the Dunkerque IIIA transgression. In addition, since many of these sites were moated, the possibility that they represent small *terpen* (terp-mounds) was also explored, reflecting the influence of Frisian parallels (VERHULST 1970; SCOLLAR *et al.* 1970a). Consequently, at the initiative of soil scientists, geologists and geographers, one of these sites behind the *Oude Zeedijk* was selected for trial excavation in 1957. Eventually, however, the site was shown to date from the late 13th and 14th centuries and not from the Carolingian or Ottonian periods (SCOLLAR *et al.* 1970b).

Other archaeological work was equally influenced by the Dunkerque (II and IIIA) model. From 1972 to 1976, a survey of medieval settlements and sites was carried out within a defined study area in the region around Veurne. The study area was selected to include areas located in both the Oudland and the Middelland in order to detect and identify possible differences in site types, chronology and location, which may have reflected different historical, geographical and pedological circumstances. The results of the survey, however, did not reveal any significant differences whatsoever (VERHAEGHE 1977; 1980).

Thoen reviewed the archaeological evidence for the Roman period, and stated that the Dunkerque II transgression must have started in the second half of the 3rd century AD. He based this conclusion on the absence of late 3rd and 4th century material amongst the archaeological finds from the coastal plain. Moreover, the author stated that the finds recovered at the beginning of the 20th century, formerly used to date Dunkerque II, were unreliable because they had not been excavated from *in situ* contexts (THOEN 1978). Thoen thus only adjusted the chronology of the Dunkerque model but did not criticise it *in globo* (see THOEN 1978).

Indeed, the model remained popular amongst archaeologists and it also gained widespread use within the field of historical geography. A side effect was that the evolution of the coastal plain often became a simplified story without any qualifying nuances. For example, it was described as a completely inaccessible coastal plain during the Dunkerque II transgression: *"... vers l'an 400, au plus tard, toute la plaine maritime et même la lisière de la région sablonneuse furent progressivement inondées ..."* (... around 400 AD, at the latest, the whole coastal plain and even the border of the Pleistocene sand area was progressively inundated ...) (VERHULST 1966, 17). Later accounts, however, became much more subtle (see, *e. g.*, VERHULST 1995).

## 4 A critical approach to the transgression model

A revival of research interest in the Holocene geology of the coastal plain, from the late 1970s onwards, based on new fieldwork and diatom analyses, gradually gave rise to the view that the traditional transgression model was no longer tenable, since it could not explain the many complex phenomena observed (BAETEMAN 1978; 1981; 1985; 1991; 1999; BAETEMAN & DENYS 1995; BAETEMAN *et al.* 1999; DENYS 1993). It was demonstrated that the sedimentary characteristics of the deposits and their patterns of succession are more complex than the established stratigraphic descriptions allow.

In addition to the surface peat, many intercalated peat layers were found that had no place in the traditional threefold stratigraphic classification (Calais and Dunkerque deposits, separated by the surface peat). In the field, it was found that,

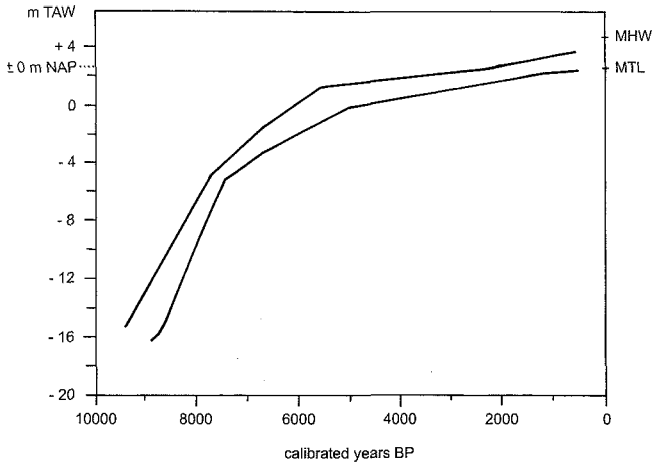


Fig. 3. Relative sea-level curve for the study area (MHW Mean high water - MTL Mean tidal level - 0 TAW lies 2.34 m below 0 NAP.) (after DENYS & BAETEMAN 1995).

in terms of sedimentology, it was impossible to discriminate between the different Dunkerque deposits. Furthermore, the causal agent for the transgressions and regressions, *i. e.* sudden accelerations and pauses in the sea-level rise, was non-existent; the sea-level curve was proved to be gradual, rather than fluctuating (Fig. 3, DENYS & BAETEMAN 1995). Generally, it must also be emphasised that during the construction and application of the transgression model the sediments themselves were never used as a focus of study.

New approaches, however, are taking into account sedimentary environmental interpretation, palaeogeography based on sedimentology, sea-level reconstruction, palynology, palaeoecological diatom studies, geo-chronology and archaeology (see BAETEMAN 1999, and the literature there).

In addition to these remarks, it can also be observed that the process of dating the different transgressions on the basis of archaeological artefacts was never critically assessed. It was not realised that the nature of the information was in itself doubtful because the whole line of reasoning was based on negative evidence, *i. e.* on not finding remains of human activity in an area and hence assuming an inundation. However, an *argumentum ex nihilo*, in this case the absence of material, is always a dangerous argument in archaeology; and this is a subject that will be explored below.

Generally, during the development of the archaeological and geological literature, the transgression model and the gaps in the archaeological record were continuously used to reinforce each other. Following a circular argument, archaeologists referred to the transgressions to explain the absence of human activity in certain periods, and geologists pointed to the absence of human activity in certain periods to prove (and date) the existence of the transgressions. Given the absence of new archaeological finds and the lack of renewed geological work, this approach remained the norm for an extended period.

The main problem, however, was that no independent evaluation of the data took place. For example, the absence of archaeological finds later than the second half of the 3rd century was explained by the start of Dunkerque II (THOEN 1978), but it was never sufficiently questioned whether this absence of finds could not be related to other phenomena than a marine transgression. Before exploring the relationships, however, between the archaeological record and geological events in the coastal plain in more depth, a new model for its Holocene geological history must be presented.

## 5 A new model for the geological history of the coastal plain

The reconstruction of the Holocene geological history of the coastal plain is based on information from more than 1000 boreholes, as well as sedimentological investigations in temporary outcrops; and data from archaeological excavations. This is supported by approximately 200 radiocarbon dates and a palaeoenvironmental reconstruction based on diatom analyses (DENYS 1993). The research was carried out in the western part of the coastal plain, since unlike its eastern expanse, this area contains a more complete Holocene sequence, because of the presence of the palaeovalley of the IJzer, which is located slightly further west than the present-day river.

A comprehensive discussion about the Holocene geological history is published in BAETEMAN (1999). Here, a short summary of it will be presented, focusing on the events that are crucial to the understanding of the development of the plain, during the first millennium AD. For this purpose, previously unpublished palaeogeographical maps (Plate 2) and schematic cross-sections (Fig. 4) have been produced.

The formation of the coastal plain is a story of infill caused by the post-glacial relative sea-level (RSL) rise (Fig. 3). The specific sediment succession in the coastal sequence is mainly controlled by changes in the rate of RSL rise and its balance with sediment supply and accommodation space. An initial rapid RSL rise prior to ca. 7800 cal BP resulted in a rapid shift of the various sedimentary sub-environments of a tidal flat across the palaeovalley towards a position close to the present-day boundary of the plain (see Plate 2). This landward shift was associated with significant vertical sediment accretion and the active sedimentation surface could rise until supratidal levels resulting in the development of salt marshes, and introducing a lot of organic matter into near-surface deposits represented as vegetation horizons in the sedimentary sequence (Fig. 4).

At approximately 7500-7000 cal BP, the RSL curve shows a distinct retardation (Fig. 3). Consequently, the landward shift of the tidal environment was reduced and sediment supply easily balanced the reduced creation of accommodation space. Peat growth occurred, initially short-lived and locally in the

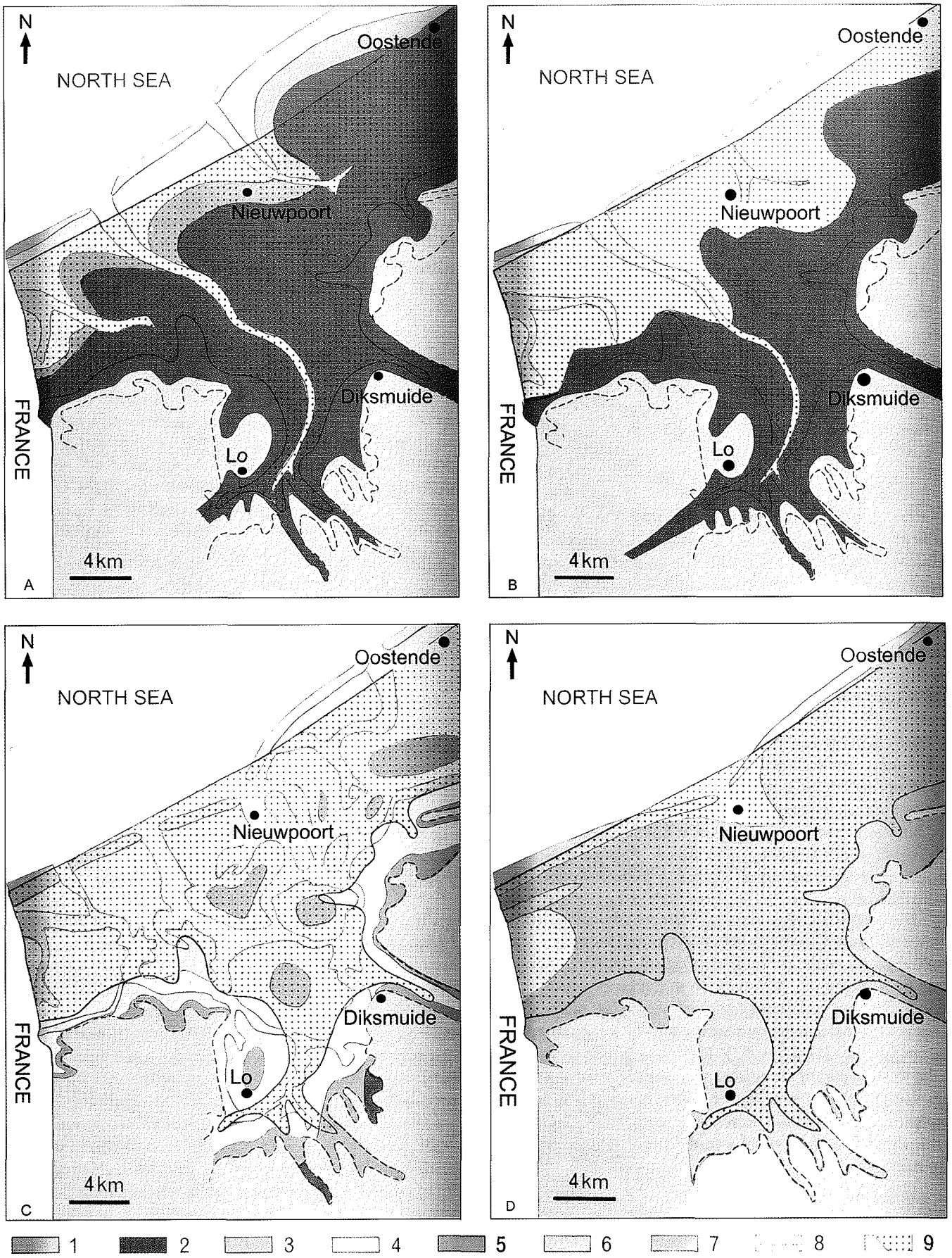


Plate 2. Schematic palaeogeographical maps of the western Belgian coastal plain.
A Ca. 5500-4000 cal BP - B Ca. 3000 cal BP - C Ca. 1500 cal BP - D 7th-8th century AD.
1 Outcropping Pleistocene deposits - 2 Freshwater marsh with peat accumulation - 3 Salt marsh - 4 Intertidal flat - 5 Tidal channel - 6 Coastal barrier - 7 Salt marsh and salt meadow - 8 Border of the present day coastal plain - 9 Extension of the coastal plain before the development of the "surface peat" (Design C. BAETEMAN).

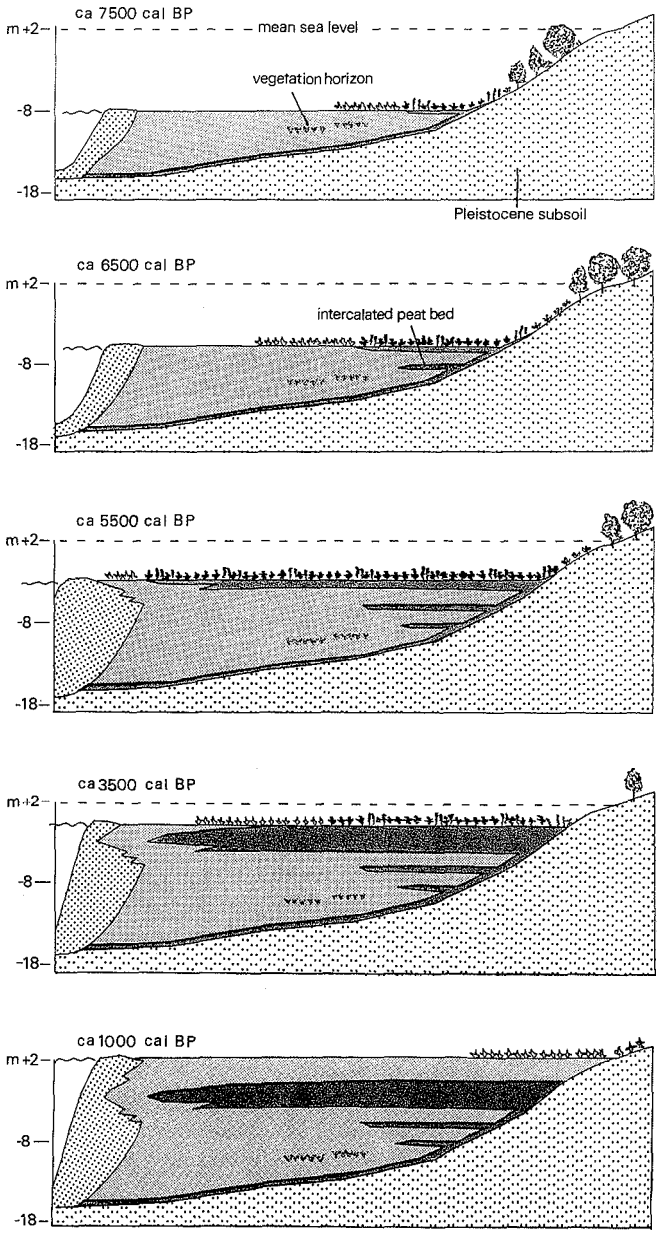


Fig. 4. Schematic cross-sections illustrating the evolution of the infilling of the Belgian coastal plain (Design C. BAETEMAN).

landward part, on the salt marshes which were now out of reach of tidal flooding for a sufficiently long period to allow a freshwater lens to form in the subsoil, resulting in the initiation of a freshwater marsh with peat accumulation (Fig. 4).

The frequent alternation of peat and mud in the sedimentary sequence, deposited between ca. 7800 and 6000 cal BP, was determined by a sedimentological control related to the tidal channel and creek network, and not by sea-level fluctuations. The channel and creek network were characterised by a high vertical sediment accretion, due to their reduced landward migration. Therefore, the channels and creeks (or portions of them) were forced to shift position, resulting in the alternate drainage and abandonment of specific parts of the tidal flat; and this happened at a higher level on each successive occasion because of the RSL rise. Periods of peat growth lasted longer and the lateral extension of the peat increased as deceleration of the RSL rise and the filling of the plain continued.

After 5500-5000 cal BP approximately, the RSL rise fell to an average of 0.70 m per 1000 years (ka) (Fig. 3). The sediment supply now overtook the rate of RSL rise, and the shoreface and shoreline started to prograde as no further accommodation space was created on the plain (Fig. 4). Nearly the entire plain changed into a freshwater marsh, of which peat accumulation was a feature (Plate 2: A). This situation lasted for about 2500 years, resulting in the formation of the thick intercalated peat bed, or "surface peat", the initiation of which dates back to as early as ca. 6200 cal BP in some areas. The tidal channels remained open during this long period of peat accumulation, serving to drain the freshwater marsh. Hence the coastal barrier was not a closed, continuous feature.

Occasional flooding of the surface peat started as early as ca. 4450 cal BP (2400 cal BC) at certain localities, in seaward areas. In several situations, renewed peat growth can be observed, indicating that the tidal effect did not permanently change the environmental conditions. The renewed peat growth, and hence the local flooding, are from different periods ranging from between 4000 to 2500 cal BP. The local flooding events must be considered as precursors for the renewed landward migration of the tidal system, which happened in successive steps, and should not be identified with the Dunkerque transgressions. It is most likely that the short-lived renewed peat growth has been interpreted as a "regression" by the Belgian Soil Survey.

The renewed landward migration of the tidal environments was not caused by a sudden RSL rise (see Fig. 3), but was most probably related to an imbalance of the sediment budget. Due to the infill of the plain and the progradation of the shoreface, the sediment source in the North Sea became exhausted. Nevertheless, as sea level was still rising, although at a reduced rate, sediment was still needed and new sources had to be found. This happened through the erosion of the shoreface and previously deposited tidal sediments. Consequently, the shoreface migrated landwards together with the tidal inlets and channels (Plate 2: B). This resulted in erosion of the freshwater marshes, causing drainage and compaction of the peat with a lowering of the ground surface.

The lowered surface of the marshes suddenly provided new accommodation space, forcing the channels to readjust by vertical erosion, since changes in tidal prism influence the size and depth of the channel. The vertical erosion in turn enhanced the drainage and compaction of the peat, and to some extent that of the underlying mud.

The varying ages of the surface of the peat, ranging between ca. 4450 and 1500 cal BP, suggest that the pattern of migration of the tidal channels and intertidal flats proceeded progressively further inland. The available $^{14}C$ dates suggest

that by 1500 cal BP (450 cal AD) a tidal flat was again installed in almost the entire coastal plain (Plate 2: C). By that time, the configuration of the present-day coastal plain had formed as its elevation was in relation with the sea level in that period.

It is not yet known how long it took before the intertidal flat silted up to a supratidal level, enabling the evolution of a salt marsh and salt meadow (Plate 2: D). A series of $^{14}C$ dates indicate that tidal channels were still active in 1306-1274 cal BP (during the 7th century AD) (VAN STRYDONCK & BAETEMAN 1998). It is quite possible that the silting up took several hundred years, because the compaction of the peat (by most probably 50%) and the lowering of the ground surface resulted in a significant vertical accommodation space which was filled by a slow sea-level rise.

People started to reclaim the area during the early medieval period. They built dikes perpendicular to the coast in order to protect themselves from the flooding of tidal channels. This, however, resulted in a reduction of accommodation space for tidal waters, which caused higher storm levels in the channels (*cf.* VOS & VAN HEERINGEN 1997). The latter phenomenon, together with a lowering of the surface of the land behind the dikes and embankments due to artificial drainage and peat digging, made certain areas vulnerable to storm catastrophes when dikes failed.

Such catastrophes are mentioned in the historical sources but they did not result in the deposition of tidal sediments, because the inhabitants did not allow a tidal environment to develop after the collapse of a dike. The only exception to this rule occurred in the region around Oostende, where dikes were deliberately breached in order to inundate the area around the town, as a defensive feature, during the wars in AD 1600 approximately. A tidal system developed in this locality over a long enough period to create a new tidal flat which was only progressively reclaimed subsequently.

The main differences between the new geological history proposed and the Dunkerque transgression model can be summarised as follows:

- the alternation of peat layers and tidal sediments is more complex than the Calais / surface peat / Dunkerque stratigraphic description allows;
- changes in sedimentary sub-environments never occurred simultaneously throughout the entire coastal plain;
- the surface peat is only one of many intercalated peat layers. It can not be used as a homogeneous stratigraphic unit or chronological marker because of the irregular pattern of peat growth in space and time;
- the surface peat accumulated whilst sea level was rising;
- the progressive drowning of the peat and renewed flooding were already well underway before the 4th century AD, or even the 2nd century BC (classical dates for the Dunkerque I and II transgressions);
- the drowning of the peat was not caused by a sudden sea-level rise;
- a differentiation of the tidal deposits overlying the surface peat into several transgressive phases is not observable in the field, and is therefore no longer tenable as a hypothesis.

The geological history revealed that it is important to consider local factors in the development of the coastal plain. The interpretation of the sedimentary succession at a particular location can certainly not be extrapolated for the entire area. This must be taken into consideration when interpreting archaeological finds in their geological context.

Despite the numerous field observations and $^{14}C$ data published since the 1980s, the Dunkerque transgression model is still commonly used by Belgian geologists and geographers (see BAETEMAN 1999). As a consequence, the new ideas about the development of the coastal plain have not fully reached the archaeological and/or historical community.

## 6 Literature review of the archaeological evidence

The new model for the geological evolution of the coastal plain has important implications for our understanding of the history of human occupation in that area. Within the framework of the new model, it is no longer possible to assume that the landscape during the Roman and the early medieval periods was entirely different. Our knowledge of the geology of the area now indicates that the marine influence had already become very pronounced before the Roman occupation, and that there were no drastic catastrophic changes in the landscape, during the transitionary era between the Roman and early medieval periods. However, the archaeological record apparently remains non-existent for that transitionary epoch, although it is relatively rich for the Roman period. In order to explain this trend within the context of the new geological model, a critical review of the published archaeological evidence is needed for the coastal plain, during the first millennium AD.

### 6.1 Roman activity in the coastal plain

A review of the archaeological record for the Roman period is given by Thoen, in a publication (THOEN 1978) that represents the interpretative results from an unpublished PhD thesis (THOEN 1973). The latter also included a catalogue of sites and an inventory of the archaeological traces and material per site, but these parts have yet to be published. Generally, Thoen's survey gives the impression that the coastal plain was a place characterised by intense occupation, or at least land use, during the Roman era. The author suggests human settlement, industrial and agricultural activities, made possible because the area was in a regressive period, according to the old geological model.

The most important set of data for the Roman activities in the coastal plain, compiled by Thoen, consisted of *"numerous*

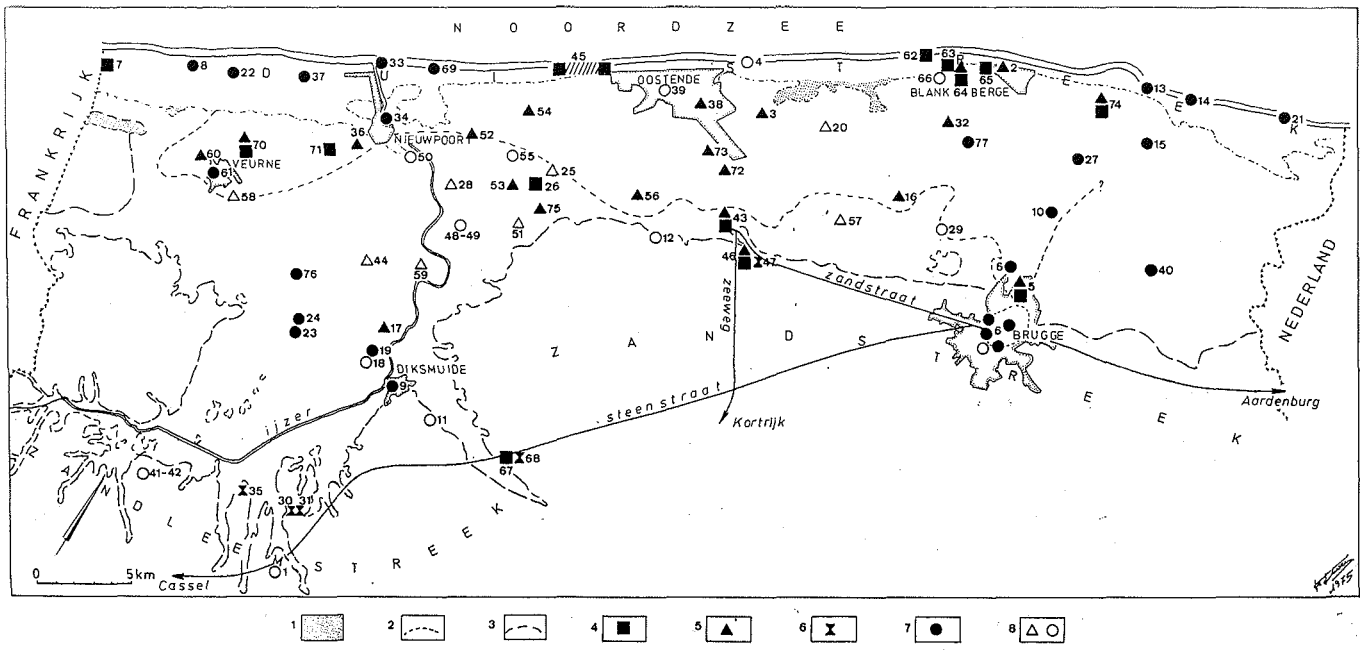


Fig. 5. The Belgian coastal plain during the Roman period, according to THOEN (1978).
1 Old dunes - 2 Boundaries of the Dunkerque I transgression - 3 Boundaries of the coastal plain (and of the Dunkerque II transgression) - 4 Settlement traces - 5 Human burial contexts - 6 Hoards - 7 Stray finds - 8 Finds with uncertain location.

*occupation traces"* found on top of the Dunkerque I deposits, dating from between 70 and 270 AD (THOEN 1978, 39; 244-245, map 4) (Fig. 5). Mostly by revisiting old finds collections and publications, the author brought together 147 find locations, of which 77 proved to be genuinely Roman, *i. e.* there were 37 occupation sites (comprising dwelling traces and graves); 5 coin hoards; and 35 (sets of) stray finds.

Of the 37 occupation sites, 31 are located in the present-day polder area, one comes from the dune belt, two were found on the beach, and three (Oudenburg, Roksem I and Werken I; terminology following THOEN 1978) are actually situated at the Pleistocene inland border of the coastal plain (THOEN 1978, 63-77). The site from the dune area (De Panne I) consists of Roman occupation traces found on an Iron Age salt production site (THOEN 1978, 50-53). The two sites detected on the beach (Raversijde I and Wenduine I) represent a salt production site (THOEN 1978, 88) and a small *vicus* that evolved into an important trading centre, respectively (THOEN 1978, 109-112). Of the 31 polder sites, 23 yielded only funerary remains; 4 yielded traces of structures (Leffinge II, Wenduine II, Wenduine IV and Wulpen II); and 4 sites contained both structural and mortuary evidence (Brugge I, Wenduine III, Wulpen I, Zeebrugge I) (THOEN 1978, 77-78). In the following discussion, the sites from the Pleistocene sand area, and the coin hoards (that come from the same area), will be left aside.

According to Thoen, the activities which developed on the sites mentioned above would have included fishing, salt production with associated peat digging, other industrial practices, agriculture, animal husbandry and trade. The exploitation of marine animal resources is demonstrated by the presence of marine molluscs (mussels, cockles, oysters) at the coastal sites, and at De Panne in the dunes. Trade in these food products is also suggested by their presence at inland Roman sites. Evidence for Roman salt production has been found at the sites of Raversijde I, Zeebrugge I and Leffinge II.

Raversijde I yielded a $^{14}C$ date for an element of a wooden structure, possibly related with the salt production: 1871 ± 83 BP, converted into calendar years as 79 ± 83 AD (IRPA 167: THOEN 1978, 88). A second $^{14}C$ date, again from an element of the wooden structure, is considered to be unreliable: 1602 ± 83 BP, converted into 348 ± 83 AD (IRPA 142: THOEN 1978, 88). It is not clear why the second date was rejected by Thoen, although this may have occurred due to the fact that the date fell out of the accepted parameters of the Roman regression. The author claimed that the wooden fragment, which was exposed to seawater, must have been contaminated. As a consequence of the reservoir effect, however, a marine contamination could only have resulted in a date that is too old.

Fortunately, because of the large standard deviation of the measurements, it is not necessary to attach too much importance to these dates. The first date (IRPA 167) must now be calibrated as 30-40 AD (2%) and 50-250 AD (98%) with 68% confidence, or as 50 BC-350 AD with 95% confidence (following STUIVER *et al.* 1998). The second date (IRPA 142) must be calibrated as 340-370 AD (7%) and 380-560 AD (93%) with 68% confidence, or 250-640 AD with 95% confidence (following STUIVER *et al.* 1998).

Industrial or small-scale craft-working activities, in addition to the exploitation of marine resources, would have included pottery production (reflected by the existence of a local, so-called "coastal" pottery); iron working (represented

by debris found at both Raversijde I and De Panne I); and textile production, suggested by specific artefacts.

Evidence for the exploitation of the landscape comes in three forms: first, as ploughing traces, visible on the top of the "surface peat" at Raversijde I (when the peat was still outcropping at the beach, before the construction of the breakwaters that captured sand deposits); secondly, in the form of a system of parallel drainage channels, in the area between Stalhille and Houtave (see Plate 1 and Fig. 1); and the third category consists of the bones of domestic animals (cattle, sheep, goat, pig), found at several sites.

The importance of trade for the inhabitants of the coastal plain is also suggested by the favourable geographic location of several sites on the coast, as well as by the presence of imported goods (mainly pottery), and the consumption of marine products (salt, molluscs) at inland sites (THOEN 1978, 84-126).

This archaeological evidence is also supported, in some cases, by textual references from classical Latin authors, and by epigraphic data (see THOEN 1978, 1987, following LAMBRECHTS 1953).

As a qualifying note to the archaeological evidence described above, it must also be mentioned that critical analysis and appraisal of the data is hampered by partial publication. Nevertheless, even on the basis of the published interpretative results alone, it would appear that evidence for Roman-period occupation in the coastal plain is rather scant, and currently of low quality.

Most of the limitations of the archaeological record have already been pointed out by THOEN (1978). Most importantly, he observed that the circumstances of recovery of finds have always been very unfavourable on most of the sites. Almost half of the sites (35 out of 77) have only yielded stray finds. Of the 31 occupation sites (both dwelling traces and graves) from the polder area, 21 were accidentally discovered during peat digging, from the 18th century onwards; 4 were found in clay quarries and a further 6 were encountered during other activities involving large-scale earth removal (THOEN 1978, 65). Significantly, however, almost none of these polder sites have been subjected to even partial excavation. Furthermore, the dune site of De Panne I was "explored" at the beginning of the 20th century, and studied before World War II; and the sites of Raversijde I and Wenduine I consist only of collections of finds recovered from the beach.

In summary, therefore, occupation traces from the Roman period are rare in the Belgian coastal plain; although, whether or not this is the result of unfavourable circumstances of recovery, is uncertain.

Indications of stone structures are present only at Oudenburg, a settlement situated just beyond the coastal plain, on higher, sandy grounds. At the same time, traces of timber buildings have been found at only two sites (Brugge I and Wulpen II) but no plans are available for analysis. The only other remains of building materials are loam fragments, possibly from wattle and daub construction techniques, from four sites; and fragments of *tegulae* or *imbrices* (ceramic roof tiles) from eight others (THOEN 1978, 78-79).

The contextual information is also scarce with regard to the grave finds (THOEN 1978, 79). Where no occupation traces could be related to specific mortuary evidence, it remains unclear whether the graves or cemeteries were isolated or linked to associated settlements. In addition, it is difficult to be sure whether all finds of complete ceramic vessels do indeed represent grave contexts, although this is undoubted on some sites where cremated human bones were found. Inhumations were apparently never encountered, or rather not recognised as Roman remains, by those who accidentally destroyed the Roman sites.

When only the density of all Roman finds from the coastal plain is taken into consideration (77 contexts from an area of ca. 800 km$^2$), rather than the quality of the information, it is not possible to ascertain whether the evidence suggests either dense or scarce occupation. The reason for this situation, as outlined above, lies in the fact that most of the material has been brought together by studying existing (and sometimes old) finds, which were rarely the result of systematic prospection. Where survey campaigns have been undertaken, they have mostly occurred in the western dune belt (see, for example, the works of de Loë, Maertens de Noordhout, de Maere d'Aertrycke, Cumont and Loppens) (TERMOTE 1987).

With regard to the activities at the sites, some of the evidence put forward needs to be set into perspective. Of course, the presence of marine animal remains, *i. e.* shells, at the coastal sites and at the dune site is not surprising. However, this does not prove that the inhabitants of these sites were collecting for more than subsistence needs. The presence of marine molluscs at Roman sites, further inland in Belgium, such as Liberchies (LENTACKER & VILVORDER 1997), Braives (LENTACKER *et al.* 1993) and Tongeren (ERVYNCK, unpubl. results), does not prove that these victuals came from the Belgian coast. They could, for example, have come from the easily accessible coast around Boulogne (Northern France), via the Boulogne - Cologne road (which passes Liberchies, Braives and Tongeren).

In that context, it is to be regretted that, due to the lack of sieving and interest in the archaeozoological aspect of the sites, no fish remains are available from the Roman settlements in the coastal plain. Although larger marine fish are generally absent from inland Roman sites in Belgium, it has recently been established that, in addition to marine molluscs, marine flatfish were also consumed at the Roman settlement of Nevele-Kerrebroek, a site located between Gent and Brugge (ERVYNCK *et al.* 1997). Because of the location of the site, these fish and molluscs most probably came from the Belgian coast, a hypothesis that can, unfortunately, not be corroborated by similar fish material from the Roman coastal sites (where virtually no fish remains were recovered). It remains unsure whether the finds at Nevele suggest a native origin from our coast, for the marine products consumed further inland. It is possible that the trade connections between the coastal and the inland sites did not reach far into the interior, on Belgian territory.

Another fish product for which consumption has been proved at inland Roman sites is fish sauce, made on the North Sea coast from locally caught small fish (VAN NEER & LENTACKER 1994). Again it is impossible to prove that this product was made at the Belgian coast rather than in another region along the North Sea, although a relationship between salt producing sites (which are present on the Belgian coast) and fish sauce production is not unlikely.

Except for the salt production and perhaps some iron working, the other evidence for industrial or craftworking activities remains limited. The pottery production centres for the "coastal wares" have never been found to date and their economic importance remains to be assessed. The same is true for textile working: in both cases it remains unclear whether production exceeded the domestic level or the context of regional-local consumption and traditions.

The evidence for the agricultural exploitation of the landscape also remains questionable. The features visible on the top of the "surface peat" at Raversijde I were interpreted as ploughing traces, but they were never dated. Similarly, it has never been proved that the remarkable system of parallel drainage channels in the area between Stalhille and Houtave had a agricultural origin, and an independent date is also lacking for this particular landscape.

Finally, the bones of domestic animals found at several sites suggest only that animal products were eaten there. The collections are too small to prove that these sites were production centres for animal husbandry. Furthermore, the animal bone finds from Oudenburg should be disregarded as evidence for animal husbandry in the coastal plain because this settlement is not located within the area, and it must have had a catchment area that included both the present-day polder area and the Pleistocene sandy soils. It is also important not to forget that the archaeozoological record for the Roman coastal plain was mostly collected long ago; and consequently with poor sampling and recovery methods, it is severely biased towards larger animals (cattle).

The evidence from the classical texts will not be discussed here, because it is too anecdotal. One example: the often mentioned and famous production of hams by the *Menapii* (the name under which the Celtic inhabitants of coastal Flanders appear in Latin texts) certainly has nothing to do with activities in the coastal plain, where forests that are needed to herd domestic pigs were lacking. Under Roman rule, the *Civitas Menapiorum* extended from the coast to the eastern banks of the river Schelde, which makes it very likely that the original homeland of the *Menapii* also covered part of sandy Flanders, where forests were still abundant. Relating the Menapian pigs to the coastal plain is therefore unnecessary.

In 1987, a more popular account of the state of research was published concerning the activities in the coastal plain, during the Roman period (THOEN 1987). The survey then comprised 42 sites with *in situ* finds. Compared to earlier publications, no significant new sites with occupation traces were presented that could alter the ideas published in earlier works. The publication shows, however, that at that time survey campaigns were under way (HOLLEVOET 1987a), the results of which were briefly presented. They confirmed the presence of a Roman occupation layer in the dune area at De Panne (TERMOTE 1987), as well as dense Roman occupation within and around Oudenburg (HOLLEVOET 1987b), and the occurrence of Roman finds *in situ* in the Zeebrugge area (HILLEWAERT 1987).

Another trend visible in the publication is the further introduction of approaches from the natural sciences into Flemish archaeology. On the basis of earlier work (BAETEMAN *et al.* 1981), a salt production site (Leffinge II) was put in its geological context (BAETEMAN 1987). Furthermore, vegetation reconstructions were attempted for the Roman and pre-Roman period (DE CEUNYNCK 1987) and archaeozoological research was taken up again, albeit on a small finds collection from Bredene II, a new site not discussed in Thoen's earlier work (PETERS 1987).

The most important results from these studies are the discovery of a thin Roman occupation layer at Leffinge II (BAETEMAN 1987), and indications of the cultivation of cereals and field beans (*Vicia faba*) near the site of Bredene II, on the basis of pollen analysis (BILLIET 1981). It is stated that the cereal production at the site could have included the cultivation of wheat (*Triticum* sp.), barley (*Hordeum vulgare*) and oats (*Avena sativa*) (THOEN 1987, 66), but the original data certainly need reviewing (BASTIAENS, pers. comm.). A pollen diagram from the site at De Panne did not reveal traces of agricultural activity (DE CEUNYNCK 1987).

From the published data, therefore, it is possible to conclude that the evidence for human occupation in the coastal plain is somewhat enigmatic during the Roman period. There is no doubt that people were active in the area but whether there was continuous occupation remains obscure. The scarcity of building remains suggests that settlements were rare and the impression given is that permanent habitation only developed along the dune belt and on the coast. It is not impossible that agriculture was practised near these habitation sites, but more archeological proof is needed. Activities in the present polder area must have been oriented towards salt (and fish sauce?) production (where salt water was entering the coastal plain) and, possibly, towards the herding of sheep and goats. Both types of activities, however, will have been of seasonal nature.

### 6.2 The late Roman and Migration Periods. The transition from the Roman to the early medieval world

Thoen dates the end of human occupation in the coastal plain to the late 3rd century AD, and even talks of an *"evacuation"* of the area, most probably between 268-270 AD. The reason for this event is given as seaborne raids of pirates, soon followed by the beginning of the Dunkerque II transgression (THOEN 1978). Indeed, according to Thoen's

survey, 4th-century artefacts are absent from the coastal plain but present at sites on the Pleistocene sandy soils (THOEN 1978, 252-253, map 8). The late Roman period seems to have left no traces in the coastal plain.

Evidence from the Migration Period is also hard to find. A survey of the published archaeological finds from the province of West Flanders up to the Viking age (BAUWENS-LESENNE 1963) mentions early medieval finds from the coastal plain but the information is difficult to use. In the inventory, finds are grouped as "Roman" or as "Merovingian" without a transition period between the two eras.

Within the "Merovingian" group, it is difficult to tell whether finds from the Migration Period are present. Only when the term "Frankish" is used, one can suspect the presence of a Migration Period find, although in older publications "Frankish" is sometimes used to indicate what we would call "Migration Period" and "Merovingian". Nevertheless, "Frankish" finds from a site at De Panne (see BAUWENS-LESENNE 1963, 24-28 for an extensive bibliography) do make it possible that continuity from the Roman to early medieval period can be suggested at that site.

Of course, in the absence of recent archaeological excavations, this observation must be viewed with caution, although according to Termote, late Roman traces are also present in the dune area at De Panne (TERMOTE 1990, 105, map 1: 3), and renewed research on existing collections has revealed the presence of "Anglo-Saxon-type" pottery in the same area (TERMOTE 1990, 107). The term "Anglo-Saxon pottery" must probably be understood in this context as referring to hand-made, early medieval pottery, without any implication with regard to geographical provenance.

At De Panne, at least 13 *sceattas* have also been found, dating from the period between 690 and 750 AD. Even earlier post-Roman coins are also known from the coastal area: a *tremissis* was found at Middelkerke, minted between ca. 500 to ca. 587 AD, and another *tremissis* was discovered at Nieuwpoort, dating from the period between ca. 587 to ca. 670 AD (SCHEERS 1991). Regretfully, contextual information for these finds is lacking.

Other published evidence for activities in the coastal plain during the first post-Roman centuries has been proved to be unreliable. The hypothesis that a population lived at Koksijde between the 4th and the 8th century, burying its dead at the site which became the 12th century the Abbey of the Dunes (SCHITTEKAT 1960) has proved false. The so-called early medieval population simply belongs to the earliest phase of occupation of the abbey (see, amongst others, THOEN & MILIS 1974).

In addition, at the beginning of the 20th century, a so-called terp-mound was excavated at Vlissegem, and the remains were published as belonging to the "Frankish" period (DE LOË 1905). The finds would point to an occupation during the Migration Periods, although no building remains came to light. However, as said before, in older publications the precise meaning of the term "Frankish" is sometimes unclear, and there are, in fact, strong indications that the earliest reliable date for material from this excavation is Carolingian (BORREMANS 1974; VERHAEGHE 1980a, 61, note 1; 1980b).

A more recent small-scale excavation at this site in 1980 revealed comparable remains; but more importantly, it showed that the site was not a real terp-mound, *i. e.* an artificially raised dwelling site. Instead, the occupation layer sat immediately on top of what proved to be a natural dune. A new analysis of the pottery finds showed that a 9th- to 11th-century date is very probable. None of the earlier or more recent finds could be attributed to an earlier phase with any degree of certainty (VERHAEGHE 1980b). In view of the limitations of the fieldwork, however, the presence of earlier settlers cannot be excluded totally.

From the published evidence available, the conclusion must be that, when human occupation did occur in the coastal plain, it must have been close to the dune area, as suggested by the finds from De Panne. No information is available on the present polder area but again, the absence of evidence does certainly not constitute evidence for the absence of activity, especially considering the scant archaeological investigation of the polder area.

### 6.3 Early medieval activity in the coastal plain

The small-scale beginnings of permanent settlement in the coastal plain, during the early Middle Ages, are relatively poorly understood, from both archaeological and historical perspectives. Nevertheless, the archaeological and historical evidence available does provide important information, which we will discuss below. Following the traditional Dunkerque transgression model, it ought to be assumed that the coastal plain remained unoccupied until the Carolingian regression, beginning during the 8th century. Such a reoccupation, however, is poorly documented archaeologically. With the exception of the already mentioned site of Vlissegem, which contained 9th-century pottery (BORREMANS 1974; VERHAEGHE 1980a, 61, note 1; 1980b), no other archaeological evidence is known from the early Carolingian period, in the eastern coastal plain. One further possible exception is the presence of several large concentrations of 8th- to 10th-century pottery, discovered during fieldwalking at Uitkerke (VANHOVE 1987, 84-88 and 107-132).

In the western dune belt, the site at De Panne could have survived into Carolingian times; and survey has revealed the presence of an 8th- to 9th-century cemetery at this settlement (TERMOTE 1990, 109). It is even possible that the site was a *portus*, a trading centre. For the western part of the polder area, Termote mentions *"Carolingian sites known from texts and finds"* located in the coastal plain, whilst older sites (labelled as *"Germanic-Merovingian"*) are apparently absent from the area (TERMOTE 1990, 108, map 2,3). Due to the absence of extensive excavations, the nature of the oldest Carolingian sites remains obscure, and it is possible that they represent only seasonal occupation (TERMOTE 1990, 110).

At present, one of the most important sites is the "manorial court" known as the "Leenhof ter Wissche", at

Lampernisse. Partial excavations in 1972 and 1973 revealed a gradual build-up of the settlement over several centuries, until its final desertion in the 14th century. Only a very small part of the earliest occupation layer could be investigated, located at a depth of approximately 3 m, but no building remains could be identified.

In the absence of reliable comparative material (and of suitable funding and material for $^{14}$C-dating), the pottery recovered from this layer was initially dated to the 9th or 10th century, at the earliest. The later layers (thought to date from the 11th and 12th centuries) yielded pottery, including a number of diagnostic fragments (notably red-painted Pingsdorf-type wares and Meuse-valley glazed wares), but also a number of hitherto unknown wares. It was realised that many of these finds were doubtlessly residual but they could not be dated.

Most prominent among these classes of pottery was the group of so-called "burnished pottery", which was tentatively dated between the 9th-10th and 12th centuries, with a peak in the 11th century (VERHAEGHE 1977). However, more recent work on these wares, starting with the Southampton "Hamwic" finds (see, *e. g.*, HODGES 1981, 68-71), followed by the analysis of other assemblages (for example from Douai in northern France) showed these burnished wares to be present from the 6th or 7th century onwards. Today, it has also been shown that their production finished during the 9th century, if not before (DEMOLON & VERHAEGHE 1993). Other classes of ceramics, again largely residual, can also be dated to the 8th or 9th century, or even earlier. All this indicates that the Leenhof ter Wissche settlement may have originated well before the 9th century.

Whether the site was originally used only seasonally cannot yet be ascertained, but the relatively high quantity of early medieval pottery finds, and the significant proportion of burnished wares (a product of fairly high quality) suggests a more permanent settlement, possibly of some status. This would imply that the landscape was already accessible for seasonal or even permanent habitation before the 9th century.

Interestingly, in 1972, topographical and soil survey of the surroundings of the site showed that the original settlement was located on a clay and peat subsoil, at the edge of a sandy ridge, which corresponds to a filled tidal channel. It is not known whether this channel was still open at the time of occupation, but it had definitely silted up by the 11th or even the 10th century. Certainly in the 11th century, the site was reorganized and expanded over the sandy ridge (VERHAEGHE 1977).

A few hundred metres north of the Leenhof ter Wissche, another, much smaller site was located on the same sandy ridge. A trial excavation yielded a few indications of activity during the 11th and 12th centuries, thus further confirming that the channel had silted up by that time.

In passing, it must also be noted that the origins of the later motte and bailey castle at Werken (the "Hoge Andjoen") can also be linked to the pre-Carolingian period, on the basis of pottery finds from what later became the lower bailey, which housed the castle chapel. The site and the finds remain to be studied and published systematically (see, however, VANTHOURNOUT 1991), and the oldest part of the settlement seems to be located on the very edge of the polder area, not in the polder itself. Nevertheless, the location suggests that the site had a significant catchment area which included at least part of the polder area.

The Carolingian period is also characterised by the so-called "*burgen*". Archaeological and historical investigations have shown that at the end of the 9th century several circular defensive structures were constructed against the Vikings, in the coastal area between Zeeland (the Netherlands) and the coast of northern France (HENDERIKX 1995, 94-101). They are regarded as "*vluchtburgen*" or "refuge forts": circular defensive earthworks where the people of the coastal area and their animals could shelter temporarily against attacks.

In the former county of Flanders, four of these fortifications can be found: Bergues and Bourbourg (now in northern France), Veurne and Oostburg (Zeeuws Vlaanderen in the Netherlands). It is almost certain that they were constructed around the years 890-891 AD, on the initiative of count Boudewijn II (HENDERIKX 1995, 95-96). Although they were, in the first instance, only temporary constructions, these "*vluchtburgen*" demonstrate that by the end of the 9th century enough people lived in the western (Veurne) and eastern (Oostburg) parts of the coastal region to justify the effort to protect them.

Some place-names in the coastal plain also suggest the presence of small-scale settlement during the period before 1000 AD. A first group are early medieval, and Germanic in origin, comprising the *-haim-* and *-ingahaim-*toponyms (meaning "the home of"), and date from the period between the 6th and the 10th century AD (GYSSELING 1950, 85; HENDERIKX 1995, 79). In the coastal area, examples of these toponyms still survive in the names of the villages of Vlissegem and Leffinge (both were already attested as parishes in 988 AD: VERHULST 1959, 6); and in fossil toponyms such as *Casinghem,* near Nieuwmunster (VERHULST 1959, 6, n. 5), and *Oudengem*, near Uitkerke (COORNAERT 1967, 130).

Another type of early medieval place-name is the *-sele-*toponym, which is unlikely to have been attributed after ca. 900 AD; for example Dudzele (AMERYCKX & VERHULST 1958, 12-13). It is important to note, however, that these early medieval toponyms only give a *terminus ante quem* and do not necessarily reveal the commencement of occupation of the settlements.

We have a slightly better knowledge of the age of some other place-names, which are attested in early medieval documents concerning the coastal area. Already by the 8th century AD, the place-names of *Locwirde*, *Merona* and *Cumbingascura* are mentioned in the salt marsh area, north of Aardenburg, Zeeland, in the Netherlands (HENDERIKX 1995, 96); whilst in the western coastal plain, the oldest known

toponyms are Lampernisse and Veurne, appearing in texts from the second half of the 9th century. The latter name refers to a settlement but the former, describing "grassland for sheep", does not by itself prove human habitation (Gysseling & Koch 1950; Ameryckx & Verhulst 1958, 14, note 49; Termote 1990, 110), although a settlement from the early medieval period was excavated there, as discussed above.

The names of *Locwirde*, *Merona* and *Cumbingascura* are connected in the historical records to so-called *marisci*. These were areas of grazing for sheep, situated on salt marshes or on terrain with salt-loving vegetation (Henderikx 1995, 33). Between the end of the 8th and the beginning of the 10th century, several *marisci* from Flanders and Zeeland are mentioned in written sources (Henderikx 1995, 77-78; Verhulst 1998, 33, n. 8), almost always related to large Benedictine abbeys (Verhulst 1998, 33-34). However, these abbeys were the only institutions which left archives for the early medieval period. Only when the secular landowners (on whom no written sources survive) donated sheep grazing areas to the abbeys, do these non-monastic proprietors become historically visible. Consequently, nothing is known about the exploitation of the sheep grazing areas from the period before the rise of the abbeys.

From the 10th century onward, the old term used for sheep farms or sheep grazing areas, *mariscus*, disappears, and is replaced by the term *terrae ad oves*, meaning literally "ground for sheep". According to Verhulst, the change in terminology points to the conversion of the salt marshes to pasture thanks to the slow but progressive desalination of the coastal sediments (Verhulst 1998, 34-35). The change from salt marsh into salt meadow indicates that in the 10th century large parts of the coastal area were beyond the reach of tidal flooding, thus allowing the upper part of the groundwater to become fresh.

## 7 New approaches

The data described so far, consisting of previously published finds and observations and re-assessments of the latter, must now be evaluated against new data, derived from archaeological fieldwork, environmental analysis and renewed historical investigations.

### 7.1 Geological and pedological observations, and diatom analysis at Raversijde

#### 7.1.1 The soil horizon

Recent observations in the excavation trenches at the deserted late medieval fishing village at Raversijde, municipality of Oostende (see Pieters 1993; 1997, for an introduction), revealed deposits predating the late medieval occupation (Pieters *et al.* 1998). These observations made it possible to give some context to the Roman traces found at the site, and to establish the history of its occupation and/or abandonment in relation to any changes in the accessibility of the surrounding landscape.

In general, Roman artefacts were rarely found. They occurred as stray finds, reworked in the medieval contexts, and only in a few instances have possible Roman small finds been found *in situ*. More traces have been left, however, by peat extraction which must have been important during the Roman period and even in the Iron Age. A pre-Carolingian date for a proportion of the peat extraction pits is suggested by a radiocarbon date from a *Scrobicularia plana* shell, recovered in life position within the tidal sediments that filled and covered the remnants of an extraction pit. The shell was dated to 624-759 cal AD (68% confidence) or 547-840 cal AD (95% confidence) and it had not been disturbed by peat digging activities during later periods (UtC-3448: Van Strydonck 1994). Given the thick layer of tidal sediments separating the remains of the extraction pit and the shell, this date suggests that the pit was excavated in the Roman period, or even earlier. An Iron Age date or earlier was attributed to another peat extraction pit in a similar way, *i. e.* by $^{14}C$ analysis of a shell dating from between 380 and 300 cal BC (68% confidence), or 390 and 230 cal BC (95% confidence) (UtC-7609, Van Strydonck unpubl. results).

Profiles observed in the excavation trenches at Raversijde reveal a peat layer, approximately 1 m thick, covered by a deposit of tidal sediments between 2 to 2.5 m deep. The peat is underlain by tidal clay and sand. At some places on the site, a soil is present within the upper clay deposits, approximately 50 cm above the top of the peat (Fig. 6), at around +1.5 m TAW. The soil characteristics are typically those of a very young clayey soil, characterised by the presence of numerous (up to ten per 100 $cm^2$) biogalleries with a diameter of 0.5 to 1 cm, and a strong prismatic structure, breaking down into a strong angular block structure in the upper 20 cm of the soil. The soil is covered by a thick organic layer, a few centimetres thick. It was dated to 2160 ± 60 BP, which is between 360 and 290 cal BC (0.36 probability) or between 260 and 110 cal BC (0.64 probability) (68% confidence), or between 380 and 50 cal BC (95% confidence) (UtC-6732, Van Strydonck *et al.* 1998). The soil must thus have been formed during the Iron Age. This date, however, does not reveal when the soil became submerged and covered by tidal deposits.

The soil horizon at Raversijde represents a humic vegetation horizon (A1), associated with a structural B-horizon, that originated on a salt marsh producing a lot of organic matter in near-surface deposits. The soil characteristics, and more specifically the structuration below the humic horizon indicate that the groundwater level was at least 0.5 m lower than the sediment surface for a certain time. With the Dunkerque model in mind, one could use this humic horizon as an indication for a "regression" as Moormann (1951) did in the Veurne area for separating the Dunkerque I and II sediments. This was referred to by Tavernier & Ameryckx (1970, 8) who extrapolated this observation into the

generalisation that a dark horizon was *"often"* found on top of the Dunkerque I deposits. In view of the date of the humic layer, however, its age does not fit into the Dunkerque model. Moreover, such a humic vegetation horizon cannot be interpreted as a regression. A vegetation horizon originates as soon as the surface silts up to a supratidal level, whence a dense salt marsh vegetation develops. Such a situation can happen locally and at any time.

The probable presence of a mature salt marsh, resulting in the humic horizon in the sedimentary sequence, does not corroborate the previous suggestion of Roman agricultural activities, at the site of Raversijde. The latter hypothesis was based mainly upon the presence of ploughing traces on the peat layer exposed on the beach, but perhaps this interpretation must be reviewed. The recent fieldwork at the site has shown that the top of the peat is always eroded (PIETERS *et al.* 1998), and maybe this phenomenon, together with some other disturbing factors, could explain the observed traces? Another indication that the area was never destined to be used as agricultural land during the Roman period, is provided by the fact that the Roman peat extraction pits were never filled immediately after the digging. They were simply abandoned and afterwards became filled by tidal sediments (PIETERS in press).

### 7.1.2 Environmental investigations

Diatom analyses of 10 samples from a profile with the soil horizon (Fig. 6) show that the tidal deposits above the peat layer are not at all homogeneous (DEMIDDELE & ERVYNCK, unpubl. results). Subdividing the diatoms found into broad ecological groups (Fig. 7) makes it clear that the lowermost sample, taken from the sediments that were deposited before the formation of the soil, must have originated in marine-brackish conditions, with little or no influence of freshwater. At the level of the soil, a distinct drop in marine influence is visible and freshwater diatoms dominate. The sediments deposited upon this soil again have a tidal origin although the marine influence is weaker than in the deposits underlying the soil. Towards the top, the marine-brackish group progressively becomes more important. The evolution towards a completely terrestrial situation could not be followed because of disturbances in the upper part of the profile.

This sequence shows that the renewed tidal influence in the area grew in importance only progressively, and that there is no evidence for a catastrophic scenario. It also demonstrates that the influence of freshwater remained significant during the deposition of the sediments above the soil layer, which was not the case for the deposition of the sediment underlying the soil.

The significance of the observations at Raversijde is at present not completely clear, especially as similar analyses from other sites in the coastal plain are lacking. They suggest, however, that the landscape at Raversijde was accessible centuries before Roman times; although the sudden change in the diatom spectra, observed when comparing the marine-

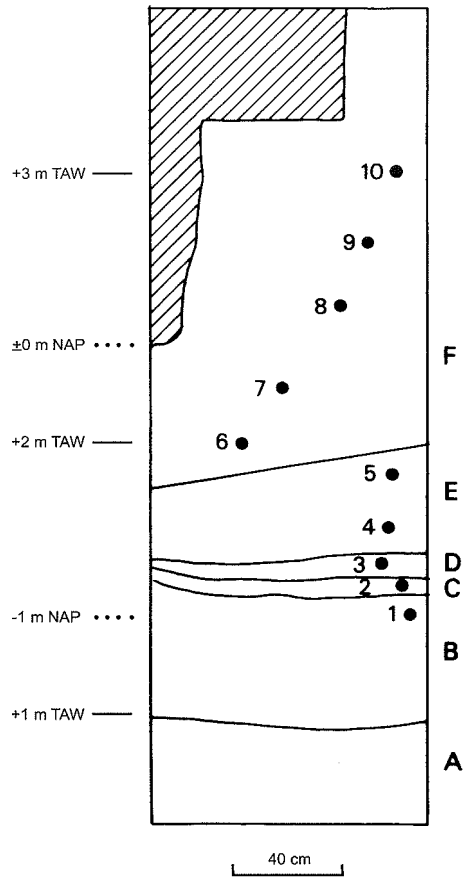


Fig. 6. Profile from Raversijde
with indication of the diatom samples (1-10).
A Peat - B Clayey sediments - C Soil horizon - D Heavy clay - E Sand and silty clays - F Clayey sediments.
(0 TAW lies 2.34 m below 0 NAP.)
(PIETERS, unpubl. data).

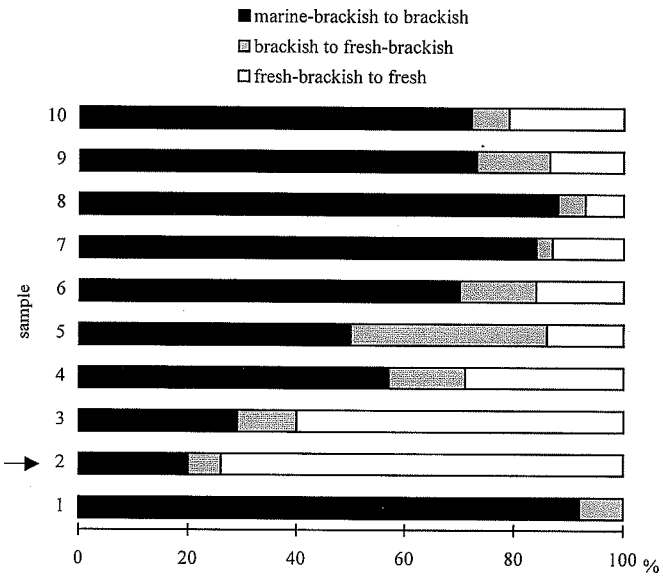


Fig. 7. Frequency of the ecological groups
within the diatom assemblages from a profile at Raversijde
(DEMIDDELE, unpubl. data in PIETERS *et al.* 1998)
(sample locations: see Fig. 6; the arrow indicates the sample from the soil horizon).

brackish assemblage beneath the buried soil and the flora from the soil itself, needs further explanation. Why did an intertidal situation abruptly give way to a terrestrial biotope? This sequence will have to be studied by higher resolution sampling in the future, but it is just possible that the process of diminishing tidal influence, represented by an ever decreasing rate of sediment deposition, is more difficult to trace than a process of growing tidal influence.

## 7.2 Environmental archaeology at Ter Beke-Oudenburg: mites and diatoms

Archaeological excavations at the site of "ter Beke", in Oudenburg, explored a terrain that is situated on the border between the outcropping Pleistocene sand area and the coastal plain. During the Roman period, more precisely between the end of the 2nd and the mid 3rd century, the site had a rural character. After this period, human activity seems to have ceased locally until the 11th-12th century, when a small agricultural settlement occupied the spot (HOLLEVOET 1992).

Samples for environmental archaeological analysis were taken from a pit, dating from the first half of the 3rd century;

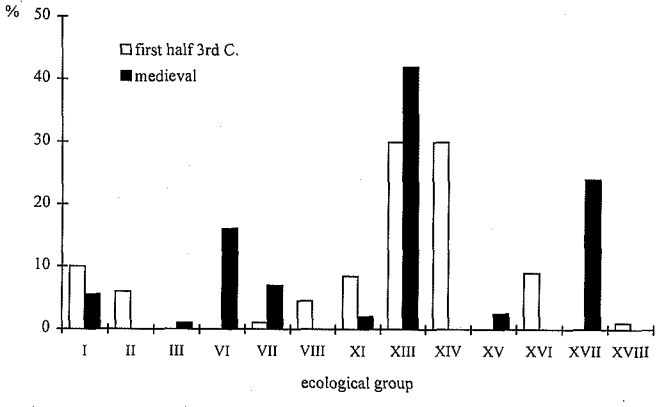


Fig. 8. Frequency of the ecological groups within the assemblages of oribatid mites from a Roman (first half of the 3rd century) and a medieval context at Oudenburg (SCHELVIS & ERVYNCK 1992, 1993).

| | |
|---|---|
| I | Moss, lichens and litter on dry sandy soil in *Calluna* heath and on dry and moist soils in moorland. |
| II | Moss, lichens and litter on dry sandy soil in *Calluna* heath only. |
| III | Dry and moist, rarely wet, litter as well as moss in woodland. |
| VI | Moist and wet woodland and moorland soils. |
| VII | As in VI but also in preferably wet *Calluna* heath. |
| VIII | As in VII but also in swamp woodland. |
| XI | Constantly soaked wet mosses, especially *Sphagnum* in moorland. |
| XIII | Moist as well as soaking wet, fresh or salty grassland. |
| XIV | Salty grassland only (salt marshes). |
| XV | Moist mosses on a solid surface. |
| XVI | Dry mosses on a solid surface. |
| XVII | Dry mosses on a solid surface and moss, lichens and litter on dry sandy soil in *Calluna* heath. |
| XVIII | Aquatic habitats. |

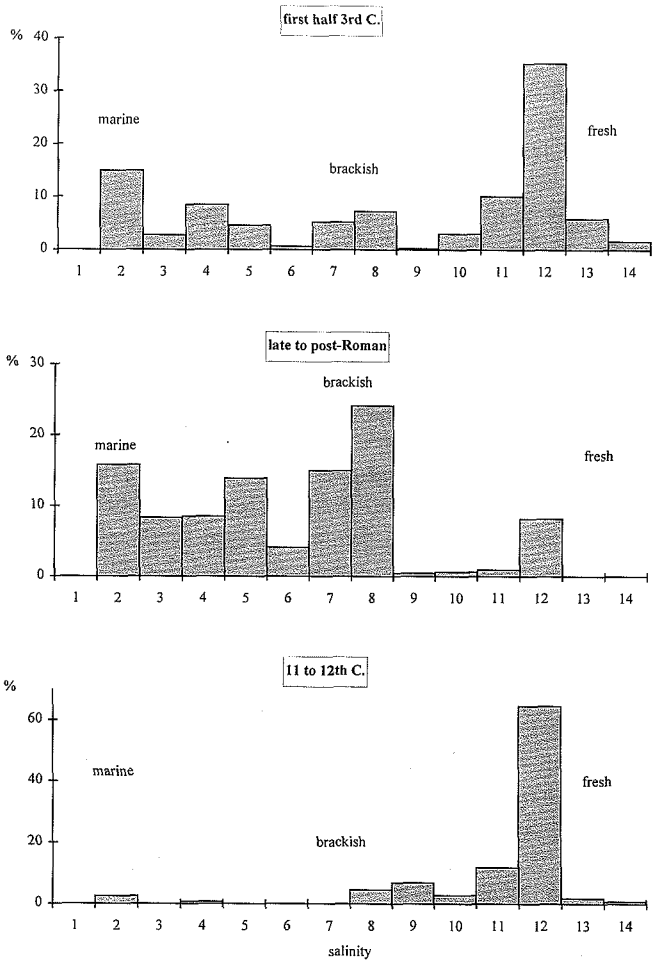


Fig. 9. Frequency of the ecological groups within the assemblages of mites from a Roman (first half of the 3rd century), a late Roman and a medieval context at Oudenburg (DEMIDDELE & ERVYNCK 1993 and unpubl. data).

secondly, from a small depression that directly post-dated the Roman occupation (but could not be dated more precisely and will therefore be labeled "late Roman"); and thirdly, from a high medieval (11th-12th-century) context. Diatoms and mites were extracted with success although the late Roman sample did not contain a sufficient number of mite remains to allow any reliable interpretation. The analyses from the 3rd-century and the medieval samples have been published (DEMIDDELE & ERVYNCK 1993; SCHELVIS & ERVYNCK 1992; 1993) but a wider comparison, also including the late Roman diatom flora (DEMIDDELE & ERVYNCK, unpubl. results), is presented here.

When the mite remains from the 3rd-century sample and from the medieval sample are subdivided into ecological groups (Fig. 8), it is clear that the older assemblage is dominated by the species living in "moist as well as soaking wet, either fresh or salty grassland" (ecological group XIII); and by the organisms exclusively living on salty grasslands and salt marshes (group XIV). The latter group completely disappeared in the sample from the medieval context. This shows that during the first half of the 3rd century, tidal influence was present at the inland border of the coastal plain, most probably via a tidal channel. The sample from the medieval context, showing no marine influence at all, proves

that the marine influence attested in the Roman assemblage cannot be related merely to the fact that the site is located in close proximity (ca. 10 km) to the sea.

The interpretations derived from the analysis of mites are corroborated by the diatom spectra from the same samples (Fig. 9). In the sample from the first half of the 3rd century, a marked marine influence is present, although the freshwater component in the flora is still dominant. The late Roman assemblage, however, showed a significant increase in the marine and brackish component of the flora, together with a near disappearance of the freshwater species. In the high medieval assemblage, nearly all marine influence had gone. Thus, the diatom spectra again illustrate the increase in marine influence during the late Roman period, and any open gullies near the site must have gained in power at this time. This observation, however, does not provide evidence for a sudden, catastrophic start of a transgression, since the tidal influence was already present throughout the coastal plain.

### 7.3 Prospection and excavation in the eastern coastal plain

In the 1980s and 1990s, a combination of survey campaigns, watching briefs during construction works, and excavations were undertaken for the first time, in a systematic manner in the eastern coastal plain (by Hollevoet, Hillewaert and others). Although the results of this fieldwork are not yet extensively published, three important conclusions can already be drawn. First of all, many new find spots with Roman material have been located. For example, in the area between Stalhille and Houtave, no less than 24 finds concentrations have been observed (HOLLEVOET, unpubl. results).

However, although the quantitative aspect of the Roman archaeological record for the coastal plain thus increased tremendously, the quality of the information remains limited. Almost all of the sites comprise concentrations of reworked Roman finds, from medieval peat extraction contexts, and they are located along former channels or creeks (HOLLEVOET 1987c). Unfortunately, due to the reworking of the finds, it is not possible to ascertain the original relationship between the location of the sites and the hydrographic network.

Roman finds were discovered *in situ* in only one case on a site at Houtave, where a layer of debris from salt production activities was found on top of a peat bed. The latter was partly extracted in an irregular manner, a process which must be related with the salt production itself (HOLLEVOET 1987d). This site again suggests that the tidal influence reached the inland border of the coastal plain, during the Roman period.

A second important conclusion which can be drawn from the fieldwork in the eastern coastal plain, relates to the discovery of Roman sites that are not covered by any tidal deposits. At the end of the 1980s, several concentrations of Roman finds were found, several of them *in situ*, during the further development of Zeebrugge harbour. A number of them were not covered by tidal sediments. On top of the Roman remains, the medieval (to modern) plough soil was present (HOLLEVOET 1989).

Theoretically, it is possible that tidal sediments, deposited after the Roman occupation, had been removed by activities such as agriculture. Nevertheless, the absence of tidal sediments seems to represent a consistent trend within the area which is also witnessed at two recently found Roman sites situated on local elevations or outcrops of the Pleistocene subsoil (PATROUILLE & HOLLEVOET, unpubl. results). A striking characteristic of all these sites is that material from the late Roman, Migration-period or Merovingian eras is absent. Apparently, these locations were never used again between the Roman period and the onset of medieval ploughing. More precisely, they were never used again in a way that left traces in the archaeological record.

Thirdly, an additional concentration of Roman sites within the coastal plain has been identified in the area between Plassendale and Bredene, again with *in situ* remains not covered by tidal deposits. These sites, however, are not situated on elevations or outcrops of Pleistocene deposits but instead upon tidal deposits. Only one site has been partially excavated at Plassendale, revealing an enigmatic set of features. A group of refuse contexts contained primary deposits of selected consumption leftovers (marine molluscs, imported from the coast, some fish remains but very few mammal bones), together with fineware pottery. Traces of structures, particularly those related with habitation, are completely absent. Human presence is further attested by two skeletons, probably dating from the Roman period (on stratigraphic grounds), which must have been buried in or deposited upon the tidal sediments, without much funeral ritual (HOLLEVOET, DEGRIJSE & VAN LAERE, unpubl. results).

The interpretation of this site is unclear, and it is not possible to define any kind of activity that took place at this location, some kilometres away from the inland border of the coastal plain. Permanent habitation seems excluded, and processing of food items beyond the level of subsistence needs is improbable. Or was this site a ritual place, located at the edge of the accessible world, at the transition zone between the salt marshes and the mudflats? Roman skeletons found in "unusual" places, away from habitation sites, are not exceptional (HESSING 1993), and perhaps the consumption refuse contexts represent offerings? The site is disturbed by features from the High Middle Ages (after 1000 AD) but earlier medieval material, dating up to the 9th century, has also been recovered locally.

### 7.4 Early medieval sites in the Oudenburg-Brugge area

With the exception of the territory of Oudenburg, the Pleistocene sand area, just inland of the coastal plain, has long been neglected by the archaeological community, and early medieval sites were until recently hardly known (BERINGS 1985). Therefore, the impression was given that the area was scarcely inhabited during the second half of the first millennium. Recent fieldwork, however, in the area between Oudenburg and Brugge (survey of ground works and building activities, excavation and fieldwalking campaigns), has demonstrated the presence of at least 20 habitation sites. The

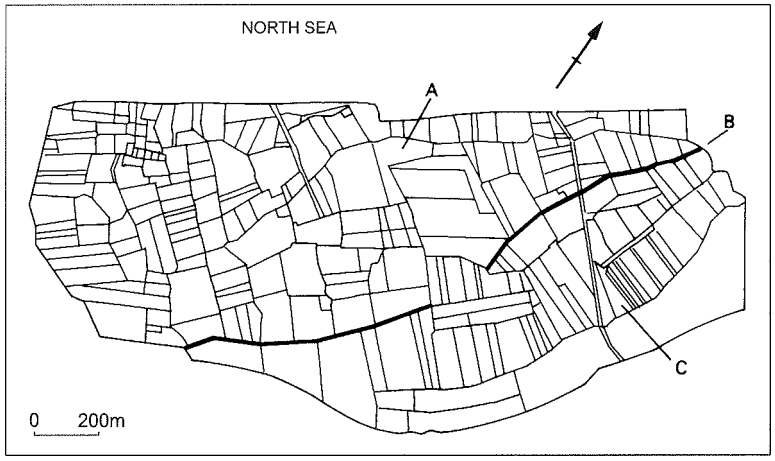


Fig. 10. The field structure of the domain of Sint-Pieters on Testerep.
A Old lands - B *Kaaidijk* - C New lands (Tys 1997).

date ranges for their occupation vary, but they go back without doubt to the 6th century (Hollevoet in prep.). At certain sites, late Roman pottery was found but not *in situ* (Hollevoet 1995, 19), and reworked post-Roman material earlier than *in situ* 6th- to 7th-century contexts, has been attested at several locations (Hollevoet, unpubl. results). Even the possibility of the presence of 5th century material is claimed for the area (De Cock *et al.* 1987). The conclusion must be drawn that the area just beyond the coastal plain was continuously inhabited, from the Migration Period to the High Middle Ages.

The observed early medieval archaeological remains between Brugge and Oudenburg must be viewed in relation to the presence of a late Roman *castellum* at the latter settlement. This fortification was constructed on a sandy outcrop, protruding into the coastal plain, and hence dominating the landscape. On the basis of the analysis of the cemetery, the duration of its use must probably be dated from the last quarter of the 3rd century to the first decade of the 5th century (Mertens 1987; Mertens & Van Impe 1971). However, renewed analysis of the collections from earlier excavations also points to the presence of Merovingian and Carolingian material amongst the finds from Oudenburg (Hollevoet 1995, 23). Thus, it is very likely that the late Roman fortification, which was only completely destroyed by its use as a quarry at the end of the first millennium, proved an attractive focus for human habitation until that time.

The resulting image, after combining the finds from Oudenburg with those from the surrounding sand area, is one of continuity in habitation, from the Roman period onwards. This continuity is also reflected in the survival of a Roman toponym *Arturiacum* (now Aartrijke), in the sandy area (Gysseling 1983).

The concentration of early medieval sites between Oudenburg and Brugge is located on sandy soils close to the transition zone into the polder area. Further inland, early medieval sites are scarce, a pattern that is also observable in the western part of the coastal plain (Termote 1990, 108, map 2: 2). This suggests that the location of the sites is not random; the edge of the sandy area must have had a specific attraction (see below).

### 7.5 Renewed investigation of the medieval landscape of the coastal area

Recently, renewed historical research has started on the evolution of the medieval landscape of the coastal plain. A detailed retrogressive reconstruction of the field structure of the middle part of the Belgian coastal plain (between the present towns of Oostende and Nieuwpoort, and including the archaeological site of Raversijde) has already been made, illustrating that it is possible to follow the evolution from salt marsh to grassland for sheep (Tys 1997, 157).

The retrogressive reconstruction of landscape evolution started from the observation that a *terrae ad oves* domain was granted to the abbey of Sint-Pieters in Gent through two donations in 992 and 995 AD (Fayen 1906, 95, nr. 100) (Fig. 10). This domain was situated on the coastal island of Testerep near a tidal channel separating the "isle" from the mainland. The (old) lands of the domain were, at least from the end of the 11th century onwards, separated from the tidal channel by a long defensive dike, the so-called *Kaaidijk* (Tys 1996, 122-125; 1997, 157-158). The tidal channel itself was reclaimed from the early 12th century. The difference between the regular and rectangular field-structure of these newly reclaimed lands and the irregular field structure on the old lands of the domain is striking. The irregular field structure of the old lands on Testerep must be older than the end of the 11th century, which is the *terminus ante quem* for the dike.

When the abbey of Sint-Pieters received the gift of this domain at the end of the 10th-century, the *terrae ad oves* had probably already been established for some time. It is even possible that before the 10th century, there might have been a kind of *marisci* on this part of Testerep. Such an occurrence, however, is not documented in the historical record. Archaeological excavations at Raversijde (see above) have shown that at least one of the boundaries of a field, within the irregular field structure follows the course of a salt marsh creek (Pieters, unpubl. results). This confirms the general idea that the irregular field structure in the coastal area originates from the pattern of the salt marshes, via the transition from *marisci* to *terrae ad oves* (Verhulst 1995, 91). When precisely the local salt marshes developed, during the early medieval period, remains unknown.

# 8 Conclusions and a new working hypothesis

The critical review of the published information, together with new field observations has resulted in the development of new ideas about the occupational history of the coastal plain during the Roman and early medieval periods. The integration of these ideas with the geological history of the area confirms that the classical Dunkerque model is just an artificially established subdivision. It must be concluded that there is no need for a transgressive subphase, starting in the late Roman period, in order to explain the differences between the patterns of occupation in the coastal plain, during the Roman and early medieval periods respectively. Moreover, when the transgression model is used as an explanation, regardless of the data that does not fit within it, one ends up with a story with too many coincidences. Or should we keep on believing that the Romans had the sheer luck of arriving at the Belgian coast at the start of a regression period, only to leave the area just before the onset of a new transgression?

From the geological point of view, no evidence was ever encountered to attribute lithological changes in the tidal deposits overlying the "surface peat" to several transgressions. The last phase in the evolution of the coastal plain started around 4000-3000 cal BP, with the deposition of tidal sediments on the surface peat. This sedimentation was continuous but not evenly distributed in space and time. Therefore, the final evolution from an intertidal to supratidal environment, which was the determining factor governing the use of the area by man, must have been different from place to place.

This occurrence has to be established separately for different areas, on the basis of archaeological and historical data. Each site investigated will show a different sediment succession, depending on local factors such as the proximity of a tidal channel, the relief and lithology of the Pleistocene subsoil, or the location of the site *versus* the shoreline and dunes. Moreover, due to the lateral migration of the tidal channels, each situation must have been unstable, until the entire coastal plain had completely silted up. According to the $^{14}C$ data, tidal sedimentation continued until at least the 7$^{th}$ or 8$^{th}$ century, at least in certain areas.

From the above, it is possible to conclude that, in general, the coastal area will have been as accessible (or as inaccessible) in the Roman period as in the early Middle Ages. During the whole silting up process (from 4000 cal BP to the early medieval period), the coastal area was characterised by intertidal flats, salt marshes, and salt meadows, crossed by tidal channels; and freshwater marshes with peat growth, all next to each other. The relative frequency of occurrence of these landscape elements will have differed between time periods, but this hardly mattered for the perception of the area as a whole by the people that visited it.

During the Roman period, the mite and diatom assemblages from Oudenburg illustrate that tidal influence still reached the landward border of the coastal plain. In such a landscape the development of Iron Age and Roman salt production sites is conceivable, and must have taken place at locations subject to some of the earliest silting up. It remains unclear whether lower lying ground was also exploited during the Roman period, and for what purpose. From the archaeological evidence, it is not possible to assume full agricultural exploitation, and the activities at sites such as Plassendale remain cryptic. Without doubt, the area was mainly used as a grazing zone for sheep as in both the Iron Age and the early medieval period. The coastal barrier, with well developed dunes in the west, could even have borne a continuous habitation, although such a conclusion needs more archaeological corroboration.

It remains unsure whether the presence of a soil horizon at Raversijde, formed during the Iron Age, represents a local event or a phenomenon of wider importance. In the latter case, the observations could point to the deposition of a thick layer of tidal sediments during the first millennium, an event that according to the traditional model would be called the result of a transgression after a regression (during which the soil developed). However, although the cause of the deposition of tidal sediments remains uncertain, it is conceivable that they are (partly) the result of the Roman activities in the coastal plain.

These certainly had ecological consequences. The drainage works in the peat areas initiated erosion of the peat, followed by further drainage, compaction, and a general lowering of the ground surface. At the same time, the extraction of peat by Iron Age and Gallo-Roman exploiters made certain parts of the area vulnerable, not only by damaging the peat layers (causing erosion, drainage, etc.) but also by leaving the extraction pits open. As a consequence of these processes, tidal currents were again allowed to enter the peat areas and the whole channel network gained power, causing more and more erosion of the peat.

At present, it is not sure how this human interference must be interpreted within the geological evolution of the coastal plain. It is possible that the progressive infilling of the plain had already reached a stable equilibrium during the late Iron Age, and that the Roman activities disrupted this, causing a new stage of peat erosion and subsequent tidal sedimentation. However, it is perhaps more likely that the transgressive movement which started around 4000 cal BP continued during the late Iron Age and the Roman period, and that human interference only enhanced the sedimentation processes.

According to the former scenario, the soil horizon at Raversijde represents an equilibrium stage of wider importance; however, according to the second possibility, the soil represents only a localised halt in sedimentation, that eventually started again by processes such as erosion, etc. Of course, without environmental data from more sites, the representativity of the observations at Raversijde can hardly be assessed. Neither explanation, however, needs to invoke

the occurrence of a "natural" transgression to explain the stratigraphy observed.

The diatom spectra from Raversijde show that the renewed influence of tidal action was a gradual process and not a catastrophic event. Furthermore, the survey campaigns, in the eastern part of the coastal plain, demonstrated that not all Roman occupation levels eventually became drowned. Hence, the slow changes in the landscape can not explain any sudden evacuation of the coastal plain.

Political instability, including the raids of pirates (THOEN 1978), could have been the reason why the archaeological record in the area seems to disappear before the 4th century. However, this theory fails to explain why the area apparently remained empty until the 8th century, a phenomenon that cannot be attributed to general depopulation, given the density of early medieval sites near the inland border of the coastal plain. It may be much more appropriate to seek the origins of the trends observed, from the end of the 3rd century, in the collapse of the economy and long-distance trade links at that time.

During the Roman period, industrial activities such as salt production or *garum* manufacture could be maintained in the coastal plain because of the high demand for such products and the presence of inland markets. By the early medieval period, however, scales of production had decreased to the extent that the local economy can be characterised as operating at the level of subsistence. Therefore, all larger industrial sites disappeared from the area. It may well be that small-scale animal husbandry, already present during the Roman period, simply continued after this economic transformation, but these activities left almost no traces which are archaeologically visible. Only when habitation sites re-emerged, do activities in the coastal plain again become archaeologically traceable.

Incidentally, coinciding with this apparent re-emergence, more and more documents become written down, which in the mind of some historians still leads to the interpretation that the coastal plain was only exploited again from that time. A more likely explanation, however, is that only the nature of the activities changed, in a transformation from non-sedentary enterprises, such as sheep herding, to more permanent habitation. Diminishing economies of scale from the Roman period, to a subsistence level by the early Middle Ages, would also explain why parts of the coastal plain not influenced by tidal activity, were not settled in the early medieval period.

With regard to agricultural activities, sites within the coastal plain could only focus upon sheep herding. This was a disadvantage compared to sites along the landward border of the coastal plain, which could maintain a catchment area of both sandy soils, dry enough for cereal cultivation, and wetter land (salt meadows, salt marshes) where the situation was favourable for sheep breeding. Indeed, the distribution of the early medieval sites along the border of the plain is not random; the settlements are located so that they could exploit both the coastal plain and the higher sandy soils.

If it is accepted that the animal husbandry activities in the coastal plain left no traces, regardless of the archaeological period, it becomes clear that only the extra activities undertaken by the Gallo-Roman population (salt and *garum* production, and mortuary ritual) give the impression that the coastal plain was "occupied" during that period. The disappearance of these activities from the 4th century onwards, makes our view of what happened in the coastal plain subject to the problems of archaeological visibility.

Furthermore, the varying nature of activities in the coastal plain is not the only complicating factor when the density of archaeological finds is compared for the Roman and early medieval periods: the archaeological record could be biased by other factors. For example, it is possible that, due to "aesthetic" or related reasons, Roman ceramics are more likely to have been kept rather than early medieval sherds, by the amateurs whose collections were reviewed by Thoen. Roman material is also more visible during field survey or watching briefs.

Moreover, the material culture of the Roman period and patterns of discard are different from those of the early Middle Ages. Whereas the first culture could be labelled a "consumption society", individuals within the latter period possibly possessed fewer goods, of which they perhaps took better care. It is also possible that material from the Migration Period has not been recognised as such, and is labelled as "pre- or protohistoric" in old collections. Besides, the chronological discrimination of pottery is not always straightforward for the early Middle Ages. Finally, as has been stated earlier, the value of an *argumentum ex nihilo* is always limited.

The results of the present survey lead to the conclusion that the renewed tidal activity, beginning at the end of the period of Roman occupation, could be the result of the predatory exploitation of the landscape in the former era, together with a potentially increasing neglect of the water management systems, during the politically troubled late Roman period. In addition, the collapse in the scale of economic activity at that time eliminated the reason of existence for the exploitation of the coastal sites.

Indeed, permanent habitation only seems to have emerged again when the subsistence economy, that succeeded the Roman large-scale economy, again made way for a more complex economy which initiated the installation of specialised habitation sites in the coastal plain, mainly relating to (surplus) sheep breeding. Whether this economic evolution is a direct consequence of more favourable conditions in the plain, such as highly silted up salt marshes, salt meadows, and completely filled channels, is still to be investigated, especially because it is still unknown when these natural processes took place.

Generally, the interpretations suggested above certainly need to be checked by further geological, archaeological and historical research. In the future, it is hoped that more geological observations will become available from archaeological excavations, and that a more systematic overview of the archaeological record for the coastal plain can be compiled, through extensive survey campaigns and further excavations. As part of this strategy, further independent dating of geological and archaeological deposits must be undertaken, using $^{14}C$ analysis. If, eventually, through this prolonged research, a more complete picture is obtained for the Belgian coastal plain, the results must be compared and integrated with those from other regions bordering the southern North Sea. There is a real hope that such an enterprise will be fruitful because similar reviews, *viz.* for the northern part of the Netherlands (KNOL 1993) and for Zeeland (southern Netherlands, VOS & VAN HEERINGEN 1997), also reached the conclusion that the Dunkerque model does not work and that human interference had disastrous effects upon the hydrography.

## 9 Acknowledgments

This contribution was developed from ideas presented during a paper at the *50th Sachsensymposion* at Bad Bederkesa (Germany): *A. Ervynck, The Forest and the Sea. Environmental archaeology of the transition from the Roman to the Early Medieval period, in Flanders (Belgium).* The authors wish to thank L. Van Impe, IAP (Institute for the Archaeological Heritage of the Flemish Community) for introducing this paper to the conference, and Prof. Dr. G. De Boe (director IAP) for his support. Thanks are also due to Dr. W. H. Zimmermann and Dr. E. Strahl of the *Niedersächsisches Institut für historische Küstenforschung* for their invitation to publish this contribution. The German abstract has been translated from the English version by Dr. E. Strahl. Correction of the English has kindly been made by Dr. C. Loveluck (Humber Archaeology Partnership). D. Van Cotthem (IAP) assisted with the drawing of the illustrations.

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