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Flandrian, a formation or just a name?¹

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Abstract. The name Flandrian is now used to indicate deposits of the Flandrian transgression or of the Holocene as a whole, in particular in Anglo-Saxon literature. As most geological connotations, Flandrian has changed significance and chronostratigraphic age since it was created in 1885 by RUTOT and VAN DEN BROECK.

At that time, Flandrian was a pleistocene "assise" which occurred at the end of long series of quaternary and tertiary stages. Therefore, it completed and still completes the geological tradition of the cenozoic sequence.

Substages of the Flandrian, as Calais and Dunkerque, are generally used, although there only exist type areas of both series instead of type localities. Work is going to define the type section in both areas of the Flemish Coastal Plain. It would be useful to re-establish the Flandrian stage on basis of these new investigations, as the last chronostratigraphic member of a continuous series in the cenozoic stratigraphical sequence.

Zusammenfassung. Der Name „Flandrian“ wird heutzutage, insbesondere in der angelsächsischen Literatur, verwendet, um Ablagerungen der Flandrischen Transgression oder des Holozäns als Gesamtes zu benennen. Wie die meisten geologischen Namen hat „Flandrian“ sowohl seine Bedeutung als auch sein chronostratigraphisches Alter seit seiner Erstverwendung durch RUTOT und VAN DEN BROECK (1885) geändert.

In jener Zeit bedeutete „Flandrian“ eine pleistozäne Schicht, die am Ende einer langen Serie von Quartär- und Tertiärstufen vorkam. Somit schloß und schließt es noch immer die geologische Tradition der känozoischen Sequenz ab.

Im allgemeinen werden Unterteilungen des „Flandrian“, wie z. B. Calais und Dunkerque, gebraucht, obwohl es von beiden Gruppen nur Typregionen und keine Typlokalitäten gibt. Man arbeitet daran, das Typenprofil in beiden Gebieten der flämischen Küstenfläche zu bestimmen. Auf der Basis dieser neuen Erkenntnisse wäre es empfehlenswert, die „Flandrian“-Stufe als letztes chronostratigraphisches Glied in der kontinuierlichen Serie der stratigraphischen känozoischen Sequenz wieder einzuführen.

1 Use of the Flandrian

The term "Flandrian" is the far most widely known connotation which is used in the utmost confusion since it was rebaptized by DUBOIS in 1924, half a century ago.

Especially in the Anglo-Saxon literature the name is largely adopted to indicate deposits of the entire post-glacial period in coastal areas mainly, also however, for continental deposits. Many references are known from the British Isles and the U. S. A., as well as from Australia and New Zealand (ZEUNER, WRIGHT, FAIRBRIDGE, FLINT, GILL, SUGGATE, WEST, SHOTTON).

In the same span of time, the term was highly amended, however, by the French and Belgian authors who were permanently confronted with the deposits of the type area of the Flandrian which is in the Flemish Coastal plain: extending from Sangatte near Calais (France) to the Scheldt Estuary in Zeeuws-Vlaanderen (The Netherlands). Actually, it has fallen in complete disuse, in France, Belgium, The Netherlands and Germany since World War II. Here, terms as "Calais" and "Dunkerque" at the level of Formation superseded the connotation Flandrian, albeit some French authors may use it with reference to Calais deposits (SOMMÉ 1969; COQUE 1972) only or to Calais and Dunkerque deposits together (SOMMÉ 1972, 1973, 1975).

Therefore, the term "Flandrian" is more safely used by those investigators in connection with the general post-glacial sealevel rise: the *Flandrian transgression*. So they escape the fact of giving this term a precise meaning.

It is clear that much of the confusion in the terminology of the Flandrian was due to the fact that the name was "misused" pell-mell in the chronostratigraphic, lithostratigraphic and genetic sense. Furthermore, even when used in one of the afore mentioned meanings, it did not cover either the same time span, the same series of deposits, nor the same phase of sea level rise. Actually, there does not exist a type section of the Flandrian, even not a type section of the Calais and Dunkerque deposits. One can only speak of a Flandrian type area.

Therefore Flandrian: a formation or just a chronostratigraphic name to store deposits of different nature and origin?

This is somewhat the way it was used on such official documents as the Geological Map of France and Belgium. Whereas on the French maps "Flandrien" is to indicate holocene deposits of the Flandrian marine transgression, one will find back exactly the same name on the Belgian maps as for the pleistocene, Last-Glacial, eolian, fluvial or/and marine sand loam, crag or/and peat deposits which may be affected by periglacial phenomena as well.

We believe that no further comments are required. But if one is to consider that the French definition was derived from the original Belgian one, he will quickly realize that it is about time to get world-wide investigators of the Holocene, alert about the kind of polluted sediment they are dealing with.

The present state of the problem is rather paradoxal: on a world wide scale, the term Flandrian is of general use, while on the local basis Calais and Dunkerque have gained more popularity amongst Northwestern European geologists and geographers. Therefore, it was strongly felt by the last mentioned group that a thorough reconsideration of the Flandrian was necessary if not notorious

2 Historical review of the name "Flandrian"

2.1 The Belgian "Flandrien"

The term "Flandrien" was introduced in 1885 by RUTOT and VANDENBROECK, almost half a century before DUBOIS' redefinition (1924), to connote the relatively thin, pre-holocene upper mantle of sand in Northern Belgium, lying in the continuity of the Dutch coversand. No relation with deposits of the Flemish coastal plain existed so far. Officially it should be reported in the geological legend of December 1891 as "Flandrien (q4)" being the uppermost member of the "Quaternaire inférieur" or "Diluvien". The "Flandrien" or Sands of Flanders are now considered to be of fluvial origin contrary to the original interpretation of DUMONT (1839) who pleaded in favour of a marine origin. In April 1896, considerable changes occurred in the Geological Legend and the meaning of the "Flandrien" was enlarged. In fact this was greatly due to recent investigations carried out in the Belgian coastal plain leading to the recognition by both RUTOT and MOURLON of the "Flandrien" in this part of Belgium as well. Moreover, in borings just North of Ghent, the "Flandrien" was found to contain amongst others "*Corbicula fluminalis*" and "*Cardium edule*" at a depth of more than 15 m below the surface, which made it possible to make a distinction between an upper continental (original) Flandrien and a lower marine Flandrien (RUTOT 1897).

Despite the most remarkable description of the boring of Oostende by DEWALQUE (1860) who created the "Assise d'Oostende" in which DOLLFUS had recognised at a depth of 25 to 33 m *Corbicula fluminalis* (MULLER) already in 1884, no relation was established by MOURLON (1896) with the new fossil findings. Yet DOLLFUS had already put forward the "pleistocene" (quaternaire inférieur) age of these "marine sands of Oostende" on basis of a their malacological content as well as their presence underneath weathered, continental loam layers similar to those found at the surface in the adjacent loess area outside the coastal plain. Above the weathered loam layers sealing the "Assise d'Oostende", younger marine fossil bearing sands, peat and surface clay and sands were found which DOLLFUS adhered to the "terrain moderne".

In fact they respectively coincide with the presently called Calais deposits under, and Dunkerque deposits above the peat layer.

It is clear that if DOLLFUS' description and interpretation had been thoroughly considered and understood, the Flandrian would have existed without any complex story.

What could be so difficult that left confusion in RUTOT's mind during twenty five years, until he discovered at HOFSTADE (North of Brussels), sands at depth containing *Corbicula fluminalis* in living position (1910). Let us explain the threads of his thoughts.

After an initial long silence, RUTOT (1900) rejects vigorously DOLLFUS' point of view entirely, stating that in the Oostende boring *Corbicula fluminalis* does not occur in situ nor that the weathered loam should be accounted for the equivalent of the Hesbayen loam which instead is a loamy facies of the Flandrian. In this new light all sediments below the main peat layer, down to the tertiary substratum, are of Flandrian stage age.

This over-simplification of the stratigraphical sequence in the coastal plain led to serious errors. First, the coastal plain facies of the Flandrian was extended by A. RUTOT

(1900) to sands containing *Cardium edule* in the hilly region south of Coastal Plain and belonging to the Yzer basin along the French-Belgian border. These sands are the later to be called "Izenberge Sands" of Holsteinian stage age (TAVERNIER and DE HEINZELIN 1962, PAEPE & R. VANHOORNE 1975).

East of Bruges, the continuity of the Flandrian was established along the "Golfe de Gand" (1897) or the Flemish valley (TAVERNIER 1943) from where at present it is known that the upper part is of periglacial Weichselian origin, whereas the lower *Corbicula fluminalis* bearing sands and gravels belong to the Oostende Formation of Eemian age (TAVERNIER 1943, 1946, 1948, 1954, DE MOOR 1963 and PAEPE 1967). Both deposits are occurring below a modern or holocene peat.

Thus appeared in the Flandrian sediments of different nature and origin, and not at least of different age and climatic period.

New emphasis was given to the Flandrian after the discovery of sand layers with bivalve specimens of *Corbicula fluminalis* at HOFSTADE (1909). This led to a renewed interpretation of the borings executed at Leffinghe, Middelkerke, Dendermonde and especially Oostende of which RUTOT (1910) now recognized the correctness of DOLLFUS' earlier interpretation in considering an Old Quaternary or "Moséen" age for the lower marine deposits of the Coastal Plain and in restricting the Flandrian to the sediments above with the exception of the peat and overlying polder sands and clays.

It is noteworthy that equal to the boring at Oostende, the layers with *Corbicula fluminalis* at HOFSTADE occurred underneath first, a heebayen loam and second, a "marine" Flandrian deposit in the sense of RUTOT (1910).

From this period also dates back the general assimilation of the connotation Flandrian to deposits which are often referred to as Calais at present. With regard to the lower-lying sands and gravels, with *Corbicula fluminalis*, the original "Assise d'Ostende" of DEWALQUE (1868) has thus been reestablished, however without precision of its age, nor of its upper boundary.

Instead of being a new point of departure, neither the official geological legend nor RUTOT's further publications and projects will give more attention to this problem, than before. Instead RUTOT was trying under the influence of new theories from abroad to adapt his quaternary subdivision to the climatic classification of PENCK & BRÜCKNER (1910) or to the archeo-geological subdivision of COMMONT (1912).

After the XI Geological Congress held at Stockholm in 1910, the Flandrian thus became incorporated into the Würm Glaciation which correlation was abandoned in 1920, in favour of an assimilation of the Flandrian with the uppermost "ergeron" of the Somme valley which chronologically is to be considered of Upper Mousterien age. During all these new adaptations the Flandrian remained of marine origin until HALET (1922) drew the attention to the fact that the marine Flandrian was limited to the present coastal plain. Outside the coastal plain, he considers deposits with *Corbicula fluminalis* as belonging to deposits of a large delta of Upper Pliocene or Lower Pleistocene age.

In HALET's mind the "Flandrian transgression" had started not earlier than the end of the Pleistocene or even beginning of the Holocene.

2.2 The French "Flandrien"

It is in the same line of thought that DUBOIS (1924) locates the "Flandrian transgression" in the time span of End-Pleistocene-Holocene-Middle Ages, as the fifth transgressive sedimentary cycle of DEPERET (1918) just after the Monastirien. His field of investigation is restricted to the coastal plain, and in particular to the area of Calais for the middle stratigraphic layers which are cropping out against the Artesian dome: he also has made an attempt to give a new interpretation to the quaternary deposits of the borings from Oostende, Middelkerke, Leffinghe and Vlissingen.

DUBOIS (1924) was well aware of the fact that RUTOT (1897) had grouped under the same connotation "Flandrien", the basal marine sands with *Corbicula fluminalis* MULLER, the weathered loams and the lower part of the upper marine sands of modern age in DOLLFUS' description of the boring of Oostende (1884). Yet he uses it again and extends the Flandrian to the top with greyblue marine sands which occurred on the Belgian Geological map as "sables gris bleu" (alr 1) of modern age and immediately appearing under the holocene peat layer (presently called: surface peat).

Thus doing DUBOIS (1924) is denying RUTOT's reconsideration of the beds with *Corbicula fluminalis* after the findings of HOFSTADE (1910). The reasons herefore must be searched in a series of studies which went on since 1900 already with regard to this specific fossil itself and to its presence in marine-estuarine deposits in the Netherlands, Danmark and Germany, and which had never been seriously considered by RUTOT. First of all, DUBOIS does not consider *Corbicula fluminalis* a representative for any specific interglacial phase. Since it is an eurytherm species no climatic significance may be attributed to it. As to the presence of this fossil in similar deposits of neighbouring countries, DUBOIS states, that LORIE (1903) had proposed to corrolate the marine Flandrian with the marine eemian deposits of Vlissingen. These eemian deposits characterized by the presence of *Bittium reticulatum* and *Tapes virgineus*, are at that moment adhered to a pre-Rissian, probably the Tyrrhenian interglacial.

The attribution of the Flandrian to the Eemian was extended to Northern France by BRIQUET (1906, 1907, 1908) whose believe it was that Eemian was identical to the Würmian. As we have seen above, RUTOT (1910) indentifies Flandrian to the Würmian as well, but relates his eolian Brabantian loess to the Eemian interglacial which had become Riss-Würm at that time.

The assimilation of the Flandrian to the Eemian is contested by the Danish investigator NORDMANN (1908) whose task it had been to make a revision of the faunistical content of the classical borings: Leffinge, Vlissingen, Middelkerke and Oostende.

His conclusions were: "No characteristic species of the Eemian occurs in the Flandrian except for *Tapes aureus* var. *eemiensis* NORDMANN but which occurs only as 6 worn fragments and two untypical bivalves". Flandrian and Eemian though both of temperate origin, are not identical.

DUBOIS was quite happy to state that this rejection by NORDMANN added to the rejuvenation of the Flandrian which he claimed on basis of the continuity which existed between the Flandrian and the uppermost grey sands. Furthermore, the presence of a molar of *E. primigenius* at the base of the boring of Coquelles under 15 m of marine

peaty sediments, containing neolithic, gallo-roman and even XIIIth century implements, covered in turn by younger marine sands laid to the assumption of an End-Pleistocene-Holocene age.

DUBOIS' assumption was in full agreement with HALET's statement, made two years before, about the age of the Flandrian.

The continuity in sedimentary evolution and timespan are at the base of the renewed creation of the one single continuous Flandrian cycle including three subseries:

- *Lower Flandrian (Assise d'Ostende)*: between -15 and -30 m with great abundance of *Corbicula fluminalis*; corresponding to the Senglacial of Denmark.
- *Middle Flandrian (Assise de Calais)*: between 0 and -15 m and with faunal assemblage similar to the present (*Zirphaea crispata*, *Ostrea edulis*); corresponding to *Littorina* and *Tapes* phase.
- *Upper Flandrian (Assise de Dunkerque)*: about sea level with present fauna (*Mya arenaria*); corresponding to the *Mya arenaria* phase.

The identity of the *Oostende series* is based on *Corbicula fluminalis* which occurs in situ as well as the presence (in several borings, Oostende, Coquelles, Calais) at the upper limit of these series of a "loam or peat layer between -15 m and -20 m depth, inferring a standstill in the positive trend of the Flandrian transgression, viz. a short negative one".

The identity of the Dunkerque series was based on the presence of a gallo-roman peat formation (= surface peat) at its base.

Hereafter, it is DUBOIS (1930) himself who will change the chronologic meaning of his original "Flandrien", a concept which he is still advocating in 1946. Hereby and in the line of thought of DEPERET, the "Flandrien" is considered as the fifth aggradation phase following on the Monastirian, and thus of full Last Glacial in age. This Flandrien should have lasted from 50,000 B.C. till about 6000 B.C. Hence the subdivision of the "Flandrien" s.l., is as follows: "Assises d'Ostende", de Calais (= Flandrien s. str.), "de Dunkerque"; but as is stated by DUBOIS (1946) it most probably will be necessary to extend the "Assise d'Ostende" again, towards the base of the "Flandrien s.l." as our knowledge about it will have grown in the future.*

It is finally the meaning of BRIQUET which dominates most the French "Flandrien" investigators. However, on the French geological maps of the northern French coastal plain, the "Flandrien" is subdivided into Calais and Dunkerque.

2.3 The end of the Flandrian in the Flanders

In Belgium there was some reaction too; in 1931, at the occasion of some new cored borings near the French border which HALET was lucky to study, he also vigorously attacked the concept of DUBOIS' Flandrian and rejects entirely the idea of any possible subdivision, quoting that the peat horizon at the limits between the Oostende-Calais and Calais-Dunkerque series are not continuous and that several peat horizons are found to exist below the main peat at the base of the Dunkerque series.

* see page 30

As a consequence, an Upper pleistocene Flandrian age was proposed again for all marine sands, Oostende and Calais, below the main peat layer; a holocene age for all those above the peat.

One should remember that in the Belgian Geological Legend, all former connotations including the Flandrian were abolished since in December 1922, Pleistocene and Holocene were introduced instead of "Quaternaire" and "Moderne".

It clarifies why in a series of short notes about findings of *Corbicula fluminalis* at St.-Denijs-Westrem (1933), Templeuve (1937) and Escanaaffles (1939) HALET will never mention the name of Flandrian again.

TAVERNIER uses the term Flandrian again, first in the sense of RUTOT, in his publication on periglacial phenomena (1940), later in a combined RUTOT — DUBOIS — HALET definition as of 1943 when describing the deposits of the Flandrian transgression. For the first time, a relation is established between the Flandrian and the Upper-Holocene, more especially with the Atlanticum as to the age of this transgression.

In the same line of thought, the main peat layer was considered to be Subboreal, and the Dunkerque transgression, Subatlanticum in age.

The peat at depth separating the Flandrian deposits from the underlying deposits with *Corbicula fluminalis* is accounted for Boreal in age. TAVERNIER introduced Upper Flandrian to designate all sediments of Post-Glacial Holocene age and Lower Flandrian for all Würm-Glacial sediments.

Deposits with *Corbicula fluminalis* then belong in TAVERNIER's opinion to the Riss-Würm or Eemian marine transgression, as well as their continental equivalents (1943).

In 1946, however he rejects his own earlier opinion in considering the "Assise d'Ostende" with *Corbicula fluminalis* as an interstadial of the Würmian, including all deposits of the Flemish Valley.

Thus he returns to DOLLFUS' interpretation where "Oostende" of Würm interstadial age almost equals "Quaternaire inférieur", "Calais" of Holocene age, the "Quaternaire supérieur" and separated from the Würm deposits by the intercalated loam layers of Late Glacial age ("= Tardiglaciaire). It is the first reappearance in Belgium of the term "Calais".

As of now, Calais will only be used to assign deposits of the Flandrian transgression equal to the *Littorina littorea* transgression of the Baltic. The Dunkerque deposits (TAVERNIER 1948) will not be included to the Flandrian, thus going back to RUTOT and HALET. The first subdivision into three phases of the Dunkerque transgression is announced.

The importance of TAVERNIER's work refers to the definite and undubious separation of the Oostende, Calais and Dunkerque deposits.

The Oostende series will further develop from Würm Interstadial (1946, 1948) to Eem interglacial (TAVERNIER 1954, 1957), the Calais series to deposits of the Flandrian Atlantic transgression and the Dunkerque series, to deposits of the Dunkerque, Subatlantic transgression.

2.4 The International "Flandrian"

In his famous book "Dating the Past", ZEUNER (1946) recommends the use of "DUBOIS' term, Flandrian, for the rise of the sea from the low level of the Last Glaciation to the comparatively high level of the present day ...". It extends from slightly before the Post-Glacial till Present.

WRIGHT (1937) also refers to DUBOIS' definition in the third edition of his book "The Quaternary Ice Age": "In 1924 DUBOIS described under the formational name Flandrian a series of deposits lying mainly below sea level and forming the maritime plain of Flanders, and these deposits have recently been shown by CHAPUT (1928) to have a wide distribution along the whole Atlantic coast of France. The surface of the plane rises 3-4 metres above mean sea-level, and the base of the deposits rests on Cretaceous or Tertiary beds at a depth of 20-30 metres".

WRIGHT also remembers to DUBOIS' subdivision into a Lower, Middle and Higher Flandrian without referring to the Oostende, Calais and Dunkerque.

FLINT (1957) in his "Glacial and Pleistocene Geology" remembers to the use in Europe of the name Flandrian to connote "sediments deposited by the marine transgression that has accompanied the last major deglaciation" (cfr. DUBOIS 1924 and 1930).

WEST (1968) clearly separates the chrono- and litho-stratigraphic term which is the Flandrian from the connotation Late Weichselian, while he also uses it commonly for continental and marine deposits.

We could go on to report on the use in the Anglo-Saxon literature, but one is already convinced that the need of such stratigraphic term was felt world-wide.

At the moment the term was launched in the Anglo-Saxon literature, it was rejected in its type-area, the Flemish (French-Belgian-Dutch) coastal plain. The French investigators continue to use it in different ways: either in the sense of BRIQUET, or in the meaning of Holocene deposits or still as the equivalent of the postglacial transgression (TERS 1973).

WOLDSTEDT never mentions it in his famous works "Das Eiszeitalter" (1954) and "Quartär" (1969), nor do the German holocene, marine investigators as a whole.

In the Netherlands where marine Holocene deposits build up to major part of the Western part of the country, "Flandrian" was used for the last time by BENNEMA in 1954.

In the meantime, Calais and Dunkerque series were commonly used by the Soil Survey Centre of Belgium under impulse of TAVERNIER, ever since 1948. From here, the two terms gain the Dutch holocene again and was officialized by DE JONG & HAGEMAN 1960 in the official legend of the Geological Map of The Netherlands.

As a creation from the same author, the Holocene North Sea Formation was presented to the members of the Holocene Commission of INQUA in 1970. It comprises three members: Calais, Dunkerque and Holland Peat member.

Renewed investigation lead to the recognition of at least five Calais and four Dunkerque levels, separated one from another by a level of the Holland peat (HAGEMAN 1960, JELGERSMA 1961, WIGGERS 1962, ROELEVELD 1974).

New investigation in the Calais region (SOMMÉ 1972, et al.), and the Belgian Flemish

coastal plain (PAEPE 1971, 1974 and BAETEMAN 1974) lead to the same conclusions about the existence of several sedimentary phases, which results fit observations of N. W. Germany (SINDOWSKI & STREIF 1974) and N. W. England (TOOLEY 1974).

3 The Flandrian Problem

3.1 The confusion about the Flandrian first results from the fact that this term is used in the Anglo-Saxon world to indicate the post-glacial deposits solely while in DUBOIS' opinion it started already at the end of the Pleistocene. Hence there is a chrono-stratigraphic confusion about its world-wide use at the present. If the Flandrien were to be limited to the Holocene, then the Pleistocene-Holocene boundary has to be reconsidered first (MORNER 1969).

3.2 In the sense as described above there is also a litho-stratigraphic confusion, for the "Oostende series" do not belong to the same cycle of sedimentation or even sea level rise as the "Calais" and "Dunkerque". PAEPE et al. (1971, 1972, 1973) have shown the existence of periglacial deposits with frost-wedges and cold peat in between the "Dunkerque series" and the "Oostende series" at Brugge, Meetkerke and Oudenburg in the Belgian Coastal plain.

In the Oostende series, *Tapes senescens* var. *eemiensis* and *Corbicula fluminalis* were found in situ (bivalves) in wad deposits overlying older coversands. Earlier PAEPE (1965) had discovered the first bivalve of *Tapes senescens* var. *eemiensis* in a boring at Stalville nearby Oostende.

All these findings have been confirmed by many other authors (DEMOOR 1970, 1972, NOLF 1974, GULLENTOPS et al. 1974). Therefore the Flandrien deposits are limited towards the base, by the lower boundary of the Calais deposits. This lower limit must thus be ascertained and it very much seems that in the Calais area, there are Calais sediments prior to Calais.

3.3 In the Belgian and French coastal plain, there is usually a thick main peat layer (as in the Calais area) between the "Calais" and "Dunkerque" series. We know that the peat growth started about 4500 B.P. and ended somewhat about 2500 B.P. in the Belgian Coastal Plain. Clay lenses occur in this peat occasionally. Recent studies in the Coastal Plain however revealed the existence of prominent clastic horizons subdividing the peat in phases similar to the ones found in the Netherlands and Germany. ^{14}C datings seem to coincide in different parts of the Coastal Plain and also show several phases of Calais and Dunkerque which do not appear in the 4500–2500 B.P. peat.

As a consequence we are favourable to the idea of a continuous sea level rise from the base of Calais towards the top of the Dunkerque. We propose to call this the Flandrian.

3.4 The reason of major litho- and chrono-stratigraphic confusion is due to the fact that the paleo-geographic distribution of the Oostende, Calais and Dunkerque series was

not known precisely for long. In some area's Calais deposits with *Corbicula* and *Tapes* are found from the main peat down to the Tertiary substratum.

In other places, as in Oostende, part of the non-eroded Oostende series with *Corbicula* and *Tapes* in situ, are found below the Calais. When peat or other marker layers do not occur along the boundary, it is difficult to disentangle the two facies.

3.5 The redefinition of the Flandrian should not impose any frustration. Numerous are the redefinitions of geological connotations in the pre-quaternary and we know that Eemian changed a lot before its present content became established.

Therefore, rather than introducing new names, we prefer "Flandrian" to "Holocene North Sea formation".

Flandrian not only has stratigraphic priority to redefinition but also originated from a geological tradition in the study of the Cenozoic formations of North Western Europe and of Belgium in particular. Indeed, after the retreat of the Tertiary North Sea from Southwest to Northeast Belgium (Diestian to Merksemian), Quaternary seas remained for long in the Northeast along the Dutch-Belgian border throughout the Tiglian, and Waalian.

Hereafter the retreat towards the northeast came to an end and marine activity became more important in the very southern part of the North Sea, as a direct consequence of the opening of the Dover Strait somewhere during the Cromerian (PÆPE & SOMMÉ 1975).

The tradition switched over to transgression from the south-west resulting in the building up of Cromerian, Holsteinian, Eemian and finally Flandrian deposits in the Flemish coastal plain of France, Belgium and the Netherlands, which continuation is found in Holland, Friesland, N-W-Germany and Danmark. Flandrian is the last in the tradition of at least five known southwest North Sea transgressions.³

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³ The term transgression is used here in its original meaning which points at an increase in geographical extension as a result of displacement of the shoreline.

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Maps

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Addendum to page 23:

In 1930, BRIQUET referring to the definition of 1896 on the Belgian Geological Legend, pleads in favour of preserving Flandrian to all marine deposits of the coastal plain beneath the main peat layer level. Actually, he distinguished a major break at this level in the positive post-glacial sea level rise, pleading in favour of a distinction between Flandrian and Dunkerquian transgressions and sediments. With regard to the absolute age, the Flandrian is post-glacial which he believes to have started about 7,000 y. ago when compared with the Litto vina transgression of the Baltic; the Dunkerquian transgression would have started only in the IVth century after the Roman occupation.

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